SUSSEX COUNTY ENGINEERING DEPARTMENT
Sussex County, Delaware

A Regional Planning Report to Assess a Joint Sussex County/City of Rehoboth Land Application Project

October 2009 – FINAL DRAFT

WHITMAN, REQUARDT & ASSOCIATES, LLP

in association with

STEARNS & WHELER LLC
Environmental Engineers and Scientists

A REGIONAL PLANNING REPORT TO ASSESS A JOINT SUSSEX COUNTY/CITY OF REHOBOTH LAND APPLICATION PROJECT

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EX-1 BACKGROUND

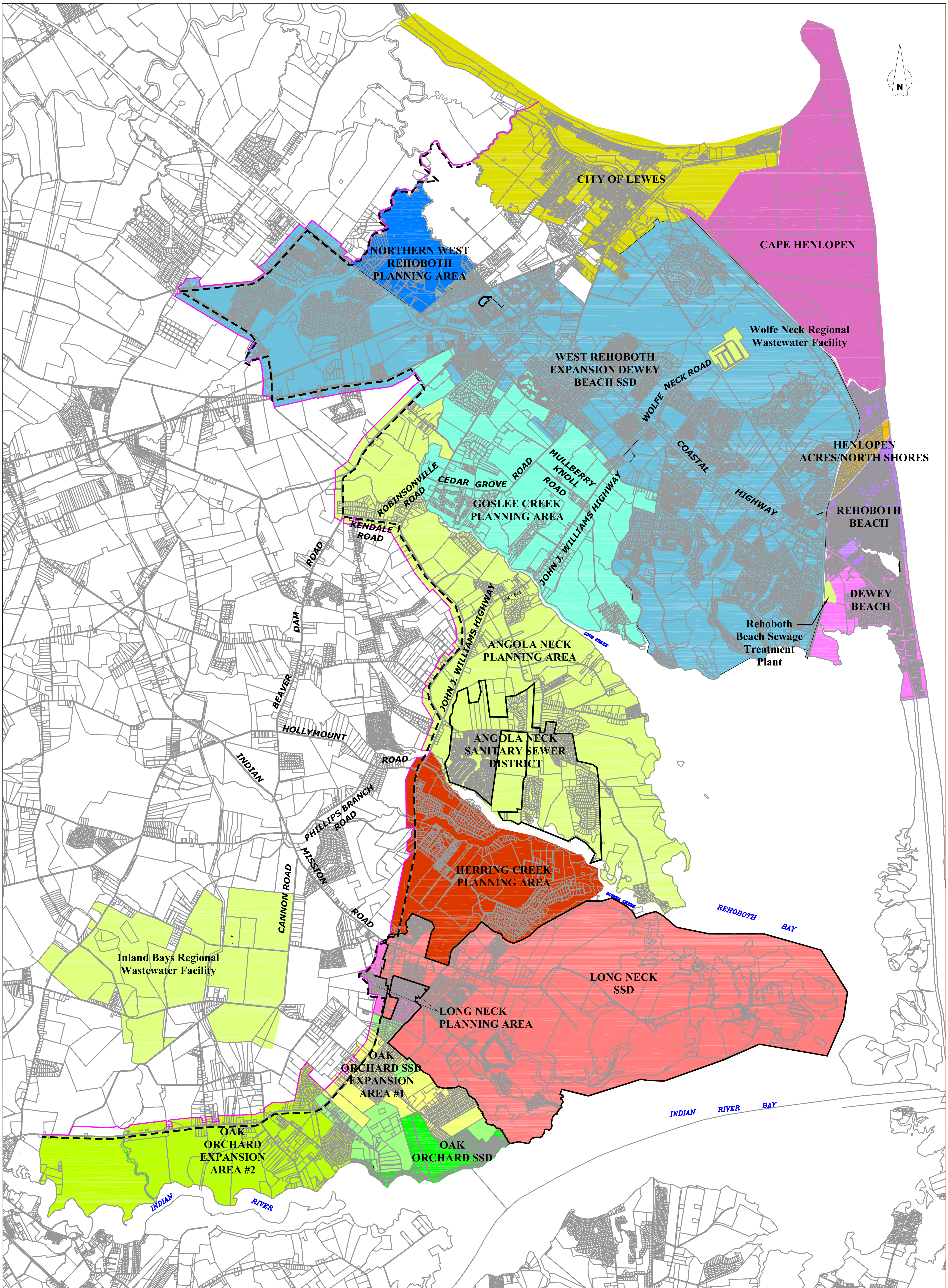
The City of Rehoboth Beach currently owns and operates the Rehoboth Beach Sewage Treatment Plant (RBSTP), which treats and disposes of wastewater into the Lewes-Rehoboth Canal. The Delaware Department of Natural Resources and Environmental Control (DNREC) and the City of Rehoboth have entered into a Consent Order to eliminate this discharge into the Lewes-Rehoboth Canal by 2014. The RBSTP currently serves the City of Rehoboth as well as the following County areas:

- Dewey Beach
- Henlopen Acres
- North Shores

Sussex County currently owns and operates both the Wolfe Neck Regional Wastewater Facility (WNRWF), and the Inland Bays Regional Wastewater Facility (IBRWF). These are both spray irrigation facilities. The WNRWF currently serves the West Rehoboth Expansion of the Dewey Beach Sanitary Sewer District. The IBRWF currently serves the Long Neck and Oak Orchard Sanitary Sewer Districts. Future service is being planned for various other planning areas within the overall Inland Bays Planning Area. The location of the RBSTP, WNRWF, IBRWF and the various districts and planning areas within the overall Inland Bays Planning Area are indicated on Figure EX-1.

EX-2 PURPOSE

The purpose of this report is to review options for a joint Sussex County/City of Rehoboth Beach Land Application Project in which the City of Rehoboth will send either raw wastewater or treated effluent to the County for treatment and disposal via land application at either the WNRWF or the IBRWF or some combination thereof.



LEGEND

- Inland Bays Planning Area Boundary
- Environmentally Sensitive Development Area
- Sanitary Sewer District Boundary

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Figure EX-1
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Alternatives implementing the use of a Private Wastewater Provider (PWWP) or combined ocean outfall have also been examined.

EX-3 ALTERNATIVES EVALUATED

There are seven possible alternatives being considered by the County to handle the wastewater in the NCPA and from the City of Rehoboth Beach. The possible solutions can be grouped into four general treatment and disposal alternatives:

- **Alternative 1A/1B:** The RBSTP shuts down and sends all of its raw wastewater to the WNRWF, which will treat as much wastewater as possible and send the excess to another facility to be treated. The excess wastewater will be treated by the County owned and operated Inland Bays Regional Wastewater Facility (Alt 1A) or a private wastewater provider (Alt 1B).

- **Alternative 2A/2B**: The RBSTP remains in service and sends its treated effluent to the WNRWF for disposal via spray irrigation. A reduced amount of WNRWF influent wastewater from its service area will continue to be treated at that facility, with all excess being sent to either to the Inland Bays Regional Wastewater Facility (Alt 2A) or a private wastewater provider (Alt 2B).

- **Alternative 3**: The RBSTP remains in service and discharges treated effluent via an ocean outfall. In this scenario, the County will continue treating and disposing wastewater via land application at its existing facilities. The WNRWF will remain in service and continue treating and disposing wastewater from its service area. Any excess flow to the WNRWF above the capacity of the facility will be sent to the IBRWF for treatment and disposal.

- **Alternative 4/4B**: The RBSTP remains in service and discharges treated effluent via an ocean outfall. The County continues to treat wastewater via land application at the WNRWF. The WNRWF will expand and upgrade its treatment capacity. Treated wastewater that exceeds the WNRWF disposal capacity will be pumped to the Rehoboth ocean outfall for disposal. Alternative 4 is based on 2030 maximum month flows. For cost sharing purposes, Alternative 4B is based on buildout maximum month flows.

EX-4 COST SHARING MODEL

A cost sharing model was developed for each alternative. This model was developed by estimating the initial capital costs, the project costs and contingencies, contract service costs associated with the private wastewater provider option and the long term operation and maintenance costs for each of the alternatives. Table EX-1 on the following page provides a summary of the resulting County/Rehoboth Costs, as well as the anticipated Rehoboth User Rates for each alternative. Table EX-2 provides the anticipated impacts to the County users.

Table EX-2 : Impacts of Alternatives on County Rates

	Dewey Beach User Rates		Henlopen Acres User Rates		City of Rehoboth Beach User Rates	
Alternative	Existing Rate	New Rate (1)	Existing Rate	New Rate (1)	Existing Rate	New Rate (2)
#2A	$350	$770	$588	$1,460	$325	$1,010
#2B	$350	$1,210	$588	$1,750	$325	$1,420
#3	$350	$540	$588	$1,030	$325	$630
#4	$350	(3)	$588	(3)	$325	$550
#4B	$350	(3)	$588	(3)	$325	$550

Notes:
(1) New rates have been rounded to the nearest $10 and are based on a 40 year loan at 5%,
(2) New rates have been rounded to the nearest $10 and are based on a 20 year loan at 4.4%,
(3) Not evaluated to date

Table EX-1: Impacts of Alternatives on City of Rehoboth User Rates (1) (2)

Alt.	Description	Total Project Cost ($ M)	County Cost Share ($ M)	Rehoboth Cost Share ($ M)	Annual Capital Cost - Rehoboth	Annual Maintenance Cost-Rehoboth	**Rehoboth User Rates**
#1A	Raw Wastewater Pumped to WNRWF with Disposal at IBRWF	$112	$44	$68	$2,900,000	$1,500,000	$1,160
#1B	Raw Wastewater Pumped to WNRWF with Disposal at Private Service Provider	$100	$50	$50	$2,100,000	$3,300,000	$1,430
#2A	Treated Effluent Pumped to WNRWF with Disposal at IBRWF	$103	$48	$54	$2,300,000	$1,500,000	$1,010
#2B	Treated Effluent Pumped to WNRWF with Disposal at Private Service Provider	$91	$54	$37	$1,600,000	$3,800,000	$1,420
#3	Rehoboth Pumps to Ocean Outfall Alternative with County Pumping to IBRWF	$94	$64	$30	$1,300,000	$1,100,000	$630
#4	Rehoboth and County Pump to Common Outfall with County Continuing to use IBRWF for Southern Service Area (2030 Max. Month)	$87	$64	$23	$1,000,000	$1,100,000	$550
#4B	Rehoboth and County Pump to Common Outfall with County Continuing to use IBRWF for Southern Service Area (Buildout Max Month)	$87	$68	$19	$800,000	$1,100,000	$500

Notes:

(1) All annual capital costs, maintenance costs, and users rates are based on 4.4% for 20 years.

(2) All total project costs, annual costs and user rates are rounded to the nearest $1M, $0.1M, and $10 respectively.

EX-5 EVALUATION OF ALTERNATIVES

It was not the intent of this study to recommend one specific alternative, but rather provide the information which could be used as a part of the overall decision process. There are other non-economic, public perception, and regulatory issues that could influence the final outcome. Rather the intent is to provide a basic summary of pros and cons for each alternative, primarily on a cost basis. Based on the analysis performed the following observations can be made regarding potential City of Rehoboth costs:

- A public/private partnership with a PWWP (Alt 1B or 2 B) does not appear to be cost effective as compared to other alternatives.
- Alternative 2A (Treated Effluent) is the most cost effective spray irrigation alternative.
- Both ocean outfall alternatives and appear to be more cost effective than the spray alternatives, with the combined City/County outfall (Alt 4/4B) being the most cost effective.

For the County, the costs of for a combined ocean outfall (Alternative 4/4B) verses conveyance and treatment/disposal at the IBRWF (Alternative 3) are essentially equal. Factors that should be considered include:

- Alternative 4 would appear to be lower operation and maintenance for energy and force main maintenance issues.
- The County has already made a capital investment in land at the IBRWF. Depending on future flows per equivalent dwelling unit (EDU). If Alternative 4/4B is implemented, the County may have excess land, which could potentially be used to provide sewer service to new areas or partner with other entities.

- Alternative 4/4B would likely be a more reliable treatment option. Factors such as weather and variable soil conditions introduce higher uncertainties for spray irrigation.
- Alternative 4/4B would provide the County with multiple methods of disposal (land disposal and ocean discharge).
- Future upgrades beyond the current 20 year planning period will likely be higher for Alternative 3 as compare to Alternative 4/4B.

1. INTRODUCTION

1.1 BACKGROUND

The City of Rehoboth Beach currently owns and operates the Rehoboth Beach Sewage Treatment Plant (RBSTP), which treats and disposes of wastewater into the Lewes-Rehoboth Canal. The Delaware Department of Natural Resources and Environmental Control (DNREC) and the City of Rehoboth have entered into a Consent Order to eliminate this discharge into the Lewes-Rehoboth Canal by 2014. The RBSTP currently serves the City of Rehoboth as well as the following County areas:

- Dewey Beach
- Henlopen Acres
- North Shores

Sussex County currently owns and operates both the Wolfe Neck Regional Wastewater Facility (WNRWF), and the Inland Bays Regional Wastewater Facility (IBRWF). These facilities treat and dispose of wastewater from the following existing Sanitary Sewer Districts within the Inland Bays Planning Area via land application:

- West Rehoboth Expansion of the Dewey Beach Sanitary Sewer District
- Long Neck Sanitary Sewer District
- Oak Orchard Sanitary Sewer District

Immediate service (within the next 2 years) is being planned for the following areas within the Inland Bays Planning Area:

- Oak Orchard Expansion Area #1
- Angola Neck Sanitary Sewer District

Future service is being planned for the following planning areas within the overall Inland Bays Planning Area:

- Herring Creek
- Angola Neck
- Northern West Rehoboth
- Long Neck
- Oak Orchard Expansion Area #2
- Goslee Creek

The location of the RBSTP, WNRWF, IBRWF and the various districts and planning areas within the overall Inland Bays Planning Area are indicated on Figure 1.1-1.

1.2 PURPOSE OF REPORT

The purpose of this report is to review options for a joint Sussex County/City of Rehoboth Beach Land Application Project in which the City of Rehoboth will send either raw wastewater or treated effluent to the County for treatment and disposal via land application at either the WNRWF or the IBRWF or some combination thereof. Alternatives implementing the use of a Private Wastewater Provider (PWWP) or combined ocean outfall have also been examined. This report is being coordinated with a separate report being performed by the City of Rehoboth entitled "The Rehoboth Beach Wastewater Treatment Plant Alternative Discharge Cost Evaluation", herein referred to as the "Rehoboth Beach Alternative Discharge Evaluation".

1.3 SCOPE OF WORK

This report will address the following issues:

1) Analysis of the operating data for the RBSTP over the past three years (2006 though 2008).

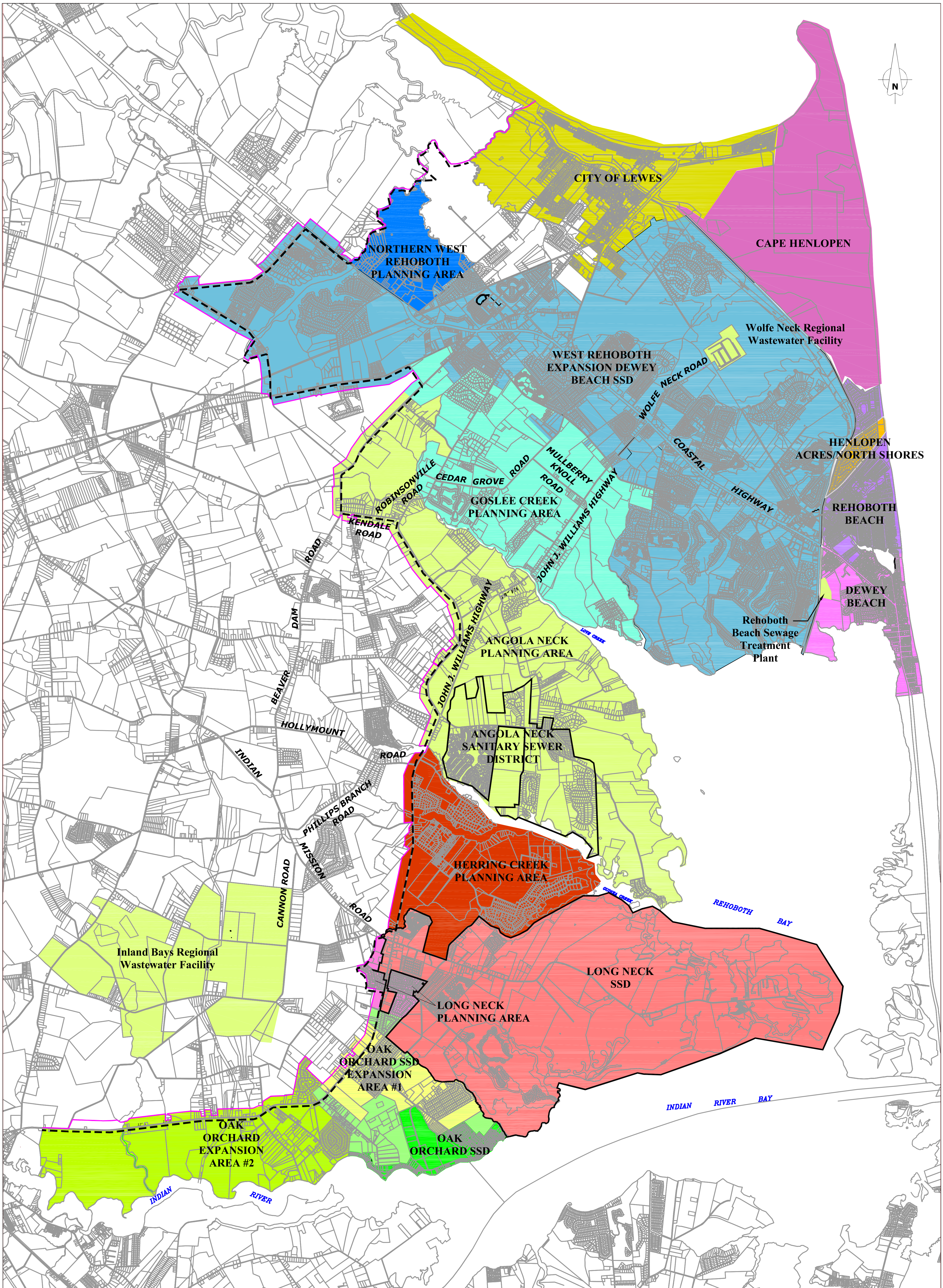

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Figure 1.1-1
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2) Estimate of future wastewater flows and loads from the RBSTP, including an estimate of the flow rate to be pumped to the WNRWF for treatment and disposal.
3) Assessment of the conveyance system required to convey flows from the RBSTP to the WNRWF, including pumping station and force main sizes, force main alignments, as well as preliminary costs.
4) Assessment of the improvements necessary at the WNRWF to accept flow from the RBSTP, including preliminary costs.
5) Assessment of the conveyance system required to convey flows from the WNRWF to the IBRWF, including pumping station and force main sizes, force main alignments, as well as preliminary costs.
6) Analysis of spray irrigation disposal capacities at both the WNRWF and IBRWF, including a timeline for future expansion at IBRWF, as well as estimated costs to perform additional hydrogeological and soils tests required.
7) Assessment of the impacts on future plant expansions at the WNRWF and IBRWF based on accepting flow from the RBSTP.
8) Development of a cost-sharing model to determine impact costs to each entity.
9) Analysis of private wastewater options in order to compare capital costs for the use of a private wastewater provider.

2. REHOBOTH BEACH FLOWS AND LOADS

The following chapter provides an overview of the existing Rehoboth Beach Sewage Treatment Plant (RBSTP), reviews historical flowrates and provides future flow and nutrient loading projections.

2.1 FACILITY SUMMARY

The RBSTP is owned and operated by the City of Rehoboth Beach. The facility is located at 20543 Roosevelt Street, on the bank of the Lewes-Rehoboth Canal.

The facility features an oxidation ditch system to achieve biological nutrient removal and is disinfected via a chlorine contact tank; final effluent is discharged into the Lewes-Rehoboth Canal. In addition to the City of Rehoboth Beach, the treatment plant services County customers from the areas of Dewey Beach, Henlopen Acres, and North Shores. The treatment facility was designed to treat a maximum month flow of 3.4 mgd. The City has an agreement with Sussex County to allocate 1.1 mgd of this for the Dewey Beach Sanitary Sewer District (DBSSD) and 0.075 mgd for the Henlopen Acres Sanitary Sewer District (HASSD) on a maximum weekly average basis.

The RBSTP operates under State Permit No. WPCC 3084D/74, which is effective until September 20, 2010. The permit stipulates daily average and daily maximum effluent concentration limits for BOD_5, TSS and enterococcus coliform. A summary of the permitted parameters is shown in Table 2.1-1.

Table 2.1-1: RBSTP Permit Summary

Parameter	Value
BOD_5	19 mg/L Daily Average 29 mg/L Daily Maximum
TSS	15 mg/L Daily Average 23 mg/L Daily Maximum
Enterococcus Coliform	10 colonies/ 100 mL
Total Residual Chlorine	None Detectable
pH	6.0 Minimum 9.0 Maximum

Note:
1. State Permit No. WPCC 3084D/74, Expiration Date: September 20, 2010.

In addition to the effluent limits listed in Table 2.1-1, the permit indicates that the total nitrogen (TN) discharged shall not exceed 24,300 lbs/yr and the total phosphorus (TP) discharges shall not exceed 5,308 lbs/yr. These loading rates are equivalent to a TN concentration of 2.35 mg/L and a TP concentration of 0.51 mg/L at the maximum month design capacity.

The 2.35 mg/L TN concentration is below the commonly accepted limit of technology; it is part of the consent order in effect until the RBSTP is required to stop discharging into the Lewes- Rehoboth Canal. The Delaware DNREC recently established Total Maximum Daily Loads (TMDLs) for the Inland Bays. The TMDL is described in the Delaware Pollution Control Strategy titled, "Regulations of the Pollution Control Watersheds, Delaware," dated November 2008. As part of these TMDLs, the RBSTP must stop discharging to the Lewes-Rehoboth Canal by December 31, 2014. These TMDLs will no longer apply when the RBSTP stops discharging into the canal and conveys flow for spray irrigation disposal or to an ocean outfall.

Available flow and loading data for the RBSTP were analyzed to asses the current influent conditions and estimate future loads. Influent flows are assumed to be equal to effluent flows because no influent data were available. Population projections and wastewater characteristics were used to estimate wastewater flows and loads which served as the basis for design in evaluating operational alternatives.

For this study, the years from 2005 through 2008 were evaluated. 2005 was included as a representation of a high flow year, either from population flux or weather patterns. Plant data are included in Appendix A.

2.2 CURRENT FLOWS

The wastewater treated at the RBSTP comes primarily from domestic and commercial sources (e.g., retail stores and restaurants). Wastewater is conveyed to the treatment facility by four force mains; two from the City of Rehoboth Beach and two directly from the DBSSD. Wastewater from HASSD and North Shores are conveyed to the RBSTP through the City of Rehoboth Beach's collection and conveyance system. Despite treating wastewater from three other districts, the City of Rehoboth Beach contributes the majority of the wastewater. Figure 2.2-1 shows the total flow for the RBSTP, Figure 2.2-2 shows the flows of the individual contributing entities.

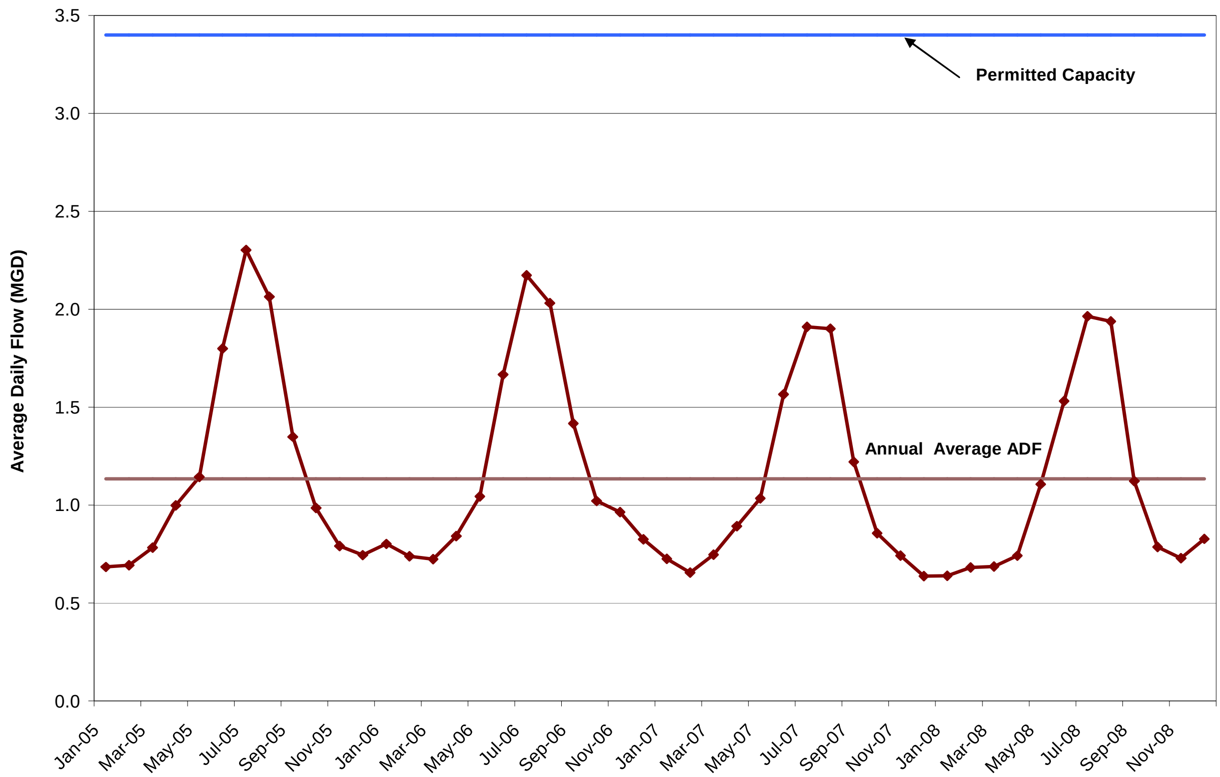


Figure 2.2-1 RBSTP Monthly Average Influent Flow (2005-2008)

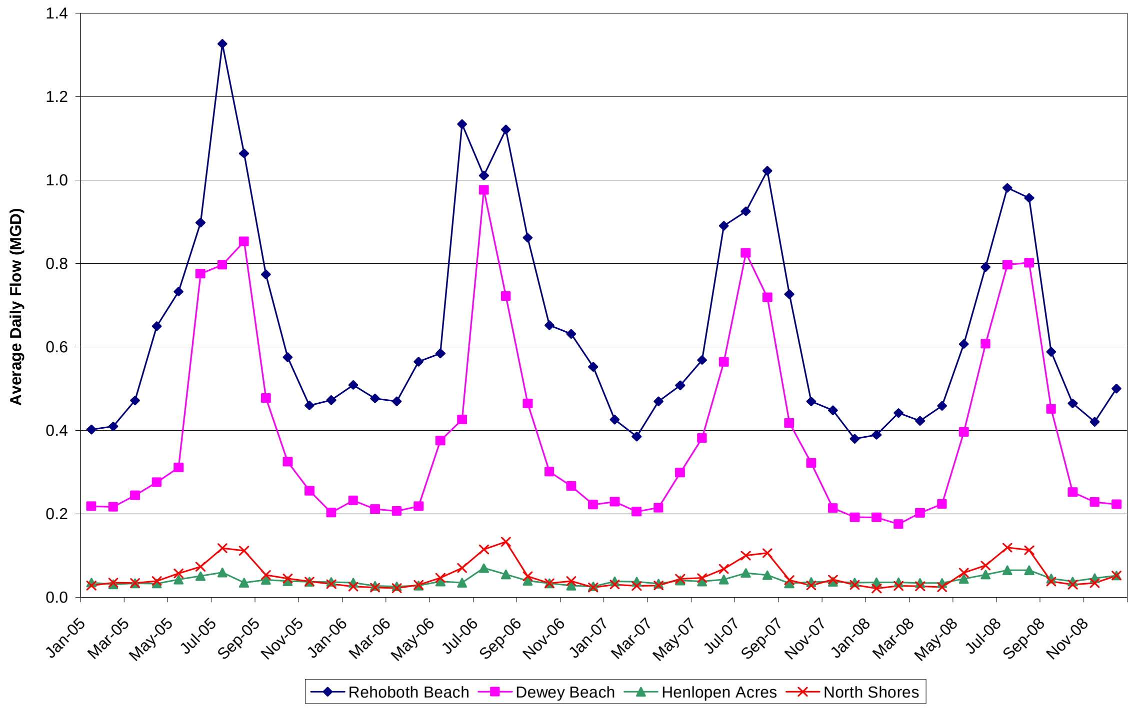


Figure 2.2-2: Individual Monthly Average Flows from Contributing Entities (2005-2008)

The maximum month ADF over the period of analysis was 2.3 mgd and occurred in July 2005. Monthly flow data dating back to 1988 was examined and the July 2005 flow was exceeded only once over this period (July 2000). Table 2.2-1 shows the average flow contribution for each of the contributing entities.

Table 2.2-1: Average Flows from Contributing Entities

Entity	Four Year Average Flow(1) (mgd)	Max Month Average Flow(2) (mgd)	Contributing EDUs	Max Month gpd/ EDU
City of RB	0.65	1.3	Not Available	N/A
DBSSD	0.39	0.80	3,612	224
HASSD	0.04	0.06	205	298
North Shores	0.05	0.12	Not Available	N/A
Total	1.1	2.3	Not Available	N/A

Notes:
1. The period of study includes 2005 through 2008.
2. July 2005 flows were shown. This was the maximum month flow over the 4 year period of review.

As shown in Table 2.2-1, the City of Rehoboth Beach currently contributes about 57% of the flow to the RBSTP.

Each year, there has been more than twice as much influent wastewater flow during the summer (defined as June, July and August) as compared to the winter (defined as December, January and February). Table 2.2-2 summarizes the seasonal flows; Table 2.2-3 summarizes the seasonal flow ratios.

Table 2.2-2: RBSTP Seasonal Monthly Influent Flowrates

Year	Max Month ADF (mgd)	Summer ADF (mgd)	Winter ADF (mgd)	Annual ADF (mgd)
2005	2.3	2.1	0.69	1.2
2006	2.2	2.0	0.77	1.2
2007	1.9	1.8	0.73	1.1
2008	2.0	1.8	0.65	1.1
Average	**2.1**	**1.9**	**0.72**	**1.1**

Note:
1. Winter is defined as December, January, February; summer is defined as June, July, August.

Table 2.2-3: RBSTP Seasonal Flow Ratios

Year	Summer / Winter Ratio	Max Month / Annual Ratio	Max Month / Summer Month Ratio
2005	3.0	1.9	1.1
2006	2.5	1.8	1.1
2007	2.4	1.8	1.1
2008	2.8	1.8	1.1
Average	**2.7**	**1.8**	**1.1**

Note:
1. Winter is defined as December, January, February; summer is defined as June, July, August.

The seasonal nature of the flow is attributed to the service area's close proximity to popular vacation coastline. The majority of the residents live in the area only during the summer months and on weekends in the spring and fall. As a result, significantly larger average wastewater flows are received during the summer months compared to the rest of the year. Due to the seasonal nature of this community, the summer average and summer maximum flows were examined to determine the current operating state of the facility and to estimate future operating conditions.

2.3 PROJECTED FLOWS

Equivalent dwelling units (EDUs) were used for this analysis instead of the total number of customers because it converts different types of customers (single-family residential, multi-unit residential, institutional, commercial, and industrial) into the equivalent number of single-family residential users. The EDUs were only available for two of the four contributing entities (DBSSD and HASSD). The maximum month flow contribution for the DBSSD and HASSD was 224 gpd/EDU and 298 gpd/EDU, respectively. For planning purposes, 225 gpd/EDU was used to project flow contributions from future EDUs added to the sewage collection system.

To develop growth projections, EDU data from 2003-2008 was analyzed for Dewey Beach and Henlopen Acres. These areas gained a total of 69 EDUs over the time span, approximately 14 EDUs per year. The EDUs added per year was proportionally scaled up to include the entire RBSTP service area. By this method, the annual rate of growth is 0.39%. Table 2.3-1 summarizes the calculations and methodology for future projections; detailed calculations are in Appendix A. Table 2.3-2 summarizes the influent flow projections for 2030 and the ultimate buildout.

Table 2.3-1: Growth Projection Methodology

Growth Determination	
EDUs Gained from HA	5
EDUs Gained From DB	64
Total EDUs Gained 2003-2008	69
EDUs Gained/Year	14
HA & DB Average Annual Flows (MG/yr)	158
Total RBSTP Average Annual Flows (MG/yr)	414
Percent Contribution of HA & DB to RBSTP (%)	38%
Estimated EDUs Gained by RBSTP per Year (Proportional)	37

Notes:

1. Data used for calculations provided by the Sussex County Engineering Department (SCED) and City of Rehoboth Beach.

Table 2.3-2: RBSTP Projected Wastewater Influent Flows

Design Period	Max Month ADF (mgd)	Summer ADF (mgd)(3)	Winter ADF (mgd)(4)	Annual ADF (mgd)
Current	2.30(1)	1.91	0.72	1.10
Year 2030	2.50(2)	2.30	0.93	1.40
Ultimate Design	3.40	3.10	1.30	1.90

Notes:
1. Current Max Month ADF based on July 2005 observed flow.
2. Year 2030 max month ADF based on current max month ADF + 37 EDU/year multiplied by 225 gpd/ EDU.
3. Summer ADF based on applying observed 1.10 average ratio of max month to average summer ADFs from Table 2.2-2 to projected max month ADF.
4. Winter ADF based on applying observed 2.7 average ratio of summer to winter ADFs from Table 2.2-2 to projected summer ADF.

2.4 INFLUENT LOADS

The RBSTP does not regularly sample influent wastewater for pollutants. Because of this, it is not recommended that facility modifications be designed based on the influent wastewater characteristics provided by the treatment plant. Instead, it is recommended that more typical influent wastewater characteristics published in the Metcalf & Eddy Wastewater Engineering design manual be used as the basis for design modifications. The average and maximum month concentrations the design will be based on are summarized in Table 2.4-1.

Table 2.4-1: Influent Concentrations Based on Typical Wastewater Strength

Parameter	Average Month (mg/L)	Maximum Month (mg/L)
BOD_5	190	250
TSS	210	270
TKN	40	52
NH_4-N	25	33
TP	7	9

Notes:
1. Average month characteristics are based on medium strength wastewater characterization as presented in Metcalf and Eddy, 4th Edition Table 3-15.

2. The maximum month to average month constituent loading ratio is expected to be about 1.3:1 (Metcalf & Eddy, Figure 3-8, 4th Edition).

Using the Metcalf & Eddy assumptions for wastewater concentrations, the current and projected influent loadings are summarized in Table 2.4-2.

Table 2.4-2: Design Current & Projected Influent Loads

Design Period	BOD_5 (lbs/day)		TSS (lbs/day)		TKN (lbs/day)		NH_4-N (lbs/day)		TP (lbs/day)	
	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.
Current (2005-2008)	3,700	4,800	4,000	5,200	770	1,000	480	630	130	170
2030 Projected	4,000	5,200	4,400	5,600	830	1,100	520	690	150	190
Ultimate Flow	5,400	7,100	6,000	7,700	1,100	1,500	710	940	200	260

Notes:
1. Average loading based on average concentrations shown in Table 2.4-1 at current max month ADF of 2.3 mgd from Table 2.3-2.
2. Maximum loading rate based on maximum concentrations shown in Table 2.4-1 at current max month ADF of 2.3 mgd from Table 2.3-1.

2.5 CURRENT EFFLUENT PERFORMANCE

The RBSTP is subject to permit limits for conventional pollutants as well as nutrients. The RBSTP has consistently produced a final effluent with concentrations well below the permit requirements. A summary of the reported values for effluent monitored pollutants is presented in Table 2.5-1. Table 2.5-2 summarizes the effluent performance of both conventional and nutrient pollutants for the study period. The seasonal performance of the plant for conventional pollutants is shown in Figure 2.5-1. Complete performance data are provided in Appendix A.

Table 2.5-1: Comparison of Actual Effluent Performance to Permit Limits

Parameter	Permit Limit	Current Value(1)
BOD_5 – Daily Average	19 mg/L	1.7 mg/L
BOD_5 – Daily Maximum	29 mg/L	4.3 mg/L
TSS – Daily Average	15 mg/L	3.2 mg/L
TSS – Daily Maximum	23 mg/L	11.0 mg/L

Notes:
1. Data were provided by the City of Rehoboth Beach. Reported values are a flow weighted average over the period of study (2005-2008).

Table 2.5-2: Current Effluent Performance

Year	BOD_5 (mg/L)	TSS (mg/L)	TN (mg/L)	TP (mg/L)
2005	1.7	3.4	6.0	0.50
2006	1.4	2.8	4.4	0.34
2007	1.6	3.6	5.1	0.38
2008	2.0	3.0	6.0	0.39
Average	1.7	3.2	5.4	0.44

Notes:

1. Data were provided by the City of Rehoboth Beach. Reported values are an annual flow weighted average.

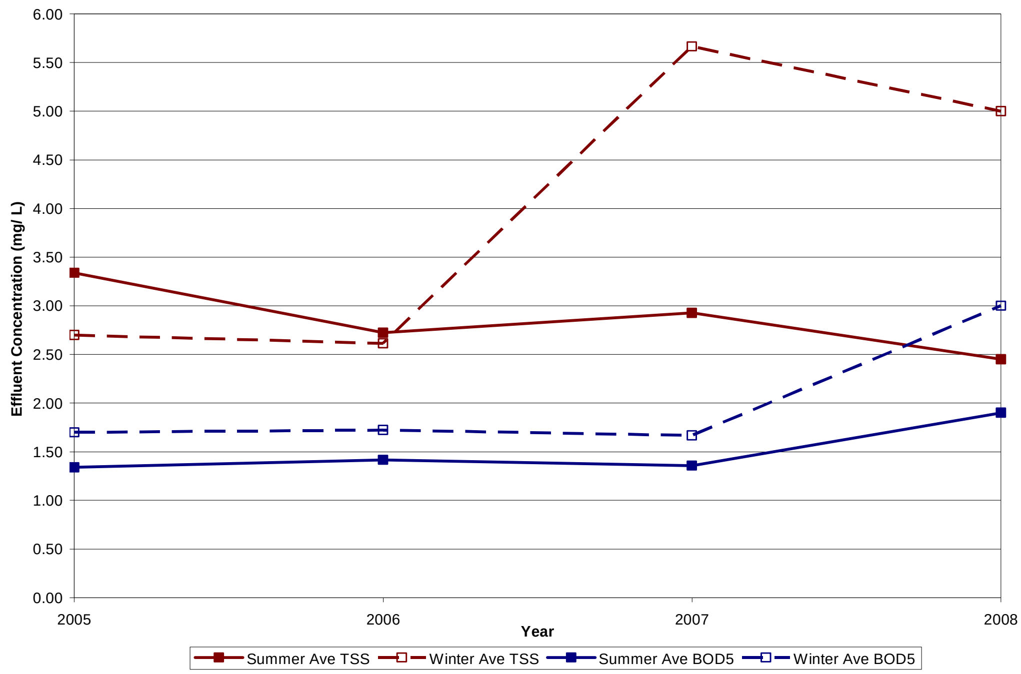


Figure 2.5-1: Seasonal BOD_5 and TSS Effluent Performance (2005-2008)

The effluent BOD_5 concentration is consistently higher in the winter than in the summer; approximately 25% higher in the winter from 2005-2008. While not as consistent, the effluent TSS concentration is generally higher in the winter as well; approximately 29% higher in the winter for the same period. Since the average daily influent flowrate is significantly lower in the winter, it follows that the temperature has a greater impact on the process than the amount of flow.

For total nitrogen and total phosphorus, the facility is required to meet annual loading limits of 24,300 lbs and 5,308 lbs, respectively. The RBSTP has also consistently met these TMDL requirements. The nutrient performance is summarized as annual loading in Table 2.5-3 and seasonal concentrations in Figure 2.5-2.

Table 2.5-3: Effluent Nutrient Performance

Year	Total Nitrogen (lbs/yr)	Total Phosphorus (lbs/yr)
2005	22,000	1,800
2006	15,900	1,400
2007	16,600	1,300
2008	19,400	1,500
Average	18,500	1,500

Notes:
1. Data were provided by the City of Rehoboth Beach.

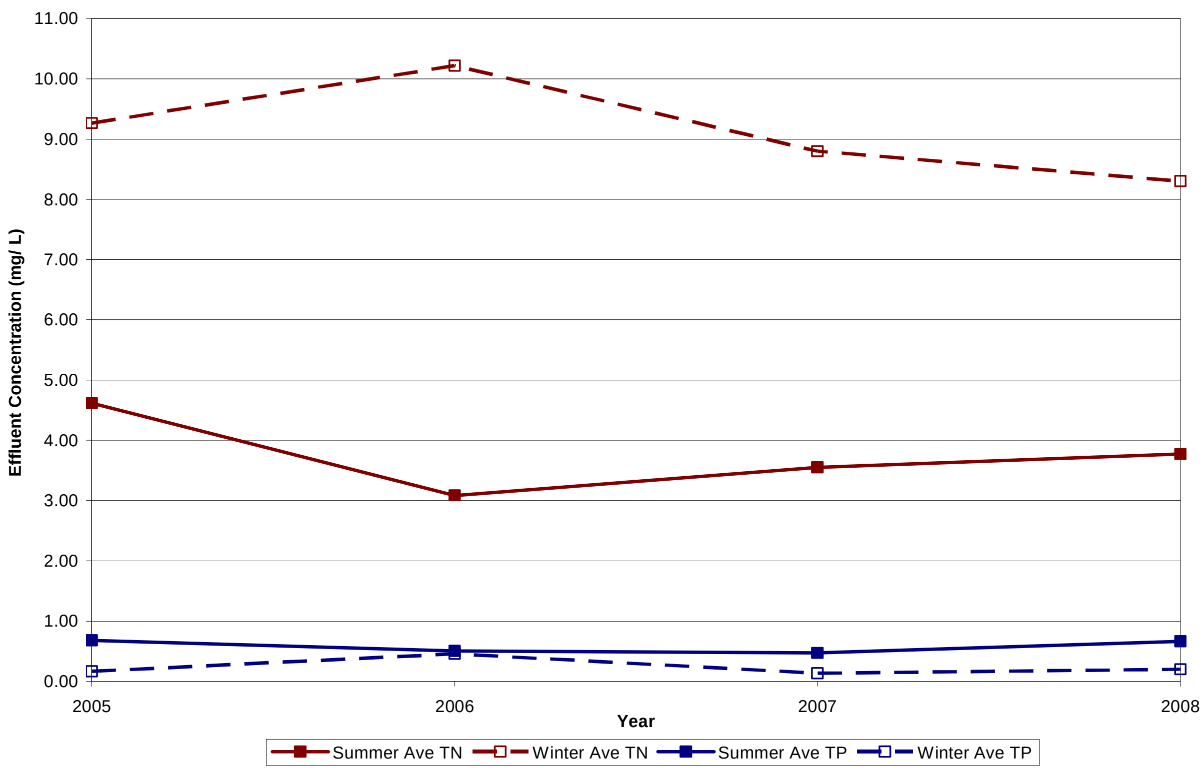


Figure 2.5-2: Seasonal TN and TP Effluent Performance (2005-2008)

Similarly to BOD_5 and TSS, the effluent TN concentration is consistently higher in the winter. This is most likely due to the sensitivity of nitrification to low temperatures. Conversely, the effluent TP concentration is lower during the winter. The process for phosphorus removal is less impacted by low temperatures than nitrogen removal and benefits from a lower flow rate.

2.6 PROJECTED EFFLUENT LOADING

Based on population and flow growth projections, future effluent performance and effluent annual loading were estimated. The RBSTP is expected to continue to perform well at its rated capacity of 3.4 mgd. For planning purposes, effluent concentrations for BOD_5 and TSS are estimated to increase slightly to 8.0 mg/ L and 4.0 mg/L, respectively, at projected 2030 flows. For the land application alternative evaluated in this report, effluent TN and TP concentrations from the RBSTP are estimated to increase under ultimate flows to 10 mg/L and 1.0 mg/L, respectively. Table 2.6-1 summarizes future performance estimations.

Table 2.6-1: Projected Effluent Concentrations and Loading

Design Period	Average Daily Flows (mgd)		Total Nitrogen		Total Phosphorus		BOD_5		TSS	
	Max Month	Annual	Conc. (mg/L)	Annual Loading (lbs/yr)	Conc. (mg/L)	Annual Loading (lbs/yr)	Conc. (mg/L)	Annual Loading (lbs/yr)	Conc. (mg/L)	Annual Loading (lbs/yr)
Current (2005-2008)	2.30	1.10	5.4	18,500	0.4	1,500	1.7	5,900	3.2	10,900
2030 Projected	2.50	1.35	8.0	33,000	1.0	4,100	2.5	10,300	4.0	16,500
Ultimate Flow (Permitted Capacity)	3.40	1.85	10.0	56,000	1.0	5,600	4.0	22,500	6.0	34,000

3. WEST REHOBOTH FLOWS & LOADS

The following chapter provides an overview of the existing Wolfe Neck Regional Wastewater Facility (WNRWF), reviews historical flowrates and provides future flow and nutrient loading projections.

3.1 FACILITY SUMMARY

The West Rehoboth Beach Expansion (WRE) of the Dewey Beach Sanitary Sewer District (DBSSD) is served by the WNRWF. The facility is located at the east end of County Road 270, approximately 1.2 miles east of Route 1 on the former Dodd farm parcel.

The WNRWF includes a headworks, partially mixed aerated treatment lagoons, an effluent storage lagoon, chlorine disinfection, and an effluent spray irrigation system. The facility has a spray irrigation permit (State Permit No. LTS 5005-95-05) issued by DNREC, which allows land application of treated effluent to spray fields.

The facility is permitted to accept up to 4.0 mgd as a monthly average influent flow from May through September and 2.23 mgd as a monthly average influent flow from October through April. The permit states that the average monthly quantity of effluent discharged to the spray irrigation fields shall not exceed 3.1 mgd. The permit also indicates that the weekly effluent applied to the spray irrigation fields shall not exceed 2.6 inches per week for the months of June and September, 2.75 inches per week for the months of July and August, and 2.5 inches per week from October 1 to May 31 with a maximum field application rate of 0.25 inches per hour. A 24-hour rest period is required between applications. The permit prohibits the application of wastewater during periods of rainfall, snowfall and when the ground is frozen. Monitoring requirements include frequency of sampling and sampling procedures for specific groundwater and soil parameters.

The permit stipulates daily average and daily maximum effluent concentration limits for BOD_5, TSS and fecal coliform. A summary of these effluent concentrations is provided in Table 3.1-1.

Table 3.1-1: Key Permit Requirements for Sprayed Effluent [(1)]

Parameter	Value
BOD_5	50 mg/L Daily Average
TSS	90 mg/L Daily Average
Fecal Coliform	200 colonies/100 mL Daily Average
Total Residual Chlorine	1.0 mg/L Minimum 4.0 mg/L Maximum
pH	5.0 Minimum 9.0 Maximum

Note:
1. State Permit No. LTS 5005-95-05, Expiration Date: October 13, 2010.

In addition to the effluent limits listed in Table 3.1-1, the permit indicates that the total nitrogen load applied to any field shall not exceed 396 lbs/yr/acre, including any supplemental fertilizer. Based on the 319 irrigated acres currently utilized at the permitted capacity of 3.1 mgd, this loading rate is equivalent to an effluent concentration of 13.4 mg/L TN, assuming no supplemental fertilizers are applied.

Available flow and loading data for the WNRWF were analyzed to asses the current influent conditions and estimate future loads. Population projections and wastewater characteristics were used to estimate wastewater flows and loads, which served as the basis for design in evaluating operational alternatives.

For this study, the years from 2005 through 2008 were evaluated. Plant data are included in Appendix B.

3.2 CURRENT FLOWS

Like the RBSTP, wastewater comes primarily from domestic and commercial sources. Pump Station Nos. 196 and 210 supply wastewater directly to the headworks through a common 30-inch forcemain. Currently, approximately 98% of the influent flow comes from Pump Station No. 210. The pumps at this station are controlled by variable frequency drives (VFDs). To serve the developing Hawkeye/Cadbury subdivision and surrounding areas, the County plans to increase the capacity of Pump Station No. 196 by directly connecting a new force main from this pump station to the WNRWF headworks. Table 3.2-1 summarizes the pump station characteristics; Figure 3.2-1 shows the influent wastewater flow rate over the period studied.

Table 3.2-1: Collection System Pump Stations Currently Connected Directly to the WNRWF

Pump Station	No.	Hp	Pump Capacity (gpm)	Pump Capacity (mgd)
PS No. 210 (Main PS) (1)	3	90	7,000	10.0
PS No. 196 (Wolfe Point Regional PS) (2)	2	88	1,896	2.7
Total			8,896	12.7

Notes:

1. Based on 2 units in service. The combined flow shown is based on August 2005 field testing by County staff. Note that the field-measured capacity was greater than the design combined pumping capacity of 6,500 gpm shown on the 1994 as-built drawings of PS 210, prepared by GMB. Pump capacity per unit is 4,400 gpm per Flygt Pumps test report, Nov. 11, 1995.
2. Based on 1 unit in service. Pump capacity taken from Flygt Pumps test report, Jan. 1, 2002.

