LEE COUNTY BOARD OF COUNTY COMMISSIONERS

CAPTIVA ISLAND WASTEWATER ALTERNATIVE STUDY

FINAL REPORT

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CAPTIVA ISLAND WASTEWATER ALTERNATIVE STUDY

Objective

This study is based on available public information and is intended to assess the feasibility of alternative wastewater management concepts suitable for Captiva Island based on current land use. The technical solutions and costs presented are conceptual and intended only for comparing alternatives. This report is in five Sections:

1.0 Existing Conditions
2.0 Effectiveness of Onsite Wastewater Treatment
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1.0 EXISTING CONDITIONS

1.1 SUMMARY OF CONCERNS

Studies in the Sanibel Captiva coastal zone have raised concerns for near shore water quality which is impacted by island development. One of the most discussed water quality impacts is nutrient loading, primarily nitrogen compounds. Nitrogen is a necessary and natural part of an aquatic system, but higher than natural levels of nutrients including nitrogen and phosphorous compounds result in algae growth higher than a natural ecosystem can absorb, and this results in numerous negative impacts to the natural aquatic environment. Studies have been performed over the years related to local water quality issues starting with the formation of the Sanibel-Captiva Conservation Foundation (SCCF) in 1967. The *Captiva Water Quality Assessment*, SCCF, published May, 2011 and supported by the Lee County Tourist Development Council and the Captiva Community Panel and conducted between October 2008 and March 2011 is the most comprehensive. This Report states, "Groundwater from the non-sewered portion of Captiva contributes nitrogen to near shore surface waters especially on the estuary side of Captiva. Nitrogen in Captiva's groundwater most likely originates from septic systems which do not typically remove nitrogen from domestic waste." This study was also published academically in Marine Pollution Bulletin, Vol 64, 2012. Significantly, elevated levels of nitrogen compounds, including ammonia, nitrates, nitrites, and organically bonded nitrogen, were found in Wulfert Channel near areas on septic systems. Elevated nitrogen levels were not found in water samples in Chatwick Bayou near areas on central sewer.

There are several sources of nitrogen that impact water quality in developed areas including stormwater runoff, fertilizer runoff, and air pollution. Locally there is concern over the contribution of Lake Okeechobee discharges into the Caloosahatchee estuary. Also, reclaimed effluent from conventional wastewater treatment, which is not treated to advanced levels for nutrient removal, can contribute to nutrient loading in the form of nitrates migrating into the ground water and then into near shore water. However, coastal communities with concentrations of septic system drainfields (which remove only a small amount of nitrogen and phosphorous) are known to impact local near shore water quality as well as the water quality in bayous and salt water canals. Studies leading to the mandatory implementation of central sewer in the Florida Keys (Monroe County Sewer Master Plan 2000), and on comparable barrier islands like Sanibel (Islandwide Master Plan for Wastewater 1994), on highly developed islands like Marco Island (Utility Master Plan 2005) and more

recently in nearby Charlotte Harbor (Waste Water Service Program Area 1 2010), have documented the impacts of concentrated septic tanks and motivated subsequent septic tank replacement programs.

Aside from water quality issues, there are other concerns for the viability of conventional septic systems on Captiva. Foremost is the high water table. Conventional septic systems meeting regulatory requirements must have a minimum of 2 feet of dry soil between the drain piping and the seasonal high ground water table. A probable projection for climate induced sea-level rise established by the NOAA for water around Captiva predicts the potential for a 2 foot rise by the year 2048. The scope of this study did not include inspections of individual existing septic systems, but it is reasonable to assume that existing septic drainfields will be impacted by higher water tables.

In addition to conventional septic systems, concerns have been raised regarding the capability of the four wastewater treatment plants (WWTPs) currently permitted and located on Captiva Island. There are three private smaller "package" WWTPs and a larger WWTP operated by the Florida Government Utilities Authority (FGUA) for the South Seas Island Resort property. None of the existing wastewater treatment plants use the advanced treatment technology that significantly reduces nutrients in the effluent produced. Effluent from these facilities is primarily disposed of by spray irrigation or land application.

1.2 EXISTING ONSITE SEWAGE TREATMENT ON CAPTIVA

1.2.1 Number of Properties Served by Onsite Treatment and Disposal Systems (OSTDS)

OSTDS are regulated under the requirements of The State of Florida Department of Health Chapter 64E-6 Florida Administrative Code, Effective July 16, 2013 (FAC 64E-6) administered locally by the Florida Department of Health Lee County (DOH). It is noted that on-going inspections for conventional septic systems are not required by FAC 64E-6. They are required annually for the advanced OSTDS like Aerobic Treatment Units (ATU) and Performance Based Treatment Systems (PBTS).

Based on a review of the Lee County Property Appraiser's database and data provided by the DOH, there are 378 developed properties on Captiva that are outside of the areas served by the four on-island wastewater treatment plants. These properties are presumed to have an OSTDS. A review of the DOH database reveals that there are 11 Aerobic Treatment Units (ATU) and 70 Performance Based Treatment Systems (PBTS) permitted on Captiva. Based on this information there are 297 conventional septic systems. Of these 224 are permitted and 73 are apparently not permitted. Based on this information, ATU and PBTS systems make up about 21% of the total OSTDS on Captiva. Conventional septic systems make up the remainder or about 79% of the total OSTDS. As stated, most OSTDS are permitted; however, it is estimated that about 73 of the conventional systems in place (25%) are grandfathered and are not permitted or monitored by the DOH. Note, the DOH started permitting septic systems about 1993 and staff explained that records were lost during Hurricane Charley. The current database has records only from 2008 to the present.

Table 1-2: Summary of Current On-Island OSTDS

Number of Developed Properties with OSTDS	Number of Permitted Conventional Septic Systems	Number of Permitted ATU	Number of Permitted Secondary PBTS	Number of Permitted Advanced Secondary PBTS (1)	Number of Permitted Advanced PBTS (2)	Number of Unpermitted Conventional Septic Systems
378	**224**	**11**	**67**	**3**	**0**	**73**
OSTDS Treatment Level	Primary	Advanced Primary	Secondary	Advanced Secondary	Advanced	Primary (assumed)
TSS Limit	50 mg/L	30 mg/L	20 mg/L	10 mg/L	10 mg/L	50 mg/L
BOD Limit	50 mg/L	30 mg/L	20 mg/L	10 mg/L	10 mg/L	50 mg/L
TN Limit	No Removal	No Limit	No Limit	20 mg/L	10 mg/L	No Removal
TP Limit	No Removal	No Limit	No Limit	10 mg/L	1 mg/L	No Removal

(1) Highest level treatment OSTDS currently permitted in Lee County

(2) Not enforceable outside Monroe County under current regulations

1.2.2 Number of Properties Underserved by Substandard Wastewater Treatment

There is no evidence of substandard or rudimentary wastewater treatment systems such as cesspools or outhouses on Captiva Island based on available public information.

1.2.3 Effluent Water Quality

There are references to comparative levels of effluent water quality used in this Study. Effluent water quality is expressed by the four residual pollutants typically monitored for compliance with permit limits. These parameters are expressed as the concentration of the pollutant in mg/L (milligrams per liter) which is equivalent to parts per million.

The pollutants typically monitored by the FDEP and DOH in treated wastewater effluent are:

1. Total Suspended Solids (TSS) in mg/L. TSS is a nuisance pollutant and high levels of TSS indicate other forms of biochemical and nutrient pollution.

2. 5-day Carbonaceous Biological Oxygen Demand $CBOD_5$ (BOD) in mg/L. BOD is a measure of the impact of the organic waste on the oxygen levels in natural receiving water bodies as natural aerobic microbiological reactions break down the organic waste and deplete the dissolved oxygen levels in the natural water bodies.

3. Total nitrogen compounds including ammonia nitrogen, nitrates, nitrites, and organically bonded nitrogen (TN) in mg/L. Nitrogen is a nutrient that stimulates undesirable and unnatural levels of algae causing a number of environmental impacts, especially degraded water clarity.

4. Total phosphorous compounds (TP) in mg/L. TP is a nutrient that stimulates undesirable and unnatural levels of algae and other nuisance growth that degrades water quality.

An effluent quality set may be expressed as 10 mg/L TSS, 10 mg/L BOD, 3 mg/L TN and 1 mg/L TP or 10/10/3/1 effluent. This concentration of pollutants in the effluent does not account for mass loading, or the total pounds of pollution released to the environment which is a function of the amount of effluent as well as the quality of the effluent.

1.3 EXISTING WASTEWATER TREATMENT PLANTS ON CAPTIVA

1.3.1 South Seas Plantation WWTP – Permit FLA 0146886

Built 1975
Permitted Capacity 0.180 MGD (180,000 gpd) AADF (Annual Average Daily Flow)
Effluent Quality Set is:
20 mg/L BOD
5 mg/L TSS
There are no limits on TN or TP

The South Seas WWTP serves the South Seas Island Resort property and associated restaurant and public restrooms. It is owned and operated by the Florida Government Utility Authority (FGUA). Currently it is operated as a conventional activated sludge process with a permitted capacity of 0.180 MGD although the facility is alternatively permitted as a 0.264 MGD facility using the higher rate contact stabilization process. The WWTP consists of a 101,000-gallon surge tank, an influent bar screen, a 42,810- gallon contact stabilization tank, a 72,500-gallon reaeration tank, a 50,000-gallon clarifier, a 7,524-gallon effluent sump, two disk filter units, a 9,500-gallon chlorine contact chamber, an effluent pump station, a 450,000-gallon reuse storage tank, a 46,480-gallon digester and a 24,730-gallon digester. High level disinfection is provided as required for use of effluent for irrigation.

According to the 2017 Annual Reuse Report, distribution of reuse water consists of 0.1502 MGD to the Golf Course for irrigation and 0.0068 MGD to a shallow injection well.

Repairs required on issuance of the 2016 permit included:

- install permanent piping for the activated sludge mode of operation;
- install piping to bypass the filters;
- install a bar screen with smaller spacing to collect more influent debris;
- replace the existing air header and associated piping.

The facility currently meets FDEP permit requirements. According the most recent Capacity Analysis Report (CAR), “assuming that the South Seas collection system and WWTF will continue to be properly operated and maintained, no expansion of the facility or its disposal system will be required in the next 10 years.” It should be noted that there were performance problems between the years of 2010 - 2015, and raw wastewater and effluent that did not meet regulatory requirements was trucked to Sanibel’s Donax Water Reclamation Facility (WRF) for treatment.

Permitted effluent disposal is by underground injection via a shallow injection well, land application, and irrigation reuse:

Underground Injection U-001: Permit condition I.A.1. and Department permit number 0326262-001-UC/5W (or its successor). Underground Injection Well System U-001 is located approximately at latitude 26° 32' 30" N, longitude 82° 11' 32" W.

Land Application R-001: An existing 0.264 MGD annual average daily flow permitted capacity slow-rate public access system. R-001 is a reuse system which consists of spray irrigation system. Ground water sources may be used to augment the supply of reclaimed water via an auxiliary irrigation supply well connected to the reclaimed system.

1.3.2 Tween Waters Inn WWTP – Permit FLA 014597-006

Built 1979
Permitted Capacity 0.040 MGD (40,000 gpd) MMADF
Effluent Quality Set is:
20 mg/L BOD
10 mg/L TSS
There are no limits on TN or TP

Tween Waters Inn WWTP serves the Tween Waters Inn Island Resort. Built in 1979 and modified in 1991 the WWTP uses the conventional activated sludge process consisting of: three 5,000 gallon surge tanks; seven aeration basins with a total volume of 70,000 gallons (six 5,000 gallon basins and one 40,000 gallon basin); a 10,360 gallon clarifier; two 18 square foot sand filters; a 22,800 gallon chlorine contact chamber; and, two 5,000 aerobic digesters. Basic disinfection is provided.

According to the June 2017 WWTP permit application the wastewater treatment plant at Tween Waters Inn is operating efficiently. Over the past ten years, the monthly daily flow has averaged 0.0217 MGD and the peak three-month average daily flow was 0.033 MGD occurring in February through April of 2010. Currently, the facility is operating at well below its permitted capacity.

Repairs required on issuance of the 2017 permit included:

- replace the filter media;
- perform maintenance on the facility's aeration diffusers;
- re-route the filter bypass piping to the headworks of the facility or remove completely.

The treatment plant provides service to the guests and employees of Tween Waters Inn only and the future flow rates and loadings for the facility are not expected to increase anytime over the next ten years.

Permitted effluent disposal is by irrigation reuse or land application on two on absorption fields.

Land Application R-001: An existing 0.040 MGD three month average daily flow permitted capacity absorption field system. R-001 is a reuse system which consists of two absorption fields located on the site of the facility having a capacity of 0.040 MGD located approximately at latitude 26°30' 48" N, longitude 81°11' 20" W.

1.3.3 Sunset Captiva WWTP – Permit FLA014465

Built 1980
Permitted Capacity 0.025 MGD (25,000 gpd) TMMADF (Three-Month Maximum Average Daily Flow)
Effluent Quality Set is:
20 mg/L BOD
10 mg/L TSS
There are no limits on TN or TP

The Sunset Captiva wastewater treatment facility was placed in service in 1980 and currently serves 66 homes and 10 condominiums. The wastewater plant uses the extended aeration process consisting of: 10,000 gallon equalization tank; 25,000 gallon aeration tank; 6,200 gallon clarifier, 3,115 and 5,000 gallon sludge tanks (total capacity 8,115 gallons); 1,830 and 2,093 gallon chlorine contact chambers (total capacity 3,923 gallons); and, two 42 square foot sand filters. Basic disinfection is provided.

According the 2016 WWTP permit application conducted by TKW Consulting Engineers, Inc., the Sunset Captiva WWTP operates at approximately 80% of its design capacity. Based on the past monitoring data, the facility is meeting the permitted effluent parameters. It was expected that the three-month average daily flow will remain below the FDEP permitted levels for the renewal period of 5 years. Repairs were made to the collection system which eliminated most infiltration.

Repairs required on issuance of the 2016 permit included:

- repairs to cracks in the surge tanks;
- repair diffusers in the aeration basins;
- construct a trench or a wall to divert run off from flooding the filter.

Permitted effluent disposal is by irrigation reuse or land application into three drainfields located at the facility:

Land Application R-001: Treated effluent is reused in an absorption field system, R-001. The permitted capacity for R-001 is 0.025 MGD. R-001 consists of 8276 square feet divided into three cells. The reuse system is located at the facility.

1.3.4 Captiva Shores Condominiums WWTP – Permit FLA014472

Built 1980
Permitted Capacity is 010 MGD MMADF (10,000 gpd)
Effluent Quality Set is:
20 mg/L BOD
10 mg/L TSS
There are no limits on TN or TP

The wastewater plant uses the extended aeration process consisting of: two 5,000 gallon aeration tanks; one 1,699 settling tank; one 2,360 gallon sludge holding tank; one 818 gallon chlorine contact chamber; and, one Hayward pool sand filter. Basic disinfection is provided.

According to the 2015 WWTP permit application, the existing Captiva Shores WWTP currently operates at an AADF rate of 3,300 gpd, which is 33% of design capacity. The flows should remain at about the same level during the next five year renewal period. Based on the past operating data, the facility is meeting the permitted effluent parameters.

Repairs required on issuance of the 2015 permit included:

- certify the backflow prevention device;
- clean diffusers and install new air headers;
- install a flow meter on the influent line.

Permitted effluent disposal is by land application to one drainfield.

Land Application R-01: An existing 0.010 MGD AADF permitted capacity absorption field system. R-01 is a land application system of one 3,333 square foot drainfield.

Table 1-3: Summary of Current On-Island WWTP

Facility	**South Seas WWTP**	**Tween Waters WWTP**	**Sunset Captiva WWTP**	**Captiva Shores WWTP**
Year in Service	1975	1979	1980	1980
Treatment Level	Secondary with Filtration	Secondary with Filtration	Secondary with Filtration	Secondary with Filtration
Permitted Capacity	180,000 gpd	40,000 gpd	25,000 gpd	10,000 gpd
TSS Limit	5 mg/L	10 mg/L	10 mg/L	10 mg/L
BOD Limit	20 mg/L	20 mg/L	20 mg/L	20 mg/L
TN Limit	No Limit	No Limit	No Limit	No Limit
TP Limit	No Limit	No Limit	No Limit	No Limit

2.0 EFFECTIVENESS OF ONSITE WASTEWATER TREATMENT

2.1 EFFECTIVENESS OF CONVENTIONAL SEPTIC SYSTEMS

The simplest design approved by the Florida Department of Health (DOH) for an Onsite Wastewater Treatment and Disposal System (OSTDS) is referred to as a "conventional" OSTDS. Commonly referred to as a conventional septic system. Conventional septic systems include a septic tank and a drainfield for liquid to be dispersed into the soil for natural treatment. Solids are removed in the septic tank, and the settled effluent is discharged underground, where natural biological processes provide treatment in the soil. It is important that an adequate depth of dry soil not connected to the groundwater table be available for this percolation and treatment. Otherwise, the effluent would immediately pollute local groundwater. While functioning septic systems are effective in removing bacteria and reducing the biological oxygen demand of the waste, a limitation of this basic treatment system is that there is limited removal of nitrogen and phosphorous. These nutrients eventually transport into surficial ground water and in coastal areas have been found to migrate into nearby open water bodies.

That said, under the appropriate conditions properly designed and maintained conventional OSTDS are an effective and safe method of wastewater disposal and will meet current environmental regulations. There are over 100,000 OSTDS reported in Lee County. Onsite treatment is highly regulated and all new OSTDS require a permit from the Florida Department of Health Lee County (DOH). Permitted OSTDS must comply with 381.0065 Florida Statutes (FS) and Chapter 64E-6 of the Florida Administrative Code (FAC 64E-6). Basic requirements are a site plan, a floor plan, an Engineer's Design, and a Site Survey.

2.1.1 Concerns for the Effectiveness of Conventional Septic Systems for Island Communities

A concern for Captiva Island should be the requirements of FAC 64E Part 6.005 Location and Installation and Part 6.006 Site Evaluation Criteria for siting of septic systems. Meeting all of these criteria is likely to be difficult on a small island community. It is noted that systems shall not be within 75 feet of boundaries of surface water, shall have an unobstructed area for the drainfield 1.5 times larger than the drainfield in addition to other setbacks required, shall have a lot size of at least 1/2 acre excluding roadway easements and surface water bodies, and placed where the water table at its maximum is at least 24 inches below the bottom of the drainfield lowest surface. The scope of this study did not include inspections of any existing onsite systems but it appears likely that there are systems currently on Captiva that do not meet all the current requirements of FAC 64E-6 for siting, especially those that were never permitted.

A number of studies have been done on the impacts of septic systems to water quality. Most of these studies indicate that septic systems in Florida coastal areas may not adequately remove nutrients. This is because conventional septic treatment only partially removes nutrients. The ability of conventional septic systems to remove nutrients is further limited due to sandy soils, high wet season water table, and seasonal use typical of a barrier island community. The following paragraphs highlight statements in a few of these studies.

In 2008 the Florida Legislature directed the Department of Heath to study nitrogen reduction strategies for OSTDS. The final report was completed in 2015. It was determined that conventional septic systems, while effective for pubic heath, remove only 10-50% of nitrogen based nutrients, and a value of 30% removal was used as a planning baseline. The study found an average of 60.4 mg/L TN in the raw wastewater for the sites monitored. This results in a value for TN of 42 mg/L in the effluent from conventional septic systems.

Charlotte County conducted studies of Charlotte Harbor in association with the Florida Atlantic University Oceanographic Institute. Subsequently the Charlotte County Utilities Department Sewer Master Plan (2016) addressed the need for septic tank replacement: "Excess nutrients from failing septic tanks can harm the environment, especially in densely populated coastal areas and as the sea levels rise."

City of Sanibel Natural Resources Department, 2009, in a paper titled "Sanibel Water Quality Monitoring Report and Recommendations 2002-2008" states:

"The City of Sanibel contracted the Charlotte Harbor Environmental Center, partnering with Mote Marine Laboratory and the Sanibel Captiva Conservation Foundation Marine Laboratory to conduct a study using stable nitrogen isotopes and phytoplankton community analysis to help identify the sources of nutrients causing the natural linear catchment slough known locally as the Sanibel River to be "impaired". They found that nitrogen, primarily ammonia, was likely the limiting nutrient in the Sanibel River and that the sources of the nutrients include wastewater re-use water used for irrigation, septic tank effluent, pet wastes, fertilizers and decaying stream-side vegetation."

Postma, et al., 1992, in an article titled *"Nutrient and Microbial Movement from Seasonally-Used Septic Systems,"* states:

"Unsewered seasonal vacation communities present unique problems for onsite sewage disposal. Seasonal occupancy may promote the transmission of contaminants to groundwater due to incomplete formation of a biological clogging mat in the soil absorption system. Groundwater surrounding three seasonally-used septic systems was monitored to determine the movement and attenuation of nitrogen, phosphorus and two bacterial indicators of human fecal contamination, fecal coliforms and Clostridium perfringens. Nitrate concentrations were often three to four-fold greater than the drinking water standard at wells 6 meters from the soil absorption systems."

Charlotte Harbor Environmental Center, 2009, "*The Sanibel River and the Impaired Waters: How Stable Nitrogen Isotopes and Phytoplankton Analyses Can Indicate Nutrient Sources and Evaluate Nutrient Reduction Efforts,"* states:

"Stable nitrogen isotope signatures of both ammonia and nitrate sampled from the eastern sub-basin were generally closer to our [AFAC 15N ammonia] observations than those in the western sub-basin, indicating that a greater proportion of the nutrients in these areas originated from treatment plant effluent and septic tank effluent rather than from fertilizer runoff."

Stoner, N. and Dorfman M., 2005, with the Natural Resources Defense Council, "*Testing the Waters 2005 – A Guide to Water Quality at Vacation Beaches,"* states:

"Aside from the disease causing organisms present in sewage, its high nutrient content acts as fertilizer that can spur blooms of microscopic organisms. In some cases, exposure to these organisms can cause illness through skin contact, inhalation, or ingestion. Toxic "red tides" outbreaks of such organisms such as Pfiesteria piscicida, have been found in recent years to be associated with fish kills in Gulf Coast marine and estuarine waters. Pfiesteria piscicida and other species of algae contain neurotoxins that may affect fishermen, swimmers, and other recreational users of near shore marine and riverine waters. Exposure to these toxic blooms may result in short-term memory loss, dizziness, muscle aches, peripheral tingling, vomiting, skin lesions, and abdominal pain. Several leading scientists believe that the number and frequency of outbreaks such as these toxic blooms may be attributed in part to coastal pollution."

2.2 EFFECTIVENESS OF ADVANCED ONSITE SYSTEMS

Advanced OSTDS technology is available that improves the level of treatment over conventional septic systems. The DOH defines four levels of Advanced OSTDS: Aerobic Treatment Units (ATU); Secondary Performance Based Treatment Systems (PBTS); Advanced Secondary PBTS; and Advanced Wastewater Treatment (AWT), or AWT PBTS. It is noted that there are 11 Aerobic Treatment Units (ATU) and 70 Performance Based Treatment Systems (PBTS) permitted on Captiva, amounting to 36% of the 224 permitted OSTDS on Captiva. These Advanced OSTDs require operating permits, maintenance contracts, and are subject to annual inspection by the DOH. The DOH Lee County reports that a few of the PBTS permitted on Captiva also meet Advanced Secondary criteria. There are no AWT PBTS on Captiva. The AWT PBTS criteria developed by the DOH is currently specifically used and required only in Monroe County (Florida Keys) because of concerns for nutrient removal. A description of the levels of Advanced OSTDS follows. These are as defined in FAC 64E-6.

2.2.1 Aerobic Treatment Unit (ATU)

Aerobic Treatment Units are similar to conventional septic systems except that air is introduced to the sewage to promote aerobic biochemical stabilization. Key points regarding ATU are:

- These systems have limited nutrient removal (although better than conventional septic), and still rely on the limited capacity of the drainfield to remove nitrogen.
- Required effluent quality less than or equal to 30 mg/L BOD and 30 mg/L TSS.
- Use of an ATU allows for a 25% reduction in the size of the drainfield.

2.2.2 Performance Based Treatment System (PBTS)

Performance based OSTDS have more requirements and restrictions than conventional systems or ATUs. The rules are established in FAC 64E-6 Part IV. They must be designed by a Professional Engineer and are essentially small individual wastewater treatment plants. The rules allow for larger homes and reduced size requirements for drainfields. The three levels of PBTS defined by the DOH are: (1) Secondary Treatment, (2) Advanced Secondary Treatment, and (3) Advanced Wastewater Treatment (AWT) which is Advanced Secondary plus Nutrient Removal.

Secondary PBTS:

- These systems have limited nutrient removal although better than ATU's and conventional septic. PBTS systems consist of multi-stage treatment tanks that typically include mechanical aeration, solids separation, and pumping units.
- They can remove up to 50% of Nitrogen down to an effluent concentration of approximately 25 mg/L, although this is not a permit criteria. The majority of the PBTS OSTDS that have been installed on Captiva provide secondary treatment according to the DOH Lee County.
- Required effluent quality less than or equal to 20 mg/L BOD and 20 mg/L TSS.

Advanced Secondary Treatment:

- Nutrient removal is required to meet the criteria for Advanced Secondary PBTS. These systems consist of multi-stage treatment tanks that typically include equalization, mechanical aeration, solids separation, recycle stream pumping units, and special filter media for nutrient removal.
- They can remove up to 70% of Nitrogen down to an effluent concentration of approximately 15 mg/L.
- According to the DOH Lee County there are a few Advanced Secondary PBTS OSTDS systems that have recently been placed in service for single family homes in the Estates area of Captiva Island.
- Required effluent quality less than or equal to 10 mg/L BOD, 10 mg/L TSS, 20 mg/L TN and 10 mg/L TP.

Advanced Wastewater Treatment (AWT):

- These systems consist of advanced secondary treatment with additional nutrient removal (As proposed for installation by Florida Keys Aqueduct Authority (FKAA) for Monroe County.
- Special Regulations are provided in FAC 64E-6 Part II specifically for Monroe County.
- They are intended to remove up to 90% of nitrogen compounds down to an effluent concentration of less than 10 mg/L.
- Current technology uses special clay aggregate absorption media for phosphorous removal down to an effluent concentration of 1 mg/L.
- In the Florida Keys the effluent from these systems is planned to be disposed of with shallow injection wells, but may be either drainfields or shallow injection well.
- Required effluent quality is less than or equal to 10 mg/L BOD, 10 mg/L TSS, 10 mg/L TN, and 1 mg/L TP.
- It should be noted that these are new technologies and there is no sustained performance data or historical operating costs.

The DOH has requirements for PBTS OSTDS that place additional responsibility on the property owner over those required for conventional septic systems:

1. The homeowner must maintain a current operating permit for the life of the system. The operating permit must be renewed every two years and costs $150.00 payable to the Department of Health. The operating permit is non-transferrable.

2. The homeowner must maintain a valid maintenance contract with an approved maintenance entity for the life of the system. The maintenance contract on new construction will initially be good for two years. Subsequent renewals must be good for at least a one-year term for the life of the system. Prices vary depending on the maintenance entity selected and type of system.

3. The maintenance contractor is required to inspect and service the PBTS at least two times per year. Inspection reports must be submitted to the Department of Health in Lee County.

4. The Department of Health must inspect the maintenance and performance of the PBTS at least once per year.

5. Additional requirements for a PBTS unit used for treating domestic or commercial sewage flows in excess of 1500 gallons per day include: a maintenance entity which has at least one Class D state certified wastewater treatment plant operator; effluent water quality samples for $CBOD_5$ (BOD), total suspended solids (TSS) and fecal coliform shall be collected at least semi-annually and the samples must be analyzed by an approved laboratory and submitted to the DOH.

Table 2-2: Summary of OSTDS Technology in Florida

DOH Regulated Permit Limits in mg/L	**Conventional Septic System**	**Aerobic Treatment Unit (ATU)**	**Secondary Performance Based Treatment System (PBTS)**	**Advanced Secondary PBTS** (1)	**Advanced Wastewater Treatment (AWT) PBTS** (2)
TSS	50 mg/L (assumed not regulated)	30 mg/L	20 mg/L	10 mg/L	10 mg/L
BOD	50 mg/L (assumed not regulated)	30 mg/L	20 mg/L	10 mg/L	10 mg/L
Total TN	No removal	No Limit	No Limit	20 mg/L	10 mg/L
Total TP	No removal	No Limit	No Limit	10 mg/L	1 mg/L

(1) Highest level treatment OSTDS currently permitted in Lee County
(2) Not enforceable outside Monroe County under current regulations

3.0 WASTEWATER MANAGEMENT ALTERNATIVES

3.1 DEFINE SERVICE AREAS

Before discussing wastewater management alternatives, it is useful to define unique service areas on Captiva Island. Four service areas have been identified, each service area identified has unique characteristics and are areas familiar to the local population. The breakdown of each service area by the number of parcels as designated by the Lee County Property Appraisers database are listed in Exhibit 1 and shown graphically in Figures 1-12. For use in wastewater capacity planning, Exhibit 2 provides an analysis of the Equivalent Residential Connections (ERCs) for the properties in the Village, Tween Waters, and Estates service areas according to criteria in the City of Sanibel's Code 1981, §19-85. A brief description of each service area is provided below. As with Sanibel Island, all potable water used and distributed on Captiva Island is provided by the Island Water Association (IWA) which operates a Reverse Osmosis (RO) WTP located on Sanibel that treats brackish groundwater to drinking water standards. RO concentrate is disposed of by a deep injection well into a deeper saline aquifer.

3.1.1 South Seas

The South Seas Service Area, located on the northern tip of Captiva Island, consists of 553 parcels of land, which mainly make up the 330-acre South Seas Island Resort, formerly known as The South Seas Plantation. (See Figures 1 and 2). The area consists of condominiums and single family residential units with a large resort hotel and restaurants. The properties located at 14790 through 14840 Captiva Drive make up the south boundary of the South Seas Service Area. Centralized wastewater collection and treatment is provided by the Florida Government Utilities Authority (FGUA) who owns and operates the South Seas Plantation WWTP.

3.1.2 The Village

The Village Service Area consists of 307 individual parcels of commercial and residential properties. The north boundary runs along the north side of the Rauschenberg estate and includes the property located at 14850 Captiva Drive continuing on the north boundary of properties located on Laika Lane as shown in Figures 3, 4, 5 and 6. Located within the Village Service Area are two private residential communities known as Sunset Captiva and Captiva Shores. Sunset Captiva and Captiva Shores are serviced by privately owned wastewater collection and package treatment plants (Sunset Captiva WWTP and Captiva Shores WWTP). The remaining properties are served by individually owned OSTDS. There are 5 ATUs and 39 PBTS located within this service area out of 219 parcels presumed to have OSTDS. Therefore advanced OSTDS make up 20% of the total OSTDS in the Village Service Area.

3.1.3 Tween Waters Stretch

The Tween Waters Service Area consists of 47 single and multifamily parcels and the 142-acre Tween Waters Inn Island Resort & Spa. The north boundary of the Tween Waters Service Area starts at the single family residence located at 15687 Captiva Drive and the south boundary ends at the single family residence located at 16213 Captiva Drive as shown on Figures 6, 7 and 8. The Tween Waters Inn is served by a privately owned wastewater collection system and the Tween Waters WWTP. The remaining properties are presumed to be served by individually owned OSTDS. There are 2 ATUs and 11 PBTS located within this service area out of 47 parcels presumed to have OSTDS. Therefore advanced OSTDS make up 28% of the total OSTDS in the Tween Waters Service Area.

3.1.4 The Estates

The Estates Service Area consists of 112 parcels with single family residential and multi-family properties. The northern boundary starts at the single family residence located at 16238 Captiva Drive with the south boundary terminates at the Lee County Turner Beach Public Park (17200 Captiva Drive) on the southernmost tip of Captiva Island. The Estates Service Area is shown in Figures 8, 9, 10, 11 and 12. There is 1 ATU and 29 PBTS located within this service area out of the 112 parcels presumed to have OSTDS. Therefore advanced OSTDS make up 27% of the total OSTDS in the Estates Service Area. The DOH reported that a few of these units (3 assumed) meet the Advanced Secondary PBTS criteria.

3.2 MAINTAIN ONSITE WASTEWATER TREATMENT ALTERNATIVE

This section attempts to identify the long-term impacts of continuing to use the existing wastewater management systems on Captiva Island, primarily the use of onsite sewage treatment and disposal systems (OSTDS) for areas outside the service areas of the four existing wastewater treatment plants. The existing wastewater treatment plants are permitted by the Florida Department of Environmental Protection (FDEP) and the owners must provide regular operating reports and annual capacity analysis reports, as well as notification to FDEP of any violation of their permit requirements. In that sense they are already monitored and in compliance with current environmental regulations. And they would be subject to any future regulations adopted by the State of Florida as enforced by the FDEP. Note that the existing permitted OSTDS are regulated separately by the State of Florida Department of Health Lee County (DOH). As discussed, there are an estimated 73 OSTDS on Captiva that are appear not to be permitted by the DOH.

3.2.1 Advantages for Maintaining Existing Onsite Wastewater Treatment

1. The current OSTDS systems on Captiva comply with the State of Florida Department of Health Chapter 64E-6 Florida Administrative Code. There are 378 developed properties using OSTDS for wastewater management. Of these 224 are permitted conventional systems, 11 are permitted ATU systems, and 70 are permitted PBTS, a few of which are Advanced Secondary PBTS. This leaves 73 unpermitted OSTDS that are grandfathered and assumed to have been constructed prior to permitting requirements. This represents only about 20% of the OSTDS on Captiva. As these existing OSTDS are replaced over time they will be required to be permitted.

2. Conventional septic tank systems are cost effective in the short term. Although there are regulatory requirements regarding the initial construction of a conventional system, once constructed there are minimal requirements as long as they are properly maintained and functioning as designed. With the exception of concerns related to nutrient impacts on near shore water quality, it could be said that conventional septic systems and OSTDS in general create the least overall environmental impact in terms of land use, energy, material resources, and manpower.

3. A large percentage (27%) of the permitted OSTDS on Captiva are either Aerobic Treatment Units (ATU) or Performance Based Treatment Systems (PBTS) that have improved effluent quality and that are routinely monitored by the DOH. These more advanced OSTDS systems have additional requirements over conventional septic systems:

    a. Designed by a Florida licensed professional engineer with a background in wastewater engineering to meet the specific and measurable established performance standards.
    b. Individual homeowners/commercial owners are responsible for maintaining the PBTS for the entire life of the system.
    c. A valid operating permit.
    d. A maintenance contract with an approved maintenance entity for the system. Quarterly lab samples.
    e. Regular Site inspections/maintenance report.
    f. DOH performs annual inspections.

4. Properly designed and maintained drain fields that are not saturated are safe as far as public health.

5. The Environmental Protection Agency, the Florida Department of Health, Florida State Water Management Districts and Lee County provide readily available guidance documents, Best Management Practices, individual Websites, and hands-on education for property owners in the maintenance of onsite wastewater management systems.

6. There are 19 Florida licensed Septic Tank Contractors listed in Lee County that service and maintain septic systems.

3.2.2 Disadvantages for Maintaining Existing Onsite Wastewater Treatment

1. There are existing septic systems that do not have a permit and are not currently monitored. These onsite systems will require permitting as they are repaired or replaced. These existing OSTDS may not meet the current requirements of FAC 64E-6. When they are required to be permitted they may need to be converted to one of the more costly advanced OSTDS technologies.

2. There is a general concern for the environmental impacts of nutrients released into ground water that migrate to near shore water. Even the highest level of advanced OSTDS defined by DOH, the AWT PBTS, does not produce an effluent quality equivalent to an advanced (AWT level) wastewater treatment plant. Environmental concerns for State protected waters could lead to mandated action, although it would likely take years. For example, in 1995 Congress directed the U.S. Environmental Protection Agency and the state of Florida to create the Water Quality Protection Program for the Florida Keys. In response, Florida State legislators adopted special rules in an update to FAC 64E-6

that specifically addresses the Florida Keys regarding the construction, installation, modification, operation, repair, maintenance, and performance of onsite sewage treatment and disposal systems. These are only now being implemented. Although unlikely, it is not unreasonable that new rules could be adopted for the West Coast of Florida to protect water quality. It is known from the recent Charlotte Harbor study (2016) that portions of upper Charlotte Harbor and parts of Estero Bay (an aquatic preserve) have nutrient hot spots due to effluent from conventional septic systems migrating to near shore waters.

3. Predictions that climate change will accelerate sea-level rise and result in a higher groundwater table if accurate may require reconstruction of existing drainfields. While the potential for sea-level and groundwater rise in coastal areas is an engineering concern for all wastewater management infrastructure, onsite systems are more vulnerable. New utility owned and operated central systems would be designed to resist the impacts of sea-level rise. Commentary regarding sea-level rise is provided in the following paragraphs.

   In 2010 the Florida east coast counties of Broward, Miami-Dade, Monroe, and Palm Beach formed the Southeast Florida Regional Climate Change Compact to coordinate sea-level mitigation and adaptation activities across county lines. According to the Southeast Florida Regional Compact Climate Action Plan, updated in October 2015, they based planning on predicted sea-level rise of 6 to 10 inches by 2030, 14 to 26 inches by 2060 and 31 to 61 inches by 2100. Recently, Broward County ordered that new flood maps be drawn using these predictions of higher water. Since then Fort Lauderdale has raised the required height of sea walls and the elevation of home sites; Delray Beach added valves to keep salt water out of the city drainage system, Florida Keys voters agreed to raise height limits for homes on the island 3 to 5 feet back in 2014; Monroe County is proposing to raising local roads in two Florida Keys neighborhoods, and the Town of Miami Beach is implementing $500 million of infrastructure improvements to address increasingly frequent non-storm related King Tides.

   Although predictions of sea-level rise are slightly lower for the west coast of Florida, sea-level rise would impact coastal groundwater levels and could make the septic tank systems inoperable. Hans J.M. Wilson, a Fort Myers planner who grew up on Captiva, said that because sea-level rise is “slow and insidious,” it is difficult to get the public and policymakers to take it seriously. Although he said the Gulf side of Captiva has some elevation, he predicted “there will be growing salt water intrusion into septic systems and wells on the island, especially on the bay side.” The US Army Corp of Engineers and the NOAA predict sea-level rise of 1.3 ft. to 2.1 ft. by 2048 for the southwest coast of Florida. [*The Coming Reality of Sea-Level Rise*, Harold Wanless, Ph.D., January 2017.]

Regarding the existing OSTDS on Captiva that are apparently not permitted, these are assumed to have been establish before there was a regulatory process in place in the 1990s. Existing conditions prior to a regulatory process are automatically grandfathered until something changes. In the future, if an existing not permitted OSTDS needs to be repaired or rebuilt, or is not functioning, it would need to be permitted and would be regulated to meet then current requirements of FAC 64E-6.

The key to the effectiveness of the existing permitted OSTDS systems is enforcement, operations, periodic inspections, and periodic maintenance. Currently this is done by the DOH and in a perfect world further management should not be necessary. Eventually it is possible that all OSTDS located on Captiva Island will be required to upgrade to provide some level of nutrient removal as existing systems are repaired, replaced and re-permitted.

3.3 PROMOTE BEST AVAILABLE TECHNOLOGY ONSITE SYSTEM ALTERNATIVE

This wastewater management alternative considers a more accelerated transition to the best available technology onsite systems than likely under the current DOH regulations. Therefore, this wastewater management alternative assumes taking a more proactive approach that phases out conventional septic systems and promotes transition to the more advanced OSTDS along with more rigorous monitoring and enforcement of permit requirements for privately owned wastewater systems. As discussed above, excluding the areas served by the four wastewater treatment plants (South Seas, Sunset Captiva, Captiva Shores, and Tween Waters Inn), there are 378 OSTDS systems currently located on Captiva Island.

According to the DOH, there are a few PBTS permitted on Captiva that meet Advanced Secondary performance criteria, the highest level of OSTDS systems currently used in Lee County. However, even the most advanced, regulated, and properly operating and maintained Advanced Secondary PBTS OSTDS systems have limited capacity to remove the nutrients in domestic wastewater. Therefore to be comparable with the water quality benefits of centralized systems, this alternative assumes a transition over time to the use of the Best Available Onsite Technology. In Florida, the most advanced OSTDS systems are those required by FAC 64E-6 for Monroe County (Florida Keys) and managed for the County by the Florida Keys Aqueduct Authority (FKAA). These AWT level PBTS OSTDS are used in locations where it is not feasible to extend central sewer.

3.3.1 Best Available Technology OSTDS Systems – the FKAA System

The Best Available Technology system envisioned for a decentralized wastewater management alternative is based on the systems developed by the FKAA for implementation in the Florida Keys. Over time this approach considers upgrading the 378 developed parcels currently served by OSTDS with Advanced Secondary PBTS with Nutrient Reduction meeting AWT PBTS criteria. The existing installed PBTS OSTDS may only need minor modifications to provide the added nutrient removal. See Appendix A for more information on the FKAA OSTDS program.

The typical FKAA Advanced Secondary with Nutrient Reduction (AWT) OSTDS system is comprised of multiple buried tanks that perform the necessary flow equalization, nitrate removal using an anoxic zone or tank, settling units, and a filtration system to remove remaining nitrogen and phosphorous. As reported by the FKAA the cost is site specific but an average cost to install an FKAA approved AWT PBTS OSTDS system with a small diameter gravity shallow injection well for effluent disposal is about $35,000 which is not unreasonably expensive. FKAA found that a shallow well is less costly than a drainfield to construct and conceivably more immune to the impact of rising water tables.

Although effective AWT level OSTDS systems have only recently been installed in the Keys, the development of an effective advanced OSTDS technology for use in the Florida Keys was initiated in 1998 with a study conducted by the EPA and Florida Department of Health. At that time it was determined that the onsite systems studied and tested provided good treatment but could not achieve the goal of 5 mg/L $CBOD_5$, 5 mg/L TSS, 3 mg/L TN, and 1 mg/L TP. Therefore, rules were subsequently established for AWT level OSTDS to meet a very high quality effluent of 10 mg/L BOD, 10 mg/L TSS, 10 mg/L TN and 1 mg/L TP.

By legislative action FAC 64E-6 has a section specifically addressing the unique character of the Florida Keys. It requires that all onsite systems remaining in Monroe County comply with the requirements for an AWT level PBTS. FAC 64E-6 allows use of either a properly designed, permitted, and maintained effluent disposal drainfield or a shallow injection well for effluent disposal. FKAA found that a shallow small diameter injection well 4 inches in diameter and about 60 feet deep is effective and more economical to construct than a drainfield. Shallow injection wells are more resistant to rising water tables and storm flooding than a mounded drainfield.

In the Florida Keys the more complex AWT PBTS are administered and managed under a utility based ownership and management system. That is, the FKAA installs and manages the OSTDS on an easement granted by the property owner. The property owner is billed for the service by the utility, and is not directly responsible for monitoring and maintenance of the installed AWT PBTS system.

An emerging concept based on network technology is distributed (or satellite) wastewater treatment. In this concept advanced on-site systems are both monitored and importantly controlled remotely by a licensed wastewater operator. Conceivably these can be permitted collectively by the FDEP as a single wastewater treatment system rather than individually by the DOH. As a FDEP permitted wastewater treatment system, distributed wastewater treatment would be subject to the same reporting, monitoring, and enforcement of the permit conditions as a FDEP permitted wastewater treatment plant. A 2-year pilot satellite wastewater treatment system is being considered by Hernando County Utilities (personal communications with Jeff Littlejohn, Senior Vice President of OnSyte Systems, August 2018). This concept however also relies on utility-based central management.

3.3.2 Enhanced Effluent Disposal with Shallow Injection Wells

As mentioned above, the FKAA found that the favorable geological condition of permeable coral rock allows the use of small diameter relatively shallow gravity fed injection wells for effluent disposal. This method of effluent disposal is also more resistant to the impact of high ground water. Although there are significant hydrogeological differences between the Florida Keys and Captiva Island, the use of a shallow well for wastewater effluent disposal for individual properties may be possible. By example the South Seas WWTP has a permitted shallow injection well for disposal of a small portion of its effluent. The following conditions would be required for any shallow injection wells permitted on Captiva Island:

1. There can be no drinking water wells to protect either below, above, or beside the injection zones used by the shallow wells.
2. The underlying aquifer contains high salinity water, and is not usable for or connected to a drinking water aquifer.
3. The aquifer formation is permeable which allows for gravity or low-pressure injection, resists clogging, and has a high level of diffusion which quickly dissipates effluent.

4. There are few options for land based infiltration due to poor soils or high ground water.

On Captiva Island, a shallow injection well would target the Tamiami Limestone aquifer that lies at a depth of 40-80 feet below land surface. The South Seas WWTP does have a permitted shallow injection well that is an 8-inch diameter well with 70 feet of casing with an open hole to a depth of 100 feet. This aquifer is permeable and generally confined both above and below the aquifer, and the water quality is generally saline. The differences that need to be considered with use of shallow injection wells on Captiva Island as compared to shallow injection wells used in the Florida Keys are as follows:

1. There may be a freshwater lens in the overlying Water Table Aquifer. Generally, permitting agencies will not see this freshwater lens as a viable resource needing regulatory protection but it is often present and could constitute an impediment to permitting if good confinement between the aquifers cannot be well established.

2. There are brackish water supplies below the Tamiami Limestone. These aquifers are considered potential drinking water sources using Reverse Osmosis Technology as used by the Island Water Association for drinking water for both Sanibel and Captiva Islands. These aquifers are confined from a potential target injection zone and therefore not likely be a technical issue; however, permitting agencies will have a concern not present in the Florida Keys.

3. The aquifer beneath Captiva Island is permeable but on the order of 1/10 that of the Biscayne Aquifer underlying the Florida Keys. The aquifer transmissivity should be adequate for a single OSTDS but is much less permeable than the aquifer underlying the Florida Keys. A 4-inch diameter well cased into the top of the Tamiami Limestone aquifer and open to a depth of 80 feet should have the capacity to receive daily disposal of the effluent from a single family AWT PBTS OSTDS. If it was permitted the cost of a small diameter shallow injection well will be comparable to the cost in the Florida Keys which is reported to be about $5,000.

3.3.3 Program Management for Best Available Technology Onsite Systems

A wastewater management system incorporating the best available technology presents an implementation challenge. This available technology is not enforceable anywhere in Florida outside Monroe County. To be enforceable would require legislation amending FAC 64E-6. Further, the best available technology systems are more complex and are better maintained by a utility rather than an individual property owner. Monroe County uses the Utility as Responsible Management Entity model, and the FKAA is tasked with providing this service. The AWT level PBTS installed in Monroe County are owned by the FKAA and located on easements granted by the property owner. The property owner is billed for wastewater services just as if they were connected to the central system.

In summary, an advanced and aggressive program as used in the Florida Keys for implementing AWT level PBTS onsite systems would require action of the State legislature and participation of a public utility to manage and implement. This scenario is very unlikely for Captiva. And, it should be noted evidence of environmental impacts from septic tank effluent to near shore waters is significantly less compelling than was experienced in the highly impacted Florida Keys. Septic tank replacement on Captiva Island is not likely to be mandated as it was in the Florida Keys. Any such program on Captiva Island would be voluntary. As such,

Captiva property owners would not have the benefit of State and Federal funding assistance provided to the FKAA that reduced the cost of implementing this technology.

3.4 DEVELOP CENTRALIZED COLLECTION AND TREATMENT ALTERNATIVE

3.4.1 Local Government Decisions for Septic Tank Replacement Programs

This section provides an overview of decisions made in other island communities implementing centralized wastewater collection and treatment. During the 1970s, 1980s, and 1990s in-migration accounted for 85-90 percent of Florida's population growth. In those years Florida's population increased by 13 million people. Rapid development into coastal areas not served by public utilities led to urban communities being developed without central wastewater or water infrastructure. The city of Cape Coral is an example, and their long-standing and costly utility expansion program is still on-going. As communities incorporated they started to look at centralizing wastewater collection and treatment. An impediment has been, and continues to be, the high cost of redeveloping water and wastewater infrastructure in already built communities, as compared to installing utilities in new developments prior to building. To the extent the information was available within the scope of this study, the following discussion summarizes the primary motivations for other island communities making the decision to replace onsite wastewater treatment and disposal with a centralized wastewater collection and treatment. Generally the motivation appears to be either to allow higher density development or a concern for environmental protection of near shore waters from nutrient pollution. Public health has not been a primary motivation.

3.4.1.1 City of Sanibel

In 1967, the Sanibel Captiva Conservation Foundation was formed with the core mission of preserving Sanibel's unique interior freshwater system. In 1974, the City of Sanibel incorporated. Until the early 1970's wastewater management on Sanibel consisted of onsite septic systems serving residences and small package wastewater treatment plants serving resorts. The first centralized system was established privately in the late 1970's and subsequently acquired by the City after incorporation in 1991, this included the Wulfert Point WWTP currently not used. The City completed its first wastewater master plan in 1992 and since that time has systematically expanded a centralized wastewater collection and treatment system with treatment at the Donax Water Reclamation Facility (WRF) constructed in 1995, and expanded in 2003. This facility is currently permitted for 5.0 mg/L TSS, 30 mg/L BOD, 5.0 mg/L TN with no limit in Phosphorus. Related to this facility development was expansion of a reclaimed water effluent disposal system though urban and golf course irrigation. The City implemented new codes and requirements for onsite stormwater management, implementation of the National Pollutant and Discharge Eliminations System (NPDES) Program, conversion of the majority of the island from septic to central sewer, elimination of wastewater treatment package plants, island-wide water quality monitoring, adoption of an urban fertilizer ordinance and management recommendations for golf courses. Even with these extensive conservation efforts, declines in canal and near shore water quality and in the previously highly impacted natural catchment slough known locally as the Sanibel River continue to be reported. It is now thought that this nutrient loading is caused by residual nutrients in the reclaimed water used for irrigation. The City is currently evaluating options for upgrading the Donax WRF to the AWT level of treatment that will further reduce nutrients in the reuse water delivered to island golf courses and residential properties. In 2016, the City received partial funding in the amount of $825,000 from the Florida Legislature to help with these upgrades. The current budget (2017) for the utility

system includes about $13.0 million for process improvements at the Donax WRF over the next 6 years (78% of the total Capital Improvement Program).

3.4.1.2 Marco Island

In 1962, the Mackle family and their company, the Deltona Corporation, purchased most of Marco Island from the heirs of Barron Collier. As part of the development, the first Marco Island Wastewater Treatment Plant was built in 1972 to serve the Islands' then population of 5,000 full and part time residents. