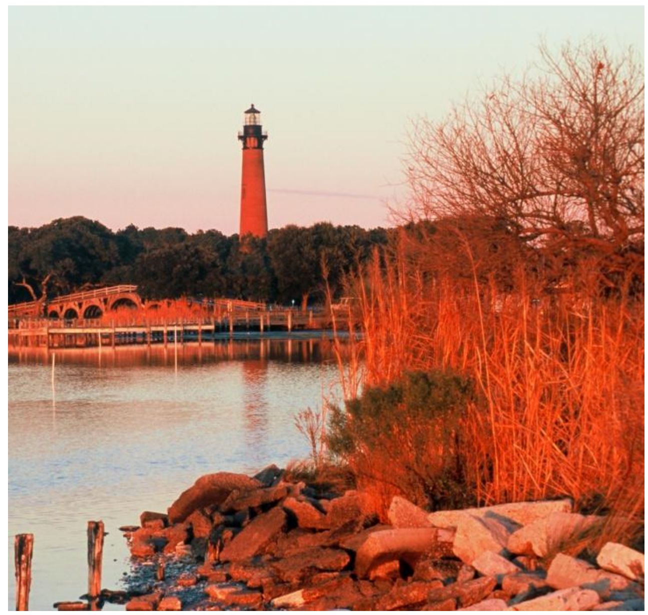

Ocean Sands Water and Sewer District Master Plan Update

Final Report

Currituck County, NC

August 2008

ARCADIS
Infrastructure, environment, buildings

Ocean Sands Water and Sewer District Master Plan Update

Currituck County, NC

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1. Introduction

This report serves as an update to the Master Plan for the Ocean Sands Water and Sewer District (OSWSD). This Master Plan is required by the Settlement Agreement and a Conditional Use Permit granted to the Coastland Corporation and recorded in the Currituck County courthouse in DB 230 pages 600-637 on August 25, 1987.

Section 8(b) of the Settlement Agreement states: "The purpose and intent of this subsection is not to require the county to prepare complete design and construction drawings for the proposed expansions or complete budgets for future years, but rather to ensure that the County undertakes the necessary planning work so that it can responsibly and in a timely fashion meet its obligations."

This Master Plan update evaluates the infrastructure needs to meet the buildout water and sewer demands for the existing OSWSD and the undeveloped areas of Ocean Sands under the following scenarios:

- Alternative 1: Sections G and T are integrated into the OSWSD.
- Alternative 2: Sections G and T develop separately and must meet their own water and sewer needs separate from the OSWSD.

ARCADIS subcontracted with AquA Hydrogeologic Consulting, LLC (AquA) to provide hydrogeologic consulting services to evaluate the wastewater disposal capacity at Sections G and T via high-rate infiltration lagoons or subsurface systems.

This Master Plan does not make any assessment to whether the allowable density in Ocean Sands per the Conditional Use Permit can be achieved in compliance with the Settlement Agreement, County Development Ordinances, or other state and federal requirements.

2. Background

2.1 Planned Development

Ocean Sands is a 678-acre oceanfront development on the Outer Banks of Currituck County, North Carolina. Residential units make up the majority of the development and are classified as single-family, multi-family, or duplex unit dwellings. Commercial development is allowed on Sections R, U, and X and on small portions of Sections G and T. Sections D through W are currently developed, with 953 connections to date. Sections G, T, R, U, and X are not developed.

Table 1 summarizes the allowable density in each section of the Ocean Sands Development per the Conditional Use Permit. Data on density transfer was provided by the Currituck County Planning Department.

The Conditional Use Permit requires that 35% of the Ocean Sands development remain common open space. Designated open spaces are listed in Table 1. Reserve Utility Open Space (U.O.S.) is included as part of the common open space, which was set aside to accommodate water resource utilities (i.e. water supply wells, and wastewater collect, treatment and disposal facilities).

Table 1. Allowable Density for Ocean Sands Development

Section	Lot Type	Planned Density	Density Transfers	[1]Open Space Required (Acres)
Existing OSWSD				
Section D	Dup./M.F./S.F	146 lots	---	17.92
Section E	S.F.	81 lots	---	15.19
Section F	M.F./S.F.	142 lots	---	18.20
Section H	S.F.	82 lots	---	13.04
Section I	S.F.	54 lots	---	8.07
Section J	S.F.	85 lots	---	7.00
Section K	S.F.	80 lots	---	4.00
Section L	S.F.	54 lots	---	5.49
Section M	S.F.	36 lots	---	5.06
Section N	S.F.	53 lots	---	2.80
Section O	S.F./M.F.	148 lots	32 lots	16.25
Section P	S.F.	43 lots	---	5.76
Section Q	S.F.	39 lots	---	4.77
Section W (Crown Point)	M.F.	430 lots	-340 lots	7.50
Section R	Comm.	39,000 s.f.	---	0.58
Section U	Comm.	139,000 s.f.	---	2.00
Section X	Comm.	100,000 s.f.	---	1.50
Unassigned Transfers	M.F.		151 lots	
Section G				
Section G Res.	M.F.	275 lots	69 lots	15.62
Hotel		250 rooms	---	
Commercial	Comm.	50,000 s.f.	---	
Section T				
Section T Res.	M.F.	350 lots	88 lots	26.25
Hotel		1,000 rooms	---	
Commercial	Comm.	100,000 s.f.	---	
Total Residential Lots		**2,098 lots**		**177**
Max. Commercial Floor Area s.f.		**428,200 s.f.**		
Total Hotel		**1,250 rooms**		

Notes: Dup. (Duplex lot); S.F. (Single-family lot); M.F. (Multi-family lot), Comm. (Commercial)

1. Open Space Required includes reserve utility open space (U.O.S.)

2.2 Water Resources

The OSWSD serves portions of the Ocean Sands area and is operated by Currituck County. The OSWSD owns five water supply well fields that are located within the Ocean Sands development (Table 2). These well fields withdraw groundwater from the surficial or water table aquifer and are approximately 40 to 60 feet deep. The average yield from these wells is approximately 110 gpm, or 105,000 gallons per day (gpd).

Table 2. Ocean Sands Shallow Well Production

Well Field	Well Field Production (gpm)	Yield[1] (gpd)
1	82	78,600
2	98	94,400
3	72	69,000
4	137	131,200
5	157	150,700
TOTAL	**546**	**523,900**

[1] Yield based on 16-hour pumping

2.3 Southern Outer Banks Water Treatment Plant

Raw water pumped from the OSWSD well fields is conveyed to the Southern Outer Banks Water Treatment Plant (WTP), which is owned and operated by Currituck County. The Southern Outer Banks WTP is part of the Southern Outer Banks Water System (SOBWS) which serves customers in the OSWSD and residents of the Villages at Ocean Hill, Ocean Hill Section 1, Corolla Village, Whalehead Beach, and Ocean Sands Sections A, B, and C developments.

The Southern Outer Banks WTP is a 2.1 million gallon per day (mgd) facility with two separate process trains: 1.1 mgd of conventional treatment and 1.0 mgd of reverse osmosis (RO) treatment. Raw water from the OSWSD well fields is treated via the conventional process using aeration, greensand filtration, and ion exchange filtration for the removal of total organic carbon, and color.

The SOBWS also owns and operates 2 additional shallow well fields located to the west of the Southern Outer Banks WTP and 5 deep wells (~250 ft) in the brackish Yorktown aquifer to provide raw water to the RO units.

The Southern Outer Banks WTP currently has a 1,500,000 gallon ground storage tank. The system has one 150,000 -gallon elevated tank located in Ocean Sands.

2.4 Ocean Sands Wastewater Treatment Plant

Wastewater from Ocean Sands is treated at the Ocean Sands Wastewater Treatment Plant (WWTP), a County-owned facility which is operated by Enviro-Tech. The WWTP was first constructed in 1978 with a capacity of 100,000 gallons per day. Since the construction of the original facility, the Ocean Sands WWTP has been expanded three times to a permitted capacity of 500,000 gallons per day as shown in Table 3. The plant consists of four independent extended aeration activated sludge treatment units followed by secondary clarifiers and tertiary filters. A schematic of the existing WWTP is shown in Figure 1.

Table 3. Ocean Sands WWTP Expansions

Phase	Type	Number of Trains	Capacity (gpd)
Original Plant (1978)	Concrete	2	100,000
Expansion	Steel Package Plant	1	50,000
Expansion (1989)	Steel Package Plant	3	150,000
Expansion (1993)	Steel Package Plant	4	200,000
		TOTAL CAPACITY	**500,000**

Effluent is disinfected using free chlorine and then conveyed to ten rotary distributors where it is land applied. The Ocean Sands WWTP is permitted to discharge up to 600,000 gallons per day, which equates to a loading rate of 7.65 gallons per day/ square foot (gpd/ft^2). The site is surrounded by a canal which serves to manage groundwater levels. A pump station located in the northeast corner of the site conveys groundwater through a force main to a ditch located on Section X that eventually drains to Currituck Sound.

3. Water and Wastewater Demand Projections

3.1 Water and Sewer Connections

Ocean Sands experienced steady growth between the early 1990s and 2004, with approximately 30 to 40 new water and sewer connections annually (Figure 1). Since 2005, the rate of growth has slowed with only 10 new connections in the last 4 years. Currently, there are 953 connections in Ocean Sands. Sections G and T remain undeveloped, as well as all designated commercial space. Sections A, B, and C are all single-family homes which are supplied by the Southern Outer Banks WTP for drinking water, but rely on septic systems for sewage disposal.

Historical annual rate of new water connections was strongly linear as shown in Figure 1. New water and sewer connections were linearly projected to determine future infrastructure needs. Based on this projection, the existing OSWSD area will reach the buildout number of connections (1,316) by 2015. Growth of the undeveloped areas of Ocean Sands (Sections, G, T, R, U, and X) is difficult to determine since the timing of initial development is not known.

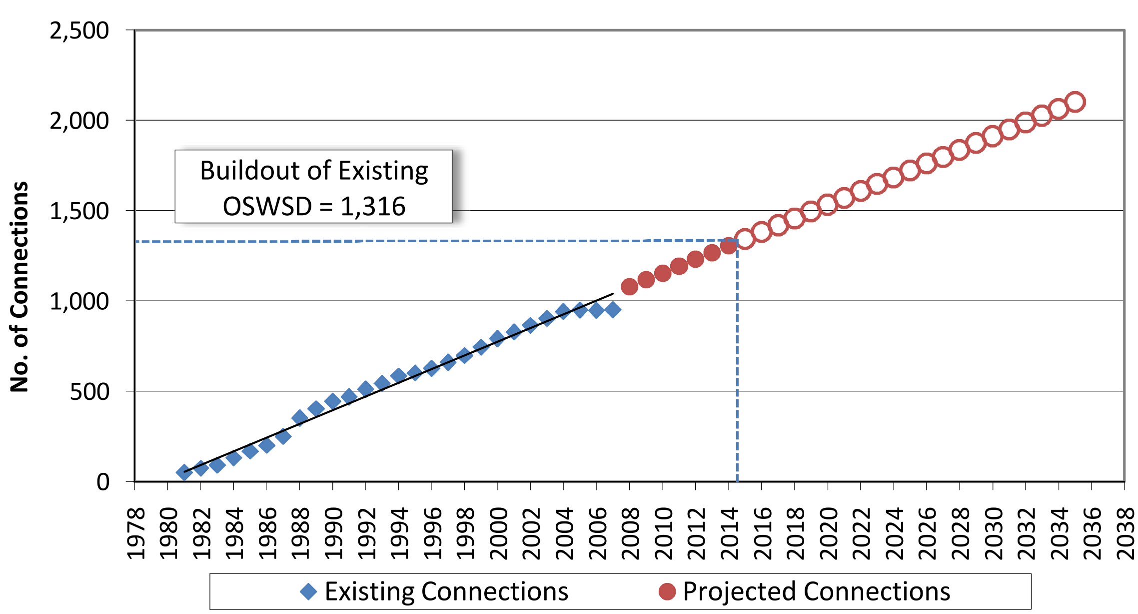


Figure 1. Historical and Projected OSWSD Water/Sewer Connections

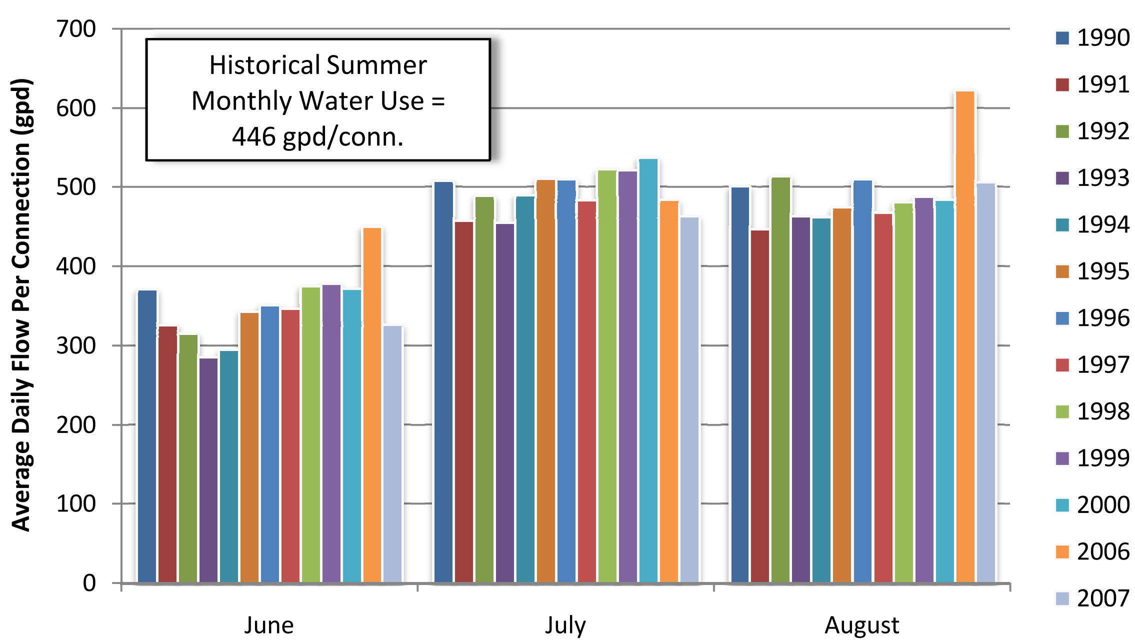
3.2 Historical Water Use

Monthly billing data were collected from Currituck County to evaluate OSWSD water consumption and unit water use. Monthly water use is not available for much of 2005 since the County was in the process of converting their billing system. Total water use for April through October 2005 is available, but not monthly water use. Therefore, the discussion below on water use focuses on years 2006 and 2007.

Average billed monthly water consumption for OSWSD in 2006 and 2007 was 174,000 gpd and 170,000 gpd, respectively. Unit water consumption in 2006 and 2007 were 183 gpd/unit and 178 gpd/unit, respectively. However, average annual demand is not a useful parameter for a beach resort community with strong seasonal water use trends. It is more appropriate to evaluate summer month water use (June, July, August) for infrastructure planning purposes.

Monthly average water use per connection for the months of June, July, and August are shown in Figure 2. Data was available for years 1990-2000, and 2006-2007. The summer monthly water use has averaged 446 gpd/connection. Peak monthly demands were 623 gpd/unit in 2006 and 506 gpd/unit in 2007.

Figure 2. Monthly Average Water Use Per Connection for OSWSD



Peak day demands are used to size water supply and water treatment capacity. Annual peak day consumption rates for the SOBWS were 1,090,000 gpd in 2005, 1,872,000 gpd in 2006 and 1,936,000 gpd in 2007 (Figure 3). However, daily demands by the OSWSD are not recorded. Water use in OSWSD is recorded only on a monthly basis at each water meter. Therefore, peak day water demands for OSWSD cannot be determined separate from the rest of the SOBWS.

Peak day to peak month water use trends for all of SOBWS were evaluated. Peak day:peak month ratios for the SOBWS have averaged 1.4 over the last 3 years (Table 4). This ratio was applied to the historical monthly water demand of 446 gpd/connection to estimate the peak day unit water use of 625 gpd/connection in OSWSD.

Figure 3. Monthly Average Southern Outer Banks WTP Production

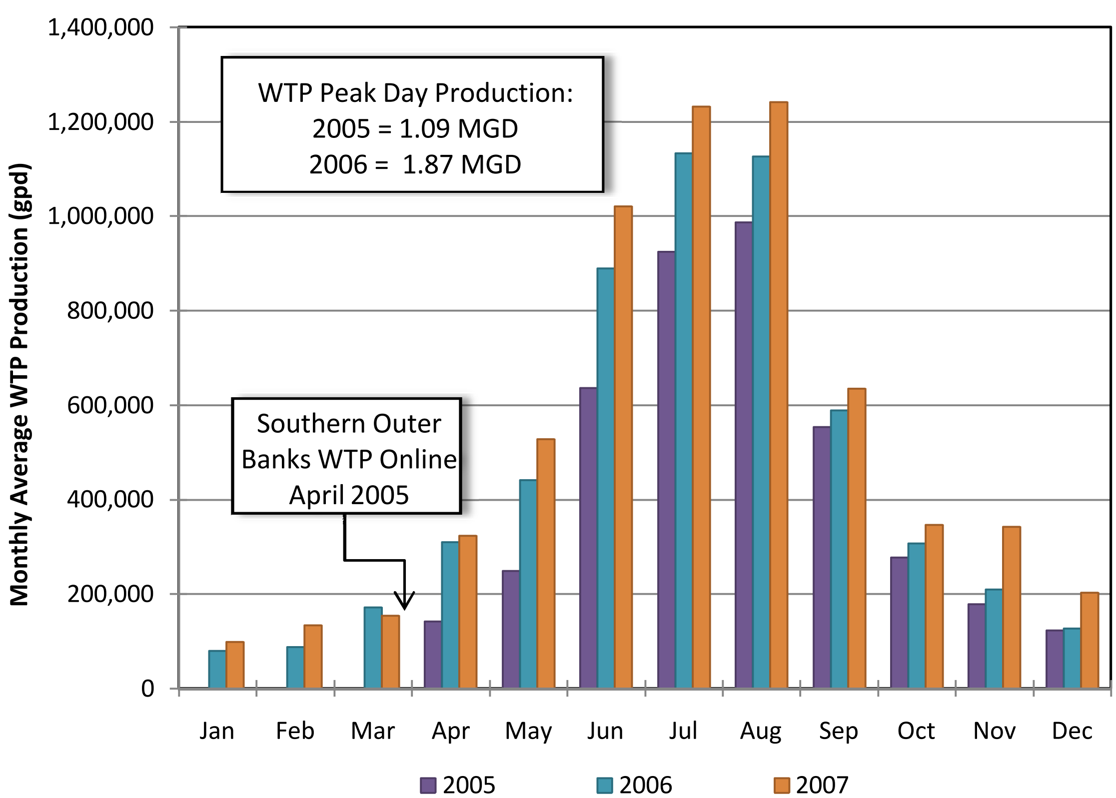


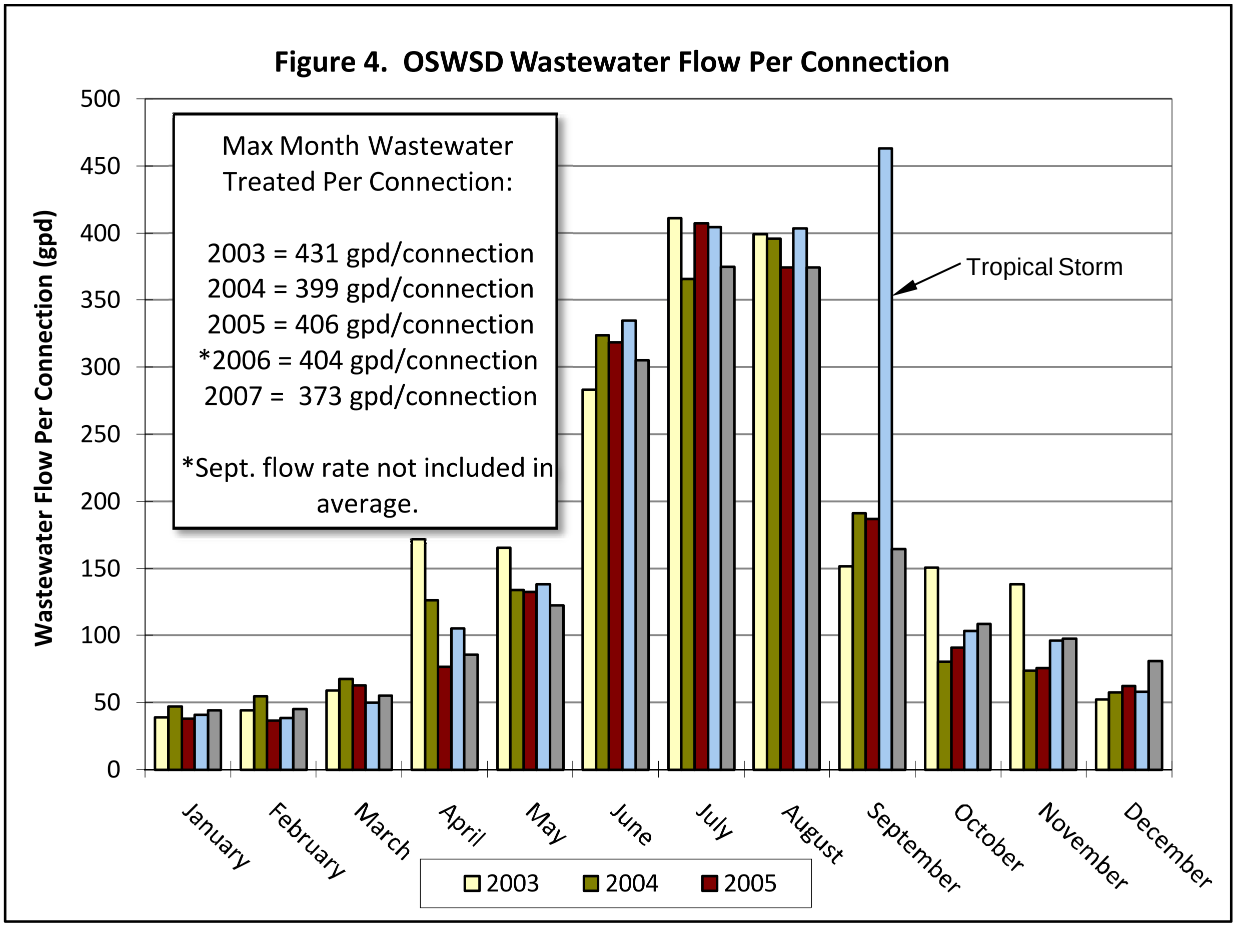
Table 4. Peak Monthly and Peak Daily Demands for SOBWS

Date	Peak Monthly Demand (gpd)	Peak Day Demand (gpd)	Peak Month:Peak Day Ratio
2005 (Aug.)	987,194	1,090,000	1.10
2006 (July)	1,132,839	1,860,000	1.64
2007 (Aug.)	1,241,645	1,936,000	1.56
		AVERAGE	**1.44**

3.3 Historical Wastewater Flows

Wastewater treatment flows were collected for each month from 2003-2007 from EnviroTech. Unit wastewater flow per connection was calculated. September 2006 data were not included in this evaluation since heavy rainfall from tropical storm Ernesto skewed the data for that month. The storm event submerged approximately 200 manholes throughout the OSWSD, resulting in high infiltration/inflow rates to the sanitary sewer system.

Maximum monthly treatment rates from 2003-2007 ranged from 373 gpd/connection to 431 gpd/connection (Figure 4), while annual averages ranged from 154 gpd/connection to 187 gpd/connection, for the 5 years observed. The average max monthly wastewater flow was 425 gpd/connection over the last 5 years. However, unit wastewater flow rates have been steadily declining during that period.



3.4 Water Demand and Wastewater Flow Projections

Water demands and wastewater flow projections for Ocean Sands were forecast based on the planned density in Table 1 and the unit use rates presented in Table 5.

Wastewater flow rates for residential use were based on historical trends as discussed in Section 3.3. Unit wastewater flow rates for commercial and hotel use are based on design flow rates in 15A NCAC 2T.0114.

Unit water use rates for residential use are based on historical trends as discussed in Section 3.2. Unit water use rates for commercial and hotel uses are based on design flow rates in 15A NCAC 2T.0114.

Table 5. Unit Water and Wastewater Use Rates for Ocean Sands Projections

Use Type	Units	Unit Water Use Rate (Peak Day)	Unit Wastewater Flow Rate (Max Month)
Residential	gpd/lot	625	425
Commercial	gpd/1,000 floor area	225	130
Hotel	gpd/room	240	200

Water demand and wastewater flow projections for the Ocean Sands Development are presented in Table 6. For the existing OSWSD, peak day water demands are projected to reach approximately 885,500 gpd at buildout. For the existing OSWSD, max month wastewater flows are projected to reach approximately 600,000 gpd at buildout.

If Sections G and T can develop to the fullest extent based on the planned density in the Condition Use Permit, then water demands and wastewater flows would nearly double as compared to the existing OSWSD. Peak day water demands for Section G are projected to reach approximately 286,000 gpd at buildout. Max month wastewater flows for Section G are projected to reach approximately 203,000 gpd at buildout.

Peak day water demands for Section T are projected to reach approximately 536,000 gpd at buildout. Max month wastewater flows for Section T are projected to reach approximately 399,000 gpd at buildout.

Table 6. Water Demand and Wastewater Flow Projections for Ocean Sands

Section	Lot Type	Planned Density (incl. transfers)	Peak Day Water Demand (gpd)	Max Month Wastewater Flow (gpd)	Green Space Required (ac.)
Existing OSWSD					
Section D	Dup./M.F./S.F.	146 lots	91,300	62,100	3.6
Section E	S.F.	81 lots	50,600	34,400	2.0
Section F	M.F./S.F.	142 lots	88,800	60,400	3.5
Section H	S.F.	82 lots	51,300	34,900	2.0
Section I	S.F.	54 lots	33,800	23,000	1.3
Section J	S.F.	85 lots	53,100	36,100	2.1
Section K	S.F.	80 lots	50,000	34,000	2.0
Section L	S.F.	54 lots	33,800	23,000	1.3
Section M	S.F.	36 lots	22,500	15,300	0.9
Section N	S.F.	53 lots	33,100	22,500	1.3
Section O	S.F./M.F.	180 lots	112,500	76,500	4.4
Section P	S.F.	43 lots	26,900	18,300	1.1
Section Q	S.F.	39 lots	24,400	16,600	1.0
Section W (Crown Point)	M.F.	90 lots	56,300	38,300	2.2
Section R	Comm.	39,000 s.f.	8,800	5,100	0.3
Section U	Comm.	139,000 s.f.	31,300	18,100	1.0
Section X	Comm.	100,000 s.f.	22,500	13,000	0.7
Unassigned Transfers	M.F.	151 lots	94,400	64,200	3.7
TOTAL for OSWSD and Future Commercial			**885,400**	**595,800**	**34**
Section G					
Section G Res.	M.F.	343 lots	215,000	146,200	8.4
Hotel		250 rooms	60,000	50,000	2.9
Commercial	Comm.	50,000 s.f.	11,300	6,500	0.4
TOTAL for Section G			**286,300**	**202,700**	**11.6**
Section T					
Section T Res.	M.F.	438 lots	273,800	186,200	10.7
Hotel		1,000 rooms	240,000	200,000	11.5
Commercial	Comm.	100,000 s.f.	22,500	13,000	0.8
TOTAL for Section T			**536,300**	**399,200**	**22.9**
GRAND TOTAL			**1,708,000**	**1,197,700**	**69**

4. Ocean Sands WWTP Facility Evaluation

4.1 Nitrate Evaluation

The North Carolina Division of Water Quality's Aquifer Protection Section has issued Currituck County a Notice of Regulatory Requirement (NORR) for nitrate concentrations above the State Groundwater Quality Standard of 10 mg/L in monitoring wells located around the Ocean Sands WWTP. These exceedances are thought to be due to the high concentration of nitrate in the treated effluent. ARCADIS evaluated the WWTP process and developed a plan to improve nitrogen removal at the Ocean Sands WWTP in the *Draft Report: Proposed Modifications for Facilitating Effluent Denitrification for the Ocean Sands Wastewater Treatment Plant* (ARCADIS, February 2008). In that report, ARCADIS evaluated the potential for the MLE process and the Moving Bed Biological Reactor (MBBR) process for improving nitrate removal. ARCADIS concluded that both treatment processes would be effective for reducing effluent nitrate concentrations to 4 mg/L. Based on the cost estimates, ARCADIS recommended that one 50,000 gpd train be retrofitted with the MLE process as a full-scale demonstration test to confirm its effectiveness under actual operating conditions at the Ocean Sands WWTP.

4.2 Facility Condition

The initial 100,000 gpd plant is composed of concrete basins. Subsequent expansions utilized steel packaged treatment units. Steel package plants typically have a design service life of approximately 20 years with preventive maintenance. However, the Outer Banks is a harsh, corrosive environment, which may reduce service life of steel package plants. Therefore, much of the Ocean Sands WWTP has reached the end of its service life.

A site visit was conducted to observe the condition of the Ocean Sands WWTP. The following are general observations regarding the condition of the WWTP:

- Steel tanks exhibit corrosion. Paint coating has peeled in areas, and exposed metal is corroding. The 200,000 gpd train was out of service during the site visit and contained the only tanks where the interior could be observed.
- Significant corrosion on chlorine dosing equipment.
- Damaged paint coating and corrosion was also noticed on control panels, piping, pipe hangers, handrails, and other appurtenances.

- The screen at the pump station in the groundwater lowering canal appeared to require cleaning. Several pump cycles were observed where pumps were started and ran for less than 10 seconds. Approximately 2 to 3 pump starts per minute were observed. The screen should be cleaned to reduce pump starts and prevent excessive pump wear.
- The original concrete basins exhibited spalling concrete and evidence of leaks at joints.
- This existing building the over chlorine contact basins is need of major repair or replacement.

On May 21, 2008, Currituck County received a Notice of Violation regarding maintenance of the Ocean Sands WWTP. Specifically, the NOV cited the following:

- Corrosion, damaged paint, and damaged steel on steel treatment basins
- Rotary distributors No. 3 and 4 in poor operating condition
- Sand bed in rotary distributor was not at specified level

5. Wastewater Disposal Alternatives Evaluation

5.1 Surface Water Discharge

Direct discharge of wastewater to surface waters on the Outer Banks is not a viable option. Obtaining a NPDES permit for direct discharge of treated wastewater to the Atlantic Ocean or the Currituck Sound is not considered feasible due to concerns over toxicity of introducing freshwater into saltwater, nutrient loading into receiving waters, coliform contamination of public beaches or nursery areas, and other water quality concerns. Wastewater disposal options for the Outer Banks are limited to non-discharge alternatives such as land application via spray irrigation, water reuse, high rate (rapid) infiltration, and low rate infiltration.

5.2 Land Application via Spray Irrigation

Land application via spray irrigation is a method for effluent disposal used for small municipal wastewater systems which have limited treatment. Generally, only limited secondary treatment is provided prior to irrigation and thus, does not facilitate other options for effluent disposal, such as reuse, or high rate infiltration. Additionally, land application systems do not maximize the value and service of the property due in part to the large buffer areas that are required. Research suggests that land application of secondary treated effluent may reduce the porosity of soil (i.e. clogging), and reduce the infiltration rate over time (Clanton and Slack, 1987). More land may therefore be required to dispose of the same quantity of effluent as the system ages. Given land values on the Outer Banks and the large land requirements for this disposal alternative, land application via spray irrigation is not considered a viable option.

5.3 Water Reuse

Irrigation using reclaimed water was evaluated by Ed Andrews & Associates (2000) for the Ocean Sands Development. Andrews determined that irrigation rates of 1.9 to 3.9 inches/week are possible depending upon soil conditions at the irrigation sites.

Based on the application rates in the Andrews report, approximately 13 to 27 acres would be required for irrigation using reclaimed water in Section G. The total amount of open space required for Section G is 15.6 acres. Total space required for water and wastewater infrastructure (i.e. WWTP, water supply well fied(s), 5-day upset storage tank, wastewater disposal) is 12 acres, so there is only 3.6 acres of open space remaining, which would also need to serve the needs for drainage and stormwater management. Therefore, there is not sufficient open space on Section G to allow for disposal of the 203,000 gpd via reclaimed water irrigation.

Based on the application rates in the Andrews report, approximately 26 to 54 acres would be required for irrigation using reclaimed water in Section T. The total amount of open space required for Section G is 26.25 acres. Total space required for water and wastewater infrastructure is 16 acres, so there is only 10.25 acres of open space remaining, which would also need to serve the needs for drainage and stormwater management. Therefore, there is not sufficient open space on Section T to allow for disposal of 399,000 gpd via reclaimed water irrigation.

5.4 Rapid Infiltration

Rapid infiltration is a method of effluent disposal that requires much less land than conventional land application systems. Rapid infiltration systems involve the application of highly treated wastewater effluent to shallow basins constructed in deep and permeable deposits of highly porous soils. Rapid infiltration, or high rate infiltration, is defined by DWQ as an application rate that exceeds 1.75 inches of wastewater effluent per week (0.156 gallons per day per square foot). In North Carolina, there are 34 existing rapid infiltration systems, located primarily in coastal counties. Rapid infiltration is currently used at the Ocean Sands WWTP via rotary distributors or fixed spray heads that apply treated effluent at a loading rate of 7.65 gpd/ft^2. Infiltration rates are typically less than those at the Ocean Sands WWTP and must be determined by a licensed soil scientist. Site selection requires analysis of soil depth, permeability, and depth to groundwater. Higher infiltration rates and reduced buffer requirements can be obtained by treating to reuse quality.

ARCADIS subcontracted with AquA Hydrogeologic Consulting, LLC (AquA) to provide hydrogeologic consulting services to evaluate the wastewater disposal capacity at Sections G and T. The evaluation included the construction of a groundwater flow model encompassing both sites. A technical memorandum summarizing the conceptual groundwater model and modeling results are included in Appendix A. Alternatives evaluated using the conceptual model include the following:

- High-rate infiltration ponds or subsurface system located parallel to the beach near the CAMA setback
- High-rate infiltration pond located towards center of property.
- High-rate infiltration pond located towards center of property with groundwater lowering wells.

The water-table surface is at or near land surface over significant portions of both Sections G and T. Under the modeled conditions, "mounding" associated with wastewater disposal has the potential to produce flooding onsite, and possibly offsite as well.

One option for disposal is construction of a high-rate infiltration pond or subsurface system parallel to the beach adjacent to the CAMA setback (Figures 6 and 7). This option did not yield any flooding or significant mounding in the conceptual groundwater model. However, feasibility of this option is not certain. According to NC DWQ staff, permitting of this option may involve NC Division of Marine Fisheries to review impact of disposal on near shore water quality and habitat. The disadvantage to this option is its highly valued oceanfront location.

Another option is construction of a high-rate infiltration pond perpendicular to the beach further back from the oceanfront as shown on Figures 8 and 9. This option is not as efficient and can result in significant mounding or flooding even with water supply wells located as close as possible to the 500-foot setback (per NCAC 02T .0706). To alleviate mounding, groundwater lowering wells could be installed setback 50 feet from the infiltration pond. Groundwater pumped from the groundwater lowering wells could be used for irrigation of green areas throughout Ocean Sands. Ed Andrews & Associates (2000) evaluated water reuse irrigation in the Ocean Sands Development and determined that irrigation rates of 1.9 to 3.9 inches/week are possible, depending on soils at the irrigation sites.

At 2-3 inches/week, approximately 15 to 22 acres would be required to irrigate groundwater pumped from groundwater lowering wells located on Section G. This exceeds the available open space on Section G. At 2-3 inches/week, approximately 26 to 40 acres would be required to irrigate groundwater pumped from groundwater lowering wells located on Section T. This exceeds the available open space on Section T. Therefore, this option is only feasible if additional land throughout Ocean Sands could be utilized for irrigation. In total, 41 to 62 acres is required depending upon location of irrigation sites.

Another option for wastewater disposal at Sections G and T includes a reduction of the development density and thus, a corresponding reduction in the amount of treated wastewater to be disposed of (i.e. buildout development is less than proposed in Table 1). Sufficient modeling was not conducted for Sections G and T to determine the amount of wastewater effluent that could be disposed of via rapid infiltration without the use of groundwater lowering wells. The modeling effort focused on alternatives to dispose of the projected wastewater flows based on the planned development density.

5.5 Low Rate Infiltration

Low rate infiltration systems ponds typically utilize a lower surface overflow or loading rate than high-rate infiltration ponds. Low-rate infiltration ponds do not have groundwater dewatering for hydraulic control. Given land values on the Outer Banks and the large land requirements for this disposal alternative, low-rate infiltration is not considered a viable option.

5.6 Summary of Effluent Disposal Alternatives

Table 7 summarizes the required effluent water quality for each effluent disposal alternative. Discharge of conventional land application quality water requires the least amount of treatment prior to discharge, but requires a large amount of land. Other disposal options require a higher level of secondary and/or tertiary treatment to meet expected discharge limits. The effluent target limits for land application, reuse spray irrigation, and rapid infiltration are not substantially different and therefore will not cause substantial difference in treatment costs.

Table 7. Summary of Effluent Water Quality Criteria for Discharge Alternatives

Effluent Disposal Alternative	Biochemical Oxygen Demand (mg/l)	Total Suspended Solids (mg/l)	Ammonia (mg/l)	Nitrate (mg/l)	Fecal Coliform (colonies/ 100 ml)
Land Application via Spray Irrigation	30	30	15	---	200
Spray Irrigation with Reuse Quality Water	10	5	4	---	14
High Rate (Rapid) Infiltration	10	15	4	10	14
High Rate (Rapid) Infiltration with reduced setbacks	10	5	4	10	14
Low Rate Infiltration	5	30	4	10	200

6. Water and Wastewater Infrastructure Improvements for the OSWSD

6.1 General

In this section, the infrastructure improvements required to meet the water supply, water treatment, and wastewater treatment and disposal needs for the OSWSD are presented, assuming Sections G and T are integrated into the existing OSWSD. Major wastewater collection infrastructure required to convey wastewater flows from Sections G and T to the existing Ocean Sands WWTP is also addressed. Wastewater collection infrastructure within each development is not included as this is dependent on final site plan for these developments and would be installed by the developer.

6.2 Water Supply

Total yield from Ocean Sand's existing five wells is approximately 520,000 gpd (based on a 16-hour pumping period). NC Public Water Supply Section requires that the combined yield of all wells of a water system shall provide in 12 hours pumping time the average daily demand (NCAC T15A:18C.0402.g.3). However, providing the 12-hour yield based on an average annual water demand would not meet peak summer demands. Therefore, water supply needs have been determined based on pumping 18 hours of the summer month demands.

The peak day demand at buildout was estimated at 1.71 MGD (Table 6). Based on historical trends, this would correlate to a monthly average (during summer months) of 1.43 MGD. The total well yield required at buildout for OSWSD, including the undeveloped sections, is 1,906,000 gpd (Table 8). Currently, the OSWSD has a well yield of 520,000 gpd, so an additional water supply of 1,386,000 gpd is needed at buildout. Based on current OSWSD demands, the existing well yield is not sufficient to meet summer month demands based on 18-hour pumping and one additional wellfield is needed now with a second wellfield by 2010.

Table 8 summarizes water supply needs for each area. Based on the report entitled *Water Resources Evaluation for Ocean Sands Subdivision Tracts X, F, and T* (Ed Andrews & Associates, 1996), there appears to be sufficient water supply in the Ocean Sands area to meet the buildout water supply needs. Ed Andrews estimated available supply as follows:

- 570,000 gpd at Tract X
- 500,000 gpd at Tract F
- 700,000 gpd at Tract T

Although the Ed Andrews report indicates that additional water supply may be available, locating new wellfields such that new wellfields do not impact existing wellfields would need to be examined closely before new wells are constructed. There is limited space remaining for new water supply wellfields in the residential areas (Sections D through W) without reducing separation between wells to less than 1,000 feet. Whether a separation of less than 1,000 feet would significantly impact well yield is not known. Providing additional recharge through irrigation using reclaimed water or infiltration of highly treated wastewater would potentially increase water supply.

Table 8. Water Supply Needs for OSWSD at Buildout

Section	Well Yield Required at Buildout (gpd)	Existing Well Yield (gpd)	New Water Supply Required (gpd)
Existing OSWSD	878,000	524,000	354,000
Section G	321,000	0	321,000
Section T	637,000	0	637,000
Future Commercial (Sections R, U, X)	70,000	0	70,000
TOTAL	**1,906,000**	**524,000**	**1,386,000**

For purposes of this master plan, new wellfields are shown in order to preserve the existing wellfield separation. A conceptual layout for the new wellfield locations is shown on Figures 10A, 10B, and 10C. Cost opinions are shown in Table 11. Recommendations for additional water supply infrastructure are provided in Section 6.8.

In general, wellfields should be located near the center of the island to the greatest extent possible to reduce the potential for saltwater intrusion from either the ocean or sound. To serve the existing OSWSD and the future commercial areas, new water supply wellfields are proposed in Section U, Section X, and Section D. Each wellfield would have a design similar to existing wellfields with 6 to 8 well points spaced 25 to 50 feet apart to achieve a total yield of approximately 100 gpm.

One new wellfield is needed currently to meet current water supply needs for OSWSD based on 18-hour pumping during summer months. For planning purposes, it is assumed that the new wellfield will be located at Section U since this site would require the minimal transmission infrastructure to the WTP. A second new wellfield is needed by 2010. For planning purposes, it is assumed that the new wellfield will be located at Section D. Section X is currently being considered as an alternative by the NC Turnpike Authority for the new Mid Currituck Bridge. Construction is planned to begin in 2010, so Section X should be held as a future wellfield option until the final location of the Mid Currituck Bridge is known. If the Mid Currituck Bridge is located at Section X and cannot accommodate a wellfield, then a new wellfield site would need to be acquired since no other wellfield sites are available in the existing OSWSD.

6.3 Water Treatment

The Engineer's Report for the Southern Outer Banks Water System (McDowell & Associates, 2003) indicates that the buildout peak day water demand was projected to be 1,568,600 gallons per day (Table 9). If Sections G and T develop to the allowable extent as described in Section 2.1, then the peak day demand for Ocean Sands will be approximately 1,708,000 gpd at buildout; greater than what was originally planned for the Southern Outer Banks WTP. The buildout capacity of the Southern Outer Banks WTP is currently estimated at approximately 3.15 mgd compared to the original planned buildout capacity of 3.0 mgd

Table 9. Planned Buildout Capacity for Southern Outer Banks WTP

Developments Served by SOBWS	Units[1]	Original Estimate of Water Use[1]	Current Estimate of Water Use
Villages at Ocean Hill	299	164,450	164,450
Ocean Hill Sect 1	113	62,150	62,150
Corolla Village Area	150	82,500	82,500
Whalehead Beach	858	471,900	471,900
OSWSD (Existing)	2,852	1,568,600	885,400
Sections G & T			822,600
Ocean Sands (A, B, C)	200	110,000	110,000
subtotal	4,472	2,459,600	2,599,000
Reserve	983	540,400	540,400
TOTAL	**5,455**	**3,000,000**	**3,139,400**

1. From *Engineer's Report for the Southern Outer Banks Water System* (McDowell & Associates, January 2003).

The Southern Outer Banks WTP experiences sharp peaks in demand compared to monthly average demands. An evaluation of daily demands was conducted to determine if additional ground storage at the WTP could mitigate peak demands and reduce the amount of treatment capacity that needs to be constructed in future phases. The Southern Outer Banks WTP produces high quality potable water (with low TOC concentrations and low chlorine demand) so providing additional storage may not have a negative affect water quality.

Water treatment production data for the summer months in 2005, 2006, and 2007 were evaluated and 2-day peak demands and 3-day peak demands were compared to peak day demands (Table 10). This evaluation shows that 2-day and 3-day peak demands are not significantly lower than peak demand demands, meaning that additional potable water storage could not significantly reduce the amount of treatment capacity. Even maximum weekly demands (not shown in table) were only 6-8% lower than peak day demands.

The OSWSD needs an additional 1.0 mgd of treatment capacity once Sections G and T develop. The cost opinion for expanding the Southern Outer Banks WTP to 3.15 mgd is approximately $3,300,000.

6.4 Finished Water Storage

The State requires that a water system have potable water storage equal to one half of the annual average demand. The amount of elevated storage depends upon the distribution system layout and hydraulics, but a rule of thumb is that one half of all storage be elevated storage and one half be ground storage. Given the seasonal nature of demands on the Outer Banks, annual average demand is not a useful measure. We recommend that summer monthly demands be used to evaluate storage needs, similar to the wellfield evaluation above.

The peak day demand at buildout was estimated at 1.71 MGD (Table 6). Based on historical trends, this would correlate to a monthly average (during summer months) of 1.43 MGD. Therefore, total storage finished water storage should be approximately 700,000 gallons; 350,000 gallons in ground storage and 350,000 gallons in elevated storage.

There is sufficient ground at the Southern Outer Banks WTP, but an additional 200,000 gallons of elevated storage will be needed in the future once Sections G and T develop.

Table 10. Evaluation of Peak Demands for Southern Outer Banks WTP

Month	2005			2006			2007			2008		
	Peak day	2-day peak	3-day peak	Peak day	2-day peak	3-day peak	Peak day	2-day peak	3-day peak	Peak day	2-day peak	3-day peak
May	0.448	0.434	0.427	0.728	0.714	0.681	1.244	1.204	1.177	1.149	1.137	1.122
June	0.830	0.810	0.792	1.441	1.438	1.415	1.723	1.677	1.676	1.753	1.655	1.610
July	1.072	1.062	1.037	1.860	1.810	1.790	1.829	1.793	1.766	NA	NA	NA
August	1.090	1.062	1.050	1.872	1.854	1.828	1.936	1.896	1.870	NA	NA	NA
Sept	0.907	0.890	0.869	1.266	1.191	1.148	1.494	1.384	1.292	NA	NA	NA

6.5 Wastewater Collection, Treatment, and Disposal

Based on the demand projections, the Ocean Sands WWTP may reach 90% capacity in 2010. An expansion to 600,000 gpd is recommended which is projected to satisfy the buildout capacity of OSWSD and the commercial sites (Sections R, U, X). It is recommended that the wastewater treatment for all of OSWSD, and the undeveloped areas (Sections G and T) be provided at the existing site as operation and maintenance costs will be lower for one facility as compared to 2 or 3 plants. The timing regarding development of Sections G and T is not known at this time, so the timing of the next expansion of the Ocean Sands WWTP beyond 600,000 gpd cannot be determined.

Denitrification is recommended to address high nitrate levels in groundwater monitoring wells and reduce the setbacks required in the 2T rules, if total nitrogen (TN) is less than 7 mg/L. Reduction of setbacks will allow relocation of the existing infiltration field to provide space for the required 5-day upset storage. Reduced setbacks would also allow for more efficient use of land on Sections G and T. At buildout, two 3.0 MG concrete tanks would be required to provide 5 days of upset storage.

The existing WWTP is reaching the end of its service life and is in deteriorating condition as discussed in Section 4. New capacity should be designed to replace existing treatment units. Four alternatives for the expansion to 600,000 gpd were considered. Each option represents a net capacity increase of 100,000 gpd. Cost opinions are shown in Table 11.

- Option 1: Construct 100,000 gpd of new capacity with denitrification. Rehabilitate and repair existing 500,000 gpd WWTP, including blasting and repainting of steel tankage, replacement of corroded pipe and pipe hangers, and repair to other severely corroded components (weir plates, pipe hangers, handrail bases, control panel bases, etc.). Retrofit existing 500,000 gpd WWTP with MLE process to improve nitrate removal to address high levels of nitrate detected in monitoring wells.
- Option 2: Construct 200,000 gpd of new capacity with denitrification. Rehabilitate and repair existing 400,000 gpd WWTP. Retrofit existing 400,000 gpd WWTP with MLE process to improve nitrate removal to address high levels of nitrate detected in monitoring wells. Demolish the oldest treatment train; the 100,00 gpd concrete train.
- Option 3: Construct 400,000 gpd of new capacity with denitrification. Rehabilitate and repair existing 200,000 gpd WWTP. Retrofit existing 200,000 gpd WWTP with MLE process to improve nitrate removal to address high levels of nitrate detected in monitoring wells. Demolish the oldest 3 trains

(total 300,000 gpd); the 100,000 gpd concrete train, 50,000 gpd steel package plant, and the 150,000 gpd steel package plant.

- Option 4: Construct 600,000 gpd of new capacity with denitrification. Demolish the entire existing WWTP.

The Ocean Sands WWTP has a permitted disposal capacity of 600,000 gpd. Additional wastewater disposal on the Ocean Sands WWTP site may not be feasible. Therefore, the existing site will be utilized for additional treatment capacity, and upset storage, so space for additional disposal is not available. Increasing the loading rate above the 7.65 gpd/ft^2 to allow for additional disposal capacity does not appear feasible. Infiltration systems with rates in excess of 7.65 gpd/ft^2 are not typical. Increasing the loading rate at the existing site would increase mounding of the water table and increase the rate of pumping from the groundwater lowering canal to the Currituck Sound. Permitting of a larger freshwater direct discharge to Currituck Sound may be difficult. NC DENR may require an evaluation of impacts to wetlands, water quality, and fish habitat. Therefore, additional disposal capacity to meet the needs of Sections G and T should be located at those sites or other property that the developer acquires.

A conceptual groundwater model was prepared by Aqua Hydrogeologic Consulting to evaluate wastewater disposal alternatives at Section G and T. The projected buildout wastewater flows for Sections G and T are 203,000 gpd and 400,000 gpd, respectively. The water-table surface is at or near land surface over significant portions of both Sections G and T. Under the modeled conditions, mounding associated with wastewater disposal has the potential to produce flooding onsite and possibly offsite as well.

As previously mentioned, one option is construction of a high-rate infiltration pond or subsurface system parallel to the beach adjacent to the CAMA setback. This option did not yield any flooding or significant mounding in the conceptual groundwater model. However, feasibility of this option is not certain. According to NC DWQ staff, permitting of this option may involve NC Division of Marine Fisheries to review impact of disposal on near shore water quality and habitat. The disadvantage to this option is its highly valued oceanfront location.

Another option is construction of a high-rate infiltration pond perpendicular to the beach further back from the oceanfront as shown on Figures 8 and 9. This option is not as efficient and can result in significant mounding or flooding even with water supply wells located as close as possible to the 500 feet setback. To alleviate mounding, groundwater lowering wells could be installed setback 50 feet from the infiltration pond. Groundwater pumped from the groundwater lowering wells could be used for irrigation of green areas. At irrigation rates of 2 to 4 inches/week as proposed by Ed Andrews & Associates (2000), approximately 11 to 23 acres would be required based on projected pumping rates for groundwater lowering wells in Section G. Approximately 20 to 41 acres would be required based on projected pumping rates for groundwater lowering wells in Section T.

Direct discharge of water pumped from the groundwater lowering wells to the Atlantic Ocean or Currituck Sound may not feasible from a permitting perspective.

If the amount of treated wastewater to be disposed of on Sections G and T is reduced (i.e. buildout development is less than proposed in Table 1), then high-rate infiltration without the use of groundwater lowering wells may be feasible. Sufficient modeling was not conducted as part of this Master Plan to determine the amount of treated wastewater that can be disposed of via high-rate infiltration without the use of groundwater lowering wells. This option could be explored further once more detailed plans for site development are available and the expected wastewater flows are finalized.

6.6 Cost Opinions

Opinions of probable construction cost for the recommended water and wastewater infrastructure are presented in Table 11.

Table 11. Cost Opinions Assuming Sections G and T are Incorporated into OSWSD

Water and Wastewater Infrastructure	Cost Opinion
Raw Water Line and Supply Wells	
OSWSD (3 wells)	$942,000
Sections G and T	$1,240,000
Water Treatment and Storage	
1.0-mgd WTP Expansion	$3,300,000
200,000 gallon Elevated Storage Tank	$800,000
Wastewater Treatment	
Oceans Sands WWTP Option 1: Expand to 0.6 MGD, Retrofit/Upgrade Existing 0.5 MGD	$5,589,000
Oceans Sands WWTP Option 2: Expand to 0.6 MGD, 0.2 MGD in New Capacity, Retrofit/Upgrade Existing 0.4 MGD	$7,121,000
Oceans Sands WWTP Option 3: Expand to 0.6 MGD, 0.4 MGD in New Capacity, Retrofit/Upgrade Existing 0.2 MGD	$11,695,000
Oceans Sands WWTP Option 4: Replace Existing WWTP with new 0.6 MGD capacity	$13,253,000
Future 0.6 MGD Expansion (Buildout)	$10,652,000
Sewer Force Main and Effluent Line	$1,607,000
Wastewater Disposal - Section G	
High-Rate Infiltration Pond (near dune line)	$644,000
High-Rate Infiltration Pond with Groundwater Lowering Wells and Irrigation	
Wastewater Disposal - Section T	
High-Rate Infiltration Pond (near dune line)	$1,288,000

6.7 Project Financing

Table 12 summarizes financing for the Ocean Sands WWTP expansion alternatives. The current cash balance of the OSWSD Fund is $4,949,799. Approximately $899,000 has been budgeted for FY 2009 with $500,000 set aside for Ocean Sands WWTP improvements. The remaining cash balance in the OSWSD will be approximately $4,000,000. Debt service was determined assuming 10-year financing at a 5% rate.

Table 12. Financing for Ocean Sands WWTP Expansion Alternatives

Description	Total Project Cost Opinion	FY 09 Capital Outlay	OSWSD Fund Contribution	Financed Amount	Annual Debt Service
Option 1 - 0.1 mgd New Capacity (Rehabilitate Existing 0.5 mgd)	$ 5,583,000	$500,000	$ 3,600,000	$1,483,000	$ 192,056
Option 2 - 0.2 mgd New Capacity (Rehabilitate Existing 0.4 mgd)	$ 7,120,800	$500,000	$ 3,600,000	$3,020,800	$ 391,209
Option 3 - 0.4 mgd New Capacity (Rehabilitate Existing 0.2 mgd)	$ 11,209,000	$500,000	$ 3,600,000	$7,109,000	$ 920,651
Option 4 - 0.6 mgd New Capacity (demolish existing plant)	$ 12,702,000	$500,000	$ 3,600,000	$8,602,000	$1,114,002

Based on a review of previous OSWSD budgets, revenues have exceeded expenditures by approximately $250,000 per year. Therefore, Option 1 above is the only financially feasible alternative without increasing sewer rates. This option would expand the Ocean Sands WWTP to 600,000 gpd and rehabilitate existing treatment trains and components.

We recommend that a detailed rate study be conducted to determine sewer rates required to provide necessary funding to replace existing treatment capacity in a future upgrade project. We understand that the County eliminated a District tax that once existed in the OSWSD and agree that funding for sewer operations, maintenance, and capital upgrades should come from impact fees and usage rates. A property tax does not allocate costs to the users based on demand.

7. Water and Wastewater Infrastructure Improvements with Sections G and T Not Incorporated into OSWSD

7.1 General

In this section, the infrastructure improvements required to meet the water supply, water treatment, and wastewater treatment and disposal needs for the OSWSD are presented, assuming Sections G and T develop separately and are NOT integrated into the existing OSWSD.

7.2 Water Supply

The recommendations regarding water supply and treatment infrastructure required for the OSWSD are the same as those presented in Section 6.2.

If Section G is not incorporated into the existing OSWSD, then existing OSWSD wells could not be used to supplement water supply needed for this development. Therefore, a total well yield of 321,000 gpd would need to be provided on Section G. Even though disposal of treated wastewater effluent will provide some aquifer recharge, it is unlikely that significant well yield could be obtained at Section G without impacting the existing wellfield located at Section R. Aquifer modeling was not conducted to confirm interference between the wellfields, but is recommended to confirm total water supply availability with this option.

For purposes of this master plan, new wellfields are shown in order to preserve the existing wellfield separation. A conceptual layout for the new wellfield locations is shown on Figures 10A, 10B, and 10C. Recommendations are included in Section 7.6.

7.3 Water Treatment

It is assumed that Sections G and T would become part of the SOBWS even if they are not incorporated into the OSWSD. Recommendations for water treatment infrastructure are the same as those presented in Section 6.8.

7.4 Wastewater Treatment and Disposal

If Sections G and T are not incorporated into the OSWSD, then the buildout capacity of the Ocean Sands WWTP would be 600,000 gpd. The Ocean Sands WWTP is projected to reach 90% of its capacity in 2009 and should be expanded to 600,000 gpd.

Denitrification is recommended to address high nitrate levels in groundwater monitoring wells. However, meeting a total nitrogen goal of 7 mg/L or water reuse standards is not required. Water quality standards for high-rate infiltration would continue to apply. The existing WWTP site can accommodate a WWTP expansion to 600,000 gpd, and the required 5-day upset storage without reduced setbacks. At buildout, one 3.0 MG concrete tanks would be required to provide 5 days of upset storage.

Recommendations for wastewater treatment and disposal infrastructure if Sections G and T are NOT incorporated into OSWSD are presented in Section 7.6.

7.5 Cost Opinions

Opinions of probable construction cost for the recommended water and wastewater infrastructure are presented in Table 13 assuming Sections G and T are not incorporated into OSWSD.

Table 13. Cost Opinions Assuming Sections G and T Develop Separate from OSWSD

Water and Wastewater Infrastructure	Cost Opinion
Raw Water Line and Supply Wells	
OSWSD	$942,000
Sections G and T	$1,240,000
Water Treatment and Storage	
1.0-mgd WTP Expansion	$3,300,000
200,000 gallon Elevated Storage Tank	$1,000,000
Wastewater Treatment	
Oceans Sands WWTP Option 1: Expand to 0.6 MGD, Rehabilitate Existing 0.5 MGD	$5,589,000
Oceans Sands WWTP Option 2: Expand to 0.6 MGD, 0.2 MGD in New Capacity, Rehabilitate Existing 0.4 MGD	$7,121,000
Oceans Sands WWTP Option 3: Expand to 0.6 MGD, 0.4 MGD in New Capacity, Rehabilitate Existing 0.2 MGD	$8,136,200
Oceans Sands WWTP Option 4: Replace Existing WWTP with new 0.6 MGD capacity	$9,897,000
Section G 0.20 MGD WWTP	$4,320,000
Section T 0.40 MGD WWTP	$8,640,000
Wastewater Disposal – Section G	
High-Rate Infiltration Pond (near dune line)	$644,000
Wastewater Disposal – Section T	
High-Rate Infiltration Pond (near dune line)	$1,288,000

7.6 Recommendations for Infrastructure Improvements (assuming Sections G and T are NOT incorporated into OSWSD)

Recommendations for wastewater treatment and disposal infrastructure assuming Sections G and T address water and sewer infrastructure separately from OSWSD are presented below and shown on Figures 10A, 10B, and 10C. A layout for expansion of the Ocean Sands WWTP is shown in Figure 12.

1) Water Supply

a. For OSWSD, water supply infrastructure recommendations are the same as those presented in Section 6.8.
b. For Sections G and T, wellfields cannot achieve the same separation as existing wellfields. However, high-rate wastewater infiltration systems and/or reuse irrigation will be utilized at these sites to provide additional recharge. Wellfields are required as development commences in Sections G and T.
c. For Section G, one new wellfield is required. The yield of the new wellfield should be confirmed with field investigations of aquifer characteristics and additional groundwater modeling.
d. For Section T, three new wellfields are required at Section T with a combined yield of 637,000 gpd.
e. A new 12-inch raw water pipeline is required to convey raw water beginning at Section R (near the former site of the Ocean Sands Water Treatment Plant) to Section T. The new pipeline is required once Sections G and/or T develop.

2) Water Treatment

a. It is assumed that even if Sections G and T are not incorporated into the OSWSD, that they would become part of the SOBWS.
b. If Sections G and T develop to the extent presented in Table 1, then projected peak day demand is projected to reach 1.70 mgd. The next expansion of the Southern Outer Banks WTP should be to 3.15 mgd.
c. An expansion of the Southern Outer Banks WTP would be required around the 2025 timeframe to meet the needs of the OSWSD.
d. The Southern Outer Banks WTP may require an expansion earlier depending upon continued bulk sales to the Carolina Water system.

3) Finished Water Storage

a. An additional 200,000 gallons of elevated storage will be needed in the future once Sections G and T develop.

4) Wastewater Treatment

a. Ocean Sands WWTP

i) Expand the Ocean Sands WWTP to 600,000 gpd meet the buildout needs of the OSWSD. Design of the Ocean Sands WWTP expansion to 600,000 gpd should be completed in 2009 when the WWTP is expected to reach 90% capacity.

ii) Ocean Sands WWTP process should be upgraded to improve nitrate removal using the MLE process.

iii) Construct one 3 million gallon storage tank to serve as upset storage required by 2T rules for high rate infiltration systems. A pump station will be required to pump stored effluent back to head of WWTP for additional treatment.

iv) Rehabilitate and repair existing 500,000 gpd WWTP, including blasting and repainting of steel tankage, replacement of corroded pipe and pipe hangers, and repair to other severely corroded components (weir plates, pipe hangers, handrail bases, control panel bases, etc.). Rehabilitation and repair is needed to improve operating condition of the WWTP and respond to the NOV issued by NC DWQ in May 2008. Rehabilitation and repair may extend the service life of the WWTP by 5 to 10 years.

v) Plan for the replacement of existing treatment trains which are reaching the end of their service life within the next 5 to 10 years. A rate study should be conducted to determine rate structure required to provide capital funding for future upgrade.

b. Section G

vi) A 200,000 gpd wastewater treatment facility would be required on Section G along with 1.0 million gallons of upset storage. Wastewater disposal options are the same as those presented in Section 6.5. Conceptual layouts of treatment and disposal facilities on Section G are shown on Figure 6 and 8. The wastewater treatment should meet reuse standards to maximize flexibility for wastewater disposal.

c. Section T

vii) A 400,000 gpd wastewater treatment facility would be required on Section T along with 2.0 million gallons of upset storage. Wastewater disposal options are the same as those presented in Section 6.5. Conceptual layouts of treatment and disposal facilities on Section T are shown on Figure 7 and 9. The wastewater treatment should meet reuse standards to maximize flexibility for wastewater disposal.

8. Summary

A summary of the recommended water and sewer infrastructure improvement for OSWSD are presented below. The recommendations assume that Sections G and T will be incorporated into the OSWSD in the future. A capital improvements plan is shown in Table 14. A project schedule is also attached:

I. WATER SUPPLY, TREATMENT, AND STORAGE

A. Proceed with design and construction of one additional wellfield to meet current water supply needs of OSWSD (based on peak monthly demands and 18-hr pumping). One new wellfield is needed to meet current demands but at minimum, should be online by summer 2009.

B. A second wellfield for OSWSD is required by 2010.

C. Recommendations are based on wellfields in the surficial aquifer. An alternative is to construct additional wellfields in the Yorktown aquifer to supply the reverse osmosis treatment system. These deep wells would need to be located in the Whalehead area or further north where the Yorktown aquifer has sufficient yield and suitable water quality.

D. Expansion of the Southern Outer Banks WTP is needed once Sections G and T develop. Buildout demands of the Ocean Sands Development will require the Southern Outer Banks WTP to be expanded to 3.15 MGD rather than 3.0 mgd originally planned for the plant.

E. Timing of the next expansion of the Southern Outer Banks WTP is also affected by demand trends in other parts of the SOBWS and continued bulk sales to the Carolina Water system.

F. A 200,000 gallon elevated storage tank is needed once Sections G and T develop. Hydraulic modeling may be required to confirm the location of the new tank.

II. WASTERWATER TREATMENT AND DISPOSAL

A. Proceed with retrofit of the 200,000 gpd train with the MLE process modification as a demonstration test to confirm that MLE can effectively denitrify under the full-scale conditions (loadings and flows) seen at the

Ocean Sands WWTP. MLE process is needed to improve nitrate removal to address nitrate levels in groundwater monitoring wells.

B. Proceed with design of expansion and upgrade of the Ocean Sands WWTP to 600,000 gpd (Option 1).

1. In conversations with NC DWQ staff, an Environmental Assessment may be required for this expansion since the 100,000 gpd capacity exceeds the minimum criteria for NC SEPA. Although this report refers to an expansion to 600,000 gpd for convenience, a smaller project (590,000 gpd) could avoid the need for an EA at this time and be addressed in the next expansion when the Sections G and T develop.

2. The new capacity (100,000 gpd) should utilize 4-stage denitrification process to meet higher total nitrogen limits to achieve smaller setbacks in anticipation of development of Sections G and T.

3. Developer of Sections G and T would need to reimburse the County for costs associated with higher level of treatment once developer requests capacity for Sections G and T.

4. Construct one 3 million gallon storage tank to serve as upset storage required by 2T rules for high rate infiltration systems. A pump station will be required to pump stored effluent back to head of WWTP for additional treatment.

5. Rehabilitation and repair of the existing Ocean Sands WWTP including blasting and repainting of steel tankage, replacement of corroded pipe and pipe hangers, and repair to other severely corroded components (weir plates, pipe hangers, handrail bases, control panel bases, etc.). These improvements are required to bring the Ocean Sands WWTP back up to good operating condition and respond to the NOV issued by NC DWQ.

6. Re-locate existing infiltration field closer to southern property boundary to provide space for upset storage. Replace existing rotary distributors with high-rate infiltration pond or spray nozzles to address deteriorating condition of existing rotary distributors and to reduce maintenance costs.

7. Final design plans and permit modification should be submitted to NC DWQ in 2009 when the WWTP is projected to reach 90% capacity.

C. Future expansions of the Ocean Sands WWTP:

1. Depend on the timing of development of Sections G and T.

2. Should be designed to meet effluent TN < 7 mg/L to achieve reduced setbacks per 2T rules.

3. Should allow for replacement of existing treatment capacity. Rehabilitation and upgrades proposed for the 600,000 gpd expansion may extend service life by 5 to 10 years. Demolition of the older trains and replacement with new capacity should be planned in a future expansion within next 5 to 10 years.

D. Development of Sections G and T:

1. Field investigations should be conducted to verify hydrogeologic conditions in the area of the proposed disposal system as part of the design of water supply and wastewater disposal infrastructure, and drainage and stormwater management features.

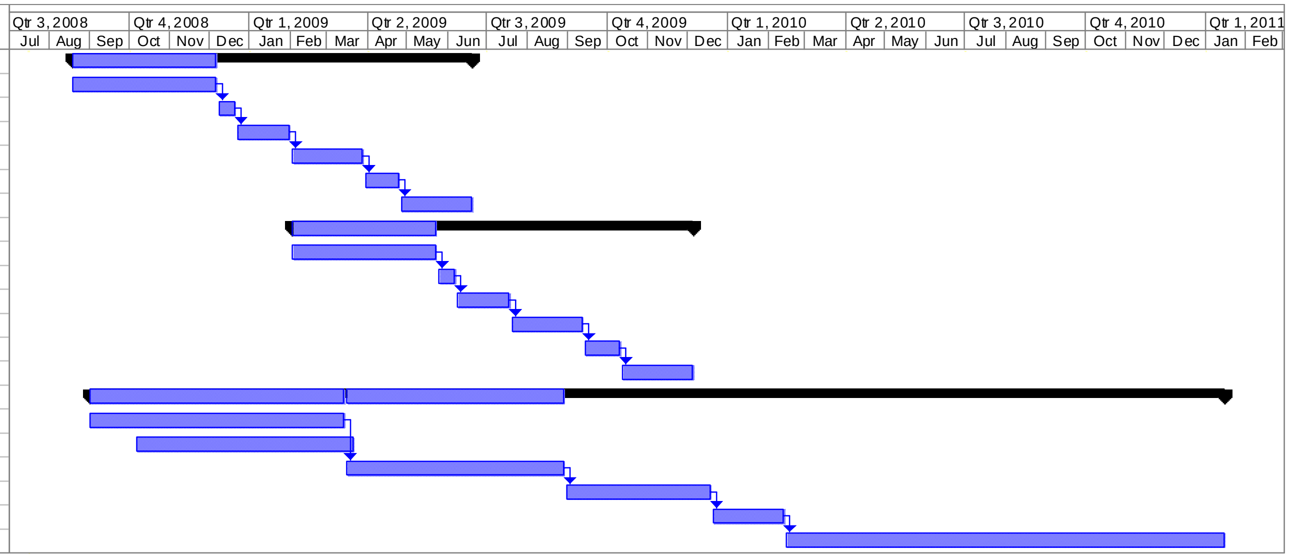
2. Require the preparation of a Comprehensive Water Management Plan for each site prior to development of Sections G and T. The comprehensive water management plan would address how site grading and drainage, land cover, wastewater disposal, pumping of water supply wells, discharge of stormwater, and discharge of water from groundwater lowering wells will be managed to ensure that flooding will be minimized and that water quality standards will be met and/or managed. The water management plan should also include the impacts of off-site groundwater sources (i.e., wastewater disposal, stormwater disposal, irrigation, etc.) and sinks (i.e., water-supply wells) on the properties being developed.

Table 14. Recommended Capital Improvements Plan for Ocean Sands Water and Sewer District

Project	FY2009	FY2010	FY2011	FY2012	FY 2013-18	Once Sections G & T Join OSWSD[1]
Water Supply, Treatment, and Storage						
New OSWSD Wellfield No. 6 (at Section U)	$291,000					
New OSWSD Wellfield No. 7 (at Section D)		$391,000				
New OSWSD Wellfield No. 8 (at Section X)					$263,000	
Wellfields for Sections G & T						$1,240,000
1.0 mgd SOBWTP Expansion	*Timing of expansion is dependent on sales to Carolina Water System*					$3,300,000
200,000-gallon Elevated Storage Tank						$1,000,000
Wastewater Treatment and Disposal						
Retrofit of 200,000 gpd train with MLE	$112,000					
Rehabilitation/Upgrade Existing WWTP	$360,000	$662,000				
Expansion of Ocean Sands WWTP to 600,000 gpd (Option 1)	$350,000	$5,189,000				
Future Replacement of Existing Treatment Capacity (0.5 mgd)					$9,373,000	
Ocean Sands WWTP Expansion to 1.2 mgd						$10,652,000
Sewer Force Main and Eflfuent FM for Sections G & T						$1,607,000
High-Rate Disposal System at Sections G & T						$1,932,000
TOTALS	$1,113,000	$6,242,000	$0	$0	$9,636,000	$19,531,000

[1] Timing of development for Sections G & T is not currently known.

ID	Task Name
1	**New OSWSD Wellfield 6**
2	Design and Hydrogeologic Investigation
3	Permitting - Site Plan Approval
4	Bidding
5	Well Drilling
6	Permitting - Final Approval
7	Wellhead Construction
8	**New OSWSD Wellfield 7**
9	Design and Hydrogeologic Investigation
10	Permitting - Site Plan Approval
11	Bidding
12	Well Drilling
13	Permitting - Final Approval
14	Wellhead Construction
15	**OS WWTP Improvements**
16	Demonstration Testing of MLE process
17	Rehabilitation of existing WWTP
18	Design of WWTP Expansion and Upgrade
19	Permitting
20	Bidding
21	Construction



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Appendix A:

Groundwater Modeling of Wastewater Disposal Alternatives at Ocean Sands Sections G and T