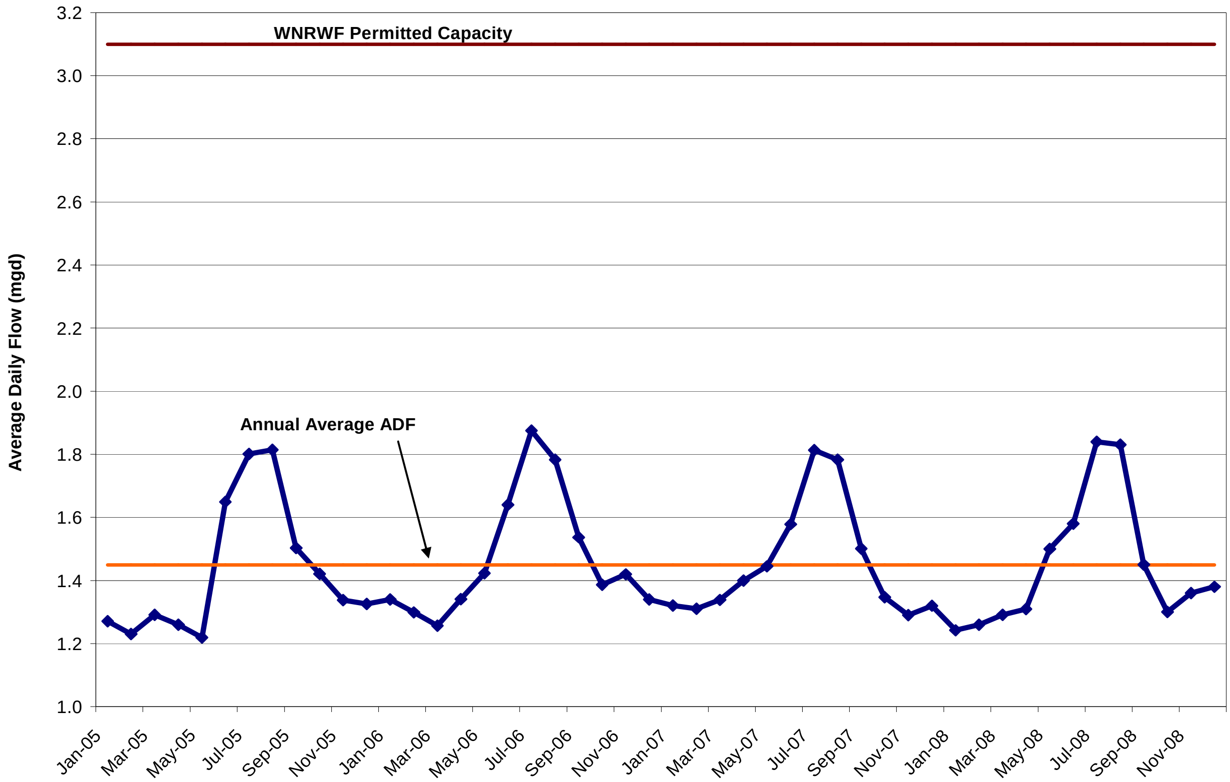


Figure 3.2-1: Influent Wastewater 2005-2008

The maximum month ADF over the period of analysis was 1.9 mgd in July 2006. Monthly flow data going back to 1999 were analyzed and July 2006 had the greatest flow rate of the entire data set. During July 2006 15,934 EDUs were connected to the WNRWF, resulting in a monthly average flow contribution of 119 gpd/ EDU.

Historically, the maximum month flow contributions from EDUs in the West Rehoboth service area has been higher (maximum of 149 gpd/ EDU in 2001), but this figure has dropped in recent years. The drop in maximum month flow per EDU may be related to the large number of constructed by unoccupied or under-occupied housing units built during the recent housing boom in the region. This trend is shown in Table 3.2-2.

Table 3.2-2: WNRWF Maximum Monthly Flow Data

Year	Summer Max Month ADF (mgd) (1,2)	Month Maximum Flow Occurred	Total Number of EDUs in Sewer Service Area(3,4)	Summer Max Month ADF per EDU (gpd/EDU)
2000	1.4	July	10,150	135
2001	1.7	July	11,472	149
2002	1.6	July, August	12,133	131
2003	1.8	July	13,155	136
2004	1.8	August	14,412	123
2005	1.8	August	15,272	119
2006	1.9	July	15,934	118
2007	1.8	July	16,775	108
2008	1.8	July	17,272	107
Average				125
Maximum				149

Notes:
1. Influent data for years 2000 to 2008 are from WNRWF Monthly Reports and the Sussex County Engineering Department.
2. Summer was defined as June, July, and August.
3. The contributing sewer service area is in the WRE of the DBSSD.
4. The total number of EDUs in the sewer service area is at mid-year (July 1). This data was provided by the Sussex County Engineering Department from billing records.

From 2005-2008, the summer (defined as June, July and August) has approximately 35% more wastewater influent than the winter (defined as December, January and February). Table 3.2-3 shows the seasonal flowrates; Table 3.2-4 summarizes the seasonal flow ratios.

Table 3.2-3: WNRWF Seasonal Monthly Influent Flowrates

Year	Summer ADF (mgd)	Winter ADF (mgd)	Annual ADF (mgd)	Max Month ADF (mgd)
2005	1.8	1.3	1.5	1.8
2006	1.8	1.3	1.5	1.9
2007	1.7	1.3	1.4	1.8
2008	1.8	1.3	1.5	1.8
Average	1.8	1.3	1.5	1.8

Note:
1. Winter is defined as December, January, February; summer is defined as June, July, August.

Table 3.2-4: WNRWF Seasonal Flow Ratios

Year	Summer/ Winter Ratio	Max Month/ Annual Ratio	Max Month / Summer Ratio
2005	1.4	1.2	1.0
2006	1.3	1.3	1.1
2007	1.3	1.3	1.1
2008	1.4	1.3	1.1
Average	1.4	1.3	1.0

Note:
1. Winter is defined as December, January, February; summer is defined as June, July, August.

Like the RBSTP, the seasonal nature of the flow to the WNRWF is attributed to its close proximity to a popular vacation coastline. The same living patterns (high population in summer, low in winter) apply to this location and cause the corresponding flux in wastewater flows. Because of these trends, both the summer average and summer maximum flows were estimated to determine the current operating state of the facility and to estimate future operating conditions.

3.3 PROJECTED FLOWS

Similar to the RBSTP, EDUs were used for this analysis. EDUs convert all different types of customers into the equivalent number of single-family residential users. For future planning projections, a contribution of 150 gpd/ EDU was used for both existing and future connections.

Historical growth rates in sewered districts typically range from 3-5%. While due to current economic conditions growth has been on the higher end from 2003 to 2008, the WRE is expected to grow at slower rate than in recent history. 3% is a more typical long term growth rate in sewered areas. To project future growth, a constant rate of 3% of the estimated existing 17,121 EDUs, approximately 513 EDUs, was added each year. This annual increase of 513 EDUs was applied through the planning period of 2030. For Goslee Creek, 100 EDUs was assumed to connect in 2025 and increase at a rate of 100 EDUs/ year. Table 3.3-1 summarizes the projected wastewater influent flows. More detailed projected flows for the entire Inland Bays Planning Area are provided in Appendix C.

Table 3.3-1: WNRWF Projected Wastewater Influent Flows

Year	Contributing EDUs	Max Month ADF (mgd)	Summer Month ADF (mgd)(3)	Winter Month ADF (mgd)(4)	Annual ADF (mgd)(5)
Current	18,600	1.9(1)	1.8	1.3	1.5
Year 2030	29,000	4.4 (2)	4.2	3.1	3.5
Ultimate Design	47,800	7.2	6.9	5.1	5.7

Notes:
1. Current max month ADF based on July 2006 observed flow.
2. Year 2030 max month ADF based on an annual increase of 513 EDUs/yr for the WRE and 100 EDUs/ yr for Goslee Creek starting in 2025. Total EDUs are multiplied by 150 gpd/ EDU.
3. Summer ADF based on applying observed 1.1 average ratio of max month to average summer ADFs from Table 3.2-3 to projected max month ADF.
4. Winter ADF based on applying observed 1.4 average ratio of summer to winter ADFs from Table 3.2-3 to projected summer ADF.
5. Annual ADF based on applying observed 1.3 average ratio of max month to annual ADFs from Table 3.2-3 to max month ADF.

3.4 CURRENT INFLUENT LOADING

The WNRWF regularly monitors influent wastewater characteristics. For this study, the monthly averages from 2005-2008 were analyzed. The average and maximum monthly concentrations are summarized in Table 3.4-1. Table 3.4-2 shows the associated monthly loading rates.

Table 3.4-1: Current WNRWF Wastewater Influent Characteristics

Parameter	Average Month Concentration (mg/L)	Max Month Concentration(3) (mg/L)
BOD5	255	332
TSS(1)	255	332
TKN	52	68
NH3-N(2)	30	40
Org-N(2)	24	31

Notes:
1. Data adjusted to closer reflect expected values. Original data suspected to be low, perhaps due to settling of samples.
2. NH_3-N and Org-N concentrations based on data from 2007-2008.

3. Due to incomplete data set, the maximum month concentration is based on a 1.3:1 maximum to average ratio (Metcalf & Eddy, Figure 3-8, 4th Edition).
4. Max month concentrations are shown at average monthly flow, but maximum month can occur at any flowrate.

Table 3.4-2: Current WNRWF Influent Loading

Parameter	Average Monthly Loading (lbs/mo)	Max Month Loading (lbs/mo)
BOD_5	3,100	4,000
TSS	3,100	4,000
TKN	660	820
NH3-N	360	480
Org-N	290	380

Notes:
1. Loading values based on observed values from 2005 to 2008.

3.5 PROJECTED INFLUENT LOADING

It is assumed that the current wastewater strength will not change dramatically. Based on this assumption, the projected influent loading is based on the current influent concentrations at the projected flows, as shown in Table 3.5-1.

Table 3.5-1: Projected Influent Loading

Design Period	BOD_5 (lbs/d)		TSS (lbs/d)		TKN (lbs/d)		NH3-N (lbs/d)		Org-N (lbs/d)	
	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.
Current(1)	4,000	5,200	4,000	5,200	820	1,100	480	620	380	490
Permitted Capacity	6,600	8,600	1,400	1,800	1,400	1,800	790	1,000	630	800
2030 Projected	9,400	12,000	9,400	12,000	1,900	2,500	1,100	1,500	900	190
Ultimate Flow	15,000	20,000	15,000	20,000	3,100	4,100	1,800	2,400	1,500	260

Notes:
1. Loading values based on concentrations shown in Table 3.4-1 and the max month ADF of 1.9 mgd.

3.6 CURRENT EFFLUENT PERFORMANCE

The operators at the WNRWF have been able to meet the DNREC-permitted discharge limits by a wide margin. The facility is required to submit monthly Spray Effluent Monitoring Reports in order to demonstrate record of discharge limit compliance. Data was provided by the County for 2005 through 2008. A summary of the average values reported over this four-year period is presented in Table 3.6-1. Figure 3.6-1 shows the seasonal BOD_5 and TSS effluent performance as a plot. Complete performance data are provided in Appendix B.

Table 3.6-1: Comparison of Actual Effluent Performance to Permit Limits

Parameter	Permit Limit	Current Value[(1)]
BOD_5	50 mg/L Daily Average	14.8 mg/L
TSS	90 mg/L Daily Average	17.0 mg/L
pH	5.0 Minimum 9.0 Maximum	8.0

Notes:
1. Data provided by the SCED. Average of monthly averages from 2005-2008.

Table 3.6-2: Current Effluent Performance

Year	BOD_5 (mg/L)	TSS (mg/L)	TN (mg/L)	TP (mg/L)
2005	Not Available	Not Available	20.3	Not Available
2006	15.7	21.8	18.8	5.8
2007	13.3	13.7	20.7	7.0
2008	15.5	15.5	19.0	7.2
Average	14.8	17.0	19.9	6.6
Percent Removal[(2)]	94%	93%	75%[(3)]	5%[(4)]

Notes:
1. Data provided by the SCED. Average of monthly averages.
2. Percent removal based on influent concentrations listed in Table 3.4-2.
3. Total Nitrogen removal based on assumed influent TN as influent TKN multiplied by 3/2.
4. Phosphorus removal based on assumed TP influent concentration of 7 mg/ L for medium strength wastewater (Metcalf & Eddy, Figure 3-8, 4th Edition).

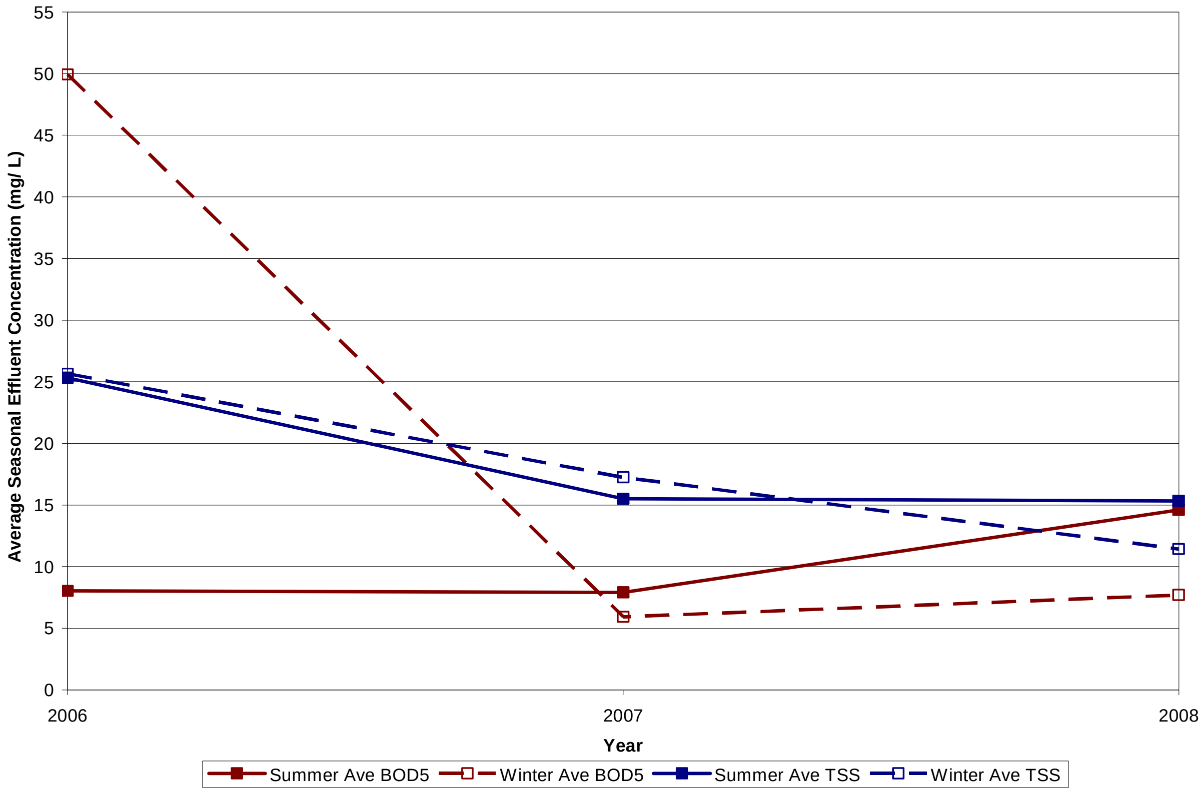


Figure 3.6-1: Seasonal BOD_5 and TSS Effluent Performance (2006-2008)

While always under permit limits, the effluent performance of the WNRWF varied over the period of study. Both BOD_5 and TSS initially had better performance during summer. During 2007, the effluent discharge of these pollutants began to be lower during winter, and remained that way through 2008.

To meet its spray irrigation requirements, the facility cannot exceed 396 lbs/ ac/ year of total nitrogen. The WNRWF has consistently met these requirements. A summary of this information is presented in Table 3.6-3; seasonal effluent concentrations are shown in Figure 3.6-2. Complete effluent nitrogen data are available in Appendix B.

Table 3.6-3: Effluent Nitrogen Performance

Year	TN (lbs/ac/yr)
2005	290
2006	240
2007	290
2008	260
Average	270

Notes:
1. Data provided by the SCED. Loading rates based on effluent loadings divided by the acres in service.

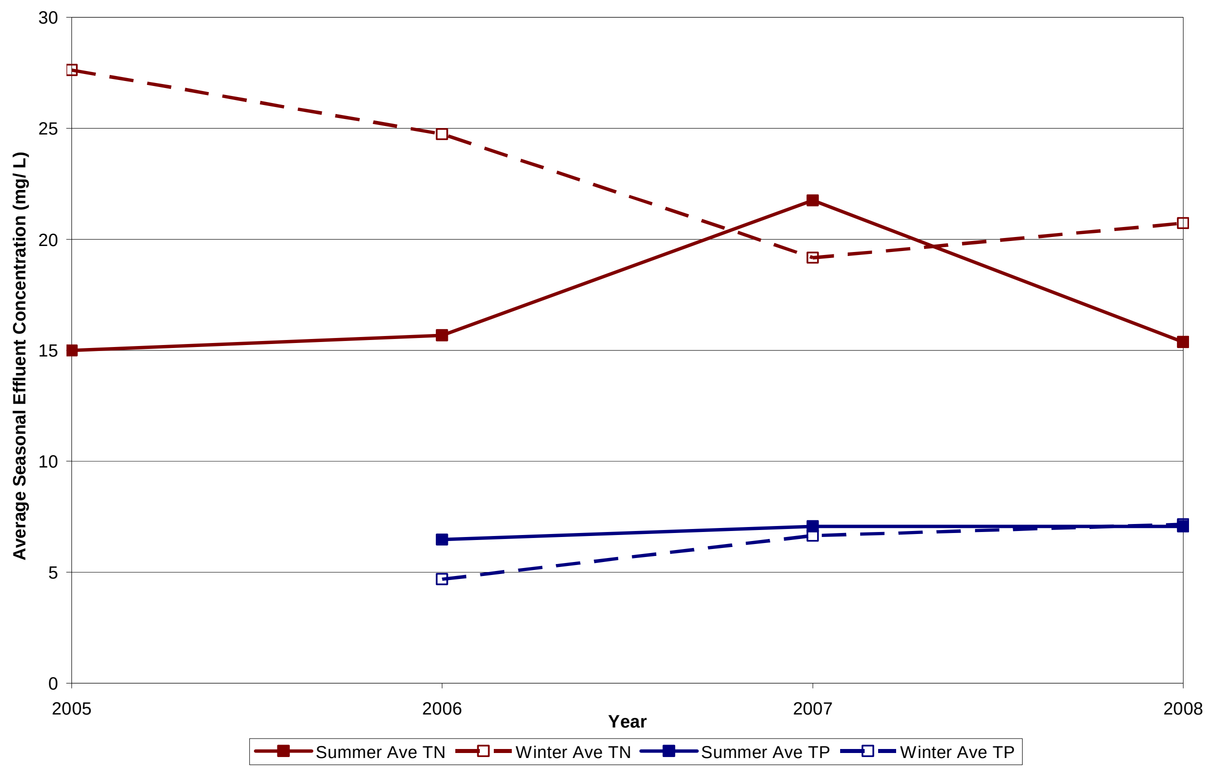


Figure 3.6-2: Seasonal TN and TP Effluent Performance (2005 – 2008)

As with BOD_5 and TSS, the TN performance varied throughout the period of study. Like $BOD_{5,}$ the TN effluent is higher during the beginning of the period of study compared to 2008. The effluent TP concentration remained relatively constant from 2005-2008, with little seasonal variation.

3.7 PROJECTED EFFLUENT PERFORMANCE

To estimate future performance, it was assumed that effluent concentrations of BOD_5, TSS, and TN increase in proportion to flow. This approximately translates into doubling the current effluent concentrations since the current annual average daily flow of 1.5 mgd is approximately 50% of the permitted capacity of 3.1 mgd. Future TP effluent concentrations were increased to 7 mg/L because performance is expected to decrease, but the effluent concentrations cannot exceed influent concentrations. Development of these calculations is further discussed in Chapter 7.

Table 3.7-2: WNWRF Projected Effluent Performance

Design Period	Flow	Total Nitrogen		Total Phosphorus		BOD_5		TSS	
	Annual ADF (mgd)	Conc. (mg/L)	Annual Loading (lbs/yr)	Conc. (mg/L)	Annual Loading (lbs/yr)	Conc. (mg/L)	Annual Loading (lbs/yr)	Conc. (mg/L)	Annual Loading (lbs/yr)
Current	1.5	20.0	91,000	6.6	30,000	15.0	68,00	17.0	78,000
Permitted Capacity	3.1	41.0	390,000	7.0	66,000	31.0	330,000	35.0	330,000

Notes:
1. Projected concentrations are based on a 2.1:1 ratio. This ratio was derived by assuming a linear relationship between performance and flow.

4. WASTEWATER TREATMENT AND DISPOSAL ALTERNATIVES

4.1 INTRODUCTION

There are four possible options being considered by the County to handle the wastewater in the NCPA and from the City of Rehoboth Beach. The possible solutions can be grouped into four general treatment and disposal alternatives:

- **Alternative 1:** The RBSTP shuts down and sends all of its raw wastewater to the WNRWF, which will treat as much wastewater as possible and send the excess to another facility to be treated. The excess wastewater will be treated by the County owned and operated Inland Bays Regional Wastewater Facility (IBRWF).

- **Alternative 2**: The RBSTP remains in service and sends its treated effluent to the WNRWF for disposal via spray irrigation. A reduced amount of WNRWF influent wastewater from its service area will continue to be treated at that facility, with all excess being sent to either the IBRWF or a private contractor for treatment and disposal.

- **Alternative 3**: The RBSTP remains in service and discharges treated effluent via an ocean outfall. In this scenario, the County will continue treating and disposing wastewater via land application at its existing facilities. The WNRWF will remain in service and continue treating and disposing wastewater from its service area. Any excess flow to the WNRWF above the capacity of the facility will be sent to the IBRWF for treatment and disposal.

- **Alternative 4**: The RBSTP remains in service and discharges treated effluent via an ocean outfall. The County continues to treat wastewater via land application at the WNRWF. The WNRWF will expand and upgrade its treatment capacity.

Treated wastewater that exceeds the WNRWF disposal capacity will be pumped to the Rehoboth ocean outfall for disposal.

4.2 PRIVATE WASTEWATER TREATMENT PROVIDER

In addition to the four previous alternatives, the County has received a proposal from a Private Wastewater Provider (PWWP) to convey wastewater in excess of the available capacity at the County's WNRWF to a privately owned location for treatment and disposal.

Figure 4.2.1 details the infrastructure proposed by the PWWP to convey excess wastewater from the WNRWF to the privately owned location. A transfer pumping station will be required at the WNRWF to accept flow in excess of the plant's capacity. This pumping station will pump through a 24-inch force main, approximately 82,000 LF to the treatment and disposal lands. The PWWP has proposed a booster pumping station at the intersection of Coastal Highway and Cave Neck Road in order to accept flow from outside the County's planning area. This pump station has been removed from this evaluation since this station would provide capacity for flows not being contributed by the County. The use of a PWWP only impacts Alternatives 1 and 2.

4.3 ALTERNATIVE 1

In Alternative 1, the RBSTP is taken out-of-service and all raw wastewater currently conveyed to that treatment plant is pumped directly to the WNRWF by a new Rehoboth Beach Wastewater Pumping Station (RBWWPS). The raw wastewater would enter a new WNRWF headworks where it will mix with influent wastewater from the Wolfe Neck Service Area. Because the mixed influent will exceed the treatment and disposal capacity of the WNRWF, the total influent wastewater will be split between being treated at this facility and being sent elsewhere via the proposed

Wolfe Neck Transfer Pump Station (WNTPS). Figure 4.3-1 is a schematic showing how the influent wastewater would be transferred between the RBSTP, WNRWF, and third treatment facility.

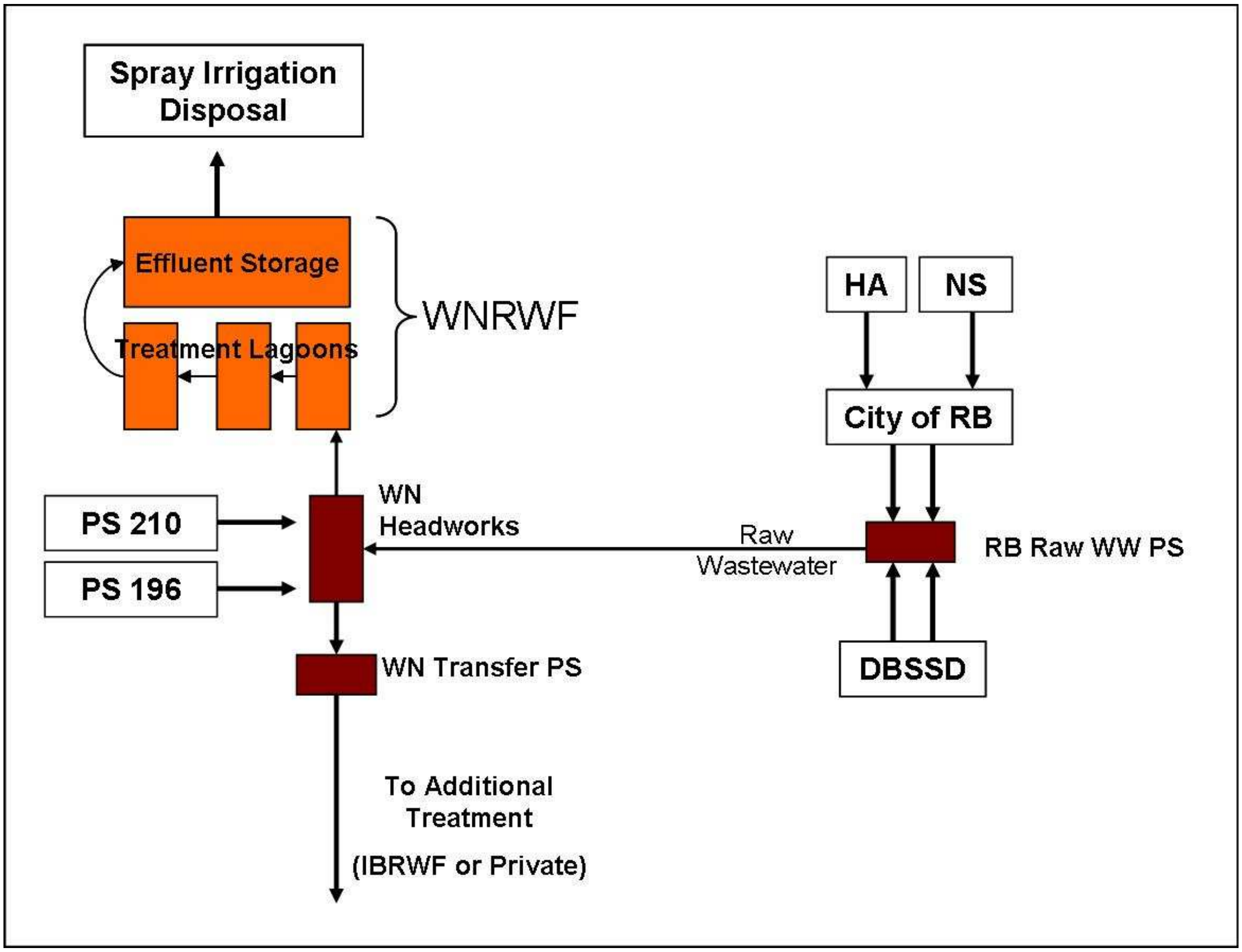


Figure 4.3-1: Alternative 1 Wastewater Flow Schematic

The excess wastewater will be sent either to the IBRWF for treatment and disposal. Figure 4.3-2 is the flow distribution diagrams for Alterative 1A. The flow rates given in these figures will be discussed in Chapter 7 of this report.

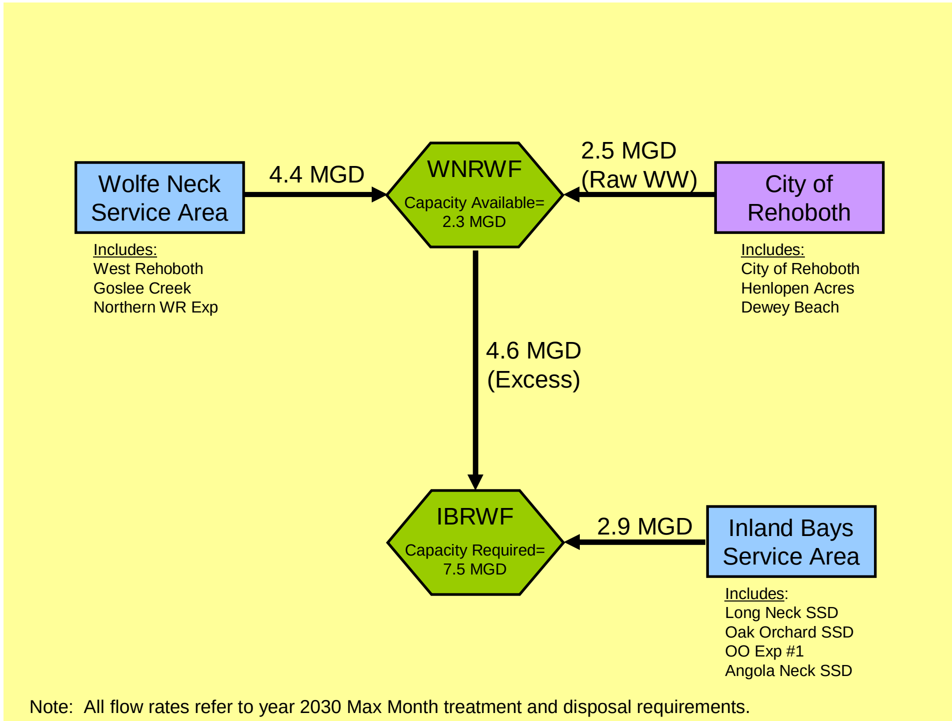


Figure 4.3-2: Alternative 1A NCPA Flow Distribution Diagram

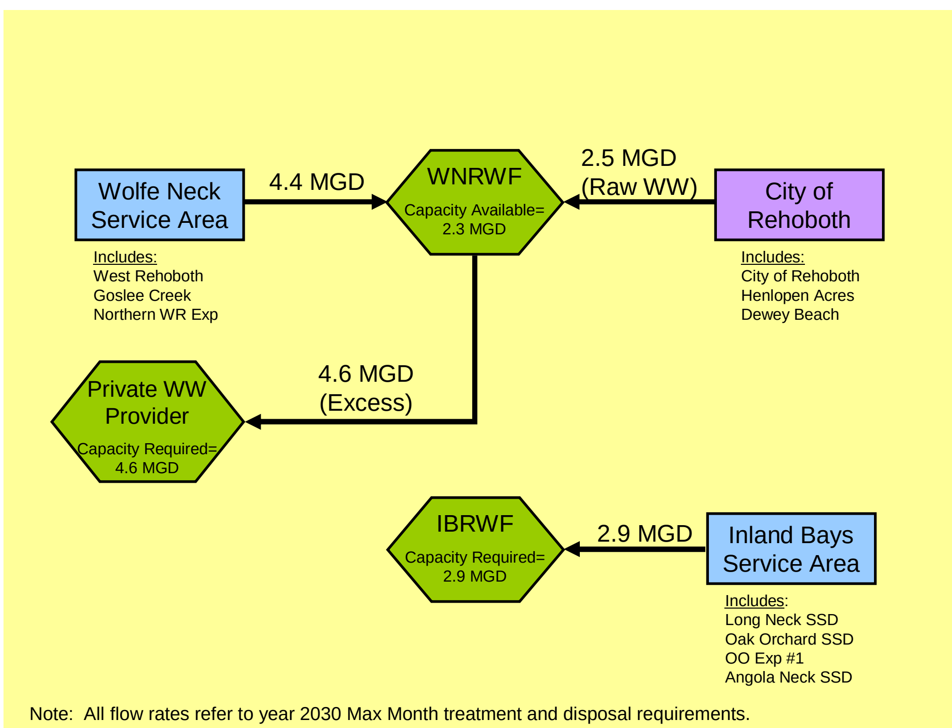


Figure 4.3-3: Alternative 1B NCPA Flow Distribution Diagram

If Alternative 1A is selected and excess wastewater is sent to the IBRWF for treatment and disposal, the treatment and disposal capacities at this facility will need to be expanded accordingly. This concept is discussed further in Chapter 9.

4.4 ALTERNATIVE 2

In Alternative 2, the RBSTP would continue to operate and achieve biological nutrient removal. Treated effluent from the RBSTP would be pumped by a new effluent pumping station and sent directly to the WNRWF treated effluent storage lagoon for spray irrigation disposal. A portion of the influent flow from the Wolfe Neck Service Area would continue to be treated in the existing WNRWF treatment lagoons and disposed of on-site along with the treated effluent from the RBSTP, while the balance of the raw wastewater from West Rehoboth would be transferred to either the IBRWF or a private contractor for treatment and disposal. Figure 4.4-1 is a schematic showing how the influent wastewater would be transferred between the RBSTP, WNRWF, and a third treatment facility.

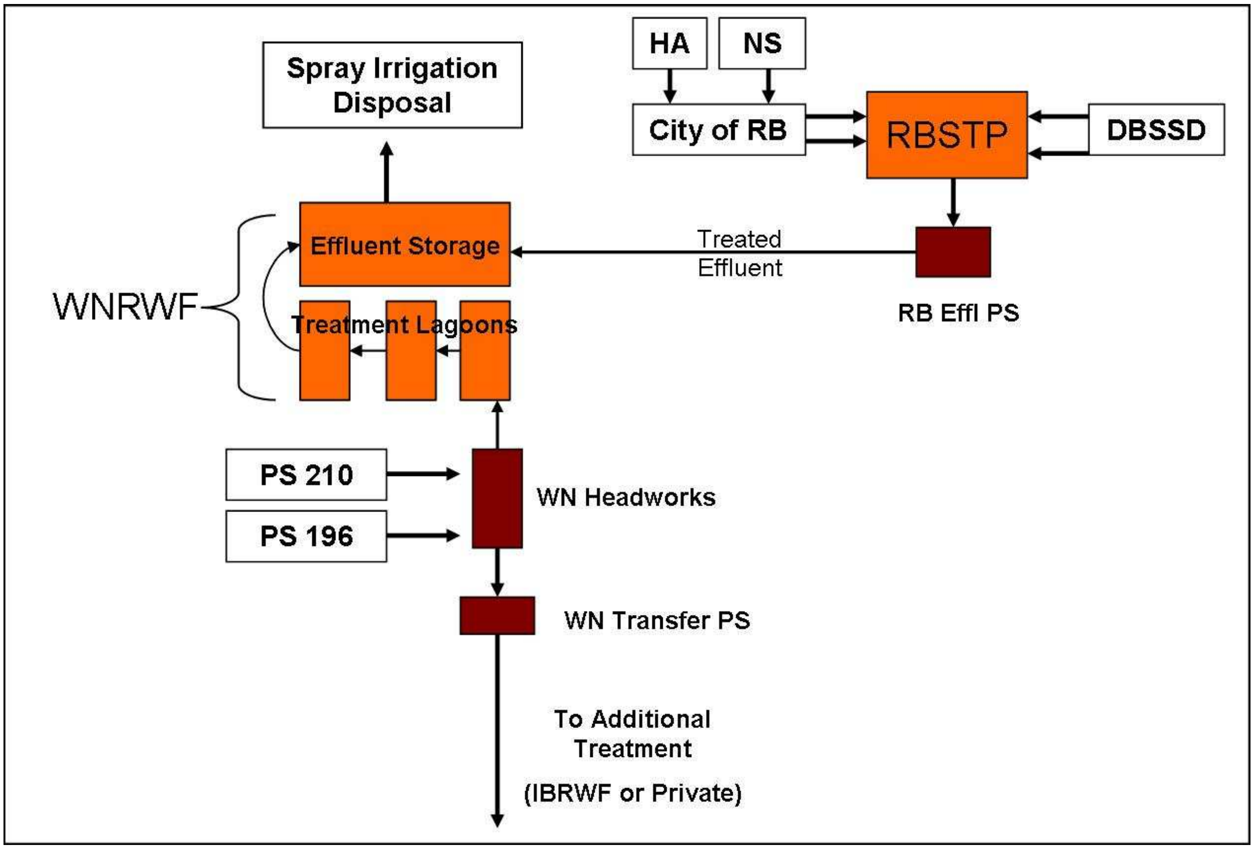


Figure 4.4-1: Alternative 2 Wastewater Flow Schematic

Figures 4.4-2 and 4.4-3 are flow distribution diagrams of Alterative 1A and 1B. The flow rates given in these figures will be discussed in Chapter 7 of this report.

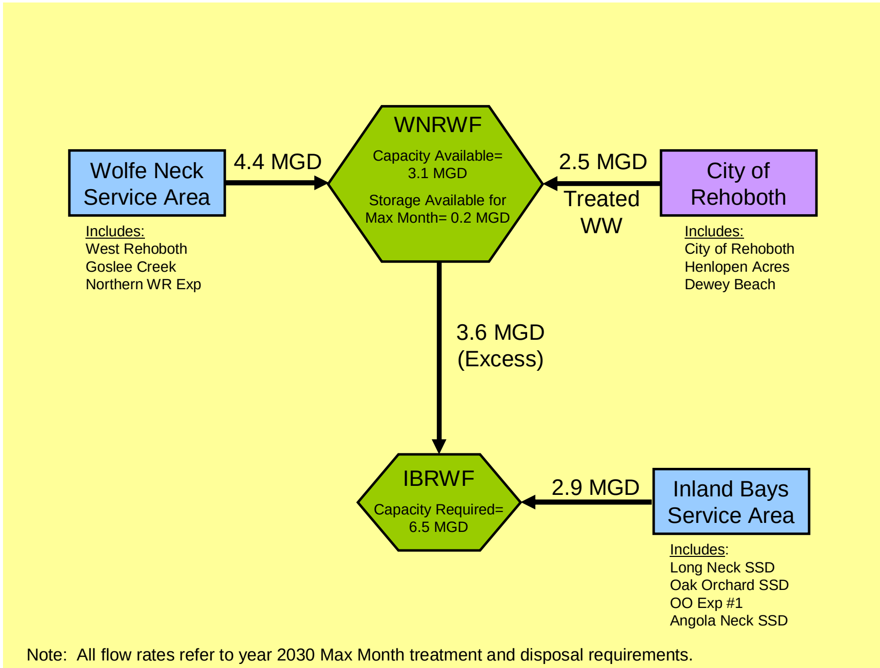


Figure 4.4-2: Alternative 2A NCPA Flow Distribution Diagram

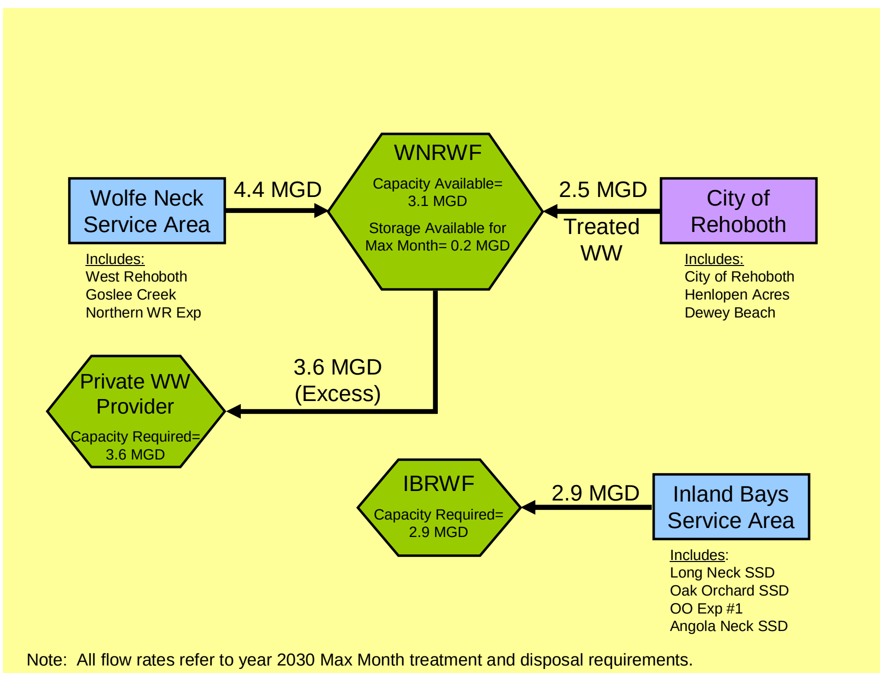


Figure 4.4-3: Alternative 2B NCPA Flow Distribution Diagram

Similar to Alternative 1A the IBRWF will need to be expanded if Alternative 2A is selected. This concept is discussed further in Chapter 9.

4.5 Alternative 3

In Alternative 3, the Rehoboth Beach would find its own solution for effluent discharge independent of the County. This solution would likely be an ocean outfall. Sussex County would then manage the NCPA wastewater at the WNRWF and IBRWF.

It is projected that in the future the influent wastewater from the Wolfe Neck service area will exceed the WNRWF treatment and disposal capacity and additional capacity will be required elsewhere. The IBRWF will likely provide the additional capacity required by the WNRWF and a private contractor option will no longer be necessary. Similar to Alternative 1, influent wastewater would enter into a new headworks at the WNRWF and be separated by what the WNRWF can treat and what will need to be sent to IBRWF. Wastewater to IBRWF will be transferred via the WNTPS. Figure 4.5-1 is a flow schematic of the wastewater treated by the WNRWF and the IBRWF. Figures 4.5-2 is a flow distribution diagram of Alterative 3. The flow rates given in Figure 4.5-2 will be discussed in Chapter 9 of this report.

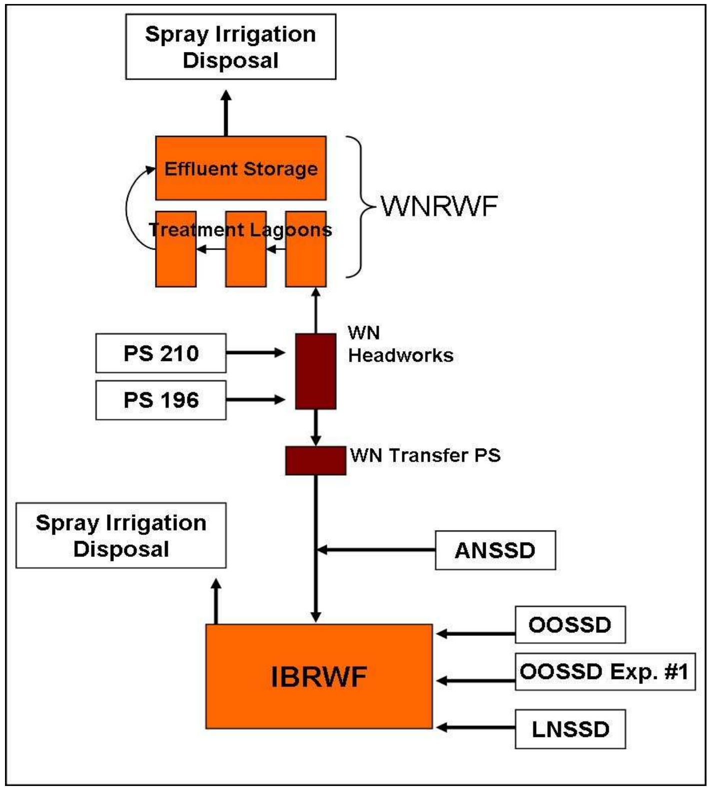


Figure 4.5-1: Alternative 3 Wastewater Flow Schematic

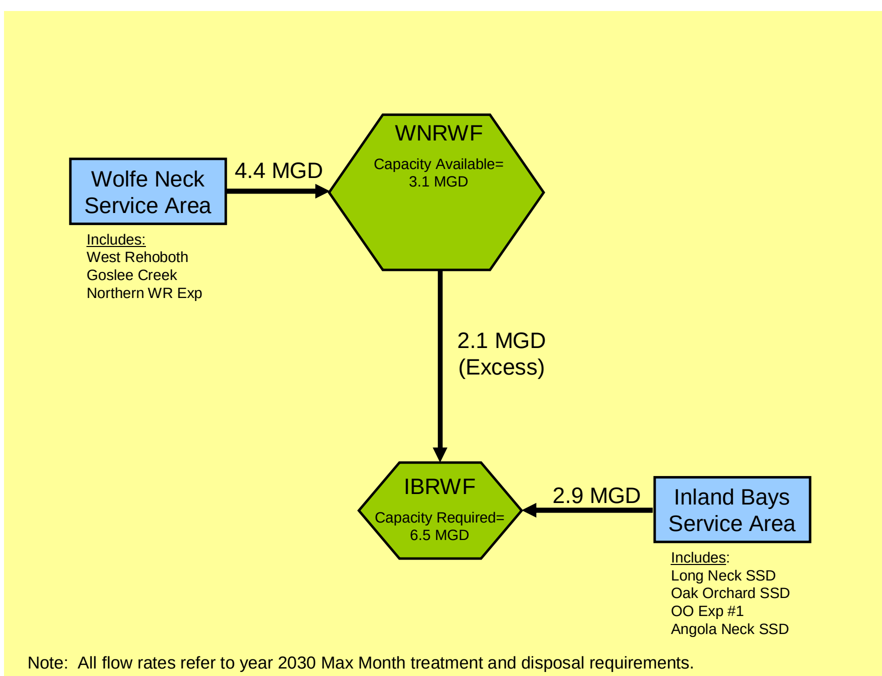


Figure 4.5-2: Alternative 3 NCPA Flow Distribution Diagram

4.6 Alternative 4

In Alternative 4, the RBSTP would continue to operate and achieve biological nutrient removal. Treated effluent from the RBSTP would be pumped by a new effluent pumping station and sent to an ocean outfall for disposal. A portion of the influent flow from the Wolfe Neck Service Area would continue to be treated in the existing WNRWF treatment lagoons and disposed of on-site. The balance of the raw wastewater from West Rehoboth would be treated through an independent treatment train designed to achieve biological nutrient removal. Figure 4.6-1 is a schematic showing how the influent wastewater would be transferred between the RBSTP, WNRWF, and the combined ocean outfall..

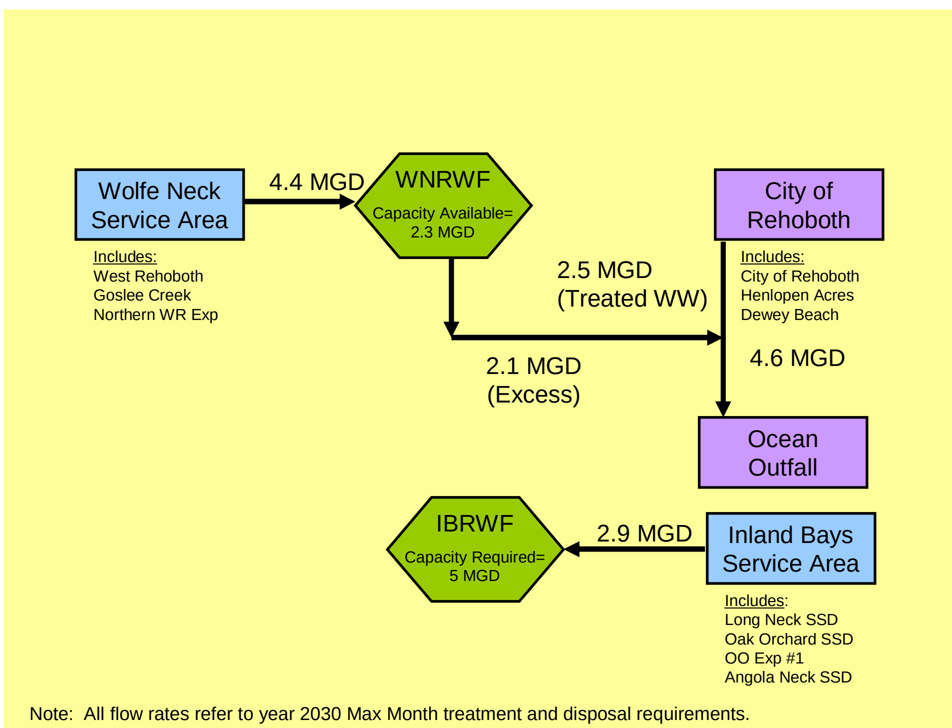


Figure 4.6-1: Alternative 4 NCPA Flow Distribution Diagram

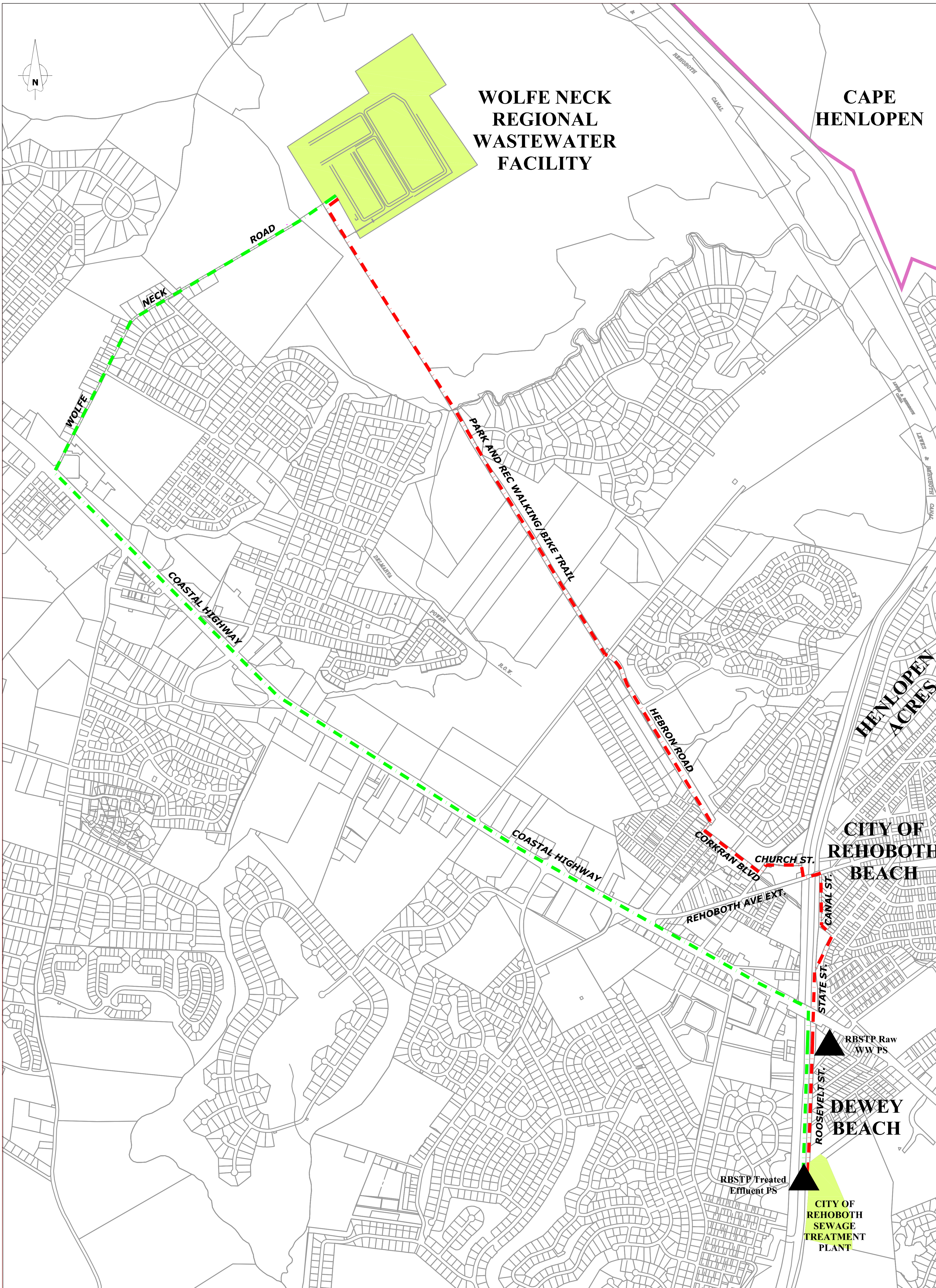
5. REHOBOTH BEACH CONVEYANCE SYSTEM

Of the four base alternatives (Alt. 1, 2, 3, &4) outlined in Chapter 5 for Rehoboth, Alternatives 1 and 2 will require conveyance of wastewater from the RBSTP to the WNRWF. This chapter presents the options and associated costs for conveying wastewater from the RBSTP to the WNRWF for Alternatives 1 (raw wastewater) and 2 (treated effluent). Per the Rehoboth Beach Alternative Discharge Evaluation, the required design flowrate for both alternatives is 10.2 mgd, which is the peak instantaneous design rate associated with the 3.4 mgd ultimate design of the RBSTP.

5.1 ALTERNATIVE 1: RAW WASTEWATER CONVEYANCE

In Alternative 1, the RBSTP will be taken out of service and a new pumping station will be constructed to collect raw wastewater from the City of Rehoboth Beach, the Dewey Beach SSD and the Henlopen Acres SSD and pump to the Wolfe Neck Regional Wastewater Facility. The location of this proposed station along with two potential force main alignments, has been indentified and are shown on Figure 5.1-1.

The force main alignment Option #1 involves the construction of approximately 16,200 lf of 30-inch force main from the proposed raw wastewater pumping station location, north along State Street and Canal Street to Rehoboth Avenue (SR 1A), where the force main will be installed underneath the Rehoboth Canal to Church Street. From this point the force main will be installed north and west along Church Street to Corkran Boulevard, northwest along Corkran Boulevard to Hebron Road and northwest along Hebron Road to the intersection of Holland Glade Road. The remaining portion of the force main will be installed in an easement along the Park and Recreational Walk/Bike Trial to Wolfe Neck Road, and then north and east along Wolfe Neck Road to the WNRWF headworks.



WR&A
Whitman, Requardt & Associates LLP

in association with

STEARNS & WHELER LLC
Environmental Engineers and Scientists

LEGEND

- Alignment Option #1
- Alignment Option #2

JOINT SUSSEX COUNTY/CITY OF REHOBOTH BEACH LAND APPLICATION PROJECT

SUSSEX COUNTY, DELAWARE

Figure 5-1.1
October 2009

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Force main alignment Option #2 involves installing approximately 21,000 lf of 30-inch force main northwest along Coastal Highway (SR 1) to Wolfe Neck Road, and northeast along Wolfe Neck Road to the WNRWF headworks.

5.2 ALTERNATIVE 2: TREATED EFFLUENT CONVEYANCE

In Alternative 2, the RBSTP will remain in service and a new effluent pumping station would be constructed on or near the RBSTP site, as indicated in the previous Figure 5.1-1, to convey treated effluent to the WNRWF. From the Rehoboth Beach Alternative Discharge Evaluation, the design concept for this station would involve the retrofit of an existing reparation basin at the RBSTP and the installation of vertical turbine pumps to draw treated effluent from the RBSTP. This configuration would decrease the cost for the pump station as compared to Alternative 1.

The same force main alignment options will be considered for this alternative, with the exception that 2,000 lf of additional force main would need to be installed from the RBSTP to Roosevelt St.

5.3 FORCE MAIN DESIGN CRITERIA

In accordance with Sussex County Design Standards, a Hazen-Williams “C-factor” of 140 is used for all hydraulic computations for new PVC force main, with a target design force main velocity of 3 to 5 feet per second (ft/s). Table 5.3-1 is a summary of the hydraulic calculations for both alignment options under each treatment alternative.

Table 5.3-1 Summary of Force Main Hydraulic Information

				Alignment Option #1- Utility Easements		Alignment Option #2- Coastal Highway	
	Peak Q	FM size	Velocity	Length	Total Dynamic Head (1)	Length	Total Dynamic Head (1)
Treatment Alternative	(MGD)	(in.)	(ft/s)	(ft)	(ft)	(ft)	(ft)
#1 - Raw Wastewater	10.20	30	3.6	16,200	76	21,000	82
#2 - Treated Effluent	10.20	30	3.6	18,200	78	23,000	84

Notes:
1) 45 feet of static head was assumed along with 8' of minor losses were included in the calculation for Total Dynamic Head.

5.4 PRELIMINARY COST ESTIMATES

For Alternative 1, a new pump station would be constructed to intercept all flows entering the treatment plant. The station would be designed as a three pump station, with two pumps operating and one back-up pump. Based on the hydraulic conditions in Table 5.3.1, pumps in the 100-150 HP range are anticipated. This station would be a stand alone pump station similar to other large Sussex County regional pump stations such as Beaver Dam (PS#293), Ocean View (PS#99), or Rehoboth (PS#210). Construction would involve a cast-in-place concrete wetwell, with associated items such as an external valve vault, backup generator, and a control building to house the electrical equipment. Costs for the Alternative 1 pump station are based on bid costs for similarly sized County stations. The pump station cost for Alternative 2 is per the Rehoboth Beach Alternative Discharge Evaluation.

Cost estimates for the proposed force mains for each treatment alternative and each alignment option are presented in Appendix D. Table 5.4-1 provides a cost summary for both the pump stations and force main alignments for each Alternative. The total project costs for each alternative are one component of the cost sharing model as further described in Chapter 10.

Table 5.4-1 Summary of Rehoboth to WNRWF Conveyance Costs

Treatment Alternative	Alignment Option	Estimated FM Cost	Estimated PS Cost	Estimated Total Project Cost (1.)
Alternative #1 (Raw WW from New Pumping Station Location)	Option #1 (Park and Rec Easement)	$4,191,000	$4,039,000	$8,230,000
	Option #2 (Coastal Highway)	$7,247,000	$4,039,000	$11,286,000
Alternative #2 (Treated Effluent Pumped from RBSTP)	Option #1 (Park and Rec Easement)	$4,684,000	$1,208,000	$5,892,000
	Option #2 (Coastal Highway)	$7,766,000	$1,208,000	$8,974,000

Note:
1. Costs include 10% construction contingency and 22% project costs.

Table 5.4-2 provides a summary of the force main alignment options for both Conveyance Option 1 and Option 2. Based on the costs presented above for the FM, along with the added difficulty of construction along Coastal Highway, Alignment Option #1 through the Park and Recreational Walk/Bike Trail would be the preferred Option for either Alternative.

Table 5.4-2 Summary of Force Main Alignment Options

Description	Option #1 Utility Easement	Option #2 Coastal Highway
Details		
Total length	Option 1 - 16,200 feet Option 2 – 18,200 feet	Option 1 - 21,000 feet Option 2 – 23,000 feet
Size	30 inch	30 inch
Pavement restoration length	Option 1 - 4,000 feet Option 2 – 5,000 feet	Option 1 – 17,750 feet Option. 2 – 18,750 feet
Environmental Considerations	Rehoboth Canal Crossing	Rehoboth Canal Crossing
Crossings		
Major Water Crossings	1) Rehoboth Canal	1) Rehoboth Canal
Minor Stream Crossings	1	0
Construction		
Major Highway Installation	0	14,500
County Road Installation	10,000	8,500
Installation Ranking	**1**	**2**
Easements		
Temporary Easements	Yes	Yes
Permanent easements	Yes	Yes

Notes:

1) Major Highway Installation refers to installation along Coastal Highway, County Road Installation refers to installation along all other County Roads.
2) Pavement restoration length was obtained assuming 100% restoration in Major Highways and 50% restoration elsewhere.

6. SPRAY IRRIGATION DISPOSAL ANALYSIS

6.1 WOLFE NECK REGIONAL WASTEWATER FACILITY

The Wolfe Neck Regional Wastewater Facilities (WNRWF) began operating in the mid 1990s. It has five circular spray irrigation fields, which have a combined size of 319 acres. Field No. 1 is 165 acres; No. 2 is 66 acres; No. 3 is 46 acres; No. 4 is 25 acres; and No. 5 is 17 acres. Sussex County has a permit from DNREC, which requires that the average quantity of effluent discharged to the spray fields not exceed 3.1 million gallons/day (mgd) in any calendar month. The maximum permitted application rates are as follows: 2.6 inches/week in June and September; 2.75 inches/week in July and August; and 2.5 inches/week in October through May. Other permit conditions include a 24-hour rest period between spraying events, a prohibition on spraying when there is rain, snowfall, or freezing or saturated ground; and ground water mounds must be 2 feet or greater below the land surface.

Effluent data provided by the Sussex County for the period January 2006 to September 2008 indicates that they have sprayed a monthly average of 1.4 mgd to 2.7 mgd; and a peak day of 2.2 to 4.7 mgd. There are several possible reasons why less than the permitted monthly average of 3.1 mgd has been sprayed at the WNRWF. The first reason is that the effective area of the spray fields on a given day is less than the permitted 319 acres. The effective area has been estimated as 233 acres. Factors that tend to reduce the effective spray area include the farmer taking fields out of service for planting and harvesting; and the operators not spraying on fields when the ground conditions are freezing and the ground is saturated or ponded with water. The second reason is the reduced spraying days. The operating days per year are estimated as 268 days, i.e. less than a full year. The third reason is localized areas may be underlain by soils that may have been compacted by farming operations, or they may be naturally poorly draining soils. WR&A performed a disposal capacity analysis using a conservative (i.e. slow) infiltration rate based on field rates from the design development report for the WNRWF, assuming conservative estimates of 268 spraying days per year, and an effective area of 233 acres. The result of that analysis is a capacity estimate of 1.0

mgd for the spray fields. Assuming less conservative values for parameters leads to a higher capacity estimate. For example, a 3.1 mgd estimate can also be arrived at by selecting higher field-measured values from the design development report infiltration tests. A program consisting of plowing areas with compacted soils, and changes in farming practices, and increased storage for effluent, might lead to a 3.1 mgd monthly disposal at the existing fields. However, for planning purposes, a disposal rate of 2.3 mgd, which is closer to the actual recent disposal of 2.0 mgd, appears more realistic than the permitted 3.1 mgd.

6.2 INLAND BAYS REGIONAL WASTEWATER FACILITY

The Inland Bays Regional Wastewater Facilities (IBRWF) began operating in 1992. It has two, 103.9-acre circular spray irrigation fields which are designated the north and south fields. The County's spray irrigation permit requires that the average quantity of effluent discharged to the spray fields not exceed 1.5 million gallons per day in any calendar month. The maximum permitted application rate is 1.86 inches/week. The County sprayed an average of 0.5 to 1.45 million gallons per day (mgd), with peak days ranging from 0.65 to 1.6 mgd, in the period January 2006 through September 2008. Sussex County has purchased land surrounding the IBRWF, and it plans to expand the spray irrigation fields in phases. Table 6.2-1 provides capacity estimates for properties currently owned by Sussex County.

Table 6.2-1 IBRWF Capacity Estimates (4)

Category	Parcel Number (TM 2-34-22)	Site	Spray Fields (acres) (4)	Application Rate (inches/week)	Capacity (million gallons/day)
Existing	12	North field (1)	103.9	1.86	0.75
	13	South field (1)	103.9	1.86	0.75
Ex. Subtotal					***1.50***
Initial Exp. Areas	12	N. Burton(2)	52	1.5	0.30
	12	S. Burton(2)	47	1.0	0.18
	19	Hettie-Lingo(2)	54	2.0	0.43
	19	Hettie-Lingo(2)	81	1.0	0.31
	10	Townsend(2)	58	2.0	0.45
	10	Townsend(2)	56	2.5	0.55
	18	Cordrey Parcel (2)	192	2.0	1.49
Initial Exp Subtotal					***3.71***
Long Term Subtotal	(5)	Glatfelter Site (3)	1,000	2.0	***7.80***
Totals			**1,748**		**13.0**

Notes
(1) Capacity permitted by DNREC
(2) Capacity based on subsurface investigations and field-tested rates
(3) Capacity based on assumed rates, without subsurface investigations
(4) From Inland Bays Regional Wastewater Facility Design Development Report.
(5) Includes parcels 2-34-22-8, 2-34-21-145,148,149,150,151,152.02, and 2-34-28-1.

Hydrogeologic investigations have been performed on parcels 10, 12, and 19 on tax map number 2-34-22. Hydrogeologic or soil studies have not been performed at the Cordrey or Glatfelter sites. The estimates for these two expansion lands are based only on a desktop review of published maps.

6.3 IBRWF HYDROGEOLOGIC AND SOILS TESTING COSTS

A hydrogeologic study was completed in 2005 for approximately 650 acres associated with parcels 10, 12, and 19 at a cost of $235,000 or $360/acre. The total acreage for the Glatfelter and Cordrey parcels is approximately 1,195 and 250 respectively. Based on previous costs and adding a 15% factor for inflation and contingency would result in testing costs of approximately $500,000 for the Glatfelter parcel and $100,000 for the Cordery parcel.

7. WOLFE NECK REGIONAL WASTEWATER FACILITY IMPROVEMENTS

7.1 ALTERNATIVE 1 DISPOSAL CAPACITY

In Alternative 1 the proposed Rehoboth Beach Raw Wastewater Pumping Station (RBWWPS) will send raw wastewater to the WNRWF for treatment and disposal. All wastewater that exceeds the WNRWF treatment or disposal capacity will be pumped to the IBRWF or a PWWP for treatment and disposal. The raw wastewater from the RBWWPS would blend with the wastewater coming from Goslee Creek (GC) SSD and the WRESSD.

In Alternative 1, the limiting factor for effluent disposal is the total nitrogen limits. The WNRWF spray irrigation permit has two criteria for TN, the percolate concentration must be less than 10.0 mg/L and the total annual loading cannot exceed 396 lbs/ac/yr.

The average influent TN concentration for the WNRWF is 52 mg/L. The average influent TN concentration for wastewater pumped from the RBWWPS is not measured, but was estimated in Chapter 2 to be 40 mg/L. Because there is relatively little difference in these values, it is assumed that the blended influent TN concentration will not significantly change from the influent concentrations the WNRWF currently receives. Using this assumption, the future performance of the treatment lagoons at the WNRWF will be projected from current performance.

Currently, the WNWRF produces a final effluent TN concentration of 19.9 mg/ L at an annual influent flow of 1.5 mgd. At this flowrate, the plant is operating at approximately 50% of its 3.1 mgd design capacity. Assuming final effluent TN increases proportional to increase in flow, the effluent TN concentration was increased by a factor of two to project effluent performance of the existing lagoon treatment system. A linear projection between these two points was compared to the maximum allowable TN concentrations at various flowrates to determine the operational limit. Figure 7.1-1 shows this comparison.

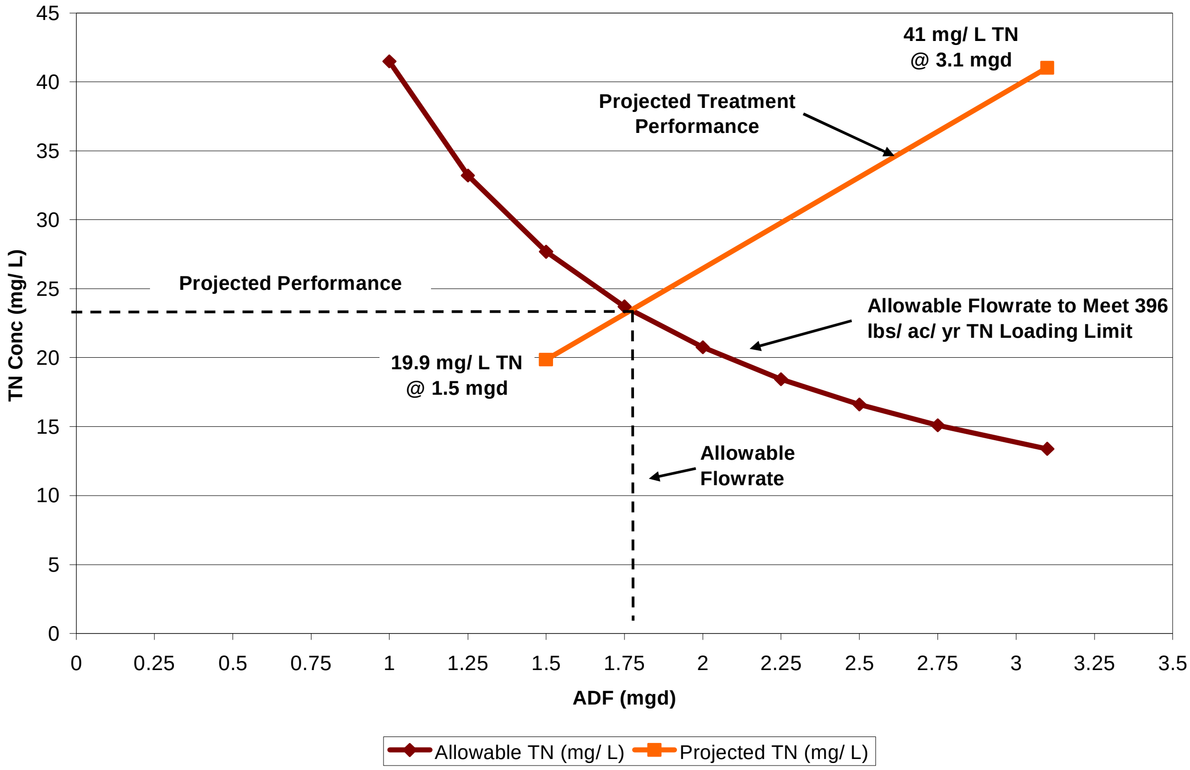


Figure 7.1-1: Alternative 1 Effluent Projection

Using this analysis, the projected performance and allowable flowrates intersect at a flowrate of 1.8 mgd. At this flowrate, the effluent TN concentration is approximately 23 mg/L. To adhere to the 396 lbs TN/ac/yr loading limit on 319 irrigated acres, the plant cannot exceed an annual average of 1.8 mgd to be discharged via spray irrigation.

The TN percolate concentration must also be calculated to verify 10.0 mg/L TN is not exceeded. Using the projected values of 23 mg/L TN and 1.8 mgd average daily flow, a nitrogen balance yielded an annual average percolate concentration of 6.3 mg/L with a maximum of 10.2 mg/L TN occurring in May. These values assume the current planting schedule of corn in summer and a winter cover crop of wheat is continued through 2030. The full nitrogen balance for the WNRWF is available in Appendix B.

Based on these two analyses, the WNRWF will be limited by annual TN loading. The maximum quantity of effluent spray irrigated cannot exceed 1.8 mgd on an annual average basis (2.3 mgd on a max month basis), even though the state spray application permit allows a hydraulic land application rate of up to 3.1 mgd as a maximum monthly average. Table 7.1-1 summarizes the performance characteristics of the WNRWF under Alternative 1.

Table 7.1-1: Alternative 1 Disposal Capacity Summary

Parameter	Value
Max Month ADF (mgd)	2.3
Summer ADF (mgd)	2.2
Winter ADF (mgd)	1.6
Annual ADF (mgd)	1.8
Effluent TN Conc. (mg/L)	23
Effluent TN Loading (lbs/ac/yr)	395

In order to spray apply more effluent in this alternative, the existing treatment lagoons would need to be replaced with a nitrogen removal process such as the activated sludge system being designed for the IBRWF. This upgrade would be quite costly and only result in the ability to marginally increase effluent disposal capacity from an annual ADF of 1.8 mgd to approximately 2.15 mgd as described in the next section.

7.2 ALTERNATIVE 2 DISPOSAL CAPACITY

In Alternative 2 the RBSTP will continue to operate. The treated effluent will be pumped directly into the WNRWF effluent storage lagoon to be discharged via spray irrigation. Because the treated effluent from RBSTP has a low TN concentration, both hydraulic loading and nutrient limits have to be considered.

In 2030, the RBSTP is expected to contribute a summer average of 2.3 mgd and a 0.93 mgd winter average. At this time, the entities contributing to the WNRWF are estimated to have seasonal averages of 4.2 mgd in summer and 3.1 mgd in the winter. Given the increased flows and the land application permit hydraulic limit of 3.1 mgd as a monthly average, some combination of these flows will be treated at the WNRWF and the remaining wastewater will be sent to the IBRWF or a PWWP.

In the summer, the WNRWF will accept all of the treated effluent from the RBSTP directly into its storage lagoon to be land applied. The remaining 0.8 mgd of disposal capacity will be used for raw wastewater coming from Goslee Creek (GC) and the WRESSD, treated by the existing lagoons at the WNRWF. Any excess flow from these sewer districts will be sent to the IBRWF or a PTWP. Because the WNRWF has a large effluent storage lagoon, operations has the flexibility to potentially accept more wastewater in the summer from GC and the WRESSD as long as spray conditions allow and the effluent storage lagoon will be empty by the middle of fall (beginning of October).

Even though the summer averages are being used to define the operating schedule, the facility has to be able to accommodate maximum monthly flows in its storage lagoon. For the RBSTP in 2030, the maximum monthly flow is 2.5 mgd and the summer average is 2.3 mgd, a difference of 0.2 mgd. Over the span of a month (31 days assuming July is the maximum month), the total volumetric difference of treated effluent is 6.2 million gallons. The WNRWF historically has a 1.05 peaking factor; applied to the 0.8 mgd flow in 2030, the peak monthly flow would be 0.85 mgd. The total volumetric difference for the GC and WRESSD flows between an average month and maximum month is 1.5 million gallons. Together, the total excess volume of water for a maximum month is 7.7 million gallons. With a 69 MG capacity, the effluent storage lagoon will easily be capable of handling this extra volume. Figures 7.2-1 and 7.2-2 illustrate these calculations graphically.

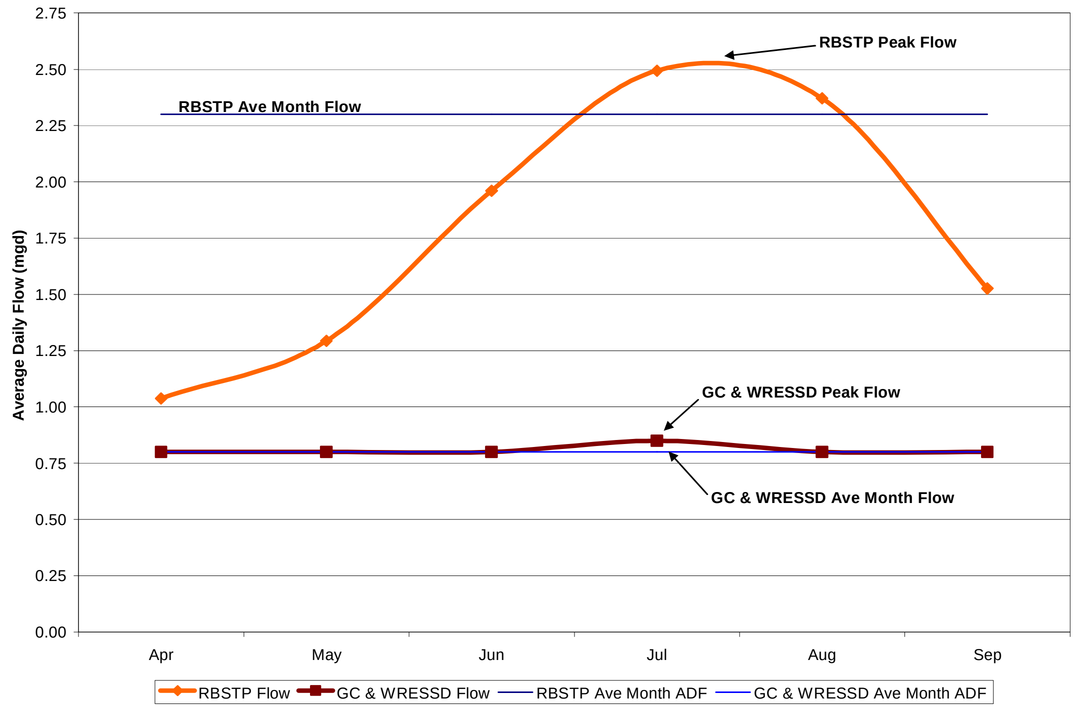


Figure 7.2-1: 2030 Summer Flows to WNRWF

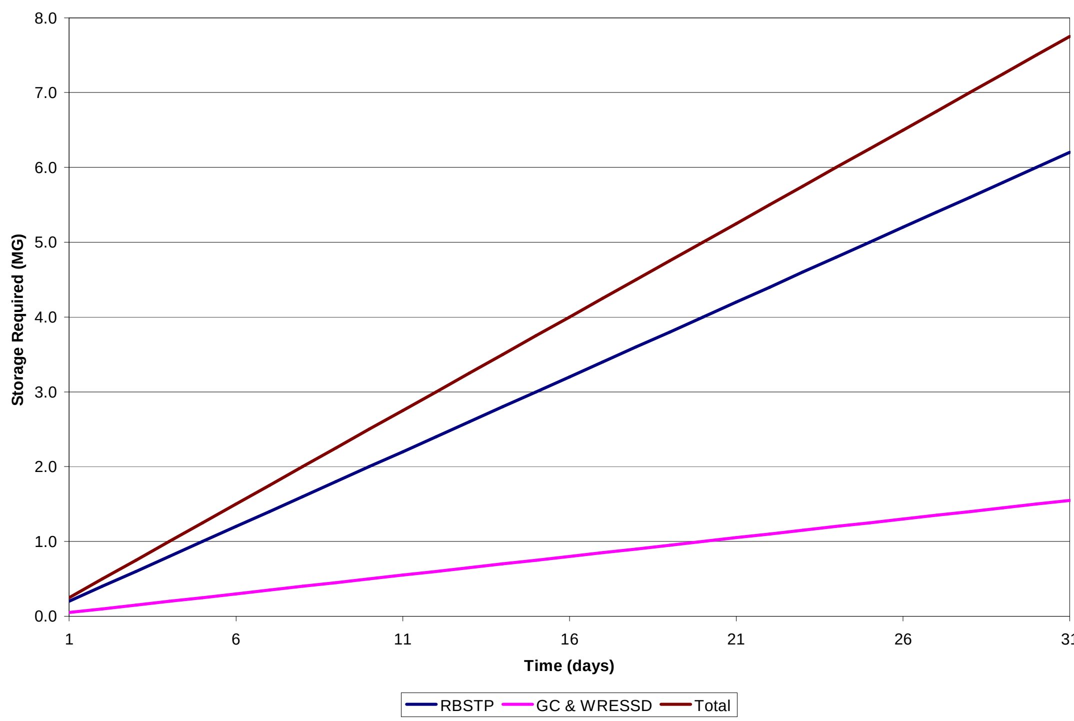


Figure 7.2-2: 2030 Alternative 2 Summer Storage Required

It is recommended that the WNRWF treat a constant monthly average of 0.8 mgd year-round, even though flows from RBSTP are lower in the winter months. Added to the expected 0.93 mgd from RBSTP, the total amount discharged in the winter will average approximately 1.73 mgd. This is approximately 30% more flow than is currently disposed of during the winter at the WNRWF based on 2005 to 2008 spray application data for the months of December through February. However, improvements currently being implemented to the WNWRF spray irrigation system will allow for increased spray coverage and, therefore, quantity during winter operation. The operators at the WNRWF were able to operate the spray irrigation system approximately 14.6 days per month during the winter from 2005 through 2008 compared to 24.2 days per month in the summer over the same period. If the facility can apply wastewater at the equivalent permitted spray rate of 3.1 mgd in the summer and the spray rate is proportionally reduced during the winter (14.2 days vs. 24.2 days, or 60%) disposal of up to 1.8 mgd should be possible in the winter after the irrigation rig optimization is completed. Deep plowing or other spray field improvements may also be required to maximize field disposal potential.

Maintaining a constant flowrate of 0.8 mgd is intended to keep plant operations relatively simple year round. Also, given the difficulty inherent to the spray application of wastewater in the winter, the reduced flowrate will provide a buffer if the fields cannot be sprayed for extended amounts of time due to unfavorable weather conditions. At an average daily flow rate of 1.73 mgd, the effluent storage lagoon can provide storage for just less than 40 days during the winter. WNWRF has recently converted the third treatment lagoon for winter storage. This adds approximately 28 MG of storage, which increases the total amount of storage to over 55 days.

Table 7.2-1 summarizes the seasonal treatment patterns for Alternative 2.

Table 7.2-1: 2030 Alternative 2 Disposal Capacity Summary

Facility	Max Month ADF (mgd)	Summer ADF (mgd)	Winter ADF (mgd)	Annual Average ADF (mgd)
RBSTP	2.5	2.3	0.93	1.35
WNRWF	0.8	0.8	0.8	0.8
Total	**3.3(1)**	**3.1**	**1.7**	**2.15**

Notes:
1. All flow in excess of 3.1 mgd, approximately 0.2 mgd, will be stored in the effluent storage lagoon to be discharged during a month with less flow.

Nitrogen loading also has to be considered in this scenario. The 396 lbs TN / ac/ yr loading limit translates into 126,000 lbs TN annually, assuming it is evenly spread across 319 acres. In 2030, the RBSTP is estimated to produce 24,700 lbs TN using the assumed values of 6.0 mg/L of TN and 1.35 mgd annual ADF. Because the amount of wastewater being treated at the WNRWF is decreasing to 0.8 mgd, effluent performance is expected to increase. Assuming a linear relationship between flowrate and performance (as in the Alternative 1 scenario), the estimated effluent TN concentration at an annual average daily flowrate of 0.8 mgd is 10.4 mg/ L. With this concentration and a 0.8 mgd flowrate, the total annual TN loading is estimated to be 25,300 lbs. The total annual TN loading for the facilities is 58,200 lbs, well under the allowable loading limit of 126,000 lbs TN. Table 7.2-2 summarizes these values.

Table 7.2-2: 2030 Alternative 2 Projected TN Loading

Treatment Facility	Annual Average Flow (mgd)	TN Concentration (mg/L)	TN Loading (lbs/yr)
RBSTP	1.35	8.0	33,000
WNWRF	0.8	10.4	25,300
Total	**2.15**	**8.9(1)**	**58,200**

Notes:
1. 8.9 mg/L TN concentration is a blended average of the effluent concentrations from RBSTP and WNRWF.

Using these performance values, the average TN percolate concentration was checked to make sure it did not exceed permissible limits. a nitrogen balance yielded an annual average percolate concentration of 1.4 mg/L with a maximum of 2.4 mg/L TN occurring in May. This calculation takes into account the same assumptions for the WNRWF crop planting schedule. The full nitrogen balance for this scenario is provided in Appendix B.

In Alternative 2, the WNRWF disposal capacity is limited by a combination of hydraulic loading limits and effluent storage capacity. At an annual average of 2.15 mgd, it can spray apply more effluent than Alternative 1 by 0.35 mgd as an annual average. The maximum month capacity for Alternative 2 is 3.3 mgd compared to 2.3 mgd for Alternative 1.

7.3 ALTERNATIVE 3 DISPOSAL CAPACITY

In Alternative 3, the WNRWF will only treat influent wastewater from its existing service area, GCSSD and WRESSD. The RBSTP will continue to operate and discharge its treated effluent via an ocean outfall; no pump station conveying wastewater to the WNRWF, raw or treated, will be constructed. All wastewater that exceeds the WNRWF treatment or disposal capacity will be pumped to the IBRWF for treatment and disposal.

Similar to Alternative 1, the disposal capacity of the WNRWF is constrained by nutrient loading. Without treatment upgrades, the expected effluent performance is identical to that discussed in Section 7.1, an effluent TN concentration 23 mg/L at an annual average flow of 1.8 mgd. Table 7.4-1 summarizes the disposal capacities for the WNRWF under the Alternative 3 scenario.

Table 7.4-1: Alternative 3 Disposal Capacity Summary

Parameter	Value
Max Month ADF (mgd)	2.3
Summer ADF (mgd)	2.2
Winter ADF (mgd)	1.6
Annual ADF (mgd)	1.8
Effluent TN Conc. (mg/L)	23
Effluent TN Loading (lbs/ac/yr)	395

7.4 ALTERNATIVE 4 DISPOSAL CAPACITY

In Alternative 4, the WNRWF will only treat influent wastewater from its existing service area, GCSSD and WRESSD. The RBSTP will continue to operate and discharge its treated effluent via an ocean outfall; no pump station conveying wastewater to the WNRWF, raw or treated, will be constructed. The WNRWF will expand and upgrade its treatment capacity to accommodate the entire 2030 design influent wastewater flow of 4.4 mgd on a maximum monthly basis. Treated wastewater that exceeds the WNRWF disposal capacity will be pumped to the Rehoboth ocean outfall for disposal.

For this alternative, the current WNRWF treatment lagoons will continue to operate without improvements and treat up to 2.3 mgd on a maximum month basis. At this point, the disposal capacity will become nutrient limited. The year 2030 excess flow above 2.3 mgd, 2.1 mgd on a maximum month basis, will be treated separately through an independent treatment train designed to achieve biological nutrient removal. This treated wastewater will be pumped to the Rehoboth Beach ocean outfall. The treated effluent being disposed at the WNRWF site is identical to the Alternative 1 and 3 scenarios, and is summarized in Table 7.5-1.

Table 7.5-1: Alternative 3 Disposal Capacity Summary

Parameter	Value
Max Month ADF (mgd)	2.3
Summer ADF (mgd)	2.2
Winter ADF (mgd)	1.6
Annual ADF (mgd)	1.8
Effluent TN Conc. (mg/L)	23
Effluent TN Loading (lbs/ac/yr)	395

7.5 RECOMMENDED IMPROVEMENTS FOR ALTERNATIVE 1

Based on the projected influent flows, the WNRWF headworks will need to be upgraded. A two-phase approach is proposed. Phase 1 will be completed for the projected 2030 flows, and Phase 2 will have the capacity for the ultimate build out design. A summary of these flows and the corresponding pump stations is presented in Table 7.5-1.

Table 7.5-1: Alternative 1 Projected Influent Pumping to WNRWF

Entity	Year 2030 (mgd)(1)	Ultimate Design (mgd)(1)
Goslee Creek	0.6	6.5
Northern WRE Expansion	N/A	1.1
RBSTP	10.2	10.2
WRESSD	16.7	20.7
Total	**27.5**	**39.1**

Notes:
1. Pumping capacity given as peak capacity.

Phase 1 will increase the headworks capacity to handle the projected 2030 peak flowrate of 27.5 mgd. The upgrade will include a new headworks facility with two mechanical screens capable of handling the peak flowrate and a third parallel channel with an overflow weir and manual bar rack. The screens will discharge to a screw conveyor, which will bring the screenings to a compactor where the screenings will be washed and dewatered prior to discharge into a dumpster. Motorized gates will be used to isolate screenings channels for maintenance. All equipment will be enclosed in a heated block building for weather protection. Screened effluent will be routed to a new Transfer Pumping Station. A pipe from the Transfer Pumping Station will connect to a junction box to direct WNWRF influent to either treatment lagoon No. 1 or No. 2. The invert of the pipe to the junction box will be set above the normal water level in the pumping station so only flow in excess of the pumping set point will be directed to the treatment lagoons, as shown schematically in Figure 7.5-1. The new building will also contain an electrical room. A site plan of the proposed headworks and Transfer Pumping Station is shown in Figure 7.5-2

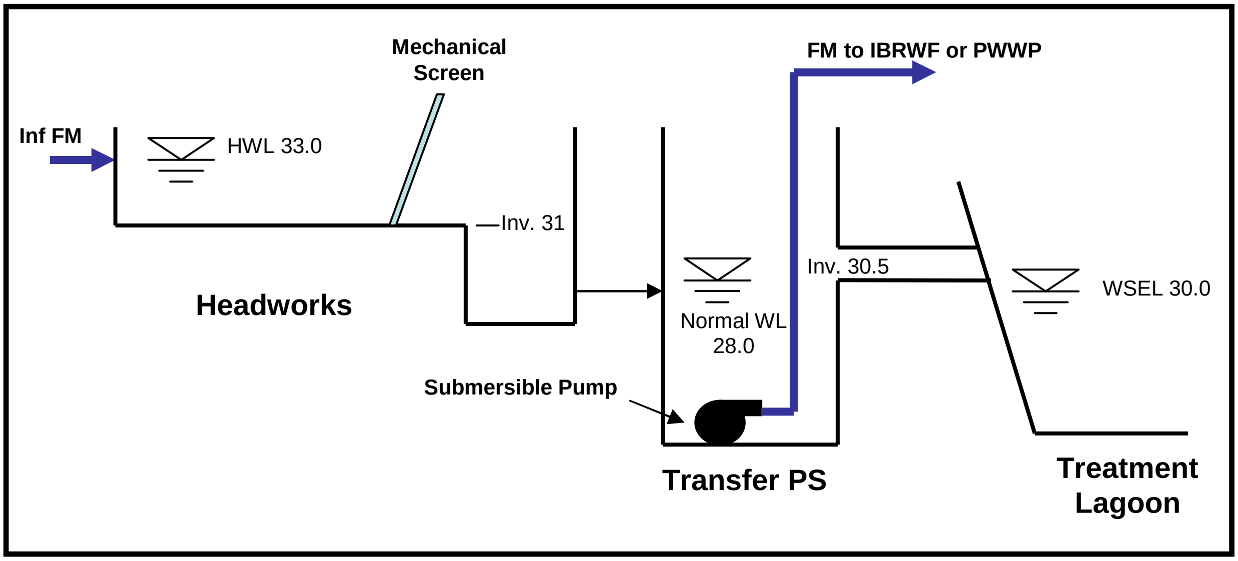


Figure 7.5-1: WNWRF Headworks and Transfer PS Flow Schematic

The Transfer Pump Station will send any flows above the WNRWF spray disposal capacity (2.3 mgd during the maximum month, 1.6 mgd in winter) to the IBRWF.

Table 7.5-2: Alternative 1 Flow Balance for 2030

Flows	Max Month ADF (mgd)	Summer ADF (mgd)	Winter ADF (mgd)	Annual ADF (mgd)
Flows To WNRWF (+)	4.4	4.2	3.1	3.5
RBSTP to WNRWF (+)	2.5	2.3	0.9	1.4
WN Disposal Capabilities (-)	2.3	2.2	1.6	1.8
Net Pumped Flow to IBRWF	**4.6**	**4.3**	**2.4**	**3.1**

In 2030, the estimated maximum monthly flow that will have to be sent to the IBRWF is approximately 4.6 mgd. The Transfer Pumping Station will be sized to pump 150% of the maximum monthly transfer flow, 6.9 mgd, to account for diurnal flow variations. The transfer pumps will operate on VFDs which ramp up and down on a pre-set diurnal flow pattern to mimic actual dry-weather diurnal flows. During storm events or other peak flows periods when actual influent flow exceeds the pre-set transfer flow, the excess flow will automatically be conveyed into the treatment lagoons when the normal high water level in the wet well is exceeded.

For ultimate build out, the headworks facility will be expanded to handle a peak flow of 39 mgd. To do so, a third fine screen will be fitted into the Phase 1 overflow channel. An overflow pipe will need to be added at this time as an emergency bypass around the screens. Table 7.5-3 shows the projected flowrates to the IBRWF or a PWWP for the ultimate design.

Table 7.5-3: Alternative 1 Flow Balance for Ultimate Design

Flows	Max Month ADF (mgd)	Summer ADF (mgd)	Winter ADF (mgd)	Annual ADF (mgd)
Flows To WNRWF (+)	7.2	6.9	5.1	5.7
RBSTP to WNRWF (+)	3.4	3.1	1.2	1.8
WN Disposal Capabilities (-)	2.3	2.2	1.6	1.8
Net Pumped Flow to IBRWF or PWWP	**8.3**	**7.8**	**4.7**	**5.7**

To account for diurnal flow variations, the Transfer Pumping Station will be sized for an annual average flow of 12.5 mgd (150% of the projected maximum month average daily flow).

7.6 RECOMMENDED IMPROVEMENTS FOR ALTERNATIVE 2

The same two phase approach will be taken if Alternative 2 is selected. However, the capacity will be reduced because the RBSTP will pump directly into the effluent storage lagoon. A summary of the projected flows for Alternative 2 is shown in Table 7.6-1.

Table 7.6-1: Alternative 2 Projected Influent Pumping to WNRWF

Entity	Year 2030 (mgd)(1)	Ultimate Design (mgd)(1)
Goslee Creek	0.6	6.5
Northern WRE Expansion	N/A	1.1
WRESSD	16.7	20.7
Total	17.3	28.3

Notes:
1. Pumping capacity given as peak capacity.

Phase 1 will include the same headworks building and electrical room as Alternative 1, but the screen sizes will be reduced accordingly. The WNRWF only treats 0.8 mgd year round in this scenario; all raw wastewater in excess of that amount is sent to the IBRWF. Table 7.6-2 shows the seasonal projected flowrates to be transferred to the IBRWF or a PWWP in 2030.

Table 7.6-2: Alternative 2 Flow Balance for 2030

Flows	Max Month ADF (mgd)	Summer ADF (mgd)	Winter ADF (mgd)	Annual ADF (mgd)
Flows To WNRWF (+)	4.4	4.2	3.1	3.5
WN Disposal Capabilities (-)	0.8	0.8	0.8	0.8
Net Pumped Flow to IBRWF or PWWP	**3.6**	**3.4**	**2.3**	**2.7**

To account for diurnal flow variations, the Transfer Pumping Station will be sized for maximum month average daily flow of 5.4 mgd (150% of the projected maximum month average daily flow).

Phase 2 will use the same strategy as Alternative 1 to increase capacity. A third fine screen will be fitted to the existing overflow channel; allowing the WNRWF to handle the 28.3 mgd projected flow. An overflow channel will be added in this phase. Table 7.6-3 shows the projected flowrates to the IBRWF or a PWWP for the ultimate design.

Table 7.6-3: Alternative 2 Flow Balance for Ultimate Design

Flows	Max Month ADF (mgd)	Summer ADF (mgd)	Winter ADF (mgd)	Annual ADF (mgd)
Flows To WNRWF (+)	7.2	6.9	5.1	5.7
WN Disposal Capabilities (-)	0.8	0.8	0.8	0.8
Net Pumped Flow to IBRWF or PWWP	**6.4**	**6.1**	**4.3**	**4.9**

To account for diurnal flow variations, the Transfer Pumping Station will be sized for a maximum month average daily flow of 9.6 mgd (150% of the projected maximum month average daily flow).

7.7 RECOMMENDED IMPROVEMENTS FOR ALTERNATIVES 3 AND 4

The influent wastewater flowrates to the WNRWF for Alternatives 3 and 4 are identical to those for Alternative 2. The two phase upgrade schedule will be designed for 2030 design flows and ultimate design flows, which are summarized in Table 7.7-1 below.

Table 7.7-1: Alternatives and 4 Projected Influent Pumping to WNRWF

Entity	Year 2030 (mgd)(1)	Ultimate Design (mgd)(1)
Goslee Creek	0.6	6.5
Northern WRE Expansion	N/A	1.1
WRESSD	16.7	20.7
Total	17.3	28.3

Notes:

1. Pumping capacity given as peak capacity.

The influent Phase 1 wastewater will flow into a common headworks designed to handle the above 2030 design flows. The headworks and electrical will be identical to the facilities described in Section 7.6.

In Alternative 3, the screened effluent will flow to a new Transfer Pump Station like the station designed for the Alternative 1 scenario. The Transfer Pump Station facility designed for either Alternative 3 will be reduced due to a lesser pumped flowrate. Any wastewater in excess of 2.3 mgd on a maximum monthly basis will be pumped to the IBRWF for treatment and disposal. Table 7.7-2 summarizes the transfer flowrates.

For Alternative 4, the screened effluent will be separated and sent to one of two treatment trains at the WNRWF. On a maximum monthly basis, 2.3 mgd will be treated and discharged through the existing partially aerated lagoon system and discharged via spray irrigation. Any flow above the 2.3 mgd threshold will be sent to a new treatment facility on site that is capable of achieving biological nutrient removal. Due to the RBSTP permit limits, biological nutrient removal treatment will be required for all treated wastewater to be discharged via the ocean outfall. Due to limited space on the existing treatment facility property, a treatment operation with a small footprint, such as membrane biological reactors (MBR) or sequencing batch reactors (SBR) would likely be required. The new treatment train would also include disinfection and solids handing, if required. A new pump station will be constructed to pump the treated effluent to the Rehoboth Beach ocean outfall. Table 7.7-2 summarizes the transfer flowrates.

Table 7.7-2: Alternatives 3 and 4 Flow Balance for 2030

Flows	Max Month ADF (mgd)	Summer ADF (mgd)	Winter ADF (mgd)	Annual ADF (mgd)
Flows To WNRWF (+)	4.4	4.2	3.1	3.5
WN Disposal Capabilities (-)	2.3	2.2	1.6	1.8
Net Pumped Flow from WNRWF(1)	**2.1**	**2.0**	**1.5**	**1.7**

Note:
1. For Alternative 3 excess wastewater would be pumped to the IBRWF . For Alternative 4 treated effluent would be pumped to the Rehoboth Beach ocean outfall.

To account for diurnal flow variations, the Transfer Pumping Station will be sized for maximum month average daily flow of 3.2 mgd (150% of the projected maximum month average daily flow).

For the Ultimate Design flow the proposed headworks, treatment, pump facilities will be increased as necessary. Table 7.7-3 summarizes the pumping capacity required to accommodate the Ultimate Design flowrates.

Table 7.7-3: Alternatives 3 and 4 Flow Balance for Ultimate Design

Flows	Max Month ADF (mgd)	Summer ADF (mgd)	Winter ADF (mgd)	Annual ADF (mgd)
Flows To WNRWF (+)	7.2	6.9	5.1	5.7
WN Disposal Capabilities (-)	2.3	2.2	1.6	1.8
Net Pumped Flow from WNRWF(1)	**4.9**	**4.7**	**3.5**	**3.9**

Note:

1. For Alternative 3 excess wastewater would be pumped to the IBRWF. ForvAlternative 4 treated effluent would be pumped to the Rehoboth Beach ocean outfall.

To account for diurnal flow variations, the Transfer Pumping Station will be sized for a maximum month average daily flow of 7.4 mgd (150% of the projected maximum month average daily flow).

7.8 WOLFE NECK RWF UPGRADE PRLEMINARY COST ESTIMATES

Wolfe Neck RWF will need to increase its preliminary treatment capacity to be able to handle the projected influent flow rates. This section discusses the methodology and presents the capital costs for the recommended improvements for both Alternative 1 and Alternative 2. The conceptual design will allow the WNRWF to accommodate the projected 2030 flows. All dollar amounts are presented in year 2009 dollars.

Several different sources of information were consulted to develop the capital cost estimations. Where recent contractor bids or vendor proposals are available for similar projects, they have been used. If neither contractor bids nor proposals are available, quantity takeoffs were computed based on the conceptual designs described in sections 7.5 through 7.7.

Costs described in this section are based on conceptual design. As such, a level of detail appropriate to such a design was considered during the development of costs. Conceptual design does not provide the resolution needed for quantification of all construction materials. In recognition of this fact, percentages of construction cost have been applied to such items as piping, electrical, and site work. The percentages used for these items are summarized below:

- A 10% contingency was included with all construction costs.
- Yard Piping: 9% of subtotal.

- Electrical: 20% of subtotal.
- Planning, Engineering, and Administrative Services: 22% of subtotal.

Tables 7.8-1 through 7.8-3 below summarize the total capital costs for the WNRWF Headworks and Treatment upgrade for all four Alternatives.

Table 7.8-1: Estimated Alternative 1 Phase 1 Headworks Probable Project Cost

Description	Estimated Cost
Civil	$65,000
Structural	$151,000
Building Cost	$47,000
Screening Equipment	$634,000
Flow Measuring Equipment	$40,000
Plumbing	$10,000
Subtotal	**$947,000**
Yard Piping @ 9% of Subtotal	$85,000
Electrical @ 20% of Subtotal	$189,000
Site work @ 3% of Subtotal	$28,000
Startup @ 2% of Subtotal	$19,000
Subtotal	**$1,267,000**
General Conditions @ 5% of Subtotal	$63,000
Overhead @ 10% of Subtotal	$133,000
Profit @ 5% of Subtotal	$67,000
Subtotal	**$1,530,000**
Contingency @ 10% of Subtotal	$153,000
Total Construction Cost (Year 2009 Dollars)	**$1,683,000**
Planning, Engineering, and Admin @ 22% of Subtotal	$370,000
Total Project Cost (Year 2009 Dollars)	**$2,050,000**

Table 7.8-2: Estimated Alternatives 2, 3, and 4 Phase 1 Headworks Probable Project Costs

Description	Estimated Cost
Civil	$56,000

Structural	$114,000
Building Cost	$38,000
Screening Equipment	$542,000
Flow Measuring Equipment	$40,000
Plumbing	$10,000
Subtotal	**$800,000**
Yard Piping @ 9% of Subtotal	$72,000
Electrical @ 20% of Subtotal	$160,000
Site work @ 3% of Subtotal	$24,000
Startup @ 2% of Subtotal	$16,000
Subtotal	**$1,073,000**
General Conditions @ 5% of Subtotal	$54,000
Overhead @ 10% of Subtotal	$113,000
Profit @ 5% of Subtotal	$56,000
Subtotal	**$1,296,000**
Contingency @ 10% of Subtotal	$130,000
Total Construction Cost (Year 2009 Dollars)	**$1,430,000**
Planning, Engineering, and Admin @ 22% of Subtotal	$314,000
Total Project Cost (Year 2009 Dollars)	**$1,740,000**

Table 7.8-3: Estimated Alternative 4 Phase 1 Treatment Probable Project Costs

Description	**Estimated Cost**
Total Treatment Costs @ $10 per gallon	$21,000,000
Total Project Cost (Year 2009 Dollars)	**$21,000,000**

The civil site work includes the fill required to raise the headworks area to match the existing berm elevation, as well as any bedding and paving costs. Structural costs consist of the concrete needed for the facility and building costs include items such as aluminum grating and stairs. The screening equipment includes almost all of the mechanical equipment inside the headworks: mechanical screens and a manual bar rack, screenings conveyor, slide gates, a hoist, dumpster and insulation and heat tracing for all of the equipment that will require it. Flow measuring equipment includes the flow meter itself as well as a vault to house the device. All other costs were calculated as a percentage of the subtotals and construction costs. Appendix D contains a detailed cost estimate for the headworks for both Alternative 1 and Alternative 2.

8. WOLFE NECK BAYS CONVEYANCE SYSTEM

This chapter presents the alternative alignments and associated costs for conveying flows from the WNRWF to either the IBRWF (Alt. 1A,2A,3), PWSP (Alt 1B, 2B), or a combined City/County ocean outfall (Alt 4). A Hazen-Williams "C-factor" of 140 is used for all hydraulic computations for new PVC pipeline and a "C-factor" of 100 for DIP. The target design velocity for all force mains is 3 to 5 feet per second (ft/s). All flow projections referenced in this chapter are provided in Appendix B.

Cost estimates are provided for Wolfe Neck Conveyance system for the various alternatives. However, this conveyance system is just one component of the cost sharing model as further described in Chapter 10.

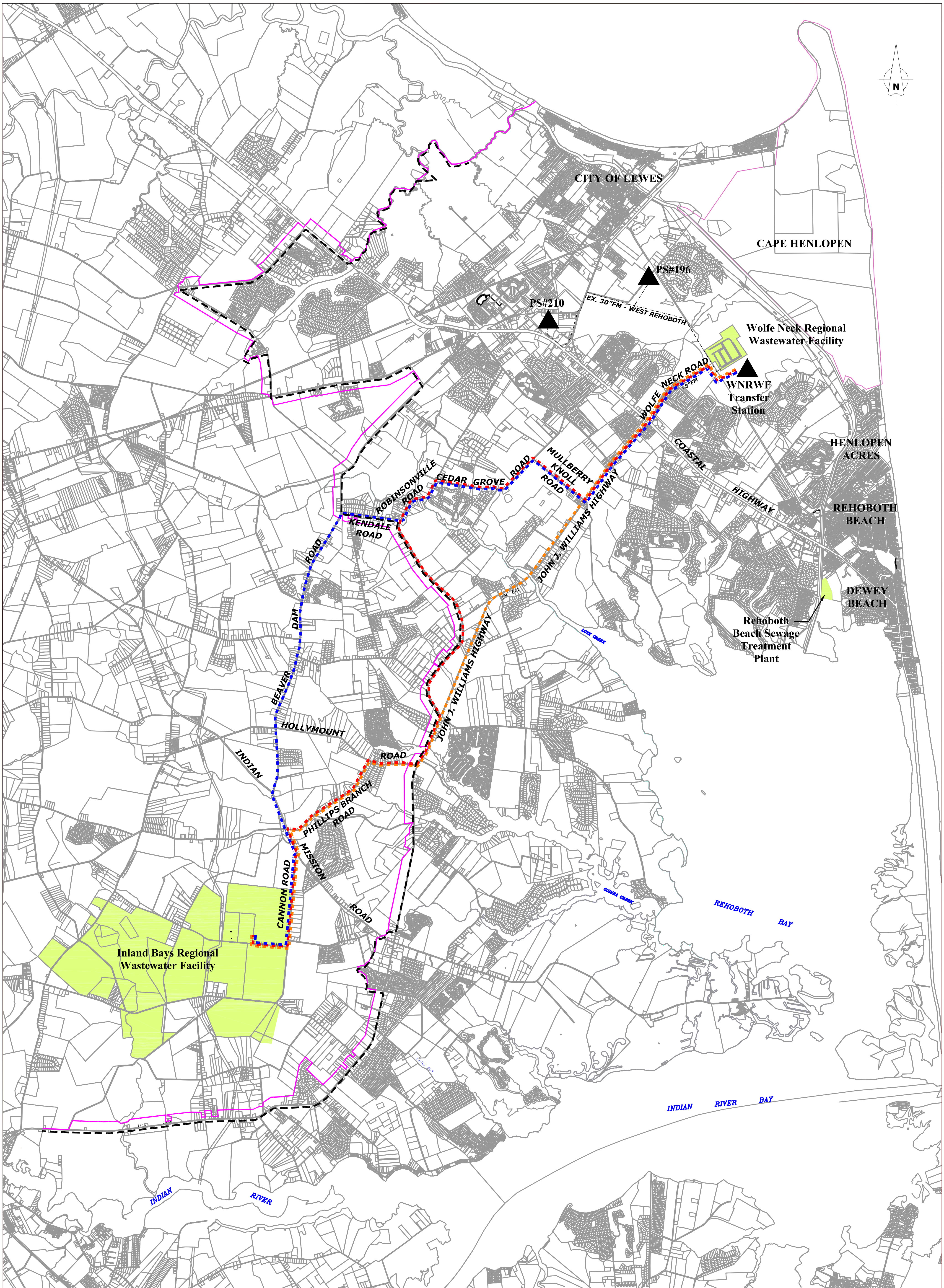
8.1 ALTERNATIVE 1A, 2A, AND 3

8.1.1 ALIGNMENT ALTERNATIVES

Three alignments were evaluated for the conveyance of wastewater from the WNRWF to the IBRWF Figure 8.1.1-1 indicates three potential force main alignments from the WNRWF to the IBRWF.

Alignment Option #1 involves the installation of approximately 58,900 lf of force main south from the WNRWF along Wolfe Neck Road, crossing underneath Coastal Highway along John J. Williams Highway to Hollymount Road, where it will run west to Phillips Branch Road, then southwest to Indian Mission Road, then south to Cannon Road and then west on Inland Bays Road to the IBRWF headworks.

Alignment Option #2 involves the installation of approximately 72,600 lf of force main along a similar alignment to the intersection of John J. Williams Highway and Mullberry Knoll Road, where it will run west to Cedar Grove Road and then south along



WR&A
Whitman, Requardt & Associates LLP
in association with
STEARNS & WHELER LLC
Environmental Engineers and Scientists

LEGEND

- Aligment Option #1
- Aligment Option #2
- Aligment Option #3
- Existing Infrastructure
- Inland Bays Planning Area Boundary
- Environmentally Sensitive Development Area

JOINT SUSSEX COUNTY/CITY OF REHOBOTH BEACH LAND APPLICATION PROJECT

SUSSEX COUNTY, DELAWARE

Figure 8.1-1
October 2009

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Robinsonville Road to the intersection of John J. Williams Highway. From this point, it will follow the same alignment as Option #1 to the IBRWF headworks.

Alignment Option #3 involves the installation of approximately 68,600 lf of force main following a similar alignment as Option #2 to the intersection of Robinsonville Road and Kendale Road, at which point it will run west to Beaver Dam Road, then south to Indian Mission Road. From this point it will follow the same alignment as Options #1 and #2 along Indian Mission Road to the IBRWF headworks.

8.1.2 FORCE MAIN HYDRAULICS

As outlined in Chapter 7, the Wolfe Neck transfer pump station for Alt. 1A (raw wastewater), Alt. 2A (treated effluent) and Alt. 3 (County only flows) will be required to pump 6.9 mgd, 5.4 mgd, and 3.2 mgd respectively in year 2030. Table 8.1.2-1 summarizes the hydraulic calculations for all three treatment alternatives for all three alignment options in year 2030.

Table 8.1.2-1: Alternative 1A, 2A and 3 Hydraulics Summary

Treatment Alternative				Alignment Option #1 John J. Williams Highway (SR.24)		Alignment Option #2 Robinsonville Road (CR 277)		Alignment Option #3 Beaver Dam Road (SR 23)	
	Peak Q (mgd)	FM Size (in)	Vel. (1) (ft/s)	Length (ft)	TDH(1) (ft)	Length (ft)	TDH (1) (ft)	Length (ft)	TDH (1) (ft)
Alt 1A	6.9	24	3.7	58,900	155	72,600	178	68,600	171
Alt 2A	5.4	24	2.9	58,900	118	72,600	133	68,600	129
Alt 3	3.2	18	3.0	58,900	150	72,600	172	68,600	160

Notes:

1. Velocities and head losses are based on C-900 PVC reduced interior diameters (i.e. 23" inside diameter for a 24"FM).

The velocities and head conditions presented in these tables represent a preliminary evaluation, as the final length of the alternative route will impact actual headlosses.

Based on this information the recommended force main size is 24-inches for Alt. 1A and 2A and 18-inches for Alt. 3.

There is the potential for a portion of these proposed force mains to be shared with a proposed Angola Neck Sanitary Sewer District Regional Force Main, which is slated for construction in the spring of 2010. This force main follows the same alignment as Option #1 from the intersection of Robinsonville Road (CR 277) and John J. Williams Highway (SR 24) down to the IBRWF. The portion of this force main from Indian Mission Road (SR 5) to the IBRWF could be shared with alignment Option #3.

8.1.3 PUMP STATION DESIGN

The proposed stations in these alternatives would be designed as a three pump station, with two pumps operating and one stand-by pump. Table 8.1.3-1 summarizes the ranges of pump sizes required each alignment option.

Table 8.1.3-1 Preliminary Pump Size

	Alignment Option #1	Alignment Option #2	Alignment Option #3
	HP Range (per pump)	HP Range (per pump)	HP Range (per pump)
Alternative 1A	160-185	185-250	185-250
Alternative 2A	90-110	160-185	160-185
Alternative 3	80-100	160-185	80-100

Notes:

1) Horsepower ranges supplied are based on preliminary pump selections, assuming a three pump station with two pumps operating and 1 stand-by.

The proposed pumping station for either Alt. 1A or Alt. 2A from the WNRWF to the IBRWF would be large regional pump stations, involving a cast-in-place wetwell with external valve vault and a small control building to house the electrical equipment. Alt. 3 would involve a smaller station with pre-cast wetwell and valve vault structures.

8.1.4 COST ESTIMATES

To account for varying installation conditions, traffic control, and road restoration and requirements, each FM alignment was broken into the following four categories from most expensive to least expensive:

- Major Highway Construction
- Intermediate Highway Construction
- County Road Construction
- Easement Construction

Cost estimate breakdowns for the proposed force mains for each alignment option are provided in Appendix E. Table 8.1.4-1 provides a summary of each alternative.

Table 8.1.4-1 WNRWF to IBRWF Force Main Cost Summary

Force Main Alignment	Estimated Total Project Cost
Option #1 - John Williams Highway	$18,122,000
Option #2 – Robinsonville Road	$19,298,000
Option #3 – Beaver Dam Road	$17,493,000

Based on these cost estimates, Option #3 appears to be the most cost effective alignment. Option #1 is the shortest alignment, but would present the most challenging construction conditions due to the high traffic nature of John J. Williams Highway, along with the significant number of unknowns along this roadway. Option #3 is the preferred alignment as far as overall cost and constructability. One disadvantage of Option #3 is it provides the least amount of potential shared costs with the imminent Angola Neck SSD Force Main to IBRWF.

Cost estimate breakdowns for the proposed pumping stations from the WNRWF to the IBRWF are provided in Appendix E. Table 8.1.4-2 provides a summary of both alternatives.

Table 8.1.4-2 Pumping Station Cost Summary

Force Main Alignment	Estimated Total Project Cost
Alternative 1A (Raw Wastewater PS)	$3,300,000
Alternative 2A (Treated Effluent PS)	$3,050,000
Alternative 3 (County Only)	$2,680,000

8.1.5 SUMMARY

Table 8.1.5-1 provides a summary of the alignment options for the WNRWF to IBRWF alternatives. As stated previously, alignment Option #3 is the preferred alignment.

Table 8.1.5-1 Summary of WNRWF to IBWRF Alignment Options

Description	**<u>Option 1</u>** **John Williams Highway (SR 24)**	**<u>Option 2</u>** **Robinsonville Road (CR 277)**	**<u>Alternative 3</u>** **Beaver Dam Road (SR 23)**
Total length	58,900 feet	72,600 feet	68,600 feet
Size	24 inch	24 inch	24 inch
Pavement restoration length	43,825 feet	41,700 feet	37,850 feet
Potential County Shared Costs	25,400 lf	25,400 lf	10,700 lf
Environmental Ranking	3	2	1
Operation and Maintenance Ranking	1	3	2
Crossings			
Major Roadway Crossings	1) Coastal Highway 2) John J. Williams Hwy.	1) Coastal Highway 2) John J. Williams Hwy.	1) Coastal Highway
Major Stream Crossings	1) Love Creek 2) Burton Prong	1) Burton Prong	None
Minor Stream Crossings	3	6	5
Construction			
Major Highway Installation	28,750	10,800	7,100
Intermediate Highway Installation	1,700	5,000	28,550
County Road Installation	28,450	56,800	32,950
Installation Ranking	**3**	**2**	**1**
Easements			
Temporary Easements	Yes	Yes	Yes
Permanent easements	Yes	Yes	Yes

Notes:

1) Major Roadway Installation refers to John J. Williams Highway, Intermediate Roadway Installation refers to Beaveer Dam Road and Indian Mission Road, County Road Installation refers to installation along all other County Roads.
2) Pavement restoration length was obtained assuming 100% restoration in Major Highways and 50% restoration elsewhere.

8.2 ALTERNATIVE 1B AND 2B

8.2.1 ALIGNMENT ALTERNATIVES

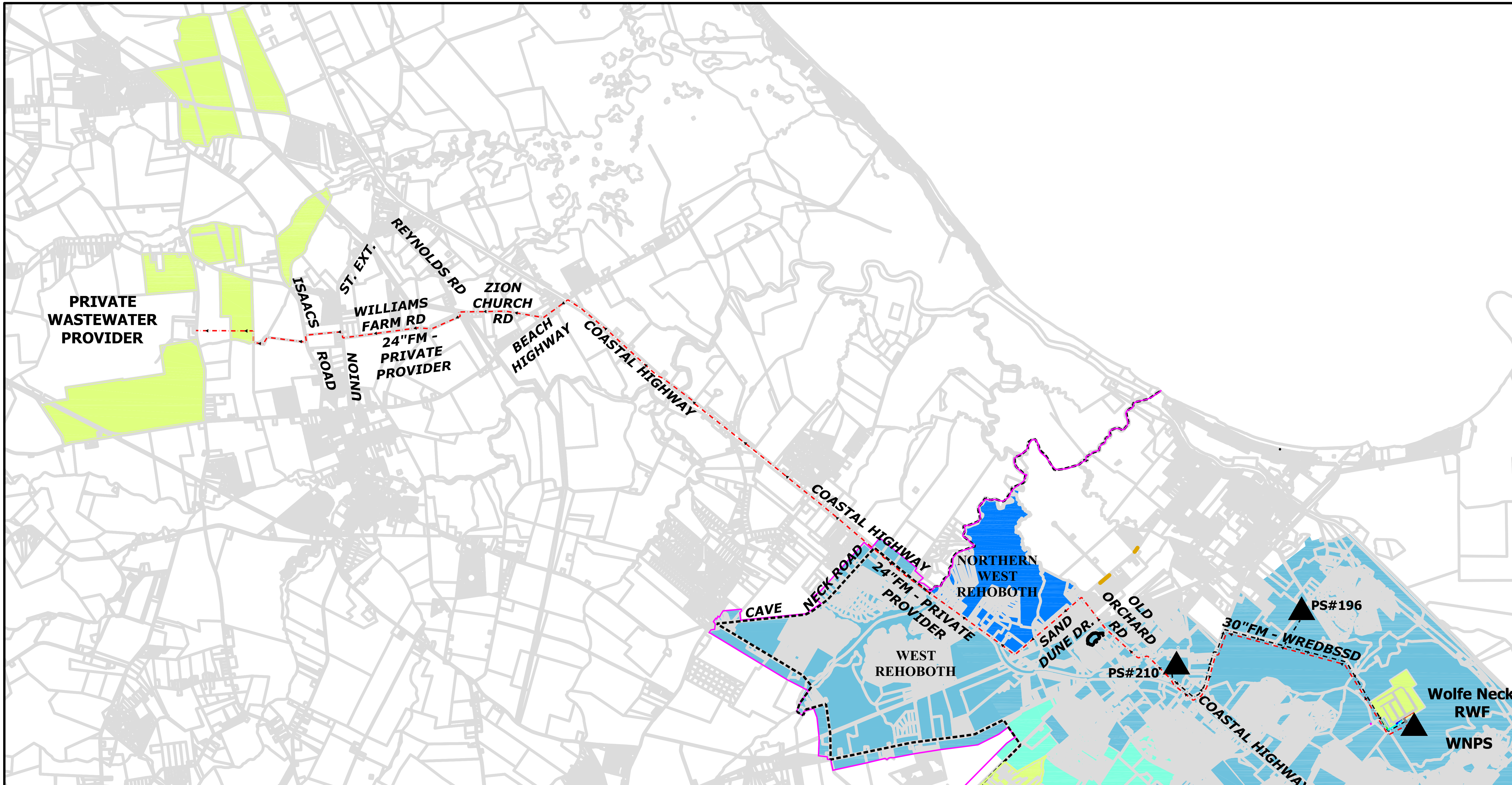
Only one alignment was evaluated to go from the WNRWF to the Private Wastewater Provider's (PWWP) treatment and disposal site. This alignment is indicated on Figure 8.2-1 and is based on a contract proposal received from Artesian Wastewater Services. Similar to Alternatives 1A and 2A, a transfer pumping station will be required at the WNRWF to accept flow in excess of the plant's capacity. This pumping station will pump through a 24-inch force main, approximately 82,000 LF to the treatment and disposal lands. The PWWP has proposed a booster pumping station at the intersection of Coastal Highway and Cave Neck Road in order to accept flow from outside the County's planning area. This station has been excluded from this report since it would provide capacity for flows that are not being contributed by the County.

8.2.2 FORCE MAIN HYDRAULICS

The transfer station for Alt. 1B (raw wastewater) and Alt. 2B (treated effluent) will be required to pump 6.9 mgd and 5.4 mgd respectively in year 2030. Table 8.2.2-1 summarizes the hydraulic calculations for both treatment alternatives.

Table 8.2.2-1: Alternative 1B and 2B Hydraulics Summary

Treatment Alternative	Peak Q	FM Size	Vel. (1)	Length	TDH(1)
	(mgd)	(in)	(ft/s)	(ft)	(ft)
Alt 1B	6.9	24	3.7	82,000	194
Alt 2B	5.4	24	2.9	82,000	143



GRAPHIC SCALE

5000 0 5000 10,000

SCALE: 1" = 5000'

LEGEND

- 24" Force Main from WNRWF to Private Provider
- EX. 30" Force Main from PS#210 to WNRWF
- Inland Bays Planning Area Boundary
- Environmentally Sensitive Development Area
- Sanitary Sewer District Boundary

OCTOBER 2009

WR&A Whitman, Requardt & Associates LLP

in association with

STEARNS & WHELER Environmental Engineers and Scientists

SUSSEX COUNTY ENGINEERING DEPARTMENT
GEORGETOWN, DELAWARE

JOINT SUSSEX COUNTY/CITY OF REHOBOTH BEACH LAND APPLICATOIN PROJECT

FIGURE 8.2-1

The velocities and head conditions presented in these tables represent a preliminary evaluation, as the final length of the alternative route will impact actual headlosses. Based on this information the recommended force main size is 24-inches for both Alt. 1B and 2B.

8.2.3 COST ESTIMATES

Cost estimate breakdowns for the proposed alignment option are provided in Appendix E. This estimate was broken into two sections to maintain constancy with what was presented by the PWWP. Table 8.2.3-1 provides a summary for each section.

Table 8.2.3-1 WNRWF to PWWP Force Main Cost Summary

Force Main Alignment	Estimated Total Project Cost
Section #1 – WNRWF to Cave Neck Road	$9,240,000
Section #2 – Cave Neck Road to the PWWP site	$11,820,000
Total	**$21,060,000**

As compared to Alternatives 1A and 2A, Alternative 1B and 2B would result in higher costs due to larger pumps and associated electrical gear. This is due to the higher associated TDH from the longer pumping distance. However, the costs for the pump station structures and mechanical piping would be similar. Cost estimate breakdowns for Alt. 1B and 2B stations were assumed to be the same as those previously presented for Alt. 1A and 2A respectively.

8.3 ALTERNATIVE 4

8.3.1 ALIGNMENT

For Alternative 4, all flows from the West Rehoboth District and future Goslee Creek District would be treated at the WNRWF. All excess flows that could not be disposed of at the WNRWF would be disposed of through a combined City/County ocean outfall. For this analysis, it is assumed that the force main from the Wolfe Neck Transfer PS would manifold into the Rehoboth force main and be conveyed by a common effluent force main to the ocean outfall.

In chapter 5, two alignment options were reviewed for the proposed force main from Rehoboth to WNRWF, with alignment option #1 chosen as the recommended alternative. This same alignment corridor would be recommended for the alternative alignment from WNRWF to Rehoboth. See Chapter 5 for alignment specifics.

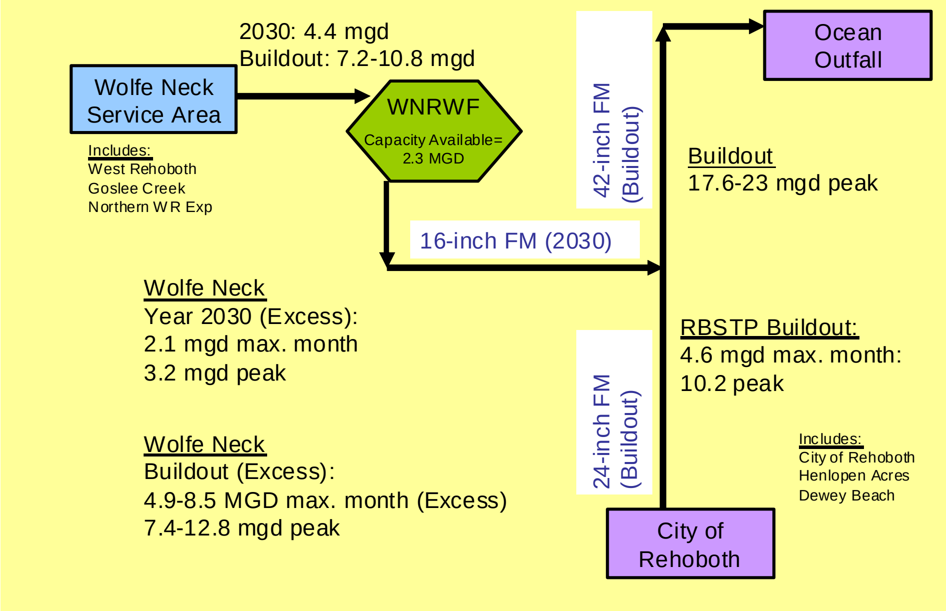
8.3.2 FORCE MAIN HYDRAULICS

To remain consistent with the cost analysis performed for other alternatives, the WNRWF to Rehoboth FM was sized for year 2030 flows. For the WNWRF, the projected 2020 maximum month flow is 4.4 mgd (based on 150 gpd/EDU). Similar to other alternatives, it was assumed that 2.3 mgd would be disposed of at the WNRWF and the rate to be pumped by the Wolfe Neck Transfer Pump Station is 150% of the excess maximum month or 1.5*(4.4 mgd-2.3 mgd) = 3.2 mgd. This 2030 flowrate would require a 16-inch FM from the WNTPS to the Rehoboth effluent force main manifold.

All ocean outfall alternatives presented by Rehoboth were based on buildout flows of 3.4 mgd for maximum month and 10.2 mgd at an instantaneous peak. For these flows, a 24-inch effluent force main and ocean outfall was recommended in the Rehoboth Beach Alternative Discharge Evaluation. For the combined City/County ocean outfall, all flows were also analyzed on a buildout basis. The buildout design for the WNRWF has been projected at 7.2 mgd based on 150 gpd/EDU. Assuming 2.3 mgd is disposed of at the WNRWF, the peak County contribution to the outfall would be (7.2 mgd-2.3 mgd)*1.5=7.4 mgd. The combined City/County flow through the effluent force main and outfall would be 17.6 mgd. Based on this design rate, the effluent force main and ocean outfall would need to be 36-inches at a design velocity of approximately 4 ft/s.

If Alternative 4 is implemented, considering the expense of installing the ocean outfall and the amount of potential growth within the WNRWF service area, the impacts of using a higher flowrate may need to be reviewed. For example, at a future flow contribution of 225 gpd/EDU, the maximum month average daily flow increases to 10.8 mgd. This would increase the County contribution to the effluent force main and outfall to (10.8 mgd -2.3 mgd)*1.5=12.8 mgd and the total flow to the outfall to 23 mgd. At this flowrate, the design flowrate through a 36-inch outfall would be 5 ft/s or through a 42-inch outfall would be almost 4 ft/s. Using a 42-inch would be most conservative, but could also cause issues due to low initial velocities. If Alternative 4 is implemented, a more detailed evaluation would be required to determine the final effluent force main/outfall size. Regardless, for this study, the more conservative 42-inch was assumed. Figure 8.3.1 indicates this configuration.

Figure 8.3.1
Combined Ocean Outfall



8.3.3 FORCE MAIN HYDRAULICS

From the previous Figure 8.3.1, the WNTPS would pump against losses from its own 16-inch FM as well the competing heads from the Rehoboth pump station through the effluent force main and ocean outfall. It was assumed that the effluent force main and ocean outfall is non –PVC (i.e. DIP or concrete encased steel). Preliminary hydraulic calculations were performed based on this configuration and assuming a static head of 10-feet going from the IBRWF to the ocean outfall. For the 3.2 mgd peak design flow, pumping heads would vary from 70 to 85-feet depending on the size of the effluent force main and outfall (i.e. 36 or 42 inches). This would require the installation of three 50-70 HP pumps.

8.3.4 COST ESTIMATES

Cost estimate breakdowns for the force main alignment are provided in Appendix E. Based on this, the estimated total project cost for the 16-inch is $2.3M. Based on previous

County pump stations of this size, the Alternative 4 Wolfe Neck Transfer Pump Station costs have been estimated at approximately $2.3M.

Cost breakdowns for the effluent force main and Ocean Outfall for both Alternatives 3 and 4 are outlined in Table 8.3.4-1. Alternative 3 costs are from the Rehoboth Beach Alternative Discharge Evaluation. Costs for Alternative 4 were developed based on an upsizing of the effluent force main and ocean outfall from 24-inches to 42-inches. The upsizing costs for 12,100 l.f. of effluent force main were based on recent bids from other projects. The upsizing cost for the Ocean Outfall was assumed to be $300/l.f. to primarily account for increased material costs.

Table 8.3.4-1 WNRWF to PWWP Force Main Cost Summary

Component	Alt. 3	Alt. 4
Effluent Force Main	$2,560,000	$6,160,000
Effluent FM Contingency (10%)	$256,000	$616,000
Effluent FM Subtotal	*$2,816,000*	*$6,776,000*
Outfall	$14,800,000	$16,600,000
Outfall Contingency (15%)	$2,220,000	$2,490,000
Outfall Subtotal	*$17,020,000*	*$19,090,000*
Outfall permitting (5% of outfall subtotal)	$850,000	$950,000
Engineering/Admin (22% of Effluent FM and Outfall Subtotal)	$4,360,000	$5,690,000
Project Total	**$25,050,000**	**$32,510,000**

9. INLAND BAYS REGIONAL WASTEWATER FACILITY IMPACTS

9.1 INTRODUCTION

The Inland Bays Regional Wastewater Facility (IBRWF) is a partially aerated lagoon treatment facility with effluent spray irrigation. It currently serves the Long Neck SSD (LNSSD) and the Oak Orchard SSD (OOSSD). Sussex County has recently started designing the facility upgrade and expansion necessary to accommodate the growth in these districts and the planned Angola Neck SSD (ANSSD), the Oak Orchard Expasnion Area #1 (OOEA#1), as well as future anticipated flow from the Herring Creek SSD (HCSSD).

The expansion is designed to be completed in three phases, the timing of which depends on the growth of its service districts and the solution chosen for RBSTP and WNWRF. To comply with the recent Inland Bays TMDL requirements and to ensure total nitrogen loading does not limit spray field capacity before hydraulic loading rates do, process improvements at the IBRWF are planned. The existing treatment lagoons will be converted into phased aeration lagoons, followed by secondary clarifiers using an activated sludge process. This is expected to reduce effluent TN concentrations to 10 mg/L or below. This reduction will allow the IBRWF to load the irrigation fields to their hydraulic limit without exceeding either the permitted nitrogen loading rate of 250 lbs/ac/yr or the Inland Bays TMDL percolate requirement of 5.0 mg/L or less as an annual average.

To remain in compliance with its effluent spray irrigation limits, the IBRWF has acquired over 2,000 acres of agricultural land for effluent disposal; over 700 acres of this land will be used to accommodate the facility's short term expansion. The additional property acquired is expected to bring the total short term effluent disposal capacity to 5.2 mgd using spray irrigation. A detailed hydrogeological soil survey has not been completed on the long term expansion lands, but preliminary studies estimate that it provides approximately 7.8 mgd of effluent disposal capacity using spray irrigation. Combined with the short term storage capacity, the property owned by the County at the IBRWF provides an estimated spray irrigation disposal capacity of approximately 13.0 mgd. Additional capacity could be obtained with the purchase of additional property for spray irrigation or the use of alternative disposal methods at this site.

Table 9.1-1 summarizes the phased expansion approach and lists the total effluent disposal capacity for each.

Table 9.2-2: IBRWF Expansion Phases and Disposal Capacity

Design Phase	Added Disposal Acreage per Phase	Total Disposal Capacity (mgd)
Current	206	1.5
Phase 1	150	2.1
Phase 2	203	3.7
Phase 3A	190	5.2
Phase 3B	To be determined(1)	6.0

Note:

1. A detailed hydrogeolocial soil survey will be completed prior to determining the area required for additional effluent disposal capacity.

Please reference the Inland Bays PER for a detailed explanation on the upgrade and expansion. The possibility of wastewater from additional service areas being sent to IBRWF will affect the expansion schedule, but not the treatment design. The possible alternatives for the NCPA discussed in this report will each impact the IBRWF uniquely. The scenarios discussed in this chapter are presented from the least impact to the most impact on the IBRWF expansion schedule.

A. Either Alternatives 1B, 2B, or 4 is chosen. RBSTP and WNRWF create a separate solution that does not involve IBRWF. These solutions could be either ocean outfall or an off-site PWTP. IBRWF will expand according to its original schedule.

B. Alternative 3 is chosen. RBSTP devises a separate solution independent of WNRWF or IBWRF. WNWRF would send all raw wastewater in excess of 1.8 mgd on an annual basis (2.3 mgd on a maximum month basis) to IBWRF for treatment and disposal. This is based on the analysis that using existing facultative aerated lagoon treatment system, the effluent disposal capacity at the WNRWF will be nitrogen limited at 1.8 mgd on an annual average basis.

C. Alternative 1A is chosen. The RBWWPS and WNRWF SSDs will send all raw wastewater flow greater than 1.8 mgd on an annual basis (2.3 mgd on a maximum month basis) to IBRWF for treatment and disposal. The IBRWF will receive an increased raw wastewater flow because the RBWWPS raw wastewater is included in the flow to WNRWF.

D. Alternative 2A is chosen. All raw wastewater flow greater than 0.8 mgd from the WNRWF SSDs will be sent to Inland Bays for treatment and disposal.

9.2 SCENARIO A

Scenario A entails RBSTP and WNRWF choosing a solution that does not involve the IBRWF. To accomplish this, RBSTP and WNRWF will likely choose to dispose of treated effluent either by discharging it to an ocean outfall (Alt. 4), or off-site spray irrigation (Alt. 1B or 2B). Regardless of the disposal mechanism, the timeline for the expansion of the IBRWF will be based on the wastewater flow projections from the districts currently served or planned for service by this facility (ANSSD, HCSSD, LNSSD, OOSSD).

The current maximum month flow received at the IBRWF is 0.7 mgd (July 2005). With the continued growth of the LNSSD and OOSSD and the addition of the ANSSD and HCSSD, the IBRWF service area influent flows will increase substantially in the future.

Based on 150 gpd/ EDU for all existing and future EDUs, projected 2030 flow rates are summarized in Table 9.2-1.

Table 9.2-1: Projected 2030 Flows for IBRWF Contributing Entities

Service Districts	Max Month ADF (mgd)$^{(1)}$	Summer ADF (mgd)$^{(2)}$	Winter ADF (mgd)$^{(3)}$	Annual ADF (mgd)$^{(4)}$
LNSSD	1.8	1.7	1.1	1.4
OOSSD	0.48	0.45	0.28	0.36
ANSSD	0.50	0.47	0.30	0.37
HCSSD	0.09	0.08	0.05	0.06
Total	2.90	2.7	1.7	2.1

Notes:

1. Max month ADF based on growth projecting using 150 gpd/ EDU for existing and future connections.
2. Summer ADF determined by applying observed IBRWF 1.1:1 max month ADF to summer ADF ratio to projected max month ADF.
3. Winter ADF determined by applying observed IBRWF 1.6:1 summer ADF to winter ADF ratio to projected summer ADF.
4. Annual ADF determined by applying observed IBRWF 1.4 max month ADF to annual ADF ratio to projected max month ADF.

The ultimate projected wastewater flow to the IBRWF under this scenario is 6.3 mgd on a maximum monthly basis.

Figure 9.2-1 shows the projected IBRWF flows vs. the disposal capacities for each expansion phase.

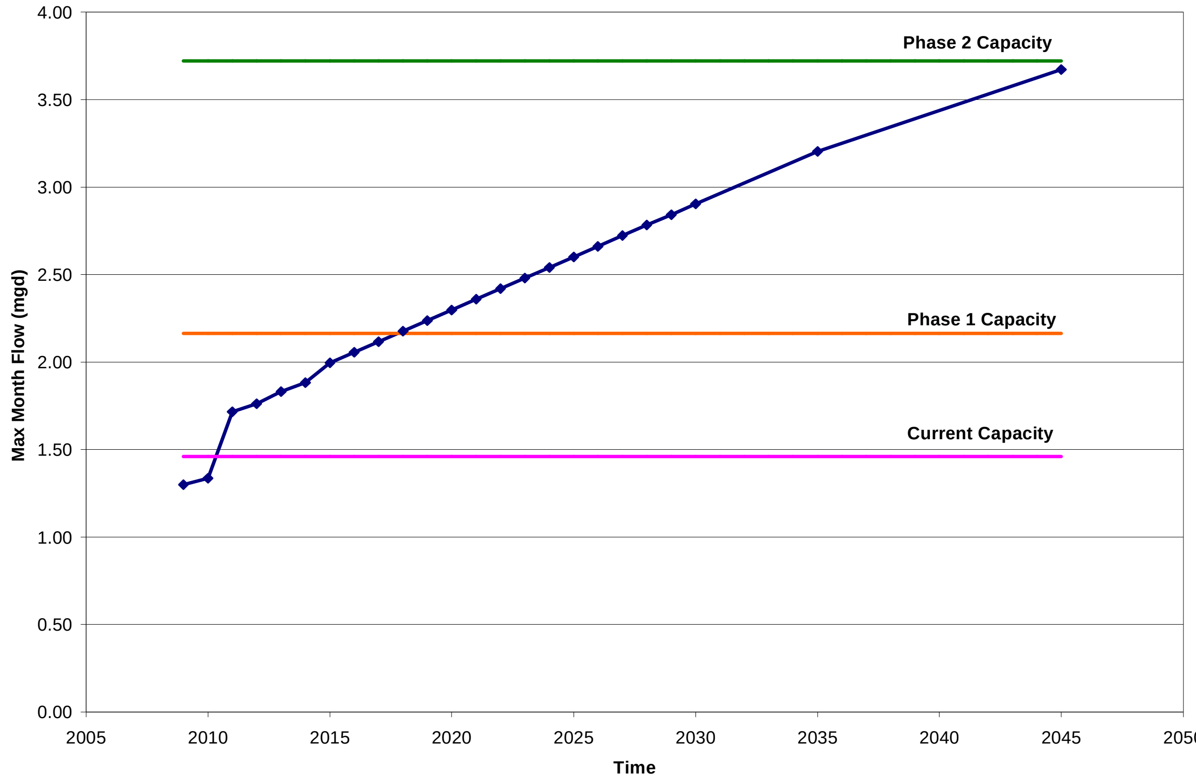


Figure 9.2-1: Scenario A IBRWF Projected Flows and Expansion Timeline

The Phase 1 expansion has recently entered the design phase and will be completed in time to accommodate the increased flows through 2017. As indicated on Figure 9.2-1 the Phase 2 expansion will be sufficient to treat the projected influent flows through 2045. The ultimate build out flow of 6.3 mgd (not shown) will require additional treatment and disposal capacity at the IBRWF.

9.3 SCENARIO B

In Scenario B, the RBSTP will not transfer any wastewater or treated effluent to either the WNRWF or the IBRWF. If this is chosen, the RBSTP will likely discharge its treated effluent via an ocean outfall (Alt. 3). The WNRWF will continue to treat all incoming wastewater and dispose of it using spray irrigation until the annual average daily flow exceeds 1.8 mgd. At this flowrate, the WNRWF irrigation fields will become nitrogen limited and the remaining wastewater will be sent to the IBRWF for treatment. Table 9.3-1 shows the contributing entities and their associated flows to the IBRWF.

Table 9.3-1: Scenario B 2030 Projected Influent Flowrates to IBRWF

Service Districts	Max Month ADF (mgd)(1)	Summer ADF (mgd)(2)	Winter ADF (mgd)(3)	Annual ADF (mgd)(4)
LNSSD	1.8	1.7	1.08	1.4
OOSSD	0.48	0.45	0.28	0.36
ANSSD	0.50	0.47	0.30	0.37
HCSSD	0.09	0.08	0.05	0.06
WNRWF(5)	2.1	1.9	1.5	1.7
Total	**5.0**	**4.7**	**3.2**	**3.8**

Notes:
1. Max month ADF based on growth projection using 150 gpd/ EDU for existing and future connections.
2. IBRWF summer ADF determined by applying observed IBRWF 1.1:1 max month ADF to summer ADF ratio to projected max month ADF.
3. IBRWF winter ADF determined by applying observed IBRWF 1.6:1 summer ADF to winter ADF ratio to projected summer ADF.
4. IBRWF annual ADF determined by applying observed IBRWF 1.4:1 max month ADF to annual ADF ratio to projected max month ADF.
5. WNRWF flows are determined using observed seasonal flow ratios (Table 3.2-3)

The ultimate projected wastewater flow to the IBRWF under this scenario is 11.2 mgd on a maximum monthly basis.

Using growth projections, the entire expansion timeline will be accelerated. WNRWF will start sending raw wastewater to IBRWF as soon as a transfer pumping station and forcemain can be constructed (likely 2012). Both Phase 1 and Phase 2 expansions will need to be completed by that time. The Phase 3A expansion will be required by 2022, with Phase 3B after 2035. If IBRWF accepts flow from WNWRF an additional expansion, Phase 4, will also be required. To accommodate the ultimate build out flowrate of 11.2 mgd, an extensive upgrade or new treatment facility will be required in the future. Figure 9.3-1 shows the expansion timeline for scenario B.

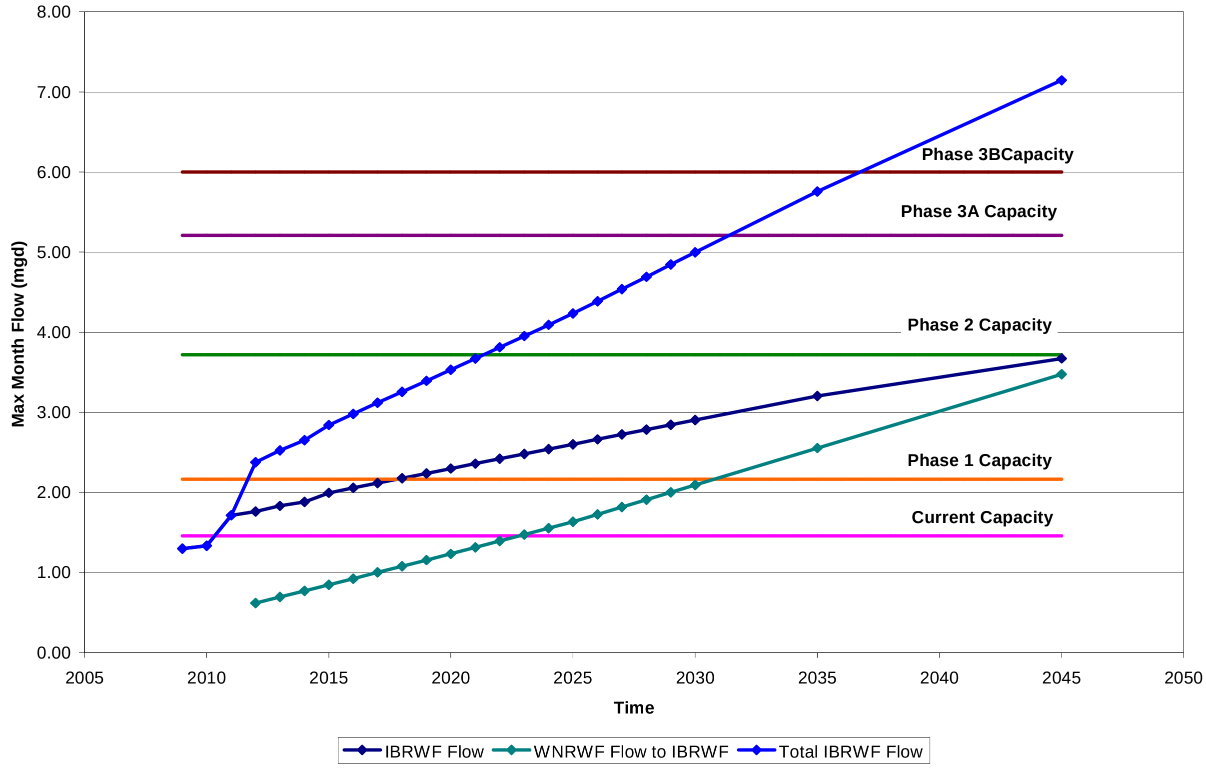


Figure 9.3-1: Scenario B IBRWF Projected Flows and Expansion Timeline

Due to the short interval in between when Phases 1 and 2 are required, there may be cost savings associated with immediately beginning the design on Phase 2 so construction of the expansions can be simultaneous or continuous. Before the Phase 3 expansion is required soil investigations and hydrogeological studies on the Cordrey parcel will need to be performed. If this scenario is chosen, it may be more cost effective to build a new treatment facility to accommodate the ultimate build out wastewater flows, rather than expanding the IBRWF further.

9.4 SCENARIO C

In Scenario C, Alternative 1A is chosen to manage RBSTP and WNWRF wastewater. The RBSTP will shut down and the RBWWPS will be constructed to send raw wastewater to WNWRF. For the Wolfe Neck Transfer Pump Station, this option is very similar as Scenario B. At an annual average of 1.8 mgd (2.3 mgd during the maximum month), the WNRWF will become nitrogen limited and any additional wastewater will be transferred to the IBRWF. Table 9.4-1 shows the contributing entities and their associated flows to the IBRWF.

Table 9.4-1: Scenario C 2030 Projected Influent Flowrates to IBRWF

Service Districts	Max Month ADF (mgd)(1)	Summer ADF (mgd)(2)	Winter ADF (mgd)(3)	Annual ADF (mgd)(4)
LNSSD	1.8	1.7	1.08	1.4
OOSSD	0.48	0.45	0.28	0.36
ANSSD	0.50	0.47	0.30	0.37
HCSSD	0.09	0.08	0.05	0.06
WNRWF(5)(6)	4.6	4.3	2.4	3.1
Total	**7.5**	**7.0**	**4.1**	**5.2**

Notes:

1. Max month ADF based on growth projection using 150 gpd/ EDU for existing and future connections.
2. Summer ADF determined by applying observed IBRWF 1.1:1 max month ADF to summer ADF ratio to projected max month ADF.
3. Winter ADF determined by applying observed IBRWF 1.6:1 summer ADF to winter ADF ratio to projected summer ADF.
4. Annual ADF determined by applying observed IBRWF 1.4:1 max month ADF to annual ADF ratio to projected max month ADF.
5. WNRWF flows are determined using observed seasonal flow ratios (Table 3.2-3).
6. WNRWF includes the projected 2030 flows from the RBWWPS.

The ultimate projected wastewater flow to the IBRWF under this scenario is 14.6 mgd on a maximum month basis.

Because the RBSTP is contributing raw wastewater to the WNRWF, more flows relative to Scenario B will have to be transferred to the IBRWF. To comply with their permit, the IBRWF will need to construct expansion Phases 1 and 2 as soon as possible (likely 2012). Assuming RBSTP start sending raw wastewater to te WNRWF in 2014, the total incoming IBRWF flow is 4.1 mgd; expansion Phase 3 will need to be completed by that time. To accommodate the projected 2030 influent flow rate of 7.5 mgd, a fourth expansion phase will be required. Similarly to Scenario B, the County may want to explore a new treatment facility to accommodate the ultimate build out wastewater flowrate of 14.6 mgd. Figure 9.4-1 displays when the IBRWF flows will exceed the disposal capacities for each expansion phase.

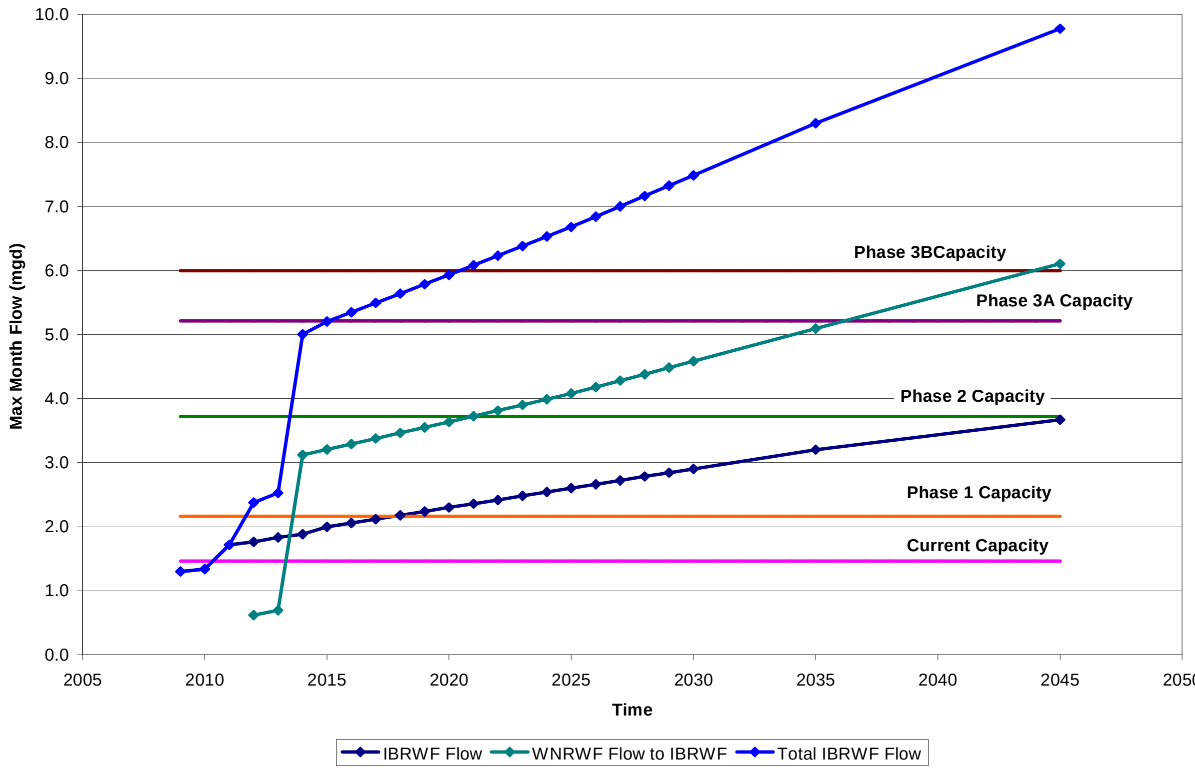


Figure 9.4-1: Scenario C IBRWF Projected Flows and Expansion Timeline

This timeline assumes that the RBSTP will start sending raw wastewater to WBRWF in 2014. If RBSTP starts transferring war wastewater prior to 2014, the IBRWF will need to expand sooner. This situation would most likely dictate simultaneous construction of multiple expansion phases. Under this scenario, the ultimate projected wastewater flow to the IBRWF cannot be accommodated by spray irrigation at the existing site.

9.5 SCENARIO D

Alternative 2A is chosen for Scenario D. In this scenario the RBSTP will continue treating wastewater and will send the treated effluent directly into the WNRWF effluent storage lagoon to be discharged via spray irrigation. The other WNRWF contributing entities (GC, WRESSD, etc) and WRESSD contributions will be limited to approximately 0.8 mgd year round, and all excess flow will be transferred to IBRWF for treatment and disposal. Table 9.5-1 shows the contributing entities and their associated flows to IBRWF.

Table 9.4-1: Scenario D 2030 Projected Influent Flowrates to IBRWF

Service Districts	Max Month ADF (mgd)(1)	Summer ADF (mgd)(2)	Winter ADF (mgd)(3)	Annual ADF (mgd)(4)
LNSSD	1.8	1.7	1.08	1.4
OOSSD	0.48	0.45	0.28	0.36
ANSSD	0.50	0.47	0.30	0.37
HCSSD	0.09	0.08	0.05	0.06
WNRWF(5)	3.6	3.4	2.3	2.7
Total	**6.5**	**6.1**	**4.0**	**4.8**

Notes:
1. Max month ADF based on growth projecting using 150 gpd/ EDU for existing EDUs and future connections.
2. Summer ADF determined by applying observed IBRWF 1.1:1 max month ADF to summer ADF ratio to projected max month ADF.
3. Winter ADF determined by applying observed IBRWF 1.6:1 summer ADF to winter ADF ratio to projected summer ADF.
4. Annual ADF determined by applying observed IBRWF 1.4:1 max month ADF to annual ADF ratio to projected max month ADF.
5. WNRWF flows are determined using observed seasonal flow ratios (Table 3.2-3).

The ultimate projected wastewater flow to the IBRWF under this scenario is 15.9 mgd on a maximum month basis.

This scenario sends the second most wastewater to IBRWF; scenario C sends approximately 1 more. WNRWF would start sending wastewater in excess of 1.8 mgd on an annual average basis (2.3 mgd during the maximum month) to the IBRWF once the transfer pump station and force main are constructed, assumed to be 2012; both Phases 1 and 2 will be required by that time. The will RBSTP begin sending treated effluent to the WNRWF for disposal by 2014. At this time, the WNRWF only continue to treat and discharge 0.8 mgd, all excess wastewater will be sent to Inland Bays. This will increase the total wastewater influent at IBRWF to 4.1 mgd, requiring the Phase 3 upgrade to be completed by this time. Depending on the schedule for the RBSTP to stop discharging to the Lewes-Rehoboth Canal, this timeline could be further accelerated. Given the schedule proximity of the necessary expansions, some cost savings could be gained by designing and constructing multiple phases simultaneously. Under this scenario, the total influent to the IBRWF is 6.5 mgd in 2030, which will require an additional expansion. Additional treatment and disposal capacity will be required to treat the ultimate build out projected influent flowrate of 15.9 mgd. Figure 9.5-1 illustrates this expansion timeline with the associated flows.

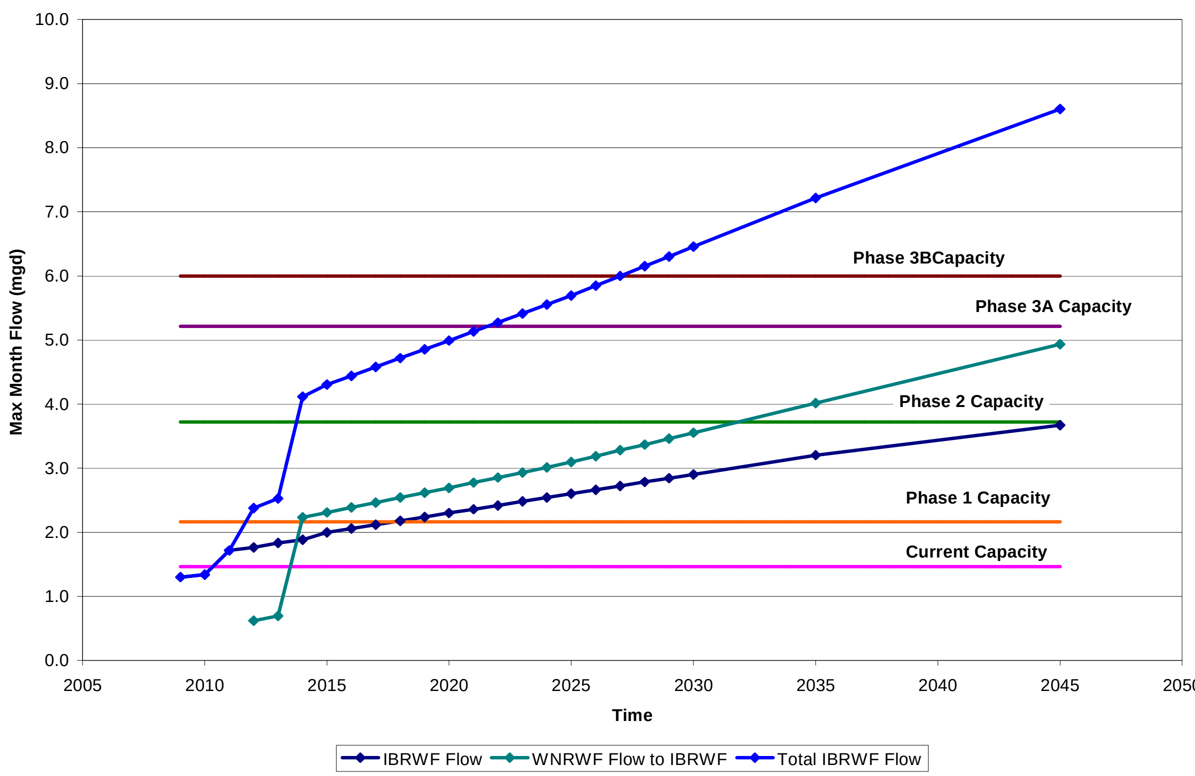


Figure 9.5-1: Scenario D IBRWF Projected Flows and Expansion Timeline

Under this scenario, the ultimate projected wastewater flow to the IBRWF cannot be accommodated by spray irrigation at the existing site.

9.6 PLANNED IMPROVEMENTS FOR THE INLAND BAYS RWF

As described in Section 9.1 the County is beginning the design of upgrading and expanding the IBRWF. The planned improvements for the treatment facility will enable the IBRWF to achieve biological nutrient removal and increase its treatment and disposal capacity. Please reference the Inland Bays PER for more detailed information about the improvements planned for the facility.

To enable the facility to handle increased influent flows, the headworks will be expanded to add an additional mechanical screen as part of each expansion phase. A grit removal system will be installed as part of the Phase 2 expansion.

To achieve biological nutrient removal, each phase of expansion will convert one existing partially aerated treatment lagoon into two phased-aeration treatment lagoons. Circular clarifiers will be constructed (two in Phase 1, one each in Phases 2 and 3) to separate the activated sludge from the wastewater. Clarified effluent will be disinfected via chlorination in a new chlorine contact tank. The treated wastewater will enter effluent lagoons to be stored until it can be discharged via spray irrigation.

Phase 2 expansion will include solids handling facilities capable of achieving Class A biosolids. Waste sludge will be pumped to holding lagoons to achieve preliminary thickening. Thickened sludge will subsequently undergo dewatering (likely by a belt filter press) and lime pasteurization. The treated biosolids will be dried and stored as cake to be distributed to regional farmers.

Auxiliary improvements will also be constructed as necessary. This includes structures such as the distribution boxes for the raw influent and clarifiers, chemical storage, sludge pumping stations, and an improved electrical and process control infrastructure.

Inland Bays Upgrade and Expansion Preliminary Cost Estimates

This section discusses the methodology and presents the capital costs for the recommended improvements for Phase 1 through 3 expansions. All dollar amounts are presented in year 2009 dollars.

Several different sources of information were consulted to develop the capital cost estimations. Where recent contractor bids or vendor proposals are available for similar projects, they have been used. If neither contractor bids nor proposals are available, quantity takeoffs were computed based on the conceptual designs described in this chapter and the Inland Bays PER.

Costs described in this section are based on conceptual design. As such, a level of detail appropriate to such a design was considered during the development of costs. Conceptual design does not provide the resolution needed for quantification of all construction materials. In recognition of this fact, percentages of construction cost have been applied to such items as piping, electrical, and site work. The percentages used for these items are summarized below:

- A 10% contingency was included with all construction costs.
- Yard Piping: 9% of subtotal.
- Electrical: 20% of subtotal.
- Planning, Engineering, and Administrative Services: 22% of subtotal.

In addition to the percentages listed above, several other assumptions had to be made regarding the construction of the facilities. Major assumptions made during this process are bulleted below:

- Distribution boxes for unit processes would be constructed during Phase 2 for the Phase 3B design flows to simplify future construction.
- Solids handling facilities will be built in Phase 2 and sized to accommodate Phase 3B

flows.

- The grit removal system will be built in Phase 2 to handle Phase 3B flows.
- A new building would be constructed during Phase 1 for the sodium hypochlorite disinfection system and would include space provisions for future bulk storage tanks and chemical feed systems.
- It was assumed piles would not be required under concrete structures, based on our experience with other facilities constructed in the area.

Phase 3B specific costs were not developed because most of the required process expansions are included in previous phases. There is not sufficient site information for Phase 3B to develop detailed costs for effluent storage and disposal.

Tables 9.6-1 through 9.6-3 summarize the costs for the IBRWF Phase 1 through 3 expansions, respectively.

Table 9.6-1: Cost Summary for Phase 1 Expansion

DESCRIPTION	ESTIMATED COST
Screening	$540,000
Biolac Treatment System (Convert Treatment Lagoon No. 1)	$1,800,000
Secondary Clarifiers	$1,650,000
RAS/ WAS Pump Station	$370,000
Chlorine Contact Tank	$270,000
Chemical Feed System	$570,000
New Storage Lagoon	$1,700,000
Irrigation Pumping Station	$1,070,000
Subtotal	**$8,000,000**
General Site Work @ 3% of Subtotal	$240,000
Yard Piping @ 9% of Subtotal	$720,000
Electrical/Controls @ 20% of Subtotal	$1,600,000
Startup/Testing @ 2% of Subtotal	$160,000
Parcels #12 and # 19 Spray Field Development	$560,000
Subtotal	**$11,300,000**
Construction Contingencies @ 10% of Subtotal	$1,100,000
Total Construction Cost (Year 2009 Dollars)	**$12,400,000**
Project Costs @ 22% of Construction Cost	$2,700,000
Total Project Costs (Year 2009 Dollars)	**$15,100,000**

Table 9.6-2: Cost Summary for Phase 2 Expansion

DESCRIPTION	ESTIMATED COST
Screening	$540,000
Grit Removal	$880,000
Influent Dist Box	$370,000
Biolac Treatment System (Convert Treatment Lagoon 2)	$1,800,000
Secondary Clarifier Distribution Box	$370,000
Secondary Clarifiers	$1,070,000
RAS/ WAS Pump Station	$370,000
Chlorine Contact Tank	$400,000
New Storage Lagoon	$2,610,000
Irrigation Pumping Station	$870,000
Solids Handling System	$3,920,000
Waste Sludge Holding Lagoon (Convert Lagoon 3)	$690,000
Cake Storage Building	$370,000
Administration Building Expansion	$740,000
Subtotal	**$15,000,000**
General Site Work @ 3% of Subtotal	$450,000
Yard Piping @ 9% of Subtotal	$1,350,000
Electrical/Controls @ 20% of Subtotal	$3,000,000
Startup/Testing @ 2% of Subtotal	$300,000
FM to Spray Field #10	$195,000
Parcel # 10 Spray Field Development	IBRWF
Subtotal	**$20,300,000**
Construction Contingencies @ 10% of Subtotal	$2,000,000
Total Construction Cost (Year 2009 Dollars)	**$22,300,000**
Project Costs @ 22% of Construction Cost	$4,900,000
Total Project Costs (Year 2009 Dollars)	**$27,200,000**

Note:
1. Budgetary cost allocation provided by Sussex County. Conceptual design of these components has not been completed.

Table 9.6-3: Cost Summary for Phase 3A Expansion

DESCRIPTION	ESTIMATED COST
Screening	$540,000
Biolac Treatment System (Convert WAS Lagoon)	$1,200,000
Secondary Clarifiers	$1,070,000
Chlorine Contact Tank	$290,000
New Storage Lagoon	$2,300,000
Irrigation Pumping Station	$1,170,000
Waste Sludge Holding Lagoons	$1,540,000
Subtotal	**$8,100,000**
General Site Work @ 3% of Subtotal	$240,000
Yard Piping @ 9% of Subtotal	$730,000
Electrical/Controls @ 20% of Subtotal	$1,620,000
Startup/Testing @ 2% of Subtotal	$160,000
Cordrey Parcel Spray Field Development	$1,840,000
Subtotal	**$12,700,000**
Construction Contingencies @ 10% of Subtotal	$1,300,000
Total Construction Cost (Year 2009 Dollars)	**$14,000,000**
Project Costs @ 22% of Construction Cost	$3,100,000
Total Project Costs (Year 2009 Dollars)	**$17,100,000**

10. SUSSEX COUNTY/REHOBOTH BEACH COST SHARING MODEL

This chapter will present the cost sharing model developed between the City of Rehoboth and Sussex County for the six identified treatment and disposal alternatives. This cost model was developed to estimate the financial implications of each of these alternatives to Sussex County and the City of Rehoboth Beach. Flow schematics and associated descriptions for each of the six alternatives (Alt. 1A, 1B, 2A, 2B, 3, and 4) previously discussed are provided. In addition, as discussed in the following sections, a 7th alternative (Alternative 4B) has been added for cost sharing discussion purposes.

- **Alternative 1A/1B:** The RBSTP shuts down and sends all of its raw wastewater to the WNRWF, which will treat as much wastewater as possible and send the excess to another facility to be treated. The excess wastewater will be treated by the County owned and operated Inland Bays Regional Wastewater Facility (Alt 1A) or a Private Wastewater Provider (PWWP) (Alt 1B).

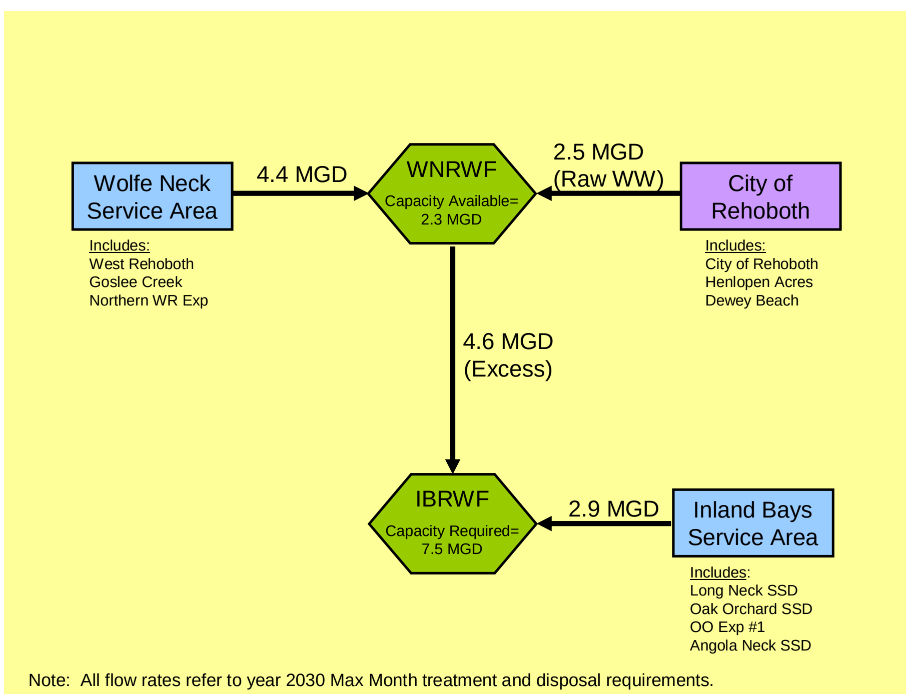


Figure 10-1: Alternative 1A Flow Distribution Diagram

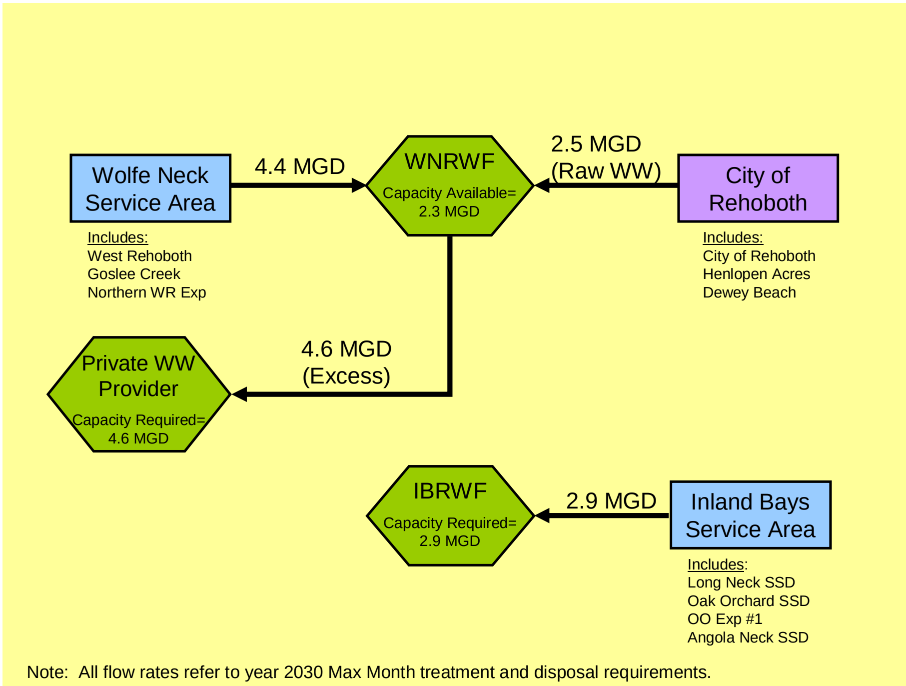


Figure 10.1-2: Alternative 1B Flow Distribution Diagram

- **Alternative 2A/2B**: The RBSTP remains in service and sends its treated effluent to the WNRWF for disposal via spray irrigation. A reduced amount of WNRWF influent wastewater from its service area will continue to be treated at that facility, with all excess being sent to either to the Inland Bays Regional Wastewater Facility (Alt 2A) or a PWWP (Alt 2B).

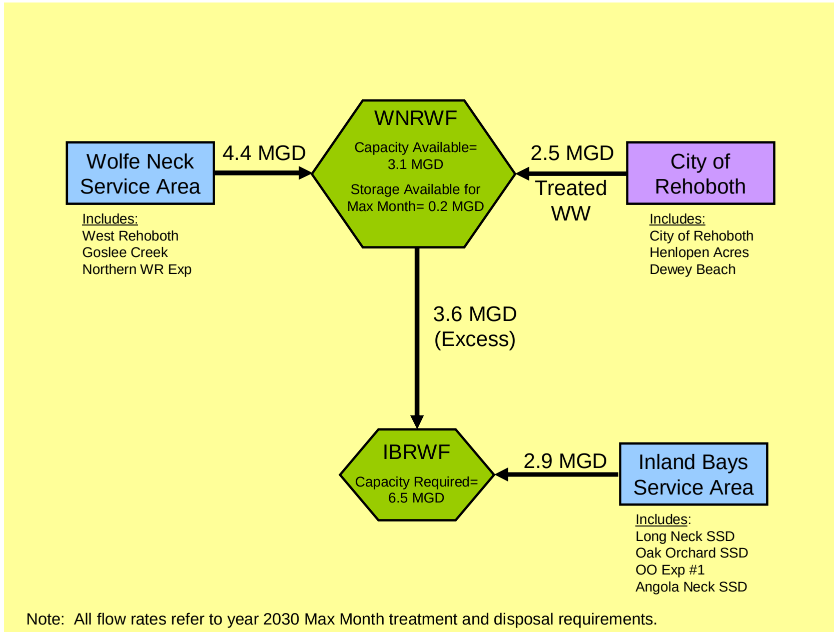


Figure 10.1-3: Alternative 2A Flow Distribution Diagram

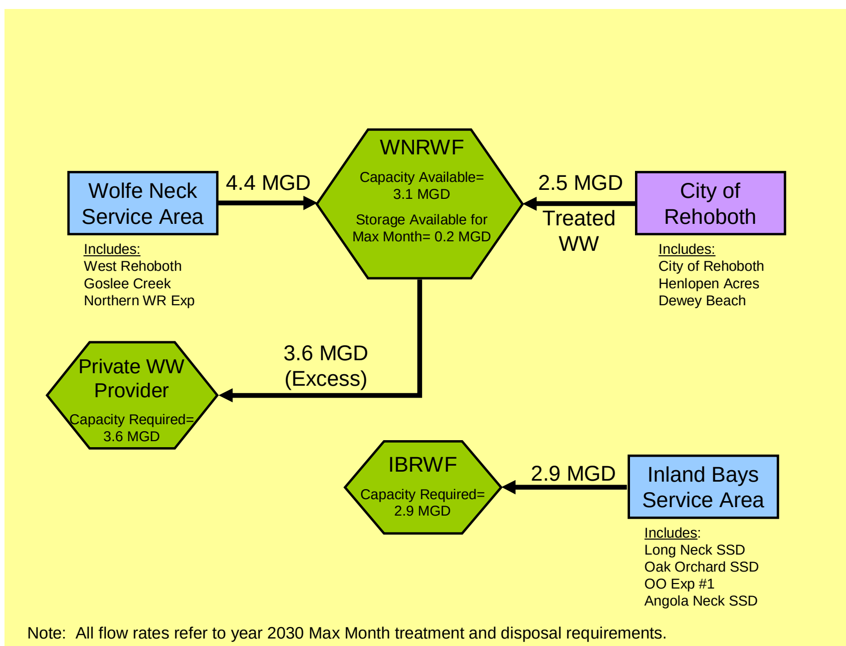


Figure 10.1-4: Alternative 2B Flow Distribution Diagram

- **Alternative 3**: The RBSTP remains in service and discharges treated effluent via an ocean outfall. In this scenario, the County will continue treating and disposing wastewater via land application at its existing facilities. The WNRWF will remain in service and continue treating and disposing wastewater from its service area. Any excess flow to the WNRWF above the capacity of the facility will be sent to the IBRWF for treatment and disposal.

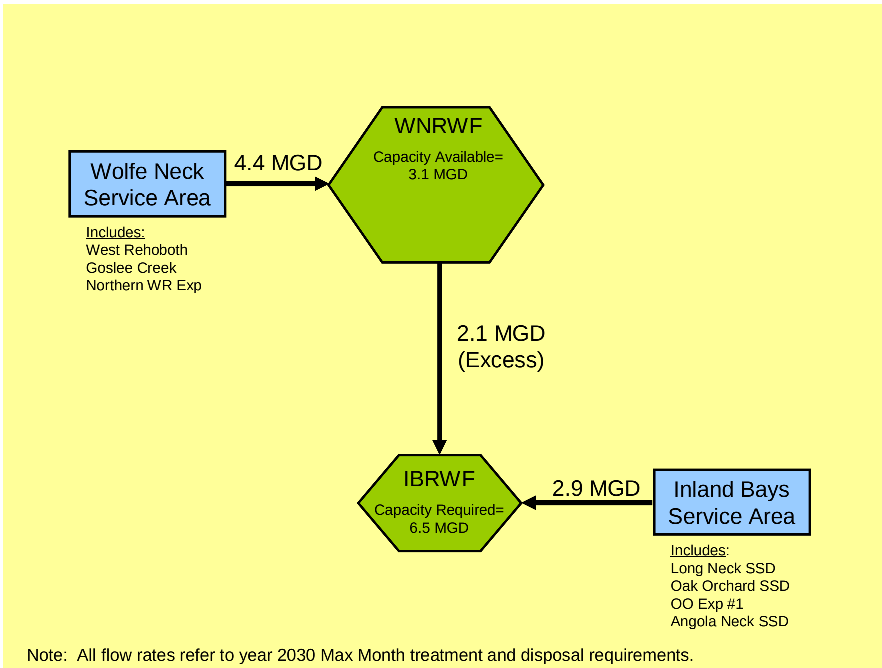


Figure 10.1-5: Alternative 3 Flow Distribution Diagram

- **Alternative 4**: The RBSTP remains in service and discharges treated effluent via an ocean outfall. The County continues to treat wastewater via land application at the WNRWF. The WNRWF will expand and upgrade its treatment capacity. Treated wastewater that exceeds the WNRWF disposal capacity will be pumped to the Rehoboth ocean outfall for disposal.

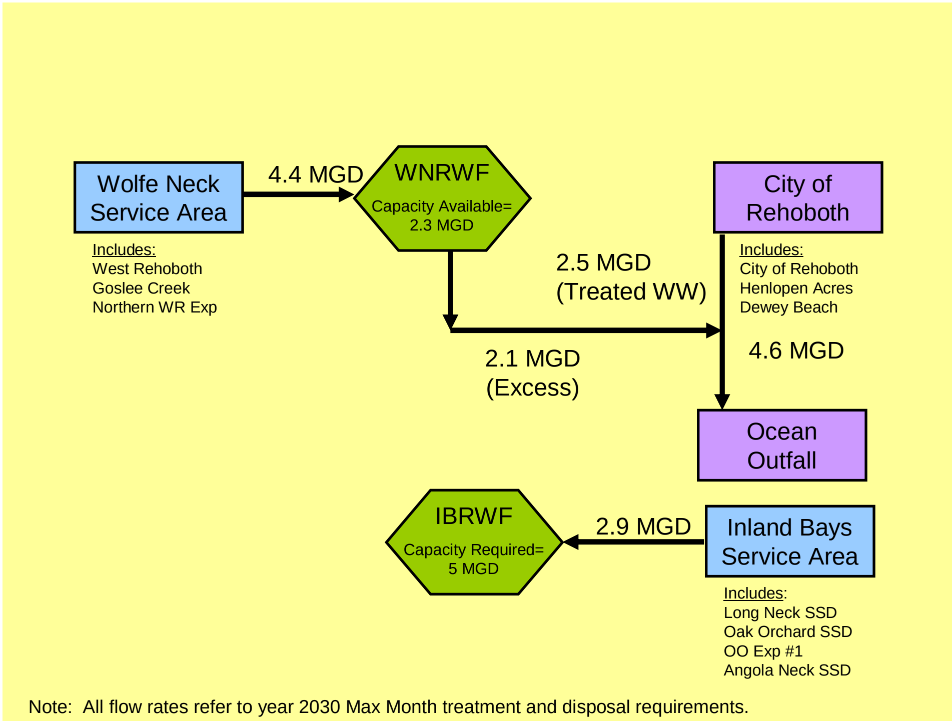


Figure 10.1-6: Alternative 4 Flow Distribution Diagram

- **Alternative 4B**: Alternative 4B is the same treatment and disposal concept as Alternative 4, with the exception of what flows are used for the cost sharing analysis. All other alternatives use the maximum month 2030 year flows. Alternative 4B uses buildout maximum month flows.

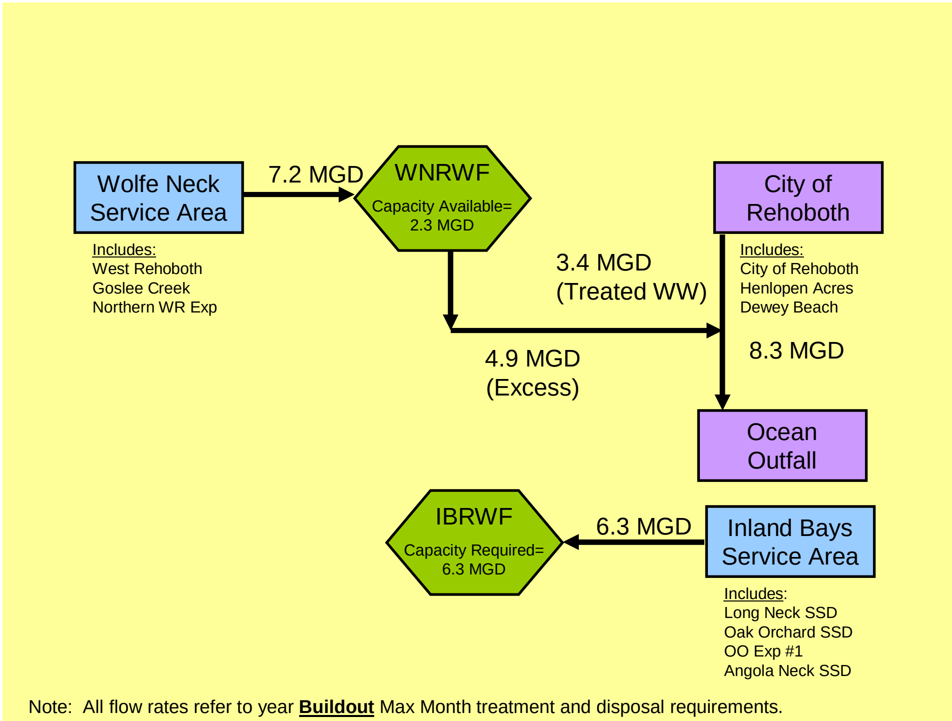


Figure 10.1-7: Alternative 4B Flow Distribution Diagram

10.1 ANNUAL USERS COSTS

Total annual user costs for each alternative were evaluated based on anticipated initial capital costs, the associated project costs and contingencies, contract service costs associated with the private provider option and the long term operation and maintenance costs. All of these components are discussed in the following sections.

10.1.1 CAPITAL COSTS

Each of the seven alternatives has specific required conveyance and treatment/disposal components. Capital costs associated with each of these components were discussed in the previous chapters as follows:

- Chapter 5: Rehoboth to WNRWF Conveyance Costs
- Chapter 7: WNRWF Upgrades Costs

- Chapter 8: WNRWF to IBRWF/PWWP Conveyance Costs
- Chapter 9: IBRWF Upgrades

The following Table 10.1.1-1 summarizes the capital cost components used for the cost sharing analysis.

Table 10.1.1-1: Summary of Capital Cost Components for Cost Sharing Analysis

Item #	Description	Chapter Discussed
1	RBSTP Pumping Station	5
2A	Force Main from RBSTP to WNRWF (Option #1)	5
2B	Force Main from WNRWF to Rehoboth (Option #1)	8
3A	Rehoboth Treatment Upgrades	NA (1)
3B	Rehoboth FM to Ocean Outfall	NA (1)
3C	Rehoboth Ocean Outfall	NA (1)
4	WNRWF Upgrades	7
5	WNRWF Headworks Upgrades	7
6	WNRWF to IBRWF/PSP P.S.	8
7	Force Main to IBRWF (Option #3)	8
8	IBRWF Phase 2 Upgrades	9
9	IBRWF Phase 3 Upgrades	9
10	IBRWF Phase 4 Upgrades	9
11A	Force Main to Cave Neck Road	8
11B	Force Main from Cave Road to PWWP	8

Notes:
(1) From 2009 Rehoboth Beach Alternative Discharge Evaluation

As described in Chapters 5 and 8, for several of the alternatives, there were several alignment options reviewed. For the cost sharing analysis it was assumed that the recommended alignment would be implemented. Items indicated in parentheses, such as for the Force Main to WNWRF (Option 1), are in reference to the alignment options recommended in the other sections.

All costs for the IBRWF Phase 1 Expansion were excluded from this analysis. The Phase 1 expansion is currently in the design phase and is primarily being implemented to service customers in the existing IBRWF service area and is therefore independent of this cost sharing analysis.

10.1.2 PROJECT COSTS AND CONTINGENCIES

Additional project costs and contingencies associated with each alternative included the items listed in Table 10.1.2-1

Table 10.1.2-1: Project Cost Components for Cost Sharing Analysis

Item #	Description
12	PWWP Treatment and Disposal
13	Land/Easements
14A	10% Contingency (All Items Except Ocean Outfall and RBSTP)
14B	15% Contingency (Ocean Outfall and RSTP Upgrade Only)
15	Engineering and Administration
16	Permitting (Ocean Outfall Only) (5%)

Costs for Item 12 were based on the Private Wastewater Provider's Contract Proposal received by the County in December 2008.

For Item 13, if either Alternative 1A and 2A was implemented, the City of Rehoboth Beach would be required to reimburse the County for its equivalent amount of land required for disposal. This value has been estimated at $11.25M for 450 acres of land at $25,000 per acre. Easement costs and engineering costs for the PWWP alternatives (Alternatives 1B and 2B) were based on the December 2008 PWWP proposal. There are no land sharing costs associated with Alternative 3 (Rehoboth outfall) or Alternative 4 (combined ocean outfall).

As indicated in Table 10.1.2-1, a 10% contingency was included for all capital costs items, with the exception of Rehoboth items #3A and #3C. As specified by the City of Rehoboth, a 15% contingency was applied to these two items per the Rehoboth Beach Alternative Discharge Evaluation. The outfall permitting costs were also in accordance with the Rehoboth Beach Alternative Discharge Evaluation.

Engineering and administration costs were allocated as 22% of construction costs, with the exception of the PWWP, which was based on the Private Wastewater Provider's Contract Proposal.

10.1.3 COST SHARE PERCENTAGES

Cost share percentages were calculated for each project cost line item. In general, cost percentages were calculated based on the 2030 maximum month average daily flow associated with each line item. As such, the City of Rehoboth Beach will be responsible for 100% of the RBSTP pumping station and the associated force main to the WNRWF. The cost for the WNRWF transfer pumping station, its associated force main, and any treatment/disposal costs will be split between the County and the City of Rehoboth Beach on a 2030 maximum month flow rated basis unless noted below.

1. All costs for the WNRWF headworks upgrade are split on a flow rated basis, with the exception of Alternatives 2A and 2B (treated effluent alternatives). For these alternatives, the treated effluent from Rehoboth is only disposed of and bypasses the WNRWF headworks facility. Therefore, Rehoboth would not share in any of the headworks upgrades costs.
2. For treatment costs associated with Alternatives 1A and 2A, the City of Rehoboth is displacing disposal capacity at County facilities for County sewer customers and would be responsible for the applicable costs of treatment and disposal capacity at the IBRWF. For example, in Alternative 1A, the County would provide Rehoboth 2.5 mgd of treatment/disposal capacity. Phase II upgrades will increase the IBRWF's treatment and disposal capacity from 2.0 mgd to 3.7 mgd (max month). Phase III upgrades will increase the plant capacity from 3.7 mgd to 5.2 mgd. It was assumed that the City of Rehoboth would be responsible for 100% of Phase II upgrades, and 53% (or 0.8 mgd) of Phase III upgrades.
3. As discussed previously, for Alternative 4B, the buildout maximum month is used to calculate flow splits associated with the Rehoboth effluent force main and

ocean outfall. This changes the County/City flow split from 46/54 for Alt 4 to 59/41 for Alt 4B.

Tables summarizing the resulting percentages used for all seven alternatives (Alt. 1A, 1B, 2A, 2B, 3, 4, and 4B) are included in Appendix L.

10.1.4 OPERATION AND MAINTENANCE COSTS

Annual operation and maintenance costs were estimated for each alternative. For all $/gallon Sussex County annual costs, a value of 450 mg/year was used as the average annual flow for the current 2030 planning period. For all $/gallon PWWP annual costs, a value of 730 mg/year was used. This is based on a minimum 2 mgd annual average charge required by the PWWP. Table 10.1.4-1 summarizes each of these components.

Table 10.1.4-1: O&M Components for Cost Sharing Analysis

Item	Cost/Year	Applicable Alternatives
Rehoboth - Plant Operations	$1,590,000	All
Rehoboth – Collection System	$150,000	All
Sussex County WNRWF Pump Station Maintenance	$100,000	Alt 1A, 1B
Sussex County Operations and Maintenance –Treatment and Disposal	$5.08/1,000 gal	Alt 1A
Private Service Provider - Treatment and Disposal (1)	$6.84/1,000 gal	Alternative #1B, #1C
Sussex County Operations and Maintenance- Conveyance Only to PWWP	$1.21/1000 gal	Alternative #1B, #1C
Sussex County Operations and Maintenance- Conveyance System (Disposal Only) (2)	$2.00/1,000 gal	Alt 2A
Rehoboth - Pump Station, FM and Outfall	$150,000	Alt 3 & 4,4B

Notes:

(1) The agreement specifies an annual increase of 3% or the CPI, whichever is greater.

(2) Includes WNWRF PS maintenance.

10.2 PROJECTED USER RATES

Based on the estimated capital costs, O&M costs, and cost share percentages, Rehoboth's anticipated user rates were calculated for each of the alternatives. Rehoboth's rates were calculated assuming 56.3% of all plant operations costs and 92.5% of all collection system costs were paid for by Rehoboth customers. The remainder of costs (43.7% and 7.5% respectively) will be paid for by County customers (i.e. Dewey Beach, Henlopen Acres, and North Shore) that are served through the Rehoboth system. These percentages were estimated in the Rehoboth Beach Alternative Discharge Evaluation based on flow contributions from each entity. User rates were calculated assuming a 20 year loan at a 4.4% interest rate, which was the financing option presented in the Rehoboth Beach Alternative Discharge Evaluation.

Table 10.2-1 on the following page provides a summary of the resulting County/Rehoboth Costs, as well as the anticipated Rehoboth User Rates. Backup tables for all alternatives are provided in Appendix L.

An additional financing option to the one presented in the Rehoboth Beach Alternative Discharge Evaluation was also evaluated. This option assumes 1/3 of the loan is financed for 20 years at a 4.4%, with the remaining 2/3 of the loan financed for 40 years at 5%. Table 10.2-2 provides a City of Rehoboth user rate comparison for the two financing options.

Table 10.2-1: Impacts of Alternatives on City of Rehoboth User Rates (1) (2)

Alt.	Description	Total Project Cost ($ M)	County Cost Share ($ M)	Rehoboth Cost Share ($ M)	Annual Capital Cost - Rehoboth	Annual Maintenance Cost- Rehoboth	**Rehoboth User Rates**
#1A	Raw Wastewater Pumped to WNRWF with Disposal at IBRWF	$112	$44	$68	$2,900,000	$1,500,000	$1,160
#1B	Raw Wastewater Pumped to WNRWF with Disposal at Private Service Provider	$100	$50	$50	$2,100,000	$3,300,000	$1,430
#2A	Treated Effluent Pumped to WNRWF with Disposal at IBRWF	$103	$48	$54	$2,300,000	$1,500,000	$1,010
#2B	Treated Effluent Pumped to WNRWF with Disposal at Private Service Provider	$91	$54	$37	$1,600,000	$3,800,000	$1,420
#3	Rehoboth Pumps to Ocean Outfall Alternative with County Pumping to IBRWF	$94	$64	$30	$1,300,000	$1,100,000	$630
#4	Rehoboth and County Pump to Common Outfall with County Continuing to use IBRWF for Southern Service Area (2030 Max. Month)	$87	$64	$23	$1,000,000	$1,100,000	$550
#4B	Rehoboth and County Pump to Common Outfall with County Continuing to use IBRWF for Southern Service Area (Buildout Max. Month)	$87	$68	$19	$800,000	$1,100,000	$500

Notes:

(1) All annual capital costs, maintenance costs, and users rates are based on 4.4% for 20 years.

(2) All total project costs, annual costs and user rates are rounded to the nearest $1M, $0.1M, and $10 respectively.

Table 10.2-2 : Comparison of Financing Options (1)

Alt.	Description	Rate/Year: (SRF 4.4% for 20 years)	Rate/Year: 1/3 SRF @ 4.4% for 20 years & 2/3 RD @ 5% for 40 years
#1A	Raw Wastewater Pumped to WNRWF with Disposal at IBRWF	$1,160	$1,040
#1B	Raw Wastewater Pumped to WNRWF with Disposal at Private Service Provider	$1,430	$1,340
#2A	Treated Effluent Pumped to WNRWF with Disposal at IBRWF	$1,010	$920
#2B	Treated Effluent Pumped to WNRWF with Disposal at Private Service Provider	$1,420	$1,360
#3	Rehoboth Pumps to Ocean Outfall Alternative with County Pumping to IBRWF	$630	$580
#4	Rehoboth and County Pump to Common Outfall with County Continuing to use IBRWF for Southern Service Area (Based on 2030 max. Month)	$550	$510
#4B	Rehoboth and County Pump to Common Outfall with County Continuing to use IBRWF for Southern Service Area (Based on Buildout max. Month)	$500	$470

Notes:
(1) Rates have been rounded to the nearest $10.

Table 10.2-3 provides a summary of the resulting impact on County User Rates for Alternatives 2, 3 and 4.

Table 10.2-3 : Impacts of Alternatives on County Rates

	Dewey Beach User Rates		Henlopen Acres User Rates		City of Rehoboth Beach User Rates	
Alternative	Existing Rate	New Rate (1)	Existing Rate	New Rate (1)	Existing Rate	New Rate (2)
#2A	$350	$770	$588	$1,460	$325	$1,010
#2B	$350	$1,210	$588	$1,750	$325	$1,420
#3	$350	$540	$588	$1,030	$325	$630
#4	$350	(3)	$588	(3)	$325	$550
#4B	$350	(3)	$588	(3)	$325	$550

Notes:
(1) New rates have been rounded to the nearest $10 and are based on a 40 year loan at 5%,
(2) New rates have been rounded to the nearest $10 and are based on a 20 year loan at 4.4%,
(3) Not evaluated to date

10.3 CONCLUSIONS

Based on the analysis conducted for this study, the following observations are provided.

10.3.1 ALTERNATIVES 1A AND 2A (COUNTY SPRAY ALTERNATIVES)

If spray irrigation is chosen as the method of treatment and disposal by Rehoboth, it appears that Alternative 2A (treated effluent) would be the most cost effective alternative. The main advantage of Alternative 1A would be that the City of Rehoboth could take their existing treatment plant off-line; However the lost treatment capacity would have to be reconstructed elsewhere as a result. Alternative 2A is less expensive from a user rate standpoint.

10.3.2 ALTERNATIVES 1B AND 2B (PWWP ALTERNATIVES)

A public/private partnership with a PWWP (Alt 1B or 2 B) does not appear to be cost effective as compared to other alternatives from a user rate perspective. While the initial capital costs are lower, the long term service agreement and O&M costs create user rates that are significantly higher for Alt. 1A and 1B as compared to all other alternatives. Some additional unknowns with the PWWP include:

- Future cost increases. Per the draft proposal provided by Artesian, for 3 years from the initial service date, the initial bulk rate (i.e. $6.84/ 1,000 gallons) will be adjusted for inflation at a variable rate. This variable rate will be either 3% or the % change in the consumer price index over the 3 year time period, whichever is greater. After this 3 year period, a cost of service adjustment could be requested from the Public Service Commission to further rate increases. Neither inflation nor potential cost increases have been accounted for in this analysis.
- Term of conditions. The term of conditions is 25 years.

- Minimum flow rate: The draft proposal requires a minimum annual flowrate of 2.0 mgd (or 730 mgal/year). The projected 2030 annual average flow rates for the RBSTP and the WNRWF are 1.40 mgd and 2.15 mgd respectively, for a total annual average of 3.55 mgd. The annual average treatment and disposal capacity used in this analysis for the WNRWF is 1.8 mgd. Thus, unless treatment and disposal is reduced at the WNRWF, the annual average being sent to the PWWP in year 2030 would be 1.75 mgd (or 639 mgal/year) and the County would never reach, but would still be paying fees associated with the minimum annual flowrate throughout the current 2030 planning period.

10.3.3 ALTERNATIVES 3, AND 4/4B (OCEAN OUTFALL ALTERNATIVES)

For the City of Rehoboth, the most cost effective alternative appears to be the combined ocean outfall (Alt. 4 or 4B). The inclusion of the County provides an opportunity for cost sharing and a reduction in user rates as compared to all the other alternatives. However, there may be other non-economic factors such as public perception or permitting which may impact the City's final decision.

For the County, the costs of for a combined ocean outfall verses conveyance and treatment/disposal at the IBRWF (Alternative 3) are essentially equal. However, all costs incurred by the City have an impact on user rates for County customers served through the City. Other general pros and cons for Alternatives 3 and 4 are as follows:

- Alternative 4/4B would provide the County with multiple methods of disposal (land disposal and ocean discharge).
- The County has already made a capital investment in land at the IBRWF. Buildout flow projection estimates for the current IBRWF service area range from 6.3 to 9.5 mgd on a maximum month basis depending on future flow/EDU contributions. Based on preliminary estimates, the disposal capacity of the lands purchased by the County is 13 mgd. If Alternative 4/4B is implemented, there

may be excess lands, which could potentially be used to provide sewer service to new areas or partner with other entities. Conversely, total buildout flows from the IBWRF and WNRWF service areas have been projected to be between 13.5 to 20.2 mgd depending on future flow/EDU contributions.

- An advanced wastewater treatment plant train with an ocean outfall (Alt 4/4B) is typically more reliable than a lagoon treatment/spray irrigation system (Alt 3) based on factors such as weather and variable soil conditions introducing higher uncertainties for spray irrigation disposal.
- The long term O&M will likely be less for Alternative 4/4B. While the cost analysis model developed did incorporate a level of O&M costs, specific costs such as increased energy consumption were not accounted for. For example, due to its longer pumping distance and greater total dynamic head (TDH), Alternative 3's energy costs would be expected to be 50% higher than Alternative 4/4B due to longer pumping distances. Based on the information on pump sizes given in Chapter 8, this corresponds to an increase in County energy costs of approximately $20K/year for Alternative 3 as compared to Alternative 4/4B. Other O&M costs such as utility locating responsibilities and maintenance of force main appurtenances would also be expected to be higher.
- This current analysis was through year 2030. Future upgrades beyond 2030 will likely be higher for Alternative 3 as compared to 4/4B. This is due to the fact that the ocean outfall and effluent force main are assumed to be sized for buildout flows. So while 16,000 l.f. of future parallel force main would be required from the WNRWF to Rehoboth, a majority and the most costly portion of the WNRWF conveyance system would already be constructed. For Alternative 3, a future parallel 69,000 l.f. of force main from the WNRWF to the IBRWF would be required.
- For Alternative 3, the County could review upsizing the WNRWF to IBWRF force main. Based on information provided in Chapter 8, the buildout force main would be required to handle anywhere from 7.4 to 12.8 mgd based on future flow contributions. This would require a 30 to 36-inch force main, which would have

very low initial velocities, likely creating additional O&M issues. For Alternative 4/4B, while the currently proposed 36 to 42-inch effluent force main and ocean outfall is not ideal, there will be two sources of initial wastewater which will create a larger base flow. In addition, the effluent force main and ocean outfall are both conveying treated wastewater. So presumably, sedimentation issues from lower initial velocities should not be as big an issue as compared to Alternative 3.

APPENDIX A

Rehoboth Sewage Treatment Plant Data and Future Flows

Appendix A:

Table A-1 Rehoboth Beach Sewage Treatment Plant Flow Data 2005-2008

Date	Rehoboth Beach		Dewey Beach		Henlopen Acres		North Shores		Total Rehoboth Beach Service Area		
	Monthly Flow (MG)	Average Daily Flow (mgd)	Monthly Flow (MG)	Average Daily Flow (mgd)	Monthly Flow (MG)	Average Daily Flow (mgd)	Monthly Flow (MG)	Average Daily Flow (mgd)	Monthly Flow (MG)	Average Daily Flow (mgd)	Max Day Flow (mgd)
Jan-2005	12.46	0.40	6.77	0.22	1.10	0.04	0.88	0.03	21.21	0.68	1.98
Feb-2005	11.48	0.41	6.07	0.22	0.88	0.03	0.98	0.03	19.40	0.69	1.27
Mar-2005	14.62	0.47	7.57	0.24	1.04	0.03	1.07	0.03	24.29	0.78	1.58
Apr-2005	19.49	0.65	8.26	0.28	1.00	0.03	1.18	0.04	29.93	1.00	2.77
May-2005	22.72	0.73	9.64	0.31	1.31	0.04	1.79	0.06	35.46	1.14	3.29
Jun-2005	26.95	0.90	23.28	0.78	1.53	0.05	2.19	0.07	53.96	1.80	2.55
Jul-2005	41.14	1.33	24.71	0.80	1.86	0.06	3.65	0.12	71.37	2.30	3.52
Aug-2005	33.00	1.06	26.44	0.85	1.09	0.04	3.46	0.11	63.99	2.06	3.26
Sep-2005	23.23	0.77	14.34	0.48	1.26	0.04	1.62	0.05	40.45	1.35	2.33
Oct-2005	17.85	0.58	10.08	0.33	1.20	0.04	1.41	0.05	30.53	0.98	1.59
Nov-2005	13.81	0.46	7.66	0.26	1.12	0.04	1.14	0.04	23.72	0.79	1.16
Dec-2005	14.65	0.47	6.29	0.20	1.14	0.04	0.98	0.03	23.07	0.74	1.18
Jan-2006	15.78	0.51	7.20	0.23	1.08	0.03	0.80	0.03	24.86	0.80	2.05
Feb-2006	13.36	0.48	5.92	0.21	0.77	0.03	0.65	0.02	20.70	0.74	1.32
Mar-2006	14.56	0.47	6.41	0.21	0.81	0.03	0.68	0.02	22.46	0.72	1.09
Apr-2006	16.94	0.56	6.56	0.22	0.84	0.03	0.90	0.03	25.24	0.84	1.21
May-2006	18.13	0.58	11.64	0.38	1.17	0.04	1.44	0.05	32.38	1.04	2.29
Jun-2006	34.02	1.13	12.78	0.43	1.05	0.03	2.11	0.07	49.97	1.67	2.22
Jul-2006	31.33	1.01	30.28	0.98	2.17	0.07	3.56	0.11	67.35	2.17	3.28
Aug-2006	34.75	1.12	22.39	0.72	1.72	0.06	4.13	0.13	62.99	2.03	3.39
Sep-2006	25.85	0.86	13.94	0.46	1.19	0.04	1.52	0.05	42.50	1.42	2.63
Oct-2006	20.22	0.65	9.34	0.30	1.04	0.03	1.04	0.03	31.64	1.02	1.44
Nov-2006	18.95	0.63	8.00	0.27	0.84	0.03	1.16	0.04	28.95	0.96	2.20
Dec-2006	17.13	0.55	6.89	0.22	0.82	0.03	0.74	0.02	25.57	0.82	1.23
Jan-2007	13.21	0.43	7.11	0.23	1.19	0.04	0.96	0.03	22.46	0.72	1.37
Feb-2007	10.80	0.39	5.75	0.21	1.05	0.04	0.75	0.03	18.35	0.66	1.21
Mar-2007	14.57	0.47	6.67	0.22	1.01	0.03	0.88	0.03	23.13	0.75	1.61
Apr-2007	15.25	0.51	8.97	0.30	1.22	0.04	1.34	0.04	26.77	0.89	1.29
May-2007	17.64	0.57	11.83	0.38	1.17	0.04	1.43	0.05	32.08	1.03	2.29
Jun-2007	26.73	0.89	16.92	0.56	1.29	0.04	2.04	0.07	46.98	1.57	2.12
Jul-2007	28.69	0.93	25.59	0.83	1.81	0.06	3.11	0.10	59.20	1.91	2.52
Aug-2007	31.70	1.02	22.28	0.72	1.65	0.05	3.28	0.11	58.92	1.90	2.32
Sep-2007	21.79	0.73	12.55	0.42	1.01	0.03	1.24	0.04	36.59	1.22	2.22
Oct-2007	14.55	0.47	9.98	0.32	1.13	0.04	0.89	0.03	26.55	0.86	1.22
Nov-2007	13.45	0.45	6.41	0.21	1.12	0.04	1.27	0.04	22.25	0.74	1.52
Dec-2007	11.79	0.38	5.95	0.19	1.09	0.04	0.93	0.03	19.76	0.64	1.12
Jan-2008	12.08	0.39	5.94	0.19	1.12	0.04	0.67	0.02	19.81	0.64	0.84
Feb-2008	12.82	0.44	5.09	0.18	1.05	0.04	0.81	0.03	19.76	0.68	1.59
Mar-2008	13.12	0.42	6.26	0.20	1.07	0.03	0.83	0.03	21.28	0.69	0.94
Apr-2008	13.77	0.46	6.71	0.22	1.03	0.03	0.73	0.02	22.24	0.74	1.52
May-2008	18.82	0.61	12.29	0.40	1.38	0.04	1.82	0.06	34.31	1.11	2.21
Jun-2008	23.76	0.79	18.24	0.61	1.64	0.05	2.29	0.08	45.93	1.53	2.75
Jul-2008	30.43	0.98	24.73	0.80	2.02	0.07	3.69	0.12	60.86	1.96	3.06
Aug-2008	29.69	0.96	24.86	0.80	2.01	0.06	3.51	0.11	60.08	1.94	2.68
Sep-2008	17.65	0.59	13.54	0.45	1.35	0.05	1.14	0.04	33.68	1.12	2.94
Oct-2008	14.41	0.46	7.83	0.25	1.17	0.04	0.94	0.03	24.34	0.79	1.93
Nov-2008	12.63	0.42	6.85	0.23	1.38	0.05	1.02	0.03	21.88	0.73	0.95
Dec-2008	15.51	0.50	6.91	0.22	1.63	0.05	1.62	0.05	25.67	0.83	1.72
2005-2008 Average	**19.74**	**0.65**	**11.91**	**0.39**	**1.24**	**0.04**	**1.59**	**0.05**	**34.48**	**1.13**	**1.97**

Appendix A:
Table A-1 Rehoboth Beach Sewage Treatment Plant Flow Data 2005-2008

Yearly Averages	Rehoboth Beach		Dewey Beach		Henlopen Acres		North Shores		Total Rehoboth Beach Service Area	
	Monthly Flow (MG)	Average Daily Flow (mgd)	Monthly Flow (MG)	Average Daily Flow (mgd)	Monthly Flow (MG)	Average Daily Flow (mgd)	Monthly Flow (MG)	Average Daily Flow (mgd)	Monthly Flow (MG)	Average Daily Flow (mgd)
2005	20.95	0.69	12.59	0.41	1.21	0.04	1.69	0.06	36.45	1.20
2006	21.75	0.71	11.78	0.39	1.12	0.04	1.56	0.05	36.22	1.19
2007	18.35	0.60	11.67	0.38	1.23	0.04	1.51	0.05	32.75	1.08
2008	17.89	0.59	11.60	0.38	1.40	0.05	1.59	0.05	32.49	1.07

Monthly Averages	Rehoboth Beach		Dewey Beach		Henlopen Acres		North Shores		Total Rehoboth Beach Service Area	
	Monthly Flow (MG)	Average Daily Flow (mgd)	Monthly Flow (MG)	Average Daily Flow (mgd)	Monthly Flow (MG)	Average Daily Flow (mgd)	Monthly Flow (MG)	Average Daily Flow (mgd)	Monthly Flow (MG)	Average Daily Flow (mgd)
January	13.38	0.43	6.76	0.22	1.12	0.04	0.82	0.03	22.08	0.71
February	12.11	0.43	5.71	0.20	0.94	0.03	0.80	0.03	19.55	0.69
March	14.22	0.46	6.73	0.22	0.98	0.03	0.86	0.03	22.79	0.74
April	16.36	0.55	7.63	0.25	1.02	0.03	1.04	0.03	26.05	0.87
May	19.33	0.62	11.35	0.37	1.26	0.04	1.62	0.05	33.56	1.08
June	27.87	0.93	17.81	0.59	1.38	0.05	2.16	0.07	49.21	1.64
July	32.90	1.06	26.33	0.85	1.96	0.06	3.50	0.11	64.69	2.09
August	32.28	1.04	24.00	0.77	1.62	0.05	3.60	0.12	61.49	1.98
September	22.13	0.74	13.59	0.45	1.20	0.04	1.38	0.05	38.31	1.28
October	16.76	0.54	9.30	0.30	1.14	0.04	1.07	0.03	28.27	0.91
November	14.71	0.49	7.23	0.24	1.11	0.04	1.15	0.04	24.20	0.81
December	14.77	0.48	6.51	0.21	1.17	0.04	1.07	0.03	23.52	0.76

Summer Averages[1]	Rehoboth Beach		Dewey Beach		Henlopen Acres		North Shores		Total Rehoboth Beach Service Area	
	Monthly Flow (MG)	Average Daily Flow (mgd)	Monthly Flow (MG)	Average Daily Flow (mgd)	Monthly Flow (MG)	Average Daily Flow (mgd)	Monthly Flow (MG)	Average Daily Flow (mgd)	Monthly Flow (MG)	Average Daily Flow (mgd)
2005	33.695	1.097	24.814	0.809	1.494	0.049	3.101	0.101	63.104	2.055
2006	33.369	1.089	21.817	0.708	1.646	0.053	3.269	0.106	60.102	1.957
2007	29.042	0.946	21.596	0.703	1.584	0.052	2.810	0.091	55.031	1.792
2008	27.961	0.910	22.609	0.736	1.891	0.062	3.163	0.103	55.624	1.811

Note: 1. Summer is defined as June, July, August

Winter Averages[1]	Rehoboth Beach		Dewey Beach		Henlopen Acres		North Shores		Total Rehoboth Beach Service Area	
	Monthly Flow (MG)	Average Daily Flow (mgd)	Monthly Flow (MG)	Average Daily Flow (mgd)	Monthly Flow (MG)	Average Daily Flow (mgd)	Monthly Flow (MG)	Average Daily Flow (mgd)	Monthly Flow (MG)	Average Daily Flow (mgd)
2005	11.969	0.406	6.420	0.218	0.989	0.033	0.928	0.032	20.306	0.689
2006	14.570	0.493	6.558	0.222	0.926	0.031	0.725	0.024	22.780	0.771
2007	13.712	0.455	6.582	0.219	1.019	0.034	0.815	0.027	22.127	0.735
2008	12.228	0.404	5.660	0.186	1.086	0.036	0.802	0.026	19.775	0.653

Note: 1. Winter is defined as December, January, February

Appendix A:
Table A-2: Rehoboth Beach Service Area Growth Projections

Rehoboth Beach Service Area			
Stearns & Wheler LLC	Service Area Growth Projections (Subject)	July-09 (Date)	40284 (Job No.)
Environmental			
Engineers and Scientists		JVS (Comp By)	TAY (Checked By)

Assumptions

Assumptions		Notes:
Annual EDU Growth (%)	0.36%	Based on historical data provided by SCED
GDP/ EDU	225	
Baseline Flow (mgd)	2.3	Based on average ADF from max month (July 2005)
Baseline EDUs	10222	

Rehoboth Beach Service Area Growth History

Year	Henlopen Acres					Dewey Beach					Rehoboth Beach (estimated)			
	EDU	EDUs Gained	Summer EDU	Summer Average Daily Flow (mgd)	Summer gpd/ EDU	EDU	EDUs Gained	Summer EDU	Summer Average Daily Flow (mgd)	Summer gpd/ EDU	EDU	Summer EDU	Summer Average Daily Flow (mgd)	Summer gpd/ EDU
2003	202	3	203.5	0.059	292	3584	19	3593.5	0.77	213	N/A	5208.2	1.17	225
2004	205	0	205	0.064	314	3603	6	3606	0.79	219	N/A	4512.5	1.02	225
2005	205	-2	204	0.049	239	3609	-12	3603	0.81	224	N/A	4873.7	1.10	225
2006	203	2	204	0.053	262	3597	18	3606	0.71	196	N/A	4838.3	1.09	225
2007	205	2	206	0.052	250	3615	15	3622.5	0.70	194	N/A	4206.3	0.95	225
2008	207	0	207	0.062	298	3630	18	3639	0.74	202	N/A	4046.6	0.91	225
2009	207					3648								
	Net EDUs Gained	5				Net EDUs Gained	64							
				Average Summer gpd/ EDU	276				Average Summer gpd/ EDU	208				
				Maximum Summer gpd/ EDU	314				Maximum Summer gpd/ EDU	224				

Rehoboth Beach Service Area Annual Growth Calculation

Growth Determination for Rehoboth Beach Service Area	
EDUs Gained from HA	5
EDUs Gained From DB	64
Total EDUs Gained 2003-2008	69
EDUs Gained/ Year	14
HA & DB Average Annual Flows (MG/ yr)	157.83
Total RBWWTP Average Annual Flows (MG/ yr)	413.71
Percent Contribution of HA & DB to RBRWF (%)	38.15%
EDUs Gained by RBRWF per Year (Proportional)	37

Rehoboth Beach Service Area Projected Growth

Year	Total EDUs	EDU Added per Year	Maximum Month Flow
2008	10,222	37	2.30
2009	10,259	37	2.31
2010	10,296	37	2.32
2011	10,333	37	2.32
2012	10,370	38	2.33
2013	10,408	38	2.34
2014	10,446	38	2.35
2015	10,484	38	2.36
2016	10,522	38	2.37
2017	10,560	38	2.38
2018	10,598	38	2.38
2019	10,636	38	2.39
2020	10,674	39	2.40
2021	10,713	39	2.41
2022	10,752	39	2.42
2023	10,791	39	2.43
2024	10,830	39	2.44
2025	10,869	39	2.45
2026	10,908	39	2.45
2027	10,947	40	2.46
2028	10,987	40	2.47
2029	11,027	40	2.48
2030	11,067	40	2.49
2031	11,107	40	2.50
2032	11,147	40	2.51
2033	11,187	40	2.52
2034	11,227	41	2.53
2035	11,268	41	2.54
2036	11,309	41	2.54
2037	11,350	41	2.55
2038	11,391	41	2.56
2039	11,432	41	2.57
2040	11,473	42	2.58
2041	11,515	42	2.59
2042	11,557	42	2.60
2043	11,599	42	2.61
2044	11,641	42	2.62
2045	11,683	42	2.63
2046	11,725	42	2.64
2047	11,767	43	2.65
2048	11,810	43	2.66
2049	11,853	43	2.67
2050	11,896	43	2.68

Rehoboth Beach STP Projected Growth Summary

Design Period	Max Month ADF (mgd)	Summer ADF (mgd)	Winter ADF (mgd)	Annual ADF (mgd)
Current	2.30	1.91	0.72	1.13
Year 2030	2.49	2.27	0.93	1.35
Ultimate Design	3.40	3.10	1.27	1.85

Appendix A:
Table A-3: Rehoboth Beach Sewage Treatment Plant Performance Data 2005-2008

Date	Biological Oxygen Demand (BOD5)				Total Suspended Solids (TSS)				Total Nitrogen (TN)					Total Phosphorus (TP)				
	Concentration (mg/L)		Loading		Concentration (mg/L)		Loading		Concentration (mg/L)			Loading		Concentration (mg/L)			Loading	
	Average	Maximum	Average Daily (lbs/day)	Monthly (lbs/month)	Average	Maximum	Average (lbs/day)	Monthly (lbs/month)	Minimum	Average	Maximum	Average Daily (lbs/day)	Monthly (lbs/month)	Minimum	Average	Maximum	Average Daily (lbs/day)	Monthly (lbs/month)
Jan-2005	2.0	5.0	15	354	3.0	7.0	17	531	2.9	7.8	12.1	44	1,379	0.2	0.3	0.5	2	53
Feb-2005	2.0	4.0	12	324	4.0	7.0	23	647	6.0	9.5	15.2	55	1,537	0.1	0.2	0.3	1	32
Mar-2005	2.0	4.0	9	405	4.0	10.0	26	811	0.8	11.7	21.8	77	2,372	0.1	0.2	0.3	1	41
Apr-2005	1.0	4.0	8	250	7.0	14.0	58	1,748	1.8	4.0	8.3	33	999	0.1	0.4	1.0	3	100
May-2005	1.0	5.0	10	296	2.0	9.0	19	592	2.0	5.3	13.9	51	1,568	0.1	0.3	1.2	3	89
Jun-2005	1.0	9.0	15	450	3.0	10.0	45	1,350	2.2	5.2	8.8	78	2,341	0.3	0.9	1.4	14	405
Jul-2005	1.0	4.0	19	595	3.0	14.0	58	1,785	0.4	4.1	9.6	79	2,440	0.3	0.5	0.9	10	298
Aug-2005	2.0	7.0	34	1,067	4.0	14.0	69	2,135	2.3	4.7	15.0	81	2,508	0.3	0.7	1.3	12	374
Sep-2005	3.0	14.0	34	1,012	4.0	9.0	45	1,349	2.8	4.2	6.7	47	1,417	0.2	0.5	1.7	6	169
Oct-2005	2.0	4.0	16	509	3.0	11.0	25	764	2.1	5.2	12.7	43	1,324	0.2	0.6	1.4	5	153
Nov-2005	3.0	6.0	20	694	1.0	5.0	7	198	3.4	9.9	15.6	65	1,959	0.1	0.5	1.1	3	99
Dec-2005	2.0	6.0	12	385	3.0	14.0	19	577	7.8	11.1	14.5	69	2,135	0.1	0.1	0.3	1	19
Jan-2006	2.0	4.0	13	415	3.0	12.0	20	622	4.6	8.2	12.4	55	1,700	0.0	0.2	0.4	1	41
Feb-2006	1.0	3.0	6	173	2.0	13.0	12	345	1.5	8.5	11.1	52	1,467	0.1	0.2	0.4	1	35
Mar-2006	1.0	2.0	6	187	1.0	5.0	6	187	0.8	4.8	8.6	29	898	0.0	0.2	0.5	1	37
Apr-2006	1.0	2.0	7	210	3.0	21.0	21	631	1.9	4.6	9.3	32	968	0.0	0.2	0.4	1	42
May-2006	3.0	4.0	26	811	3.0	9.0	26	811	1.3	2.8	7.0	24	756	0.0	0.2	0.4	2	54
Jun-2006	2.5	3.0	35	1,043	2.0	7.0	28	834	2.5	3.8	5.5	53	1,585	0.6	0.9	1.3	13	375
Jul-2006	1.0	3.0	18	562	3.0	8.0	54	1,685	2.7	3.1	3.8	56	1,741	0.3	0.4	0.9	7	225
Aug-2006	1.0	3.0	17	525	3.0	13.0	51	1,576	1.5	2.5	3.7	42	1,313	0.1	0.3	0.6	5	158
Sep-2006	1.0	5.0	12	355	3.0	7.0	35	1,064	2.0	4.0	6.5	47	1,418	0.2	0.7	1.2	8	248
Oct-2006	1.0	2.0	9	264	4.0	11.0	34	1,056	2.0	3.8	5.8	32	1,003	0.1	0.2	0.4	2	53
Nov-2006	1.0	2.0	8	241	3.0	13.0	24	724	2.5	4.0	5.2	32	966	0.0	0.2	0.4	2	48
Dec-2006	2.0	4.0	14	427	2.0	12.0	14	427	5.9	9.8	15.0	67	2,090	0.1	0.4	0.7	3	85
Jan-2007	2.0	4.0	12	374	3.0	11.0	18	562	4.1	10.3	15.7	62	1,928	0.1	0.4	0.6	2	75
Feb-2007	1.0	4.0	5	153	3.0	5.0	16	459	8.8	10.7	12.8	58	1,637	0.4	0.6	0.8	3	92
Mar-2007	2.0	9.0	12	386	3.0	10.0	19	579	2.3	6.3	9.9	39	1,215	0.3	0.6	1.1	4	116
Apr-2007	0.1	1.0	1	22	4.0	19.0	30	893	1.1	4.2	6.8	31	937	0.0	0.4	1.1	3	89
May-2007	5.0	12.0	43	1,338	5.0	15.0	43	1,338	1.6	6.9	21.2	60	1,846	0.1	0.2	0.3	2	54
Jun-2007	1.0	2.0	13	392	4.0	17.0	52	1,567	1.5	3.3	6.3	43	1,293	0.0	0.4	0.6	5	157
Jul-2007	1.0	2.0	16	494	2.0	5.0	32	987	2.2	3.4	7.2	54	1,678	0.2	0.4	0.7	6	197
Aug-2007	2.0	4.0	32	982	3.0	10.0	48	1,474	0.7	3.9	11.8	62	1,916	0.1	0.6	1.3	10	295
Sep-2007	2.0	4.0	20	610	4.0	12.0	41	1,221	1.2	2.4	3.6	24	733	0.1	0.5	1.1	5	153
Oct-2007	0.2	1.0	1	44	3.0	17.0	21	664	1.1	3.4	6.4	24	752	0.1	0.2	0.3	1	44
Nov-2007	2.0	4.0	12	371	4.0	10.0	25	743	0.9	6.7	14.2	41	1,244	0.1	0.2	0.5	1	37
Dec-2007	1.0	2.0	5	165	7.0	15.0	37	1,153	3.7	8.8	12.1	47	1,449	0.0	0.1	0.2	1	16
Jan-2008	2.0	4.0	11	330	5.0	16.0	27	826	2.2	8.3	16.4	44	1,371	0.0	0.2	0.4	1	33
Feb-2008	2.0	3.0	11	329	5.0	12.0	28	824	4.4	9.3	15.6	53	1,532	0.0	0.1	0.3	1	16
Mar-2008	1.0	3.0	6	177	2.0	7.0	11	355	1.6	5.0	9.7	29	887	0.1	0.2	0.3	1	35
Apr-2008	2.0	5.0	12	371	3.0	10.0	19	556	0.8	3.0	7.7	19	556	0.1	0.2	0.3	1	37
May-2008	2.0	4.0	18	572	2.0	9.0	18	572	1.5	4.3	8.1	40	1,231	0.1	0.2	0.6	2	57
Jun-2008	1.0	3.0	13	383	1.0	6.0	13	383	2.1	4.5	10.2	57	1,724	0.1	0.7	1.2	9	268
Jul-2008	1.0	4.0	16	508	3.0	10.0	49	1,523	0.7	2.5	4.0	41	1,269	0.3	0.5	0.8	8	254
Aug-2008	3.5	8.3	57	1,754	3.0	9.0	48	1,503	2.2	4.5	8.9	73	2,255	0.0	0.8	1.7	13	401
Sep-2008	2.0	4.0	19	562	2.5	15.5	23	702	0.0	7.3	22.2	68	2,051	0.1	0.8	1.1	7	225
Oct-2008	2.5	3.0	16	507	3.0	9.0	20	609	4.7	14.0	32.6	92	2,841	0.3	0.6	0.9	4	122
Nov-2008	3.0	3.0	18	547	4.0	11.0	24	730	1.7	10.4	19.7	63	1,897	0.0	0.2	0.3	1	36
Dec-2008	3.0	6.0	21	642	5.0	20.0	35	1,070	2.1	8.3	12.9	57	1,777	0.1	0.2	0.3	1	43
2005-2008 Average	**1.7**	**4.3**	**16**	**489**	**3.3**	**11.2**	**30**	**911**	**2.4**	**6.1**	**11.3**	**51**	**1,540**	**0.1**	**0.4**	**0.7**	**4**	**127**

Yearly Averages	Biological Oxygen Demand (BOD_5)				Total Suspended Solids (TSS)				Total Nitrogen (TN)					Total Phosphorus (TP)				
	Average Concentration (mg/L)	Max Concentration (mg/L)	Average Daily Loading (lbs/day)	Average Monthly Loading (lbs/month)	Average Concentration (mg/L)	Max Concentration (mg/L)	Average Daily Loading (lbs/day)	Average Monthly Loading (lbs/month)	Min Concentration (mg/L)	Average Concentration (mg/L)	Max Concentration (mg/L)	Average Daily Loading (lbs/day)	Average Monthly Loading (lbs/month)	Min Concentration (mg/L)	Average Concentration (mg/L)	Max Concentration (mg/L)	Average Daily Loading (lbs/day)	Average Monthly Loading (lbs/month)
2005	1.7	6.0	17	520	3.4	10.3	34	1041	2.9	6.0	12.9	60	1832	0.2	0.5	1.0	5	153
2006	1.4	3.1	14	434	2.7	10.9	27	830	2.4	4.4	7.8	44	1326	0.1	0.4	0.6	4	117
2007	1.6	4.1	15	444	3.8	12.2	32	970	2.4	5.1	10.7	46	1388	0.1	0.4	0.7	4	110
2008	2.1	4.2	18	503	3.0	11.2	26	715	2.0	6.0	13.9	53	1468	0.1	0.5	0.7	4	124

Year	Summer Average BOD_5 (mg/L)[1]	Winter Average BOD_5 (mg/L)[2]	Summer Average TSS (mg/L)	Winter Average TSS (mg/L)	Summer Average TN (mg/L)	Winter Average TN (mg/L)	Summer Average TP (mg/L)	Winter Average TP (mg/L)
2005	1.34	1.70	3.34	2.70	4.62	9.27	0.68	0.17
2006	1.42	1.72	2.72	2.61	3.08	10.22	0.50	0.46
2007	1.36	1.67	2.93	5.67	3.65	8.80	0.47	0.13
2008	1.90	3.00	2.45	5.00	3.77	8.30	0.68	0.20
Average	1.50	1.87	2.87	3.70	3.76	9.15	0.58	0.24

Notes:
1. Summer is defined as June, July, August.
2. Winter is defined as December, January, February

APPENDIX B

Wolfe Neck Regional Wastewater Facility Flow, Performance Data and Future Flows

Appendix B:
Table B-1: Wolfe Neck Regional Wastewater Facility Influent Data 2005 - 2008

Wolfe Neck Regional Wastewater Facility Influent Wastewater Characteristics

Date	Influent Average Daily Flow (mgd)	Biological Oxygen Demand (BOD_5)		Total Suspended Solids (TSS)		Total Keldahl Nitrogen (TKN)		Organic Nitrogen (Org-N)		Ammonia (NH_3-N)	
		Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)
Jan-2005	1.27	375	3,975	213.00	2,258	-	-	-	-	-	-
Feb-2005	1.23	328	3,366	102.00	1,047	-	-	-	-	-	-
Mar-2005	1.29	313	3,370	136.00	1,464	-	-	-	-	-	-
Apr-2005	1.26	325	3,415	76.00	799	-	-	-	-	-	-
May-2005	1.22	515	5,237	133.00	1,352	-	-	-	-	-	-
Jun-2005	1.65	358	4,925	76.00	1,046	42	-	-	-	-	-
Jul-2005	1.80	423	6,353	198.00	2,974	37	-	-	-	-	-
Aug-2005	1.81	393	5,946	206.00	3,117	45	-	-	-	-	-
Sep-2005	1.50	298	3,734	215.00	2,694	48	-	-	-	-	-
Oct-2005	1.42	330	3,910	194.00	2,299	47	-	-	-	-	-
Nov-2005	1.34	265	2,956	150.00	1,673	47	-	-	-	-	-
Dec-2005	1.33	390	4,311	320.00	3,538	55	-	-	-	-	-
Jan-2006	1.34	[illegible]	[illegible]	[illegible]	[illegible]	-	-	-	-	-	-
Feb-2006	1.30	[illegible]	[illegible]	[illegible]	[illegible]	-	-	-	-	-	-
Mar-2006	1.26	355	3,721	163	1,708	48	-	-	-	-	-
Apr-2006	1.34	305	3,412	59	660	49	-	-	-	-	-
May-2006	1.42	235	2,789	71	843	46	-	-	-	-	-
Jun-2006	1.64	285	3,897	121	1,655	48	-	-	-	-	-
Jul-2006	1.88	207	3,238	84	1,314	56	-	-	-	-	-
Aug-2006	1.78	188	2,795	115	1,709	50	-	-	-	-	-
Sep-2006	1.54	226	2,897	94	1,205	56	-	-	-	-	-
Oct-2006	1.39	[illegible]	[illegible]	[illegible]	[illegible]	-	-	-	-	-	-
Nov-2006	1.42	[illegible]	[illegible]	[illegible]	[illegible]	-	-	-	-	-	-
Dec-2006	1.34	[illegible]	[illegible]	[illegible]	[illegible]	-	-	-	-	-	-
Jan-2007	1.32	173	1,905	55	606	62	683	28	308	33	363
Feb-2007	1.31	181	1,978	80	874	56	606	24	257	32	350
Mar-2007	1.34	212	2,366	88	982	54	603	24	268	30	335
Apr-2007	1.40	205	2,393	101	1,179	57	665	27	315	28	327
May-2007	1.45	215	2,591	109	1,314	57	681	25	295	32	386
Jun-2007	1.58	240	3,159	95	1,251	67	875	34	448	33	434
Jul-2007	1.81	239	3,614	195	2,949	58	877	27	408	31	469
Aug-2007	1.78	235	3,494	145	2,156	63	929	33	483	30	446
Sep-2007	1.50	211	2,641	90	1,126	69	857	34	425	35	438
Oct-2007	1.35	226	2,539	66	741	56	629	17	191	32	359
Nov-2007	1.29	226	2,432	97	1,044	59	629	32	344	36	382
Dec-2007	1.32	214	2,355	100	1,101	59	649	27	297	29	319
Jan-2008	1.24	207	2,145	85	881	56	575	18	186	31	321
Feb-2008	1.26	183	1,923	74	778	54	567	18	189	36	378
Mar-2008	1.29	184	1,982	73	786	38	409	16	172	22	237
Apr-2008	1.31	161	1,759	83	907	42	459	21	229	22	240
May-2008	1.50	142	1,776	136	1,701	40	500	24	300	24	300
Jun-2008	1.58	162	2,135	107	1,410	43	567	20	264	24	316
Jul-2008	1.84	175	2,685	98	1,504	48	737	19	292	29	445
Aug-2008	1.83	178	2,717	147	2,244	39	595	19	290	20	305
Sep-2008	1.45	187	2,261	98	1,185	57	689	22	266	35	423
Oct-2008	1.30	237	2,570	98	1,063	70	759	30	325	40	434
Nov-2008	1.36	175	1,985	59	669	53	601	23	261	31	352
Dec-2008	1.38	228	2,624	94	1,082	56	645	21	242	35	403
2005-2008 Average	**1.45**	**255**	**3,068**	**121**	**1,474**	**52**	**658**	**24**	**294**	**30**	**365**

(shaded) Data not available - interpolated

Yearly Averages	Influent Average Daily Flow (mgd)	Biological Oxygen Demand (BOD_5)		Total Suspended Solids (TSS)		Total Keldahl Nitrogen (TKN)		Organic Nitrogen (Org-N)		Ammonia (NH_3-N)	
		Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)
2005	1.43	359	4,291	168	2,022	46	-	-	-	-	-
2006	1.47	261	3,146	118	1,415	50	-	-	-	-	-
2007	1.45	215	2,622	102	1,277	60	724	28	337	32	384
2008	1.46	185	2,213	96	1,184	50	592	21	251	29	346

Winter Influent Characteristics

Year	Influent Average Daily Flow (mgd)	Biological Oxygen Demand (BOD_5)		Total Suspended Solids (TSS)		Total Keldahl Nitrogen (TKN)		Organic Nitrogen (Org-N)		Ammonia (NH_3-N)	
		Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)
2005	1.25	352	3,670	158	1,652	-	-	-	-	-	-
2006	1.32	375	4,138	268	2,951	55	-	-	-	-	-
2007	1.32	185	2,037	70	771	59	645	26	283	33	357
2008	1.30	208	2,262	88	960	56	609	21	229	33	355
Average	1.30	268	2,909	140	1,526	57	621	23	247	33	356

Note: Winter defined as December, January, February.

Summer Influent Characteristics

Year	Influent Average Daily Flow (mgd)	Biological Oxygen Demand (BOD_5)		Total Suspended Solids (TSS)		Total Keldahl Nitrogen (TKN)		Organic Nitrogen (Org-N)		Ammonia (NH_3-N)	
		Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)
2005	1.75	391	5,741	160	2,379	41	-	-	-	-	-
2006	1.77	227	3,310	107	1,559	51	-	-	-	-	-
2007	1.72	238	3,422	145	2,118	62	894	31	446	31	450
2008	1.75	172	2,512	117	1,719	43	633	19	282	24	356
Average	1.75	257	3,746	132	1,944	50	763	25	364	28	403

Note: Summer defined as June, July, August.

Appendix B:
Table B-2: Wolfe Necke Regional Wastewater Facility Performance Data 2005-2008

Wolfe Neck Regional Wastewater Facility Treated Effluent Wastewater Characteristics

Date	Effluent Average Daily Flow (mgd)[1]	Area Sprayed (acres)	Biological Oxygen Demand (BOD_5)		Total Suspended Solids (TSS)		Total Nitrogen (TN)		Total Keldahl Nitrogen (TKN)		Organic Nitrogen (Org-N)		Ammonia (NH_3-N)		Nitrate (NO_3-N)		Total Phosphorus (TP)		pH
			Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	
Jan-2005	0.65	230	-	-	-	-	24.6	134	7.09	39	4	23	2.95	16	17.55	96	-	-	-
Feb-2005	0.53	230	-	-	-	-	30.6	135	20.70	92	6	26	14.85	66	9.92	44	-	-	-
Mar-2005	0.97	230	-	-	-	-	30.6	246	25.65	207	5	41	20.60	166	4.95	40	-	-	-
Apr-2005	1.83	230	-	-	-	-	30.9	472	28.00	428	5	83	22.55	345	2.89	44	-	-	-
May-2005	1.98	230	-	-	-	-	31.5	519	29.15	481	5	81	24.25	400	2.33	38	-	-	-
Jun-2005	2.03	230	-	-	-	-	22.1	374	6.43	109	6	102	0.41	7	15.70	265	-	-	-
Jul-2005	1.95	230	-	-	-	-	8.5	137	4.89	79	5	75	0.25	4	3.58	58	-	-	-
Aug-2005	1.86	230	-	-	-	-	14.4	223	10.20	158	9	135	1.52	24	4.17	65	-	-	-
Sep-2005	1.20	230	-	-	-	-	13.1	132	6.55	66	6	63	0.25	3	6.59	66	-	-	-
Oct-2005	1.40	230	-	-	-	-	11.2	130	5.49	64	5	62	0.18	2	5.67	66	-	-	-
Nov-2005	1.76	230	-	-	-	-	12.1	177	4.96	78	5	70	0.17	2	7.10	104	-	-	-
Dec-2005	0.92	230	-	-	-	-	20.7	159	8.95	69	4	32	4.78	37	11.73	90	-	-	-
Jan-2006	0.88	319	36	268	31.3	230	28.1	207	21.89	161	16	120	5.63	41	6.18	45	5.4	40	7.3
Feb-2006	1.46	319	63	771	20.0	243	25.5	309	22.10	268	16	197	5.90	72	3.37	41	4.0	48	7.0
Mar-2006	1.59	319	8	106	9.0	119	30.6	405	28.69	380	24	318	4.66	62	1.91	25	5.0	66	7.7
Apr-2006	0.89	319	10	74	22.0	164	24.8	184	23.03	171	15	108	8.45	63	1.76	13	4.0	30	8.5
May-2006	0.88	319	25	186	43.8	322	31.5	232	29.15	215	24	178	4.90	36	2.33	17	4.2	31	8.6
Jun-2006	1.06	319	17	151	34.0	301	6.0	54	6.04	54	1	5	5.49	49	0.00	-	6.4	57	7.5
Jul-2006	1.95	319	4	65	19.0	310	23.2	378	6.16	100	0	-	6.16	100	17.03	278	7.0	114	7.7
Aug-2006	1.99	319	3	50	23.0	382	17.8	296	9.20	153	2	30	7.40	123	8.60	143	6.0	100	9.3
Sep-2006	1.25	302	8	79	18.0	188	13.7	143	4.10	43	2	20	2.20	23	9.60	100	6.6	69	9.3
Oct-2006	1.24	319	6	61	13.5	139	7.1	73	2.30	24	0	4	1.90	20	4.80	50	6.8	70	9.2
Nov-2006	1.68	273	4	56	11.0	154	6.7	94	2.20	31	0	4	1.90	27	4.50	63	7.0	98	8.9
Dec-2006	1.33	319	4	44	17.0	189	11.1	123	5.70	63	2	24	3.50	39	5.40	60	7.0	78	7.8
Jan-2007	1.37	319	7	75	9.3	105	19.8	226	10.00	114	2	16	8.40	96	9.80	112	6.4	72	7.8
Feb-2007	0.70	319	7	42	25.5	148	26.6	155	15.90	92	1	6	14.80	86	10.70	62	6.6	38	7.9
Mar-2007	1.15	319	8	77	10.0	96	29.0	278	23.20	222	1	8	22.40	215	5.80	56	7.0	67	8.0
Apr-2007	1.55	319	23	298	9.0	116	30.3	392	25.78	334	3	32	23.28	301	4.52	59	7.0	91	7.9
May-2007	1.54	319	62	801	16.0	206	31.8	409	18.50	238	5	69	13.90	179	13.33	171	7.0	89	7.3
Jun-2007	1.69	319	11	151	10.5	148	27.3	384	0.50	7	0	4	0.20	3	26.80	377	7.2	101	6.7
Jul-2007	1.98	319	8	132	13.0	214	22.3	367	3.90	64	4	58	0.40	7	18.39	303	7.0	115	8.1
Aug-2007	1.85	319	5	77	23.0	355	15.7	242	5.20	80	5	69	0.70	11	10.48	162	7.0	108	8.8
Sep-2007	1.47	319	4	49	11.0	135	9.2	113	2.20	27	2	25	0.20	2	6.98	86	7.4	90	8.8
Oct-2007	1.32	230	9	101	14.5	159	8.3	91	1.40	15	1	14	0.10	1	6.90	76	6.9	76	8.7
Nov-2007	1.39	236	5	58	17.0	197	9.4	109	2.77	32	3	31	0.07	1	6.66	77	7.0	81	7.5
Dec-2007	1.33	319	10	111	6.0	67	18.7	208	4.60	51	4	45	0.60	7	14.10	157	7.0	78	7.5
Jan-2008	1.21	307	7	72	13.3	134	18.3	184	10.70	108	3	33	7.50	76	7.60	77	7.4	75	7.4
Feb-2008	1.33	307	6	66	15.0	166	25.2	279	15.30	169	4	43	11.40	126	9.90	110	7.1	79	7.8
Mar-2008	1.34	307	26	292	15.7	175	36.3	404	24.00	267	6	67	17.00	189	12.30	137	7.2	80	7.8
Apr-2008	1.37	307	39	442	19.7	225	29.4	336	23.10	264	4	40	19.40	222	6.30	72	7.2	82	7.7
May-2008	1.49	307	25	310	15.7	195	20.7	257	9.50	118	4	55	5.10	63	11.20	139	7.1	88	7.8
Jun-2008	1.40	307	24	282	13.2	154	20.8	243	3.20	37	3	37	0.10	1	17.60	206	7.1	83	-
Jul-2008	1.32	307	11	119	11.5	127	18.6	205	2.70	30	3	30	0.10	1	15.90	175	7.1	78	-
Aug-2008	1.56	307	9	116	21.3	278	6.7	87	4.10	53	4	53	0.10	1	2.60	34	7.0	91	-
Sep-2008	1.33	307	3	29	21.0	234	10.6	118	7.30	81	7	80	0.20	2	3.30	37	7.1	79	-
Oct-2008	0.97	307	6	44	19.0	153	11.9	96	7.50	61	4	33	3.40	27	4.40	36	7.1	57	-
Nov-2008	0.91	307	6	45	6.7	51	15.4	117	8.00	61	7	56	0.60	5	7.40	56	7.1	54	-
Dec-2008	1.66	307	26	353	13.5	186	14.1	196	4.00	55	2	32	1.70	23	10.10	139	7.6	105	-
2005-2008 Average	**1.39**	**289**	**15**	**168**	**17.0**	**188**	**19.8**	**226**	**11**	**108**	**3**	**39**	**6**	**69**	**10**	**121**	**7**	**82**	**8**

Yearly Averages	Influent Average Daily Flow (mgd)	Area Sprayed (acres)	Biological Oxygen Demand (BOD_5)		Total Suspended Solids (TSS)		Total Nitrogen (TN)		Total Keldahl Nitrogen (TKN)		Organic Nitrogen (Org-N)		Ammonia (NH_3-N)		Nitrate (NO_3-N)		Total Phosphorus (TP)		pH
			Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	
2005	1.42	230	-	-	-	-	21	237	13	-	-	-	-	-	-	-	-	-	-
2006	1.35	314	16	159	22	228	19	208	13	-	-	-	-	-	-	-	-	-	-
2007	1.44	305	13	164	14	162	21	248	9	106	2	31	7	76	11	141	7	84	8
2008	1.32	307	16	181	15	173	19	210	10	109	4	47	6	61	9	101	7	79	8

Winter Influent Characteristics

Year	Influent Average Daily Flow (mgd)	Area Sprayed (acres)	Biological Oxygen Demand (BOD_5)		Total Suspended Solids (TSS)		Total Nitrogen (TN)		Total Keldahl Nitrogen (TKN)		Organic Nitrogen (Org-N)		Ammonia (NH_3-N)		Nitrate (NO_3-N)		Total Phosphorus (TP)		pH
			Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	
2005	0.69	230	-	-	-	-	28	135	-	-	-	-	-	-	-	-	-	-	-
2006	1.09	289	50	520	26	237	25	225	18	-	-	-	-	-	-	-	-	-	-
2007	1.13	319	6	54	17	147	19	168	11	90	2	16	9	74	9	78	7	63	8
2008	1.38	310	12	151	12	138	19	217	9	96	3	38	5	58	10	121	7	84	8
Average	**1.11**	**294**	**18**	**200**	**17**	**163**	**22**	**193**	**12**	**107**	**5**	**50**	**7**	**57**	**10**	**86**	**6**	**66**	**8**

Summer Influent Characteristics

Year	Influent Average Daily Flow (mgd)	Area Sprayed (acres)	Biological Oxygen Demand (BOD_5)		Total Suspended Solids (TSS)		Total Nitrogen (TN)		Total Keldahl Nitrogen (TKN)		Organic Nitrogen (Org-N)		Ammonia (NH_3-N)		Nitrate (NO_3-N)		Total Phosphorus (TP)		pH
			Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	Concentration (mg/L)	Loading (lbs/day)	
2005	1.94	230	-	-	-	-	15	245	7	-	-	-	-	-	-	-	-	-	-
2006	1.67	319	8	89	25	331	16	242	7	-	-	-	-	-	-	-	-	-	-
2007	1.84	319	8	120	16	239	22	331	3	51	3	44	0	7	19	281	7	108	8
2008	1.43	307	15	172	15	186	15	179	3	40	3	40	0	1	12	138	7	84	-
Average	**1.72**	**294**	**10**	**127**	**19**	**252**	**17**	**249**	**5**	**45**	**3**	**42**	**0**	**4**	**15**	**200**	**7**	**98**	**8**

Appendix B:
Table B-3: Inland Bays RWF Nitrogen Balance for Alternative 1

Stearns & Wheler, LLC	North Coastal Planning Area Preliminary Engineering Report	April 2009	40284.19
Environmental	Project	Date	Job No.
Engineers and Scientists	Alternative 1 Nitrogen Balance and Percolate Concentration Calculation	JVS	TAY
	Subject	Comp. By	Checked By

Objective:
To determine the total nitrogen concentration in the percolate on a yearly average based on a monthly nitrogen balance for the entire facility. This assumes design conditions of permitted effluent application rates and a corn harvest schedule.

Design Criteria / Assumptions:
According to the Mid-Atlantic Nutrient Management Handbook, grain soybean nitrogen requirements are higher than those of grain corn.
Therefore, corn is used in this sheet to calculate the nitrogen concentration in the percolate.

Wetted Field Area (acres)	319	
Average Effluent Nitrogen Concentration (mg/L)	23	
Nitrogen from Rainfall and Fixation (lbs/ac/yr)	5	assumed per Table 703-2 in the regulations
Corn Planting Date	1-Jun	assumed typical schedule (Sam Walter)
Nitrogen Uptake by Corn (lbs/ac/yr)	150	

Monthly Nitrogen Balance:

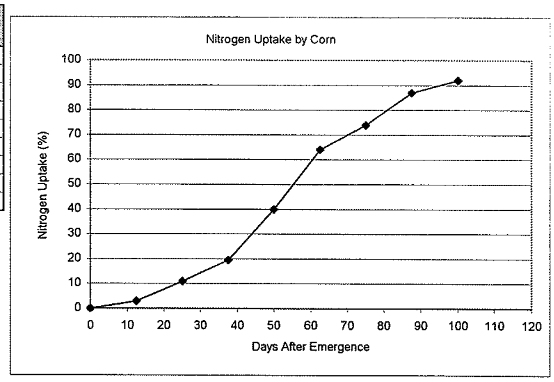
Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Notes
Days	31	28.25	31	30	31	30	31	31	30	31	30	31		
Wetted Field Area (acres)	319	319	319	319	319	319	319	319	319	319	319	319		
Effluent Rate (in/wk)	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41		
Application Rate (mgd)	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75		
Effluent Rate (in/mo)	6.3	5.7	6.3	6.1	6.3	6.1	6.3	6.3	6.1	6.3	6.1	6.3		
Wastewater Volume Applied (Mgal/mo)	54	49	54	53	54	53	54	54	53	54	53	54	639.19	
Precipitation (in/mo)	4.7	4.4	5.6	4.5	5	5.1	6.3	8.2	5.2	5.4	4.6	5.2	64	1
Potential Evapotranspiration, PET (in/mo)	0.1	0.1	0.7	1.8	3.3	4.8	5.5	4.9	3.6	1.9	0.9	0.2	28	2
Percolate (in/mo)	10.9	10.0	11.2	8.8	8.0	6.4	7.1	9.6	7.7	9.8	9.8	11.3	110	
Percolate (Mgal/mo)	94	87	97	76	69	55	61	83	66	85	85	98	954	
Percolate (mgd)	3.0	3.1	3.1	2.5	2.2	1.8	2.0	2.7	2.2	2.7	2.8	3.1		
Total Nitrogen Concentration in Effluent (mg/L)	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0		
Estimated fraction of ammonia in effluent TN	0.3	0.5	0.4	0.4	0.4	0.4	0.3	0.3	0.4	0.1	0.2	0.4		3
Ammonia Concentration in Effluent (mg/L)	7.8	10.5	9.2	8.8	8.4	9.7	7.7	7.4	8.5	1.7	3.7	9.8		
Total Nitrogen Input from Effluent (lbs/ac/mo)	32.6	29.7	32.6	31.6	32.6	31.6	32.6	32.6	31.6	32.6	31.6	32.6	384.4	
Nitrogen from Rainfall and Fixation (lbs/ac/mo)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5	
Ammonia Volatilization by Plant (lbs/ac/mo)	0.6	0.7	0.7	0.6	0.6	0.7	0.5	0.5	0.6	0.1	0.3	0.7	6	4
Ammonia Input from Effluent (lbs/ac/mo)	11.0	13.5	13.1	12.1	11.8	13.3	10.9	10.5	11.6	2.4	5.1	13.9	129	
Denitrification by plant (lbs/ac/mo)	6.5	5.9	6.5	6.3	6.5	6.3	6.5	6.5	6.3	6.5	6.3	6.5	77	5
TN after volat., denit., fixation, rain (lbs/ac/mo)	26.0	23.5	25.9	25.1	25.9	25.0	26.0	26.0	25.1	26.4	25.4	25.8	306	
Plant Uptake and Storage (lbs/ac/mo)	8	8	8	8	8	22.5	67.5	43.5	9	7.5	8	8	203	
Nitrogen Leached by Percolate (lbs/ac/mo)	18.5	16.0	18.4	17.6	18.4	2.5	0.0	0.0	16.1	18.9	17.9	18.3	163	
Percolate Nitrogen Concentration (mg/L)	**7.5**	**7.1**	**7.3**	**8.9**	**10.2**	**1.7**	**0.0**	**0.0**	**9.3**	**8.5**	**8.1**	**7.2**	6.3	

Summary:

Average Percolate Nitrogen Concentration (mg/L)	6.3
Max Month Percolate Nitrogen Concentration (mg/L)	10.2
Total Nitrogen in Percolate (lbs/yr)	50,300
Effluent Application Rate Yearly Average	1.41

Nitrogen Uptake Rate by Corn[6]:

Days After Emergence	Nitrogen Uptake (%)
0	0
12.5	3
25	11
37.5	19.5
50	40
62.5	64
75	74
87.5	87
100	92



	Jun	Jul	Aug	Sep	Oct
Days	30	31	31	30	31
Days in Growing Season at the end of each Month	30	61	92	122	153
Total Nitrogen Uptake at the end of each Month	15%	60%	89%	95%	100%
Incremental Nitrogen Uptake for each Month	15%	45%	29%	6%	5%

Nitrogen Uptake Rate by Other Crops:

Small Grain Including Barley and Wheat (lbs/ac/yr)	90	cover crop during non-corn growing season
Therefore, Small Grain (lbs/ac/mo)	8	

Notes:
1. 5 year precipitation per Table 702-3 in the Delaware Regulations Governing the Land Treatment of Wastes (1988)
2. Table 702-2 in the Delaware Regulations Governing the Land Treatment of Wastes (1988)
3. Effluent ammonia data were not submitted. This fraction is taken from the Piney Neck RWF data, where ammonia in the effluent was submitted.
4. Assume 5 % of ammonia applied based on example in the Delaware Regulations Governing the Land Treatment of Wastes (1988)
5. Assume 20 % of total N applied based on example in the Delaware Regulations Governing the Land Treatment of Wastes (1988).
6. Based on the Chesapeake Bay Region Nutrient Management Training Manual - USEPA Chesapeake Bay Program.

Appendix B:
Table B-4: Inland Bays RWF Nitrogen Balance for Alternative 2

Stearns & Wheler, LLC	North Coastal Planning Area Preliminary Engineering Report	April 2009	40284.19
Environmental	Project	Date	Job No.
Engineers and Scientists	Alternative 2 Nitrogen Balance and Percolate Concentration Calculation	JVS	TAY
	Subject	Comp. By	Checked By

Objective:
To determine the total nitrogen concentration in the percolate on a yearly average based on a monthly nitrogen balance for the entire facility. This assumes design conditions of permitted effluent application rates and a corn harvest schedule.

Design Criteria / Assumptions:
According to the Mid-Atlantic Nutrient Management Handbook, grain soybean nitrogen requirements are higher than those of grain corn.
Therefore, corn is used in this sheet to calculate the nitrogen concentration in the percolate.

Wetted Field Area (acres)	319	
Average Effluent Nitrogen Concentration (mg/L)	9	
Nitrogen from Rainfall and Fixation (lbs/ac/yr)	5	assumed per Table 703-2 in the regulations
Corn Planting Date	1-Jun	assumed typical schedule (Sam Walter)
Nitrogen Uptake by Corn (lbs/ac/yr)	150	

Monthly Nitrogen Balance:

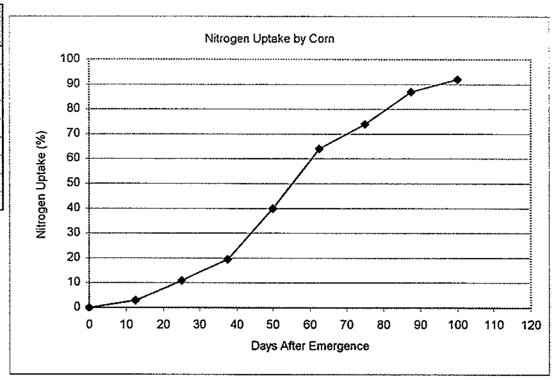
Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Notes
Days	31	28.25	31	30	31	30	31	31	30	31	30	31		
Wetted Field Area (acres)	319	319	319	319	319	319	319	319	319	319	319	319		
Effluent Rate (in/wk)	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74		
Application Rate (mgd)	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15		
Effluent Rate (in/mo)	7.7	7.0	7.7	7.4	7.7	7.4	7.7	7.7	7.4	7.7	7.4	7.7		
Wastewater Volume Applied (Mgal/mo)	67	61	67	65	67	65	67	67	65	67	65	67	785.29	
Precipitation (in/mo)	4.7	4.4	5.6	4.5	5	5.1	6.3	8.2	5.2	5.4	4.6	5.2	64	1
Potential Evapotranspiration, PET (in/mo)	0.1	0.1	0.7	1.8	3.3	4.8	5.5	4.9	3.6	1.9	0.9	0.2	28	2
Percolate (in/mo)	12.3	11.3	12.6	10.1	9.4	7.7	8.5	11.0	9.0	11.2	11.1	12.7	127	
Percolate (Mgal/mo)	106	98	109	88	81	67	74	95	78	97	97	110	1101	
Percolate (mgd)	3.4	3.5	3.5	2.9	2.6	2.2	2.4	3.1	2.6	3.1	3.2	3.5		
Total Nitrogen Concentration in Effluent (mg/L)	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9		
Estimated fraction of ammonia in effluent TN	0.3	0.5	0.4	0.4	0.4	0.4	0.3	0.3	0.4	0.1	0.2	0.4		3
Ammonia Concentration in Effluent (mg/L)	3.0	4.1	3.6	3.4	3.2	3.8	3.0	2.9	3.3	0.6	1.4	3.8		
Total Nitrogen Input from Effluent (lbs/ac/mo)	15.5	14.1	15.5	15.0	15.5	15.0	15.5	15.5	15.0	15.5	15.0	15.5	182.7	
Nitrogen from Rainfall and Fixation (lbs/ac/mo)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	5	
Ammonia Volatilization by Plant (lbs/ac/mo)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.1	0.1	0.3	3	4
Ammonia Input from Effluent (lbs/ac/mo)	5.2	6.4	6.2	5.7	5.6	6.3	5.2	5.0	5.5	1.1	2.4	6.6	61	
Denitrification by plant (lbs/ac/mo)	3.1	2.8	3.1	3.0	3.1	3.0	3.1	3.1	3.0	3.1	3.0	3.1	37	5
TN after volat., denit., fixation, rain (lbs/ac/mo)	12.6	11.4	12.5	12.1	12.5	12.1	12.6	12.6	12.1	12.8	12.3	12.5	148	
Plant Uptake and Storage (lbs/ac/mo)	8	8	8	8	8	22.5	67.5	43.5	9	7.5	8	8	203	
Nitrogen Leached by Percolate (lbs/ac/mo)	5.1	3.9	5.0	4.6	5.0	0.0	0.0	0.0	3.1	5.3	4.8	5.0	42	
Percolate Nitrogen Concentration (mg/L)	**1.8**	**1.5**	**1.8**	**2.0**	**2.4**	**0.0**	**0.0**	**0.0**	**1.5**	**2.1**	**1.9**	**1.7**	**1.4**	

Summary:

Average Percolate Nitrogen Concentration (mg/L)	1.4
Max Month Percolate Nitrogen Concentration (mg/L)	2.4
Total Nitrogen in Percolate (lbs/yr)	12,800
Effluent Application Rate Yearly Average	1.74

Nitrogen Uptake Rate by Corn[6]:

Days After Emergence	Nitrogen Uptake (%)
0	0
12.5	3
25	11
37.5	19.5
50	40
62.5	64
75	74
87.5	87
100	92



	Jun	Jul	Aug	Sep	Oct
Days	30	31	31	30	31
Days in Growing Season at the end of each Month	30	61	92	122	153
Total Nitrogen Uptake at the end of each Month	15%	60%	89%	95%	100%
Incremental Nitrogen Uptake for each Month	15%	45%	29%	6%	5%

Nitrogen Uptake Rate by Other Crops:

Small Grain Including Barley and Wheat (lbs/ac/yr)	90	cover crop during non-corn growing season
Therefore, Small Grain (lbs/ac/mo)	8	

Notes:
1. 5 year precipitation per Table 702-3 in the Delaware Regulations Governing the Land Treatment of Wastes (1988)
2. Table 702-2 in the Delaware Regulations Governing the Land Treatment of Wastes (1988)
3. Effluent ammonia data were not submitted. This fraction is taken from the Piney Neck RWF data, where ammonia in the effluent was submitted.
4. Assume 5 % of ammonia applied based on example in the Delaware Regulations Governing the Land Treatment of Wastes (1988)
5. Assume 20 % of total N applied based on example in the Delaware Regulations Governing the Land Treatment of Wastes (1988).
6. Based on the Chesapeake Bay Region Nutrient Management Training Manual - USEPA Chesapeake Bay Program.

APPENDIX C

EDU Data and Projections

Appendix C:

Table C-1: Sussex County North Coastal Planning Area EDU History 2003-2008

District	2003	Annual	%	2004	Annual	%	2005	Annual	%	2006	Annual	%	2007	Annual	%	2008	Annual	%	2009
	EDUs	Growth	Growth	EDUs	Growth	Growth	EDUs	Growth	Growth	EDUs	Growth	Growth	EDUs	Growth	Growth	EDUs	Growth	Growth	EDUs
DBWD	3521	15	0.42%	3,536	10	0.27%	3,546	-14	-0.41%	3,531	19	0.53%	3,550	16	0.44%	3,566	19	0.53%	3,585
DBSSD	3,584	19	0.53%	3,603	7	0.18%	3,609	-12	-0.34%	3,597	18	0.49%	3,615	16	0.43%	3,630	18	0.49%	3,648
HASSD	202	3	1.48%	205	0	0.00%	205	-2	-0.97%	203	2	0.98%	205	2	0.97%	207	0	0.00%	207
WRE	12,918	1,144	8.86%	14,063	986	7.01%	15,048	612	4.07%	15,660	769	4.91%	16,429	692	4.21%	17,121	301	1.76%	17,422
BBSSD	4,008	124	3.10%	4,133	116	2.80%	4,248	43	1.01%	4,291	46	1.08%	4,338	-6	-0.13%	4,332	10	0.23%	4,342
NBE	1,110	-19	-1.70%	1,092	46	4.22%	1,138	39	3.44%	1,177	-41	-3.51%	1,135	4	0.35%	1,139	4	0.32%	1,143
CNE	244	57	23.35%	301	1,235	410.29%	1,536	333	21.68%	1,869	45	2.40%	1,914	21	1.11%	1,936	33	1.72%	1,969
OVE	909	114	12.52%	1,022	123	12.01%	1,145	108	9.40%	1,253	52	4.18%	1,305	37	2.85%	1,342	15	1.09%	1,357
MVE	66	2	3.67%	69	6	8.26%	74	147	197.50%	221	137	61.82%	358	918	256.74%	1,276	700	54.90%	1,976
SBSSD	5,336	288	5.39%	5,623	314	5.59%	5,938	166	2.80%	6,104	32	0.52%	6,136	44	0.72%	6,180	3	0.05%	6,183
FISSD	5,244	147	2.80%	5,391	256	4.75%	5,647	480	8.50%	6,127	434	7.09%	6,561	137	2.10%	6,699	176	2.63%	6,875
HLSSD	297	27	9.09%	324	26	8.02%	350	50	14.28%	400	105	26.18%	505	23	4.52%	528	8	1.57%	536
MCSSD	22	0	0.00%	22	0	0.00%	22	40	181.82%	62	1	1.61%	63	119	188.89%	182	254	139.56%	436
BVESSD	0	0	0.00%	0	0	0.00%	0	85	0.00%	85	94	110.59%	179	3	1.68%	182	7	3.85%	189
SCESSD	0	0	0.00%	0	0	0.00%	0	36	0.00%	36	12	33.33%	48	0	0.00%	48	0	0.00%	48
SOVSSD	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	2	0.00%	2	197	9833.50%	199	115	58.05%	314
JCSSD	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
SCRWF	17,237	740	4.29%	17,977	2,122	11.80%	20,099	1,526	7.59%	21,625	919	4.25%	22,544	1,498	6.64%	24,042	1,328	5.52%	25,370
LNSSD	5,372	384	7.15%	5,756	398	6.92%	6,155	438	7.11%	6,592	438	6.64%	7,030	327	4.65%	7,357	163	2.22%	7,520
ANSSD	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	150	0.00%	150	0	0.00%	150
OOSSD	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	624	0.00%	624	278	44.58%	903	0	0.00%	903
In Bay	5,372	384	7.15%	5,756	398	6.92%	6,155	438	7.11%	6,592	1,062	16.11%	7,654	755	9.87%	8,410	163	1.94%	8,573
DFSSD	928	-37	-3.99%	891	-8	-0.90%	883	17	1.93%	900	135	14.97%	1,035	46	4.44%	1,081	54	4.98%	1,135
ELSSD	0	112	0.00%	112	458	410.01%	569	-6	-1.11%	563	7	1.30%	570	6	1.05%	576	-3	-0.60%	573
GVSSD	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0	0	0.00%	0
BLSSD	524	75	14.23%	566	4	0.70%	570	13	2.28%	583	12	2.06%	595	-51	-8.63%	543	8	1.39%	551
TOTAL	**44,287**	**2,455**	**5.47%**	**46,709**	**3,976**	**8.51%**	**50,685**	**2,571**	**5.07%**	**53,256**	**2,942**	**5.52%**	**56,198**	**2,979**	**5.30%**	**59,177**	**1,885**	**3.18%**	**61,062**

Appendix C:

TABLE C-2
EQUIVALENT DWELLING UNIT (EDU) PROJECTION TABLE
TREATMENT AND DISPOSAL

STUDY AREAS	2008 ESTIMATED EXISTING EDUs	2009	2010	2011	2012	2013	2014	2015	2020	2025	2030	2035	2045	BUILDOUT DESIGN (9.)
WEST REHOBOTH														
Existing WRE of DBSSD (Phases I-IV)	17,121	17,635	18,148	18,662	19,176	19,689	20,203	20,716	23,285	25,853	28,421	30,989	36,125	36,929
Northern WR Expansion	126	-	-	-	-	-	-	-	-	-		-	-	1,823
Goslee Creek	1,319	-	-	-	-	-	-	-	-	100	600	1,100	2,100	9,062
Total Potential EDUs to WNRWF	**18,566**	**17,635**	**18,148**	**18,662**	**19,176**	**19,689**	**20,203**	**20,716**	**23,285**	**25,953**	**29,021**	**32,089**	**38,225**	**47,814**
Flow to WNRWF (MGD) - Ex. @ 125 gpd/EDU, Growth @ 125gpd/EDU (6.)	-	*2.2*	*2.3*	*2.3*	*2.4*	*2.5*	*2.5*	*2.6*	*2.9*	*3.2*	*3.6*	*4.0*	*4.8*	*6.0*
Flow to WNRWF (MGD) - Ex. @ 150 gpd/EDU, Growth @ 150gpd/EDU (7.)		***2.6***	***2.7***	***2.8***	***2.9***	***3.0***	***3.0***	***3.1***	***3.5***	***3.9***	***4.4***	***4.8***	***5.7***	***7.2***
Flow to WNRWF (MGD) - Ex. @ 150 gpd/EDU, Growth @ 225gpd/EDU (7.)		*2.7*	*2.8*	*2.9*	*3.0*	*3.1*	*3.3*	*3.4*	*4.0*	*4.6*	*5.2*	*5.9*	*7.3*	*10.8*
ANGOLA NECK STUDY AREA														
Angola Neck Sanitary Sewer District	1,366	150	150	1,571	1,612	1,653	1,694	1,735	1,940	2,145	2,350	2,554	*2,646*	2,646
Phase II Service Area	-	-	-	-	-	-	-	250	500	750	1,000	1,250	1,750	9,243
Angola Neck Total EDUS	-	150	150	1,571	1,612	1,653	1,694	1,985	2,440	2,895	3,350	3,804	4,396	11,889
Estimated Average Daily Flow (MGD)	-	*0.02*	*0.02*	*0.24*	*0.24*	*0.25*	*0.25*	*0.30*	*0.37*	*0.43*	*0.50*	*0.57*	*0.66*	*1.8*
HERRING CREEK STUDY AREA	902	-	-	-	-	150	175	200	325	450	575	700	825	5,756
Estimated Average Daily Flow (MGD)	-	-	-	-	-	*0.02*	*0.03*	*0.03*	*0.05*	*0.07*	*0.09*	*0.11*	*0.12*	*0.86*
LONG NECK														
Existing Long Neck Sanitary Sewer District including Exp. Area 1	7,357	7,578	7,798	8,019	8,240	8,461	8,681	8,902	10,006	11,109	12,213	13,316	15,523	15,590
Estimated Average Daily Flow (MGD)	-	1.1	1.2	1.2	1.2	1.3	1.3	1.3	1.5	1.7	1.8	2.0	2.3	2.3
OAK ORCHARD														
Existing Oak Orchard Sanitary Sewer District	903	930	957	984	1,011	1,038	1,066	1,093	1,228	1,364	1,499	***1,614***	***1,614***	1,614
Oak Orchard Expansion 1 (8.)	790	-	-	861	885	909	932	956	1,074	1,193	1,311	1,430	1,548	3,789
Oak Orchard Expansion 2	545	-	-	-	-	-	-	165	247	329	410	492	574	3,524
Oak Orchard Total EDUs	2,238	930	957	1,845	1,896	1,947	1,998	2,214	2,549	2,885	3,221	3,536	3,736	8,927
Estimated Average Daily Flow (MGD)	-	*0.14*	*0.14*	*0.28*	*0.28*	*0.29*	*0.30*	*0.33*	*0.38*	*0.43*	*0.48*	*0.53*	*0.56*	*1.34*
Total Potential EDUs to IBRWF	**11,863**	**8,658**	**8,906**	**11,435**	**11,748**	**12,210**	**12,548**	**13,300**	**15,319**	**17,339**	**19,358**	**21,356**	**24,480**	**42,162**
Flow to IBRWF (MGD) - Ex. @ 125 gpd/EDU, Growth @ 125gpd/EDU (6.)	-	*1.1*	*1.1*	*1.4*	*1.5*	*1.5*	*1.6*	*1.7*	*1.9*	*2.2*	*2.4*	*2.7*	*3.1*	*5.3*
Flow to IBRWF (MGD) - Ex. @ 150 gpd/EDU, Growth @ 150gpd/EDU (7.)	-	***1.3***	***1.3***	***1.7***	***1.8***	***1.8***	***1.9***	***2.0***	***2.3***	***2.6***	***2.9***	***3.2***	***3.7***	***6.3***
Flow to IBRWF (MGD) - Ex. @ 150 gpd/EDU, Growth @ 225gpd/EDU (7.)	-	*1.3*	*1.4*	*2.0*	*2.0*	*2.1*	*2.2*	*2.4*	*2.8*	*3.3*	*3.7*	*4.2*	*4.9*	*9.5*
TOTAL EDUs (WNRWF and IBRWF):	**30,429**	**26,292**	**27,054**	**30,097**	**30,923**	**31,900**	**32,751**	**34,017**	**38,604**	**43,291**	**48,379**	**53,446**	**62,706**	**89,976**
Total Flow (MGD) - Ex. @ 125 gpd/EDU, Growth @ 125gpd/EDU (6.)	-	*3.3*	*3.4*	*3.8*	*3.9*	*4.0*	*4.1*	*4.3*	*4.8*	*5.4*	*6.0*	*6.7*	*7.8*	*11.2*
Total Flow (MGD) - Ex. @ 150 gpd/EDU, Growth @ 150gpd/EDU (7.)	-	***3.9***	***4.1***	***4.5***	***4.6***	***4.8***	***4.9***	***5.1***	***5.8***	***6.5***	***7.3***	***8.0***	***9.4***	***13.5***
Total Flow (MGD) - Ex. @ 150 gpd/EDU, Growth @ 225gpd/EDU (7.)	-	*4.0*	*4.2*	*4.9*	*5.1*	*5.3*	*5.5*	*5.8*	*6.8*	*7.8*	*9.0*	*10.1*	*12.2*	*20.2*

1. Constant Growth Rates for EDU projections are assumed as follows:
   a. WRE DBSSD: 3% of Existing EDUs
   b. Goslee Creek: 100 EDUs connect in 2025, growth at 100 EDUs/year
   c. Angola Neck Phase II Service Area: 250 EDUs connect in 2015, growth at 50 EDUs/year
   d. Herring Creek: 150 existing EDUs connect in year 2013, growth at 25 EDUs/year
   e. LNSSD: 3% of Existing EDUs
   f. Oak Orchard Expansion 1: 3% of Existing EDUs
   g. Oak Orchard Expansion 2: 165 EDUs connect in 2011 with growth at 3% of initial connection per year
2. Design estimates based on 20% Open Space and 90% Occupancy rate
3. EDU estimates include a reduction for wetland areas and are based on 4 EDUs per acre
4. Buildout and Design EDUs for Oak Orchard Exp. Area do not include an estimated 2,757 EDUS for the Mountaire Property in Expansion 2, which was determined not to require service.
5. Buildout and Design Calculations for Angola Neck SSD include 215 EDUs for Southern Parcels, even though service was not provided in the ANSSD Facilities Plan.
6. Representative of an Average Daily Flow
7. Representative of a Max. Month Flow
8. Includes EDUs from Exp. Area 1 that are not currently being served by the new OO Expansion Area #1 Sanitary Sewer District.
9. Projected flows based on all EDUs (existing and growth) to be applied at the Growth EDU rate.

APPENDIX D

Rehoboth to Wolfe Neck Conveyance Cost Estimates

TABLE D-1
Alternative 1 - RBSTP Raw WW to WNRWF
FM Alignment Option #1 - Permanent Easement Installation
Cost Estimate

ITEM	UNIT	UNIT COST	QUANTITY	ITEM TOTAL	NOTES
RBSTP to WNRWF Force Main (1.)					
Mobilization (5%)	LS	$165,000	-	$165,000	
30" Force Main - County Roadway Installation	LF	$175	8,000	$1,400,000	
30" Force Main - Permanent Easement Installation	LF	$130	8,200	$1,066,000	Assumes No Road Restoration
Air Release Valves and MH (2.)	EA	$7,000	6	$42,000	
Isolation Valves	EA	$45,000	2	$90,000	
Directional Drill Rehoboth Canal (3.)	EA	$360,000	1	$360,000	
SUBTOTAL				**$3,123,000**	
10% Construction Contingency				$312,300	
SUBTOTAL				**$3,435,300**	
CONSTRUCTION TOTAL				**$3,435,300**	
Project Costs		22%		$755,766	
RBSTP to WNRWF Force Main PROJECT TOTAL				**$4,191,100**	
RBSTP to WNRWF PROJECT TOTAL				**$4,191,100**	

Notes:
(1.) 10.2 MGD sized for Ultimate Design
(2.) Assumes 1 ARV per 3,000 feet of FM.
(3.) Cost for directional drill based on similar projects in Sussex County, DE.

TABLE D-2
Alternative 1 - RBSTP Raw WW to WNRWF
FM Alignment Option #2 - Coastal Highway
Cost Estimate

ITEM	UNIT	UNIT COST	QUANTITY	ITEM TOTAL	NOTES
RBSTP to WNRWF Force Main (1.)					
Mobilization (5%)	LS	$280,000	-	$280,000	
30" Force Main - Major Roadway Installation (2.)	LF	$225	14,500	$3,262,500	
30" Force Main - County Roadway Installation	LF	$175	6,500	$1,137,500	
Air Release Valves and MH	EA	$7,000	5	$35,000	
Isolation Valves (3.)	EA	$45,000	2	$90,000	
Directional Drill Rehoboth Canal (4.)	EA	$360,000	1	$360,000	
SUBTOTAL				**$5,165,000**	
10% Construction Contingency				$774,750	
SUBTOTAL				**$5,939,750**	
CONSTRUCTION TOTAL				**$5,939,750**	
Project Costs		22%		$1,306,745	
RBSTP to WNRWF Force Main PROJECT TOTAL				$7,246,500	
RBSTP to WNRWF PROJECT TOTAL				$7,246,500	

Notes:
(1.) 10.2 MGD sized for Ultimate Design
(2.) Refers to portion installed along Coastal Highway (SR 1)
(3.) Assumes 1 ARV per 3,000 feet of FM.
(4.) Cost for directional drill based on similar projects in Sussex County, DE.

TABLE D-3
Alternative 2 - RBSTP Treated Effluent to WNRWF
FM Alignment Option #1 - Permanent Easement Installation
Cost Estimate - DRAFT

ITEM	UNIT	UNIT COST	QUANTITY	ITEM TOTAL	NOTES
RBSTP to WNRWF Force Main (1.)					
Mobilization (5%)	LS	$175,000	-	$175,000	
30" Force Main - County Roadway Installation	LF	$175	10,000	$1,750,000	
30" Force Main - Permanent Easement Installation	LF	$130	8,200	$1,066,000	Assumes No Road Restoration
Air Release Valves and MH (2.)	EA	$7,000	7	$49,000	
Isolation Valves	EA	$45,000	2	$90,000	
Directional Drill Rehoboth Canal (3.)	EA	$360,000	1	$360,000	
SUBTOTAL				**$3,490,000**	
10% Construction Contingency				$349,000	
SUBTOTAL				**$3,839,000**	
CONSTRUCTION TOTAL				**$3,839,000**	
Project Costs		22%		$844,580	
RBSTP to WNRWF Force Main PROJECT TOTAL				**$4,683,600**	
RBSTP to WNRWF PROJECT TOTAL				**$4,683,600**	

Notes:
(1.) 10.2 MGD sized for Ultimate Design
(2.) Assumes 1 ARV per 3,000 feet of FM.
(3.) Cost for directional drill based on similar projects in Sussex County, DE.

TABLE D-4
Alternative 2 - RBSTP Treated Effluent to WNRWF
FM Alignment Option #2 - Coastal Highway
Cost Estimate

ITEM	UNIT	UNIT COST	QUANTITY	ITEM TOTAL	NOTES
RBSTP to WNRWF Force Main (1.)					
Mobilization (5%)	LS	$300,000	-	$300,000	
30" Force Main - Major Roadway Installation (2.)	LF	$225	14,500	$3,262,500	
30" Force Main - County Roadway Installation	LF	$175	8,500	$1,487,500	
Air Release Valves and MH	EA	$7,000	5	$35,000	
Isolation Valves (3.)	EA	$45,000	2	$90,000	
Directional Drill Rehoboth Canal (4.)	EA	$360,000	1	$360,000	
SUBTOTAL				**$5,535,000**	
10% Construction Contingency				$830,250	
SUBTOTAL				**$6,365,250**	
CONSTRUCTION TOTAL				**$6,365,250**	
Project Costs		22%		$1,400,355	
RBSTP to WNRWF Force Main PROJECT TOTAL				**$7,765,600**	
RBSTP to WNRWF PROJECT TOTAL				**$7,765,600**	

Notes:
(1.) 10.2 MGD sized for Ultimate Design
(2.) Refers to portion installed along Coastal Highway (SR 1)
(3.) Assumes 1 ARV per 3,000 feet of FM.
(4.) Cost for directional drill based on similar projects in Sussex County, DE.

TABLE D-5
ENGINEER'S ESTIMATE OF PROBABLE CONSTRUCTION COST

Project:	Wolfe Neck Headworks Upgrade Alternative 1	**Computed By:**	JVS
Location:	Sussex Co. Delaware	**Checked By:**	TAY
Owner:	Sussex Co.	**Date of Est.:**	5/1/09
Description:	**Alternative 1 WNRWF Headworks (27 mgd)**	**Project No:**	40284.19

	Quantity		Material/Equipment		Subcontract		Labor/Installation			
Description	No. Units	Basis	Per Unit	Total	Per Unit	Total	Man Hours	$/Man Hour	Total	Total Cost
Civil										
Crushed Stone Bedding	253	CY	$15	$3,795	$3	$759	0.25	$38	$2,404	$6,960
Fill (off-site material)	4275	CY	incl.		$10	$42,750	0.4	$38	$15	$42,770
Asphalt Paving	1	LS	$15,000.00	$15,000						$15,000
Structural										
Slab Concrete	119	CY	$700	$82,989						$82,990
Wall Concrete	75	CY	$900	$67,733						$67,730
painting	1	LS	$15,000	$15,000						$15,000
Architectural										
Architectural Building		SF	$150.00		incl.		incl.			
Large Overhead Door	1	EA	$12,000	$12,000			incl			$12,000
Aluminum Grating	540	SF	$35.00	$18,900			0.4	$38	$15	$18,920
Aluminum Stairways	3	RISER	$300.00	$900			1.000	$38	$38	$940
Equipment										
Fine Screens and Screw Wash Compactor	1	LS	$330,000	$330,000					$99,000	$429,000
Screenings Conveyor	1	LS	$20,000	$20,000					$6,000	$26,000
Heat Trace and Insulate Screens and Conveyo	1	LS	$40,000	$40,000					$12,000	$52,000
Slide Gates (48")	6	EA	$14,400.00	$86,400	$1,000	$6,000	120	$38	$4,560	$96,960
Grit Dumpster	1	EA	$5,000	$5,000						$5,000
Bar Rack	1	LS	$5,000.00	$5,000	$500	$500	80	$38	$3,040	$8,540
Hoist Allowance	1	LS	$10,000.00	$10,000	$1,500	$1,500	120.000	$38	$4,560	$16,060
Flow Meter	1	LS	$20,000.00	$20,000						$20,000
Valve Vault	1	LS	$20,000.00	$20,000						$20,000
HVAC		LS	$50,000							
Plumbing	1	LS	$10,000	$10,000						$10,000
Site Work										
3% of Total Cost	1	LS	$28,376	$28,376						$28,376
Electrical										
20% of Total Cost	1	LS	$189,174	$189,174						$189,174
Startup										
2 % of Total Cost	1	LS	$18,917	$18,917						$18,917
Piping										
9 % of Total Cost	1	LS	$85,128	$85,128						$85,128
Subtotal				$1,084,300		$51,500			$131,600	**$1,267,000**
General Conditions			5%	$54,200	5%	$2,600		5%	$6,600	**$63,000**
Subtotal				$1,138,500		$54,100			$138,200	**$1,331,000**
Overhead			10%	$113,900	10%	$5,400		10%	$13,800	**$133,000**
Profit			5%	$56,900	5%	$2,700		5%	$6,900	**$67,000**
Subtotal				$1,309,300		$62,200			$158,900	**$1,530,000**
Contingency			10%	$130,900	10%	$6,200		10%	$15,900	**$153,000**
Total Construction Costs				$1,440,000		$68,000			$175,000	**$1,680,000**
Project Costs			22%	$316,800	22%	$15,000		22%	$38,500	**$370,000**
TOTAL PROJECT COSTS				$1,757,000		$83,000			$214,000	**$2,050,000**

TABLE D-6
ENGINEER'S ESTIMATE OF PROBABLE CONSTRUCTION COST

Project:	Wolfe Neck Headworks Upgrade Alternative 2	**Computed By:**	JVS
Location:	Sussex Co. Delaware	**Checked By:**	TAY
Owner:	Sussex Co.	**Date of Est.:**	5/1/09
Description:	**Alternative 2 WNRWF Headworks (17 mgd)**	**Project No:**	40284.19

Description	Quantity		Material/Equipment		Subcontract		Labor/Installation			Total Cost
	No. Units	Basis	Per Unit	Total	Per Unit	Total	Man Hours	$/Man Hour	Total	
Civil										
Crushed Stone Bedding	253	CY	$15	$3,795	$3	$759	0.25	$38	$2,404	$6,960
Fill (off-site material)	3450	CY	incl.		$10	$34,500	0.4	$38	$15	$34,520
Asphalt Paving	1	LS	$15,000.00	$15,000						$15,000
Structural										
Slab Concrete	83	CY	$700	$58,100						$58,100
Wall Concrete	62	CY	$900	$55,800						$55,800
painting	1	LS	$15,000	$15,000						$15,000
Architectural										
Architectural Building		SF	$150.00		incl.		incl.			
Large Overhead Door	1	EA	$12,000	$12,000			incl			$12,000
Aluminum Grating	295	SF	$35.00	$10,325			0.4	$38	$15	$10,340
Aluminum Stairways	3	RISER	$300.00	$900			1.000	$38	$38	$940
Equipment										
Fine Screens and Screw Wash Compactor	1	LS	$280,000	$280,000					$84,000	$364,000
Screenings Conveyor	1	LS	$20,000	$20,000					$6,000	$26,000
Heat Trace and Insulate Screens and Conveyo	1	LS	$40,000	$40,000					$12,000	$52,000
Slide Gates (36")	6	EA	$10,000.00	$60,000	$1,000	$6,000	120	$38	$4,560	$70,560
Grit Dumpster	1	EA	$5,000	$5,000						$5,000
Bar Rack	1	LS	$5,000.00	$5,000	$500	$500	80	$38	$3,040	$8,540
Hoist Allowance	1	LS	$10,000.00	$10,000	$1,500	$1,500	120.000	$38	$4,560	$16,060
Flow Meter	1	LS	$20,000.00	$20,000						$20,000
Valve Vault	1	LS	$20,000.00	$20,000						$20,000
HVAC		LS	$50,000							
Plumbing	1	LS	$10,000	$10,000						$10,000
Site Work										
3% of Total Cost	1	LS	$24,025	$24,025						$24,025
Electrical										
20% of Total Cost	1	LS	$160,164	$160,164						$160,164
Startup										
2 % of Total Cost	1	LS	$16,016	$16,016						$16,016
Piping										
9 % of Total Cost	1	LS	$72,074	$72,074						$72,074
		Subtotal		$913,200		$43,300			$116,600	**$1,073,000**
		General Conditions	5%	$45,700	5%	$2,200		5%	$5,800	**$54,000**
		Subtotal		$958,900		$45,500			$122,400	**$1,127,000**
		Overhead	10%	$95,900	10%	$4,600		10%	$12,200	**$113,000**
		Profit	5%	$47,900	5%	$2,300		5%	$6,100	**$56,000**
		Subtotal		$1,102,700		$52,400			$140,700	**$1,296,000**
		Contingency	10%	$110,300	10%	$5,200		10%	$14,100	**$130,000**
		Total Construction Costs		$1,213,000		$58,000			$155,000	**$1,430,000**
		Project Costs	22%	$266,900	22%	$12,800		22%	$34,100	**$314,000**
		TOTAL PROJECT COSTS		$1,480,000		$71,000			$189,000	**$1,740,000**

APPENDIX E

Wolfe Neck Conveyance Cost Estimates

TABLE E-1
WNRWF to IBRWF Cost Estimate
Alignment Option #1 - John J. Williams Highway (SR 24)

ITEM	UNIT	UNIT COST	QUANTITY	ITEM TOTAL	NOTES
WNRWF to IBRWF Force Main					
Mobilization (5%)	LS	$700,000	-	$700,000	
30" Force Main (Major Highway Construction) (1.)	LF	$225	28,750	$6,468,750	
30" Force Main (Intermediate Highway Construction) (2.)	LF	$175	1,700	$297,500	
30" Force Main (County Road Construction) (3.)	LF	$150	28,450	$4,267,500	
Air Release Valves and MH (4.)	EA	$7,000	20	$140,000	
Isolation Valves	EA	$45,000	4	$180,000	
Miscellaneous Jack and Bore of Major Highway	EA	$50,000	5	$250,000	Assumes 5 Road Crossings
Directional Drill Coastal Highway	LS	$300,000	1	$300,000	
Directional Drill Love Creek	LS	$300,000	2	$600,000	
Directional Drill Burton Prong	LS	$300,000	1	$300,000	
SUBTOTAL				**$13,503,750**	
10% Construction Contingency				$1,350,375	
SUBTOTAL				**$14,854,125**	
CONSTRUCTION TOTAL				**$14,854,125**	
Project Costs		22%		$3,267,908	
WNRWF TO IBRWF FM PROJECT TOTAL				$18,122,000	

Notes:
(1.) Refers to the portion of the force main installed in John J. Williams Highway (SR 24)
(2.) Refers to the portion of the force main installed in Beaver Dam Road (SR 23) and Indian Mission Road (SR 5)
(3.) Refers to the portion of the force main installed along County Roads.
(4.) Assumes 1 ARV per 3,000 feet of FM.

TABLE E-2
WNRWF to IBRWF Cost Estimate
Alignment Option #2 - Robinsonville Road (CR 277)

ITEM	UNIT	UNIT COST	QUANTITY	ITEM TOTAL	NOTES
WNRWF to IBRWF Force Main					
Mobilization (5%)	LS	$750,000	-	$750,000	
30" Force Main (Major Highway Construction) (1.)	LF	$225	10,800	$2,430,000	
30" Force Main (Intermediate Highway Construction) (2.)	LF	$175	5,000	$875,000	
30" Force Main (County Road Construction) (3.)	LF	$150	56,800	$8,520,000	
Air Release Valves and MH (4.)	EA	$7,000	25	$175,000	
Isolation Valves	EA	$45,000	4	$180,000	
Miscellaneous Jack and Bore of Major Highway	EA	$50,000	5	$250,000	Assumes 5 Road Crossings
Directional Drill Coastal Highway	LS	$300,000	3	$900,000	
Directional Drill Burton Prong	EA	$300,000	1	$300,000	
SUBTOTAL				**$14,380,000**	
10% Construction Contingency				$1,438,000	
SUBTOTAL				**$15,818,000**	
CONSTRUCTION TOTAL				**$15,818,000**	
Project Costs		22%		$3,479,960	
WNRWF TO IBRWF FM PROJECT TOTAL				$19,298,000	

Notes:
(1.) Refers to the portion of the force main installed in John J. Williams Highway (SR 24)
(2.) Refers to the portion of the force main installed in Beaver Dam Road (SR 23) and Indian Mission Road (SR 5)
(3.) Refers to the portion of the force main installed along County Roads.
(4.) Assumes 1 ARV per 3,000 feet of FM.

TABLE E-3
WNRWF to IBRWF Cost Estimate
Alignment Option #3 - Beaver Dam Road (SR 23)

ITEM	UNIT	UNIT COST	QUANTITY	ITEM TOTAL	NOTES
WNRWF to IBRWF Force Main					
Mobilization (5%)	LS	$680,000	-	$680,000	
24" Force Main (Major Highway Construction) (1.)	LF	$225	7,100	$1,597,500	
24" Force Main (Intermediate Highway Construction) (2.)	LF	$175	28,550	$4,996,250	
24" Force Main (County Road Construction) (3.)	LF	$150	32,950	$4,942,500	
Air Release Valves and MH (4.)	EA	$7,000	23	$161,000	
Isolation Valves	EA	$25,000	4	$100,000	
Miscellaneous Jack and Bore of Major Highway	EA	$50,000	5	$250,000	Assumes 5 Road Crossings
Directional Drill Coastal Highway	LS	$300,000	1	$300,000	
SUBTOTAL				**$13,027,250**	
10% Construction Contingency				$1,302,725	
SUBTOTAL				**$14,329,975**	
CONSTRUCTION TOTAL				**$14,329,975**	
Project Costs		22%		$3,152,595	
WNRWF TO IBRWF FM PROJECT TOTAL				$17,482,600	

Notes:
(1.) Refers to the portion of the force main installed in John J. Williams Highway (SR 24)
(2.) Refers to the portion of the force main installed in Beaver Dam Road (SR 23) and Indian Mission Road (SR 5)
(3.) Refers to the portion of the force main installed along County Roads.
(4.) Assumes 1 ARV per 3,000 feet of FM.

TABLE E-4
Wolfe Neck Transfer Pump Station to IBRWF
Alternative #1 - Raw WW from RBSTP to WNRWF

ITEM	UNIT	UNIT COST	QUANTITY	ITEM TOTAL	NOTES
Mobilization	LS	$125,000	1	$125,000	
Mechanical Pipes, Valves and Fittings	LS	$325,000	1	$325,000	
Electrical/Control Building	LS	$80,000	1	$80,000	Pre-Engineered Building Assumed
Excavation, Dewatering, Sheeting, and Shoring and Installation of Cast In Place Concrete Wetwell and Valve Vault and Hatches	LS	$800,000	1	$800,000	Wetwell sized for 6.9 mgd, assumed total depth of 21'
Mechanical Pumps and Accessories	LS	$350,000	1	$350,000	185 HP Pumps
Electrical, Instrumentation and Controls	LS	$575,000	1	$575,000	Does Not Include Backup Generator
Sitework and Site Piping	LS	$200,000	1	$200,000	No Site Fencing or Paving Included
Station Startup and Testing	LS	$30,000	1	$30,000	
Pump Station Construction Sub-total				**$2,485,000**	
Project Contingency	10%			**$248,500**	
Project Construction Total				**$2,733,500**	
Project Costs	22%			**$601,370**	
Pump Station Project Total				**$3,330,000**	

TABLE E-5
Wolfe Neck Transfer Pump Station to IBRWF
Alternative #2 - Treated Effluent from RBSTP to WNRWF

ITEM	UNIT	UNIT COST	QUANTITY	ITEM TOTAL	NOTES
Mobilization	LS	$110,000	1	$110,000	
Mechanical Pipes, Valves and Fittings	LS	$280,000	1	$280,000	
Electrical/Control Building	LS	$80,000	1	$80,000	Pre-Engineered Building Assumed
Excavation, Dewatering, Sheeting, and Shoring and Installation of Cast In Place Concrete Wetwell and Valve Vault and Hatches	LS	$750,000	1	$750,000	Wetwell sized for 5.4 mgd, assumed total depth of 20'
Mechanical Pumps and Accessories	LS	$320,000	1	$320,000	160 HP Pumps
Electrical, Instrumentation and Controls	LS	$500,000	1	$500,000	Does Not Include Backup Generator
Sitework and Site Piping	LS	$200,000	1	$200,000	No Site Fencing or Paving Included
Station Startup and Testing	LS	$30,000	1	$30,000	
Pump Station Construction Sub-total				**$2,270,000**	
Project Contingency	10%			**$227,000**	
Project Construction Total				**$2,497,000**	
Project Costs	22%			**$549,340**	
Pump Station Project Total				**$3,050,000**	

TABLE E-6
Wolfe Neck Transfer Pump Station to IBRWF
Alternative #3 - County Only flows to IBRWF

ITEM	UNIT	UNIT COST	QUANTITY	ITEM TOTAL	NOTES
Mobilization	LS	$100,000	1	$100,000	
Mechanical Pipes, Valves and Fittings	LS	$200,000	1	$200,000	
Electrical/Control Building	LS	$80,000	1	$80,000	Pre-Engineered Building Assumed
Excavation, Dewatering, Sheeting, and Shoring and Installation of Cast In Place Concrete Wetwell and Valve Vault and Hatches	LS	$700,000	1	$700,000	Wetwell sized for 3.2 mgd, assumed total depth of 19'
Mechanical Pumps and Accessories	LS	$290,000	1	$290,000	100 HP Pumps
Electrical, Instrumentation and Controls	LS	$400,000	1	$400,000	Does Not Include Backup Generator
Sitework and Site Piping	LS	$200,000	1	$200,000	No Site Fencing or Paving Included
Station Startup and Testing	LS	$30,000	1	$30,000	
Pump Station Construction Sub-total				**$2,000,000**	
Project Contingency	10%			**$200,000**	
Project Construction Total				**$2,200,000**	
Project Costs	22%			**$484,000**	
Pump Station Project Total				**$2,680,000**	

TABLE E-7
Cave Neck Road to ANSRWRF Force Main

ITEM	UNIT	UNIT COST	QUANTITY	ITEM TOTAL	NOTES
Cave Neck Rd to PWTP Site FM					
Mobilization (5%)	LS	$460,000	-	$460,000	
24" Force Main (Major Highway Construction) (1.)	LF	$225	21,016	$4,728,600	
24" Force Main (Intermediate Highway Construction) (2.)	LF	$175	1,375	$240,625	
24" Force Main (County Road Construction) (3.)	LF	$150	11,829	$1,774,350	
24" Force Main (Easement Installation) (4.)	LF	$100	8,480	$848,000	
Air Release Valves and MH (5.)	EA	$7,000	15	$105,000	
Isolation Valves	EA	$25,000	4	$100,000	
Miscellaneous Jack and Bore of Major Highway	EA	$50,000	5	$250,000	Assumes 5 Road Crossings
Directional Drill Coastal Highway	LS	$300,000	1	$300,000	
SUBTOTAL				**$8,806,575**	
10% Construction Contingency				$880,658	
SUBTOTAL				**$9,687,233**	
CONSTRUCTION TOTAL				**$9,687,233**	
Project Costs		22%		$2,131,191	
CAVE NECK RD TO ANSRWRF FM PROJECT TOTAL				$11,820,000	

Notes:
(1.) Refers to the portion of the force main installed in Coastal Highway (SR 1)
(2.) Refers to the portion of the force main installed in Beach Highway (SR 16)
(3.) Refers to the portion of the force main installed along County Roads.
(4.) Refers to the portion of the force main installed in Easements west of Union Street Extension (SR 5)
(5.) Assumes 1 ARV per 3,000 feet of FM.

TABLE E-8
WN Transfer PS to Cave Neck Road Force Main

ITEM	UNIT	UNIT COST	QUANTITY	ITEM TOTAL	NOTES
Cave Neck Rd to ANSRWRF FM					
Mobilization (5%)	LS	$365,000	-	$365,000	
24" Force Main (Major Highway Construction) (1.)	LF	$225	10,251	$2,306,475	
24" Force Main (Intermediate Highway Construction) (2.)	LF	$175	4,175	$730,625	
24" Force Main (County Road Construction) (3.)	LF	$150	15,208	$2,281,200	
24" Force Main (Easement Installation)	LF	$100	9,632	$963,200	
Air Release Valves and MH (5.)	EA	$7,000	13	$91,000	
Isolation Valves	EA	$25,000	4	$100,000	
Miscellaneous Jack and Bore of Major Highway	EA	$50,000	1	$50,000	
SUBTOTAL				**$6,887,500**	
10% Construction Contingency				$688,750	
SUBTOTAL				**$7,576,250**	
CONSTRUCTION TOTAL				**$7,576,250**	
Project Costs		22%		$1,666,775	
WN TRANSFER PS TOCAVE NECK RD FM PROJECT TOTAL				$9,240,000	

Notes:
(1.) Refers to the portion of the force main installed in Coastal Highway (SR 1)
(2.) Refers to the portion of the force main installed in Kings Road (SR 9)
(3.) Refers to the portion of the force main installed along County Roads.
(4.) Refers to the portion of the force main installed in Easements from WNRWF to Gills Neck Rd (CR 297).
(5.) Assumes 1 ARV per 3,000 feet of FM.

TABLE E-9
WNRWF to IBRWF Cost Estimate: County Flows Only (Alternative 3)
Alignment Option #3 - Beaver Dam Road (SR 23)

ITEM	UNIT	UNIT COST	QUANTITY	ITEM TOTAL	NOTES
WNRWF to IBRWF Force Main					
Mobilization (5%)	LS	$580,000	-	$580,000	
20" Force Main (Major Highway Construction) (1.)	LF	$200	7,100	$1,420,000	
20" Force Main (Intermediate Highway Construction) (2.)	LF	$150	28,550	$4,282,500	
20" Force Main (County Road Construction) (3.)	LF	$125	32,950	$4,118,750	
Air Release Valves and MH (4.)	EA	$7,000	23	$161,000	
Isolation Valves	EA	$20,000	4	$80,000	
Miscellaneous Jack and Bore of Major Highway	EA	$50,000	5	$250,000	Assumes 5 Road Crossings
Directional Drill Coastal Highway	LS	$250,000	1	$250,000	
SUBTOTAL				**$11,142,250**	
10% Construction Contingency				$1,114,225	
SUBTOTAL				**$12,256,475**	
CONSTRUCTION TOTAL				**$12,256,475**	
Project Costs		22%		$2,696,425	
WNRWF TO IBRWF FM PROJECT TOTAL				**$14,950,000**	

Notes:
(1.) Refers to the portion of the force main installed in John J. Williams Highway (SR 24)
(2.) Refers to the portion of the force main installed in Beaver Dam Road (SR 23) and Indian Mission Road (SR 5)
(3.) Refers to the portion of the force main installed along County Roads.
(4.) Assumes 1 ARV per 3,000 feet of FM.

TABLE E-10
Alternative 1 - WNRWF to RBSTP
FM Alignment Option #1 - Permanent Easement Installation
Cost Estimate

ITEM	UNIT	UNIT COST	QUANTITY	ITEM TOTAL	NOTES
RBSTP to WNRWF Force Main (1.)					
Mobilization (5%)	LS	$90,000	-	$90,000	
16" Force Main - County Roadway Installation	LF	$100	8,000	$800,000	
16" Force Main - Permanent Easement Installation	LF	$70	8,200	$574,000	Assumes No Road Restoration
Air Release Valves and MH (2.)	EA	$7,000	6	$42,000	
Isolation Valves	EA	$10,000	2	$20,000	
Directional Drill Rehoboth Canal (3.)	EA	$200,000	1	$200,000	
SUBTOTAL				**$1,726,000**	
10% Construction Contingency				$172,600	
SUBTOTAL				**$1,898,600**	
CONSTRUCTION TOTAL				**$1,898,600**	
Project Costs		22%		$417,692	
RBSTP to WNRWF Force Main PROJECT TOTAL				**$2,320,000**	
RBSTP to WNRWF PROJECT TOTAL				**$2,320,000**	

Notes:
(1.) 10.2 MGD sized for Ultimate Design
(2.) Assumes 1 ARV per 3,000 feet of FM.
(3.) Cost for directional drill based on similar projects in Sussex County, DE.

APPENDIX F

Inland Bays Regional Wastewater Facility Cost Estimates

STEARNS & WHELER[LLC]
Environmental Engineers & Scientists

Inland Bays Regional Wastewater Facility Study Phase Estimate of Capital Cost

Table F-1

Cost Summary for Inland Bays Phase 2 Expansion

July 1, 2009

Description	Comparative Cost	Date of Comparative Cost	Date of Analysis	Escalated Cost	Comparative Capacity	Units	This Capacity	Scaled Cost	Cost Plus 5% Mobilization	Estimated Cost
Screening	$513,000	March-09	Mar-09	$513,000	6.50	mgd	6.50	$510,000	$540,000	$540,000
Grit Removal	$1,013,927	Sep-04	Mar-09	$1,186,000	9.00	mgd	5.18	$840,000	$880,000	$880,000
Influent Dist Box	$369,979	Sep-04	Mar-09	$433,000	7.20	mgd	5.18	$350,000	$370,000	$370,000
Biolac Treatment System (Convert Lagoon 2)	$2,050,000	June-07	Mar-09	$2,204,000	2.75	mgd	1.83	$1,710,000	$1,800,000	$1,800,000
Secondary Clarifier Distribution Box	$369,979	Sep-04	Mar-09	$433,000	7.20	MG	5.18	$350,000	$370,000	$370,000
Secondary Clarifiers	$2,437,052	Sep-04	Mar-09	$2,850,000	7.20	MG	1.38	$1,020,000	$1,070,000	$1,070,000
RAS Pump Station	$542,440	Sep-04	Mar-09	$634,000	7.20	MG	2.75	$350,000	$370,000	$370,000
Chlorine Contact Tank	$400,000	Jan-07	Mar-09	$433,000	3.00	mgd	2.39	$380,000	$400,000	$400,000
New Storage Lagoon (45 Day Winter ADF)	$1,283,750	Feb-07	Mar-09	$1,390,000	23.50	MG	60	$2,490,000	$2,610,000	$2,610,000
Irrigation Pumping Station	$569,000	Feb-07	Mar-09	$616,000	0.58	mgd	0.94	$830,000	$870,000	$870,000
Solids Handling System	$4,149,843	Aug-03	Mar-09	$5,260,000	9.00	mgd	5.18	$3,730,000	$3,920,000	$3,920,000
Waste Sludge Holding Lagoon (Convert Lagoon 3)	$617,000	Oct-07	Mar-09	$655,000	3.00	MG	3.00	$660,000	$690,000	$690,000
Cake Storage Building								$350,000	$370,000	$370,000
Administration Building Expansion			Oct-08					$700,000	$740,000	$740,000
Subtotal (rounded)										$15,000,000
General Site Work @ 3% of Subtotal										$450,000
Yard Piping @ 9% of Subtotal										$1,350,000
Electrical/Controls @ 20% of Subtotal										$3,000,000
Startup/Testing @ 2% of Subtotal										$300,000
FM to Spray Field #10										$195,000
Parcel # 10 Spray Field Development										IBRWF
Subtotal (rounded)										$20,300,000
Construction Contingencies @ 10% of Subtotal										$2,000,000
Construction Cost										$22,300,000
Project Costs @ 22% of Construction Cost										$4,900,000
TOTAL PROJECT COST (2009 Dollars)										$27,200,000

Notes:
1. Cost Escallation based on ENR Construction Cost Index
2. Scaled Cost based on formula Cost 2 = Cost 1 * (Flow 2 / Flow 1) ^ (0.62) with flows in mgd units.
3. Cost for screening from Wolfe Neck Regional Study (March 2009), with electrical and contingency costs removed.
4. Cost for Biolac treatment system from January 2007 estimates for Inland Bays RWF.
5. Costs for Screening and Chlorine Contact Tank from WNRWF Expansion Cost Estimate.
6. Costs for irrigation pumping station from Bridgeville WWTP 2007 Upgrade.
7. Costs for influent dist box, grit, sludge handling, clarifiers, return sludge pumping station, and chemical feed system from SCRWF Expansion No. 2 (Bid 2004).
8. Costs for Spray Field Development from January 2009 estimates for Inland Bays RWF for irrigation guns, materials take-off for piping and grading
9. No piles assumed for new structures.
10. Cost for Waste Sludge Holding Lagoon from vendor quote for Emmitsburg WWTP for mixers (October 2007) and material take-off for lagoon liner & concrete
11. Assumptions for Yard Piping, General Site Work, Startup/Testing, and Electrical/Controls based on SCRWF Expansion No. 2 as follows:
    - SCRWF Expansion No. 2 Cost (2004 dollars) – C.O. Falter contract only = $15,201,101
    - Yard Piping for Falter Contract = $1,017,000
    - Site Work for Falter Contract = $316,000
    - Electrical for Falter Contract = $1,500,000
    - Controls for Falter Contract = $1,066,400
    - Startup and Testing for Falter Contract = $209,000
    - C.O. Falter Contract w/o Yard Piping, Sitework, Startup/Testing or Electrical/Controls = $11,092,701
        - Yard Piping as a percentage of raw costs = $1,017,000 / $11,092,701= 9%
        - Site Work as a percentage of raw costs = $316,000 / $11,092,701= 3%
        - Startup/Testing as a percentage of raw costs = $209,000 / $11,092,701= 2%
        - Electrical/Controls as a percentage of raw costs = $2,566,400 / $11,092,701= 23%

STEARNS & WHELER LLC
Environmental Engineers & Scientists

Inland Bays Regional Wastewater Facility Study Phase Estimate of Capital Cost

Table F-2

Cost Summary for Inland Bays Phase 3A Expansion

July 1, 2009

Description	Comparative Cost	Date of Comparative Cost	Date of Analysis	Escalated Cost	Comparative Capacity	Units	This Capacity	Scaled Cost	Cost Plus 5% Mobilization	Estimated Cost
Screening	$513,000	March-09	Mar-09	$513,000	6.50	mgd	6.50	$510,000	$540,000	$540,000
Biolac Treatment System (Convert WAS Lagoon)	$1,060,000	Jun-07	Mar-09	$1,139,000	1.83	mgd	1.83	$1,140,000	$1,200,000	$1,200,000
Secondary Clarifiers	$2,437,052	Sep-04	Mar-09	$2,850,000	7.20	MG	1.38	$1,020,000	$1,070,000	$1,070,000
Chlorine Contact Tank	$400,000	Jan-07	Mar-09	$433,000	3.00	mgd	1.49	$280,000	$290,000	$290,000
New Storage Lagoon (45 Day Winter ADF)	$1,283,750	Feb-07	Mar-09	$1,390,000	23.50	MG	49	$2,190,000	$2,300,000	$2,300,000
Irrigation Pumping Station	$569,000	Feb-07	Mar-09	$616,000	0.58	mgd	1.49	$1,110,000	$1,170,000	$1,170,000
Waste Sludge Holding Lagoons	$970,000	Jan-07	Mar-09	$1,051,000	3.00	mgd	5.18	$1,470,000	$1,540,000	$1,540,000
Subtotal (rounded)										$8,100,000
General Site Work @ 3% of Subtotal										$240,000
Yard Piping @ 9% of Subtotal										$730,000
Electrical/Controls @ 20% of Subtotal										$1,620,000
Startup/Testing @ 2% of Subtotal										$160,000
Cordrey Parcel Spray Field Development										$1,840,000
Subtotal (rounded)										$12,700,000
Construction Contingencies @ 10% of Subtotal										$1,300,000
Construction Cost										$14,000,000
Project Costs @ 22% of Construction Cost										**$3,100,000**
TOTAL PROJECT COST (2009 Dollars)										$17,100,000

Notes:
1. Cost for screening from Wolfe Neck Regional Study (March 2009), with electrical and contingency costs removed.
2. Scaled Cost based on formula Cost 2 = Cost 1 * (Flow 2 / Flow 1) ^ (0.62) with flows in mgd units.
3. Cost for Biolac treatment system from January 2007 estimates for Inland Bays RWF.
4. Costs for Chlorine Contact Tank from WNRWF Expansion Cost Estimate.
5. Costs for irrigation pumping station from Bridgeville WWTP 2007 Upgrade.
6. Costs for influent dist box, grit, sludge handling, clarifiers, return sludge pumping station, and chemical feed system from SCRWF Expansion No. 2 (Bid 2004).
7. Costs for Komet Irrigation Spray Guns from January 2009 estimates for Inland Bays RWF
8. No piles assumed for new structures.
9. Assumptions for Yard Piping, General Site Work, Startup/Testing, and Electrical/Controls based on SCRWF Expansion No. 2 as follows:
   - SCRWF Expansion No. 2 Cost (2004 dollars) – C.O. Falter contract only = $15,201,101
   - Yard Piping for Falter Contract = $1,017,000
   - Site Work for Falter Contract = $316,000
   - Electrical for Falter Contract = $1,500,000
   - Controls for Falter Contract = $1,066,400
   - Startup and Testing for Falter Contract = $209,000
   - C.O. Falter Contract w/o Yard Piping, Sitework, Startup/Testing or Electrical/Controls = $11,092,701
     - Yard Piping as a percentage of raw costs = $1,017,000 / $11,092,701= 9%
     - Site Work as a percentage of raw costs = $316,000 / $11,092,701= 3%
     - Startup/Testing as a percentage of raw costs = $209,000 / $11,092,701= 2%
     - Electrical/Controls as a percentage of raw costs = $2,566,400 / $11,092,701= 23%

APPENDIX G

Cost Sharing Model

Appendix G: Table G-1

Alternative #1A - RAW WASTEWATER FROM REHOBOTH WITH EXCESS PUMPED TO IBWRF

Item No.	Description	Design Criteria (1.)	County Flow Contribution (MGD) (2.)	Rehoboth Flow Contribution (MGD) (2.)	Rehoboth Cost Share
1	RBSTP Pumping Station	3.4 MGD Max Month	0.0	3.4	100%
2A	Force Main to WNRWF (Option #1)	3.4 MGD Max Month	0.0	3.4	100%
5	WNRWF Headworks Upgrades	10 MGD Max Month	6.4	3.6	36.2%
6	WNRWF to IBRWF Transfer Pumping Station	4.6 MGD Max Month	2.1	2.5	54.3%
7	Force Main to IBRWF (Option #3)	4.6 MGD Max Month	2.1	2.5	54.3%
8	IBRWF Phase 2 Upgrades	3.7 MGD Max Month	0.0	1.7	100.0%
9	IBRWF Phase 3 Upgrades	5.2 MGD Max Month	0.7	0.8	53.3%
10	IBRWF Phase 4 Upgrades	7.5 MGD Max Month	0.0	0.0	0.0%

Notes:
(1.) All Design Criteria is for 2030 maximum month except Items 1 and 2A, which are for buildout per the RBWWTP Alternative Discharge Cost Evaluation and Item 5, which incoporates additional 1.5 factor to account for pumped flows.
(2.) Flow contribution for phases 2 through 4 are based on the increase from the previous phase (i.e Phase 1 to 2 is 3.7-2.0=1.7 mgd).

Alternative #1B- RAW WASTEWATER FROM REHOBOTH WITH EXCESS PUMPED TO PRIVATE WTP

Item No.	Description	Design Criteria (1.)	County Flow Contribution (MGD) (2.)	Rehoboth Flow Contribution (MGD) (2.)	Rehoboth Cost Share
1	RBSTP Pumping Station	3.4 Max Month	0.0	3.4	100%
2A	Force Main to WNRWF (Option #1)	3.4 Max Month	0.0	3.4	100%
5	WNRWF Headworks Upgrades	10 MGD Max Month	6.4	3.6	36.2%
6	WNRWF to PWWP Transfer Pumping Station	4.6 MGD Max Month	2.1	2.5	54.3%
8	IBRWF Phase 2 Upgrades	2.9 MGD Max Month	0.9	0.0	0.0%
11B	Force Main to PWWP	4.6 MGD Max Month	2.1	2.5	54.3%
12	PWWP Treatment Capacity	4.6 MGD Max Month	2.1	2.5	54.3%
13	Land/Easements	NA	2.1	2.5	54.3%

Notes:

(1.) All Design Criteria is for 2030 maximum month except Items 1 and 2A, which are for buildout per the RBWWTP Alternative Discharge Cost Evaluation and Item 5, which incorporates additional 1.5 factor to account for pumped flows.

(2.) Capacity of the IBWRF will be 2 mgd after phase 1 is completed.Flow contribution for phases 2 through 4 are based on the increase from the previous phase (i.e. Phase 1 to 2 is 3.7-2.0=1.7 mgd).

Alternative #2A - Treated Effluent FROM Rehoboth Pumped to WNRWF with Excess to IBRWF

Item No.	Description	Design Criteria (1.)	County Flow Contribution (MGD) (2.)	Rehoboth Flow Contribution (MGD) (2.)	Rehoboth Cost Share
1	RBSTP Pumping Station	3.4 Max Month	0.0	3.4	100.0%
2A	Force Main to WNRWF (Option #1)	3.4 Max Month	0.0	3.4	100.0%
3A	Rehoboth Treatment Plant Improvements	3.4 Max Month	0.0	3.4	100.0%
5	WNRWF Headworks Upgrades	6.6 MGD Max Month	6.6	0.0	0.0%
6	WNRWF to IBRWF Transfer Pumping Station	3.6 MGD Max Month	2.1	1.5	41.7%
7	Force Main to IBRWF (Option #3)	3.6 MGD Max Month	2.1	1.5	41.7%
8	IBRWF Phase 2 Upgrades	3.7 MGD Max Month	0.2	1.5	88.2%
13	Land/Easements	-	N/A	N/A	100.0%

Notes:
(1.) All Design Criteria is for 2030 maximum month except Items 1 and 2A, which are for buildout per the RBWWTP Alternative Discharge Cost Evaluation and Item 4, which incoporates additional 1.5 factor to account for pumped flows.
(2.) Capacity of the IBWRF will be 2 mgd after phase 1 is completed.Flow contribution for phase 2 is based on the increase from the previous phase (i.e. Phase 1 to 2 is 3.7-2.0=1.7 mgd).

Alternative #2B - TREATED WASTEWATER FROM REHOBOTH WITH EXCESS PUMPED TO PRIVATE WTF

Item No.	Description	Design Criteria (1.)	County Flow Contribution (MGD) (2.)	Flow Contribution (MGD) (2.)	Rehoboth Cost Share
1	RBSTP Pumping Station	3.4 Max Month	0.0	3.4	100.0%
2A	Force Main to WNRWF (Option #1)	3.4 Max Month	0.0	3.4	100.0%
3A	Rehoboth Treatment Upgrades	3.4 Max Month	0.0	3.4	100.0%
5	WNRWF Headworks Upgrades	6.6 MGD Max Month	6.6	0.0	0.0%
6	WNRWF to ANSWERF Transfer Pumping Station	3.6 MGD Max Month	2.1	1.5	41.7%
8	IBRWF Phase 2 Upgrades	2.9 MGD Max Month	0.9	0.0	0.0%
11A	Force Main to ANSRWF	3.6 MGD Max Month	2.1	1.5	41.7%
12	PWWP Treatment Capacity	3.6 MGD Max Month	2.1	1.5	41.7%
13	Land/Easements	-	2.1	1.5	41.7%

Notes:
(1.) All Design Criteria is for 2030 maximum month except Items 1 and 2A, which are for buildout per the RBWWTP Alternative Discharge Cost Evaluation and Item 4, which incoporates additional 1.5 factor to account for pumped flows.
(2.) Capacity of the IBWRF will be 2 mgd after phase 1 is completed.Flow contribution for phase 2 is based on the increase from the previous phase (i.e. Phase 1 to 2 is 2.9-2.0=0.9 mgd).

Alternative #3 - REHOBOTH OUTFALL ALTERNATIVE WITH COUNTY CONTINUING TO PUMP TO IBWRF

Item No.	Description	Design Criteria (1.)	County Flow Contribution (MGD) (2.)	Rehoboth Flow Contribution (MGD) (2.)	Rehoboth Cost Share
1	RBSTP Pumping Station	3.4 Max Month	0.0	3.4	100%
3A	Rehoboth Treatment Upgrades	3.4 Max Month	0.0	3.4	100%
3B	Rehoboth FM to Ocean Outfall	-	0.0	3.4	100%
3C	Rehoboth Ocean Outfall	-	0.0	3.4	100%
5	WNRWF Headworks Upgrades	6.6 MGD Max Month	6.6	0.0	0.0%
6	WNRWF to IBRWF/PWWP P.S.	2.1 MGD Max Month	2.1	0.0	0.0%
7	Force Main to IBRWF (Option #3)	2.1 MGD Max Month	2.1	0.0	0.0%
8	IBRWF Phase 2 Upgrades	3.7 MGD Max Month	1.7	0.0	0.0%
9	IBRWF Phase 3A Upgrades	5.0 MGD Max Month	1.3	0.0	0.0%
13	Land/Easements	N/A	0.0	0.0	0.0%

Notes:
(1.) All Design Criteria is for 2030 maximum month except Items 1 and 2A, which are for buildout per the RBWWTP Alternative Discharge Cost Evaluation and Item 4, which incoporates additional 1.5 factor to account for pumped flows.
(2.) Capacity of the IBWRF will be 2 mgd after phase 1 is completed.Flow contribution for phase 2 is based on the increase from the previous phase (i.e. Phase 1 to 2 is 3.7-2.0=1.7 mgd).

Alternative #4 - COMBINED REHOBOTH AND COUNTY OCEAN OUTFALL

Item No.	Description	Design Criteria (1.)	County Flow Contribution (MGD)	Rehoboth Flow Contribution	Rehoboth Cost Share
1	RBSTP Pumping Station	3.4 Max Month	0.0	3.4	100.0%
2B	Force Main to Rehoboth (Option #1)	2.1 Max Month	2.1	0.0	0.0%
3A	Rehoboth Treatment Upgrades	3.4 Max Month	0.0	8.3	100.0%
3B	Rehoboth FM to Ocean Outfall	5.4 Max Month	2.1	2.5	54.3%
3C	Rehoboth Ocean Outfall	5.4 Max Month	2.1	2.5	54.3%
4	WNRWF Upgrades	4.4 MGD Max Month	4.4	0.0	0.0%
5	WNRWF Headworks Upgrades	6.6 MGD Max Month	6.6	0.0	0.0%
6	WNRWF to IBRWF/PWWP P.S.	2.1 MGD Max Month	2.1	0.0	0.0%
8	IBRWF Phase 2 Upgrades	2.9 MGD Max Month	0.9	0.0	0.0%
13	Land/Easements	-	0.0	0.0	0.0%

Notes:
(1.) All Design Criteria is for 2030 maximum month except Items 1 and 2A, which are for buildout per the RBWWTP Alternative Discharge Cost Evaluation and Item 4, which incoporates additional 1.5 factor to account for pumped flows.
(2.) Capacity of the IBWRF will be 2 mgd after phase 1 is completed.Flow contribution for phase 2 is based on the increase from the previous phase (i.e. Phase 1 to 2 is 2.9-2.0=0.9 mgd).

Appendix G: Table G-6B

Alternative #4B - COMBINED REHOBOTH AND COUNTY OCEAN OUTFALL

Item No.	Description	Design Criteria (1.)	County Flow Contribution (MGD)	Rehoboth Flow Contribution	Rehoboth Cost Share
1	RBSTP Pumping Station	3.4 Max Month	0.0	3.4	100.0%
2B	Force Main to Rehoboth (Option #1)	4.9 Max Month	2.1	0.0	0.0%
3A	Rehoboth Treatment Upgrades	3.4 Max Month	0.0	8.3	100.0%
3B	Rehoboth FM to Ocean Outfall	8.3 Max Month	4.9	3.4	41.0%
3C	Rehoboth Ocean Outfall	8.3 Max Month	4.9	3.4	41.0%
4	WNRWF Upgrades	4.9 Max Month	4.4	0.0	0.0%
5	WNRWF Headworks Upgrades		6.6	0.0	0.0%
6	WNRWF to IBRWF/PWWP P.S.	4.9 Max Month	2.1	0.0	0.0%
8	IBRWF Phase 2 Upgrades		0.9	0.0	0.0%
13	Land/Easements	-	0.0	0.0	0.0%

Notes:
(1.) All Design Criteria is for buildout maximum month
and Item 4, which incoporates additional 1.5 factor to account for pumped flows.

SUMMARY OF TOTAL CAPITAL COSTS

ALTERNATIVES #1, #2 and Analysis of Private Wastewater Treatment Provider

VERSION: Oct 19, 2009: Final Draft of Report

		Alternative #1A - Raw Wastewater Pumped to WNRWF				Alternative #1B Private Wastewater Treatment Provider				Alternative #2A - Treated Effluent Pumped to WNRWF				Alternative #2B Private Wastewater Treat		
Item	Description	Table	Design Criteria	Capacity	Total Cost	Table	2030 Design Criteria	2030 Capacity	Total Cost	Table	2030 Design Criteria	2030 Capacity	Total Cost	Table	2030 Design Criteria	2030 Capacity
1	RBSTP Pumping Station	-	3.4 MGD Max Month	10.2 MGD Peak Hour	$3,001,000	-	3.4 Max Month	10.2 MGD Peak Hour	$3,001,000	N/A	3.4 Max Month	10.2 MGD Peak Hour	$900,000	N/A	3.4 Max Month	10.2 MGD Peak Hour
2A	Force Main to WNRWF (Option #1)	D-1	3.4 MGD Max Month	10.2 MGD Peak Hour	$3,123,000	D-1	3.4 Max Month	10.2 MGD Peak Hour	$3,123,000	D-3	3.4 Max Month	10.2 MGD Peak Hour	$3,500,000	D-3	3.4 Max Month	10.2 MGD Peak Hour
2B	**Force Main to Rehoboth (Option #1)**	-	-	-	-	-	-	-	-					-	-	-
3A	**Rehoboth Treatment Upgrades**	-	-	-	-	-	-	-	-	-	3.4 Max Month	3.4 Max Month	$2,930,000	-	3.4 Max Month	3.4 Max Month
3B	**Rehoboth FM to Ocean Outfall**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3C	**Rehoboth Ocean Outfall**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	**WNRWF Upgrades**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	WNRWF Headworks Upgrades	D-5	10 MGD Max Month	27.5 MGD Peak Hour	$1,527,571	D-5	10 MGD Max Month	27.5 MGD Peak Hour	$1,527,571	D-6	6.6 MGD Max Month	17.5 MGD Peak Hour	$1,296,572	D-6	6.6 MGD Max Month	17.5 MGD Peak Hour
6	WNRWF to IBRWF/PWWP P.S.	E-4	4.6 MGD Max Month	6.9 MGD Peak Hour	$2,485,000	E-4	4.6 MGD Max Month	6.9 MGD Peak Hour	$2,485,000	E-5	3.6 MGD Max Month	5.4 MGD Peak Hour	$2,270,000	E-5	3.6 MGD Max Month	5.4 MGD Peak Hour
7	**Force Main to IBRWF (Option #3)**	E-3	4.6 MGD Max Month	6.9 MGD Peak Hour	$13,027,250	-	-	-	-	E-9	3.6 MGD Max Month	5.4 MGD Peak Hour	$13,027,250	-	-	-
8	IBRWF Phase 2 Upgrades	F-1	3.7 MGD Max Month	3.7 MGD Max Month	$20,600,000	(1)	2.9 MGD Max Month	2.9 MGD Max Month	$10,905,882	F-1	3.7 MGD Max Month	3.7 MGD Max Month	$20,600,000	(1)	2.9 MGD Max Month	2.9 MGD Max Month
9	IBRWF Phase 3A Upgrades	F-2	5.2 MGD Max Month	5.2 MGD Max Month	$12,700,000	-	N/A	N/A	N/A	F-2	5.2 MGD Max Month	5.2 MGD Max Month	$12,700,000	-	-	-
10	IBRWF Phase 4 Upgrades	-	7.5 MGD Max Month	7.5 MGD Max Month	$18,852,459		N/A	N/A	N/A	-	6.5 MGD Max Month	6.5 MGD Max Month	$10,655,738	-	-	-
11A	Force Main to Cave Neck Road	-	-	-	-	E-7	4.6 MGD Max Month	6.9 MGD Peak Hour	$6,967,511	-	-	-	N/A	E-7	3.6 MGD Max Month	5.4 MGD Peak Hour
11B	Force Main to ANSWRF	-	-	-	-	E-8	4.6 MGD Max Month	6.9 MGD Peak Hour	$8,736,587	-	-	-	N/A	E-8	-	-
12	PSP Treatment Capacity	-	-	-	-	-	4.6 MGD Max Month	4.6 MGD Max Month	$48,410,902	-	-	-	N/A	-	3.6 MGD Max Month	3.6 MGD Max Month
13	Land/Easements	-	-	-	$11,250,000	-	-	-	$500,000	-	-	-	$11,250,000	-	-	-
14A	10% Contingency	-	-	-	$7,531,628	-	-	-	$3,724,655	-	-	-	$6,494,956	-	-	-
14B	15% Contingency (Ocean Outfall and Rehoboth WWTP Upgrade Only)	-	-	-	-	-	-	-	-	-	-	-	$439,500	-	-	-
15	Engineering and Administration	-	-	-	$18,226,540	-	-	-	$10,628,665	-	-	-	$16,459,084	-	-	-
16	Permitting (5%) Ocean Outfall Only															
	Total Project Cost				**$112,324,447**				**$100,010,774**				**$102,523,100**			

Notes:
(1) Ratio of (2.9-2.0)/(3.7-2.0) * Phase 2 costs used to approximate reduced upgrade.

Flow Split

Year 2030	Max Month Flow (MGD)	Notes
Sussex County		
WNRWF	4.4	
IBRWF	2.9	
Henlopen/Dewey	0.9	38% of flow from RBSTP
Subtotal	8.2	*Sussex County Flow*
City of Rehoboth	1.6	62% of flow from RBSTP
Total	9.8	

% Flow Contributed by Sussex County 84%
% Flow Contributed by City of Rehoboth 16%

SUMMARY OF TOTAL CAPITAL COSTS

ALTERNATIVES #3 & #4

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		ment Provider	Alt. 3 - Rehoboth Ocean Outfall Alternative (County Uses Inland Bays)				Alt. 4 - Rehoboth Ocean Outfall Alternative (County Uses Rehoboth Ocean Outfall)			
Item	Description	Total Cost	Table	2030 Design Criteria	2030 Capacity	Total Cost	Table	2030 Design Criteria	2030 Capacity	Total Cost
1	RBSTP Pumping Station	$900,000	X	3.4 Max Month	10.2 MGD Peak Hour	$900,000	-	3.4 Max Month	10.2 MGD Peak Hour	$900,000
2A	Force Main to WNRWF (Option #1)	$3,500,000	-	-	-	-	-	-	-	-
2B	**Force Main to Rehoboth (Option #1)**	-	-	-	-	-	E-10	2.1 Max Month	3.2 MGD Peak Hour	$1,726,000
3A	**Rehoboth Treatment Upgrades**	$2,930,000	-	3.4 Max Month	3.4 Max Month	$2,930,000	-	3.4 Max Month	3.4 Max Month	$2,930,000
3B	**Rehoboth FM to Ocean Outfall**	-	-	-	-	$2,560,000	-	-	-	$6,160,000
3C	**Rehoboth Ocean Outfall**	-	-	-	-	$14,800,000	-	-	-	$16,600,000
4	**WNRWF Upgrades**	-	-	-	-	-	-	4.4 MGD Max Month	4.4 MGD Max Month	$21,000,000
5	WNRWF Headworks Upgrades	$1,296,572	D-6	6.6 MGD Max Month	17.5 MGD Peak Hour	$1,296,572	D-6	6.6 MGD Max Month	17.5 MGD Peak Hour	$1,296,572
6	WNRWF to IBRWF/PWWP P.S.	$2,270,000	E-6	2.1 MGD Max Month	3.2 MGD Peak Hour	$2,000,000	-	2.1 MGD Max Month	3.2 MGD Peak Hour	$1,750,000
7	**Force Main to IBRWF (Option #3)**	-	E-9	2.1 MGD Max Month	3.2 MGD Peak Hour	$11,142,250	-	-	-	
8	IBRWF Phase 2 Upgrades	$10,905,882	F-1	3.7 MGD Max Month	3.7 MGD Max Month	$20,600,000	(1)	2.9 MGD Max Month	2.9 MGD Max Month	$10,905,882
9	IBRWF Phase 3A Upgrades	-	F-2	5.0 MGD Max Month	5.0 MGD Max Month	$12,700,000	-	-	-	-
10	IBRWF Phase 4 Upgrades	-	-	-	-	-	-	-	-	-
11A	Force Main to Cave Neck Road	$6,967,511	-	-	-	-	-	-	-	-
11B	Force Main to ANSWRF	$8,736,587	-	-	-	-	-	-	-	-
12	PSP Treatment Capacity	$38,576,359	-	-	-	-	-	-	-	-
13	Land/Easements	$500,000	-	-	-	$0	-	-	-	
14A	10% Contingency	$3,507,655	-	-	-	$5,119,882	-	-	-	$4,373,845
14B	15% Contingency (Ocean Outfall and Rehoboth WWTP Upgrade Only)	$439,500	-	-	-	$2,659,500	-	-	-	$2,929,500
15	Engineering and Administration	$10,469,816	-	-	-	$16,875,805	-	-	-	$15,525,796
16	Permitting (5%) Ocean Outfall Only					$851,000				$954,500
	Total Project Cost	**$90,999,883**				**$94,435,010**				**$87,052,096**

Notes:
(1) Ratio of (2.9-2.0)/(3.7-2.0) * Phase 2 costs used to

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Rehoboth Capital Costs

Alternative #1A - RAW WASTEWATER FROM REHOBOTH WITH EXCESS PUMPED TO IBWRF

Item No.	Description	Table #	2030 Design Criteria	2030 Capacity	Total Cost	County Costs Share	Rehoboth Cost Share	Rehoboth Cost
1	RBSTP Pumping Station	-	3.4 MGD Max Month	10.2 MGD Peak Hour	$3,001,000	$0	100%	$3,001,000
2A	Force Main to WNRWF (Option #1)	D-1	3.4 MGD Max Month	10.2 MGD Peak Hour	$3,123,000	$0	100%	$3,123,000
5	WNRWF Headworks Upgrades	D-5	10 MGD Max Month	27.5 MGD Peak Hour	$1,527,571	$974,590	36.2%	$552,981
6	WNRWF to IBRWF Transfer Pumping Station	E-4	4.6 MGD Max Month	6.9 MGD Peak Hour	$2,485,000	$1,135,645	54.3%	$1,349,355
7	Force Main to IBRWF (Option #3)	E-3	4.6 MGD Max Month	6.9 MGD Peak Hour	$13,027,250	$5,953,453	54.3%	$7,073,797
8	IBRWF Phase 2 Upgrades	F-1	3.7 MGD Max Month	3.7 MGD Max Month	$20,600,000	$0	100.0%	$20,600,000
9	IBRWF Phase 3 Upgrades	F-2	5.2 MGD Max Month	5.2 MGD Max Month	$12,700,000	$5,926,667	53.3%	$6,773,333
10	IBRWF Phase 4 Upgrades	-	7.5 MGD Max Month	7.5 MGD Max Month	$18,852,459	$18,852,459	0.0%	$0
13	Land/Easements	-	-	-	$11,250,000	$0	100.0%	$11,250,000
14A	10% Contingency	-	-	-	$7,531,628	$3,284,281	56.4%	$4,247,347
15	Engineering/Administration	-	-	-	$18,226,540	$7,947,961	56.4%	$10,278,579
	Total Project Cost				**$112,324,447**	**$44,075,056**		**$68,249,391**

SUSSEX COUNTY COST $44,075,056

Flow Split	Month Flow (MGD)	Notes
WNRWF	4.4	
IBRWF	2.9	
Subtotal	*7.3*	
Henlopen/Dewey	0.9	38% of flow from RBSTP
City of Rehoboth/North Shores	1.6	62% of flow from RBSTP
Total	**9.8**	

User Cost Determination	SPRAY IRRIGATION OPTION SRF 4.4% for 20 years (from S&W March 2009 Report)		SPRAY IRRIGATION OPTION 1/3 SRF @ 4.4% for 20 years & 2/3 RD @ 5% for 40 years	
COSTS DESCRIPTION	Rehoboth + DB, NS & HA	Rehoboth Only	Rehoboth + DB, NS & HA	Rehoboth Only
Annual Capital Cost	$5,201,385	$2,929,420	$4,385,428	$2,469,873
Plant Operations (From Rehoboth March 2009 Report)	$0	$0	$0	$0
Pump Station Maintenance	$100,000	$56,320	$100,000	$56,320
Collection System From Rehoboth March 2009 Report)	$150,000	$138,735	$150,000	$138,735
Sussex County Operations and Maintenance ($5.08/1000 gal)	$2,286,000	$1,287,475	$2,286,000	$1,287,475
Subtotal		**$4,411,950**		**$3,952,403**
Projected User Rate for City of Rehoboth		**$1,156**		**$1,036**

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Rehoboth Capital Costs

Alternative #1B- RAW WASTEWATER FROM REHOBOTH WITH EXCESS PUMPED TO PRIVATE ANSWERF

Item No.	Description	Table #	2030 Design Criteria	2030 Capacity	Total Cost	County Share	Rehoboth Cost Share	Rehoboth Cost
1	RBSTP Pumping Station	-	3.4 Max Month	10.2 MGD Peak Hour	$3,001,000	$0	100%	$3,001,000
2A	Force Main to WNRWF (Option #1)	D-1	3.4 Max Month	10.2 MGD Peak Hour	$3,123,000	$0	100%	$3,123,000
5	WNRWF Headworks Upgrades	D-5	10 MGD Max Month	27.5 MGD Peak Hour	$1,527,571	$974,103	36.2%	$553,468
6	WNRWF to PWWP Transfer Pumping Station	E-4	4.6 MGD Max Month	6.9 MGD Peak Hour	$2,485,000	$1,134,457	54.3%	$1,350,543
8	IBRWF Phase 2 Upgrades	(1)	2.9 MGD Max Month	2.9 MGD Max Month	10,905,882	10,905,882	0.0%	$0
11B	Force Main to PWWP	E-7	4.6 MGD Max Month	6.9 MGD Peak Hour	$15,704,098	$7,169,262	54.3%	$8,534,836
12	PWWP Treatment Capacity	E-8	4.6 MGD Max Month	4.6 MGD Max Month	$48,410,902	$22,100,629	54.3%	$26,310,273
13	Land/Easements	-	-	-	$500,000	$228,261	54.3%	$271,739
14A	Contingency	-	-	-	$3,724,655	$2,041,197	**45.2%**	**$1,683,459**
15	Engineering & Administration	-	-	-	$10,628,665	$5,824,753	**45.2%**	**$4,803,913**
	Total Project Cost				**$100,010,774**	**$50,378,543**		$49,632,231

Notes:
(1) Ratio of (2.9-2.0)/(3.7-2.0) * Phase 2 costs used to approximate reduced upgrade.

SUSSEX COUNTY COST $50,378,543

Flow Split to PWWP	Max Month Flow	Notes
WNRWF (4.4-2.3)	2.1	45.7%
Rehoboth	2.5	54.3%
Subtotal	*4.6*	
Henlopen/Dewey	0.9	38% of flow from RBSTP
City of Rehoboth/North Shores	1.6	62% of flow from RBSTP
Total	7.1	

User Cost Determination	Private Option: SRF 4.4% for 20 years (from S&W March 2009 Report)		Private Option: 1/3 SRF @ 4.4% for 20 years & 2/3 RD @ 5% for 40 years	
COSTS DESCRIPTION	Rehoboth + DB, NS & HA	Rehoboth Only @ 56.32%	Rehoboth + DB, NS & HA	Rehoboth Only @ 56.32%
Annual Capital Cost	$3,782,544	$2,130,329	$3,189,165	$1,796,138
Pump Station O&M	$100,000	$56,320	$100,000	$56,320
Collection System From Rehoboth March 2009 Report)	$150,000	$138,735	$150,000	$138,735
Artesian Disposal @ 2 MGD Minimum ($6.84/1000 gal)	$4,993,200	$2,812,170	$4,993,200	$2,812,170
Sussex County O&M ($1.21/1000 gal)	$544,500	$306,662	$544,500	$306,662
Subtotal		$5,444,217		$5,110,025
Projected User Rate for City of Rehoboth		$1,427		$1,339

Appendix G: Table G-10

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Capital Costs

Alternative #2A - Treated Effluent FROM Rehoboth Pumped to WNRWF with Excess to IBRWF

Item No.	Description	Table #	2030 Design Criteria	2030 Capacity	Total Cost	County Share	Rehoboth Cost Share	Rehoboth Cost
1	RBSTP Pumping Station	N/A	3.4 Max Month	10.2 MGD Peak Hour	$900,000	$0	100%	$900,000
2A	Force Main to WNRWF (Option #1)	D-3	3.4 Max Month	10.2 MGD Peak Hour	$3,500,000	$0	100%	$3,500,000
3A	Rehoboth Treatment Plant Improvements				$2,930,000	$0	100%	$2,930,000
5	WNRWF Headworks Upgrades	D-6	6.6 MGD Max Month	17.5 MGD Peak Hour	$1,296,572	$1,296,572	0.0%	$0
6	WNRWF to IBRWF Transfer Pumping Station	E-5	3.6 MGD Max Month	5.4 MGD Peak Hour	$2,270,000	$1,324,167	41.7%	$945,833
7	Force Main to IBRWF (Option #3)	E-9	3.6 MGD Max Month	5.4 MGD Peak Hour	$13,027,250	$7,599,229	41.7%	$5,428,021
8	IBRWF Phase 2 Upgrades	F-1	3.7 MGD Max Month	3.7 MGD Max Month	$20,600,000	$2,430,800	88.2%	$18,169,200
9	IBRWF Phase 3 Upgrades	F-2	5.2 MGD Max Month	5.2 MGD Max Month	$12,700,000	$12,700,000	0.0%	$0
10	IBRWF Phase 4 Upgrades	-	6.5 MGD Max Month	6.5 MGD Max Month	$10,655,738	$10,655,738	0.0%	$0
13	Land/Easements	-	-	-	$11,250,000	$0	100.0%	$11,250,000
14A	10% Contingency	-	-	-	$6,494,956	$3,600,651	44.6%	$2,894,305
14B	15% Contingency (Ocean Outfall and Rehoboth WWTP Upgrade Only)	-	-	-	$439,500	$0	100.0%	$439,500
15	Engineering/Administration	-	-	-	$16,459,084	$8,713,574	47.1%	$7,745,509
	Total Project Cost				**$102,523,100**	**$48,320,731**		**$54,202,369**

SUSSEX COUNTY COST $48,320,731

Flow Split		Notes
WNRWF	4.4	
IBRWF	2.9	
Subtotal	7.3	
Henlopen/Dewey	0.9	38% of flow from RBSTP
City of Rehoboth/North Shores	1.6	62% of flow from RBSTP
Total	**9.8**	

User Cost Determination	SPRAY IRRIGATION OPTION SRF 4.4% for 20 years (from S&W March 2009 Report)		SPRAY IRRIGATION OPTION 1/3 SRF @ 4.4% for 20 years & 2/3 RD @ 5% for 40 years	
COSTS DESCRIPTION	Rehoboth + DB, NS & HA	Rehoboth Only	Rehoboth + DB, NS & HA	Rehoboth Only
Annual Capital Cost	$4,130,841	$2,326,490	$3,482,823	$1,961,526
Plant Operations (From Rehoboth March 2009 Report)	$1,590,000	$895,488	$1,590,000	$895,488
Collection System From Rehoboth March 2009 Report)	$150,000	$138,735	$150,000	$138,735
Sussex County Operations and Maintenance ($2.00/1000 gal)	$900,000	$506,880	$900,000	$506,880
Subtotal		$3,867,593		$3,502,629
Projected User Rate for City of Rehoboth		$1,014		$918

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Rehoboth Capital Costs

Alternative #2B - TREATED WASTEWATER FROM REHOBOTH WITH EXCESS PUMPED TO PRIVATE ANSWERF

Item No.	Description	Table #	2030 Design Criteria	2030 Capacity	Total Cost	County Costs	Rehoboth Cost Share	Rehoboth Cost
1	RBSTP Pumping Station	N/A	3.4 Max Month	10.2 MGD Peak Hour	$900,000	$0	100%	$900,000
2A	Force Main to WNRWF (Option #1)	D-3	3.4 Max Month	10.2 MGD Peak Hour	$3,500,000	$0	100%	$3,500,000
3A	Rehoboth Treatment Upgrades				$2,930,000	$0	100%	$2,930,000
5	WNRWF Headworks Upgrades	D-6	6.6 MGD Max Month	17.5 MGD Peak Hour	$1,296,572	$1,296,572	0.0%	$0
6	WNRWF to PWWP Transfer Pumping Station	E-5	3.6 MGD Max Month	5.4 MGD Peak Hour	$2,270,000	$1,323,410	41.7%	$946,590
8	IBRWF Phase 2 Upgrades	(1)	2.9 MGD Max Month	2.9 MGD Max Month	$10,905,882	$10,905,882	0.0%	$0
11A	Force Main to PWWP	E-7	3.6 MGD Max Month	5.4 MGD Peak Hour	$15,704,098	$9,155,489	41.7%	$6,548,609
12	PWWP Treatment Capacity	-	3.6 MGD Max Month	3.6 MGD Max Month	$38,576,359	$22,490,017	41.7%	$16,086,342
13	Land/Easements	-	-	-	$500,000	$291,500	41.7%	$208,500
14A	10% Contingency	-	-	-	$3,507,655	$2,297,285	39.6%	$1,210,370
14B	15% Contingency (Ocean Outfall and Rehoboth WWTP Upgrade Only)	-	-	-	$439,500	$0	100.0%	$439,500
15	Engineering & Administration	-	-	-	$10,469,816	$6,328,423	39.6%	$4,141,393
	Total Project Cost				**$90,999,883**	**$54,088,580**		**$36,911,303**

SUSSEX COUNTY COST $54,088,580

Notes:
(1) Ratio of (2.9-2.0)/(3.7-2.0) * Phase 2 costs used to approximate reduced upgrade.

Flow Split to ANSWERF	Max Month Flow	Notes
WNRWF (4.4-2.3)	2.1	45.7%
Rehoboth	2.5	54.3%
Subtotal	*4.6*	
Henlopen/Dewey	0.9	38% of flow from RBSTP
City of Rehoboth/North Shores	1.6	62% of flow from RBSTP
Total	**7.1**	

User Cost Determination	Private Option: SRF 4.4% for 20 years (from S&W March 2009 Report)		Private Option: 1/3 SRF @ 4.4% for 20 years & 2/3 RD @ 5% for 40 years	
COSTS DESCRIPTION	Rehoboth + DB, NS & HA	Rehoboth Only @ 56.32%	Rehoboth + DB, NS & HA	Rehoboth Only @ 56.32%
Annual Capital Cost	$2,813,064	$1,584,318	$2,371,770	$1,335,781
Treatment Plant O&M From Rehoboth March 2009 Report)	$1,590,000	$895,488	$1,590,000	$895,488
Collection System From Rehoboth March 2009 Report)	$150,000	$138,735	$150,000	$138,735
Artesian Disposal @ 2 MGD Minimum ($6.84/1000 gal)	$4,993,200	$2,812,170	$4,993,200	$2,812,170
Sussex County O&M	$0	$0	$0	$0
Subtotal		$5,430,711		$5,182,174
Projected User Rate for City of Rehoboth		$1,423		$1,358

Appendix G: Table G-12

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Rehoboth Capital Costs

Alternative #3 - REHOBOTH OUTFALL ALTERNATIVE WITH COUNTY CONTINUING TO PUMP TO IBWRF

Description	Table #	2030 Design Criteria	2030 Capacity	Total Cost	County Cost	Rehoboth Cost Share	Rehoboth Cost
RBSTP Pumping Station	N/A	3.4 Max Month	10.2 MGD Peak Hour	$900,000	$0	100%	$900,000
Rehoboth Treatment Upgrades	-	3.4 Max Month	3.4 Max Month	$2,930,000	$0	100%	$2,930,000
Rehoboth FM to Ocean Outfall	-	-	-	$2,560,000	$0	100%	$2,560,000
Rehoboth Ocean Outfall	-	-	-	$14,800,000	$0	100%	$14,800,000
WNRWF Headworks Upgrades	D-6	6.6 MGD Max Month	17.5 MGD Peak Hour	$1,296,572	$1,296,572	0.0%	$0
WNRWF to IBRWF/PWWP P.S.	E-6	2.1 MGD Max Month	3.2 MGD Peak Hour	$2,000,000	$2,000,000	0.0%	$0
Force Main to IBRWF (Option #3)	E-9	2.1 MGD Max Month	3.2 MGD Peak Hour	$11,142,250	$11,142,250	0.0%	$0
IBRWF Phase 2 Upgrades	F-1	3.7 MGD Max Month	3.7 MGD Max Month	$20,600,000	$20,600,000	0.0%	$0
IBRWF Phase 3A Upgrades	F-2	5.0 MGD Max Month	5.0 MGD Max Month	$12,700,000	$12,700,000	0.0%	$0
Land/Easements	-	-	-	$0	$0	0.0%	$0
10% Contingency	-	-	-	$5,119,882	$4,773,882	6.8%	$346,000
15% Contingency (Ocean Outfall and Rehoboth WWTP Upgrade Only)				$2,659,500	$0	100.0%	$2,659,500
Engineering & Administration	-	-	-	$16,875,805	$11,552,795	31.5%	$5,323,010
Permitting (5%) Ocean Outfall Only				$851,000	$0	100.0%	$851,000
Total Project Cost				**$94,435,010**	**$64,065,500**		**$30,369,510**

SUSSEX COUNTY COST $64,065,500

Flow Split	Max Month Flow	Notes
WNRWF (4.4-2.3)	2.1	45.7%
Rehoboth	2.5	54.3%
Subtotal	*4.6*	
Henlopen/Dewey	0.9	36.0%
City of Rehoboth/North Shores	1.6	64.0%
Total	**7.1**	

User Cost Determination

COSTS DESCRIPTION	Outfall Option Rehoboth Only SRF 4.4% for 20 years (from S&W March 2009 Report) Rehoboth + DB, NS & HA	Outfall Option Rehoboth Only SRF 4.4% for 20 years (from S&W March 2009 Report) Rehoboth Only @ 56.32%	Outfall Option Rehoboth Only 1/3 SRF @ 4.4% for 20 years & 2/3 RD @ 5% for 40 years Rehoboth + DB, NS & HA	Outfall Option Rehoboth Only 1/3 SRF @ 4.4% for 20 years & 2/3 RD @ 5% for 40 years Rehoboth Only @ 56.32%
Annual Capital Cost	$2,314,504	$1,303,529	$1,951,421	$1,099,040
Plant Operations (From Rehoboth March 2009 Report)	$1,590,000	$895,488	$1,590,000	$895,488
New O&M	$150,000	$84,480	$150,000	$84,480
Collection System From Rehoboth March 2009 Report)	$150,000	$138,735	$150,000	$138,735
Sussex County Operations and Maintenance ($2.00/1000 gal)	$0	$0		$0
Subtotal		$2,422,232		$2,217,743
Projected User Rate for City of Rehoboth		$635		$581

Appendix G: Table G-13

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Rehoboth Capital Costs

Alternative #4 - COMBINED REHOBOTH AND COUNTY OCEAN OUTFALL

Item No.	Description	Table #	2030 Design Criteria	2030 Capacity	Total Cost	County Cost	Rehoboth Cost Share	Rehoboth Cost
1	RBSTP Pumping Station	-	3.4 Max Month	10.2 MGD Peak Hour	$900,000	$0	100%	$900,000
2B	Force Main to Rehoboth (Option #1)	E-10	2.1 Max Month	3.2 MGD Peak Hour	$1,726,000	$1,726,000	0%	$0
3A	Rehoboth Treatment Upgrades	-	3.4 Max Month	3.4 Max Month	$2,930,000	$0	100.0%	$2,930,000
3B	Rehoboth FM to Ocean Outfall	-	-	-	$6,160,000	$2,812,174	54.3%	$3,347,826
3C	Rehoboth Ocean Outfall	-	-	-	$16,600,000	$7,578,261	54.3%	$9,021,739
4	WNRWF Upgrades	-	4.4 MGD Max Month	4.4 MGD Max Month	$21,000,000	$21,000,000	0.0%	$0
5	WNRWF Headworks Upgrades	D-6	6.6 MGD Max Month	17.5 MGD Peak Hour	$1,296,572	$1,296,572	0.0%	$0
6	WNRWF to IBRWF/PWWP P.S.	-	2.1 MGD Max Month	3.2 MGD Peak Hour	$1,750,000	$1,750,000	0.0%	$0
8	IBRWF Phase 2 Upgrades	(1)	2.9 MGD Max Month	2.9 MGD Max Month	$10,905,882	$10,905,882	0.0%	$0
13	Land/Easements	-	-	-	$0	$0	0.0%	$0
14A	10% Contingency	-	-	-	$4,373,845	$3,949,063	9.7%	$424,783
14B	15% Contingency (Ocean Outfall and Rehoboth WWTP Upgrade Only)				$2,929,500	$1,136,739	9.7%	$1,792,761
15	Engineering & Administration	-	-	-	$15,525,796	$11,474,032	26.1%	$4,051,764
16	Permitting (5%) Ocean Outfall Only				$954,500	$435,750	54.3%	$518,750
	Total Project Cost				**$87,052,096**	**$64,064,474**		**$22,987,623**

SUSSEX COUNTY COST $64,064,474

Notes:
(1) Ratio of (2.9-2.0)/(3.7-2.0) * Phase 2 costs used to approximate reduced upgrade.

Flow Split to Outfall	Max Month Flow	Notes
WNRWF (4.4-2.3)	2.1	45.7%
Rehoboth	2.5	54.3%
Subtotal	*4.6*	
Henlopen/Dewey	0.9	38% of flow from RBSTP
City of Rehoboth/North Shores	1.6	62% of flow from RBSTP
Total	7.1	

User Cost Determination	Outfall Option Rehoboth and Sussex: SRF 4.4% for 20 years (from S&W March 2009 Report)		Outfall Option Rehoboth and Sussex: 1/3 SRF @ 4.4% for 20 years & 2/3 RD @ 5% for 40 years	
COSTS DESCRIPTION	Rehoboth + DB, NS & HA	Rehoboth Only @ 56.32%	Rehoboth + DB, NS & HA	Rehoboth Only @ 56.32%
Annual Capital Cost	$1,751,920	$986,681	$1,477,091	$831,898
Plant Operations (From Rehoboth March 2009 Report)	$1,590,000	$895,488	$1,590,000	$895,488
New O&M	$150,000	$84,480	$150,000	$84,480
Collection System From Rehoboth March 2009 Report)	$150,000	$138,735	$150,000	$138,735
Sussex County Operations and Maintenance ($2.00/1000 gal)	$0	$0	$0	$0
Subtotal		$2,105,384		$1,950,601
Projected User Rate for City of Rehoboth		$552		$511

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Rehoboth Capital Costs

Alternative #4B - COMBINED REHOBOTH AND COUNTY OCEAN OUTFALL

Item No.	Description	Table #	2030 Design Criteria	2030 Capacity	Total Cost	County Cost	Rehoboth Cost Share	Rehoboth Cost
1	RBSTP Pumping Station	-	3.4 Max Month	10.2 MGD Peak Hour	$900,000	$0	100%	$900,000
2B	Force Main to Rehoboth (Option #1)	E-10	2.1 Max Month	3.2 MGD Peak Hour	$1,726,000	$1,726,000	0%	$0
3A	Rehoboth Treatment Upgrades	-	3.4 Max Month	3.4 Max Month	$2,930,000	$0	100.0%	$2,930,000
3B	Rehoboth FM to Ocean Outfall	-	-	-	$6,160,000	$3,636,627	41.0%	$2,523,373
3C	Rehoboth Ocean Outfall	-	-	-	$16,600,000	$9,800,000	41.0%	$6,800,000
4	WNRWF Upgrades	-	4.4 MGD Max Month	4.4 MGD Max Month	$21,000,000	$21,000,000	0.0%	$0
5	WNRWF Headworks Upgrades	D-6	6.6 MGD Max Month	17.5 MGD Peak Hour	$1,296,572	$1,296,572	0.0%	$0
6	WNRWF to IBRWF/PWWP P.S.	-	2.1 MGD Max Month	3.2 MGD Peak Hour	$1,750,000	$1,750,000	0.0%	$0
8	IBRWF Phase 2 Upgrades	(1)	2.9 MGD Max Month	2.9 MGD Max Month	$10,905,882	$10,905,882	0.0%	$0
13	Land/Easements	-	-	-	$0	$0	0.0%	$0
14A	10% Contingency	-	-	-	$4,373,845	$4,031,508	7.8%	$342,337
14B	15% Contingency (Ocean Outfall and Rehoboth WWTP Upgrade Only)				$2,929,500	$1,470,000	7.8%	$1,459,500
15	Engineering & Administration	-	-	-	$15,525,796	$12,235,650	21.2%	$3,290,146
16	Permitting (5%) Ocean Outfall Only				$954,500	$563,500	41.0%	$391,000
	Total Project Cost				**$87,052,096**	**$68,415,739**		$18,636,357

SUSSEX COUNTY COST $68,415,739

Flow Split to Outfall	Max Month Flow	Notes
WNRWF (4.4-2.3)	4.9	59.0%
Rehoboth	3.4	41.0%
Subtotal	*8.3*	
Henlopen/Dewey	0.9	38% of flow from RBSTP
City of Rehoboth/North Shores	1.6	62% of flow from RBSTP
Total	**10.8**	

User Cost Determination	Outfall Option Rehoboth and Sussex SRF 4.4% for 20 years (from S&W March 2009 Report)		Outfall Option Rehoboth and Sussex 1/3 SRF @ 4.4% for 20 years & 2/3 RD @ 5% for 40 years	
COSTS DESCRIPTION	Rehoboth + DB, NS & HA	Rehoboth Only @ 56.32%	Rehoboth + DB, NS & HA	Rehoboth Only @ 56.32%
Annual Capital Cost	$1,420,304	$799,915	$1,197,496	$674,430
Plant Operations (From Rehoboth March 2009 Report)	$1,590,000	$895,488	$1,590,000	$895,488
New O&M	$150,000	$84,480	$150,000	$84,480
Collection System From Rehoboth March 2009 Report)	$150,000	$138,735	$150,000	$138,735
Sussex County Operations and Maintenance ($2.00/1000 gal)	$0	$0	$0	$0
Subtotal		$1,918,618		$1,793,133
Projected User Rate for City of Rehoboth		$503		$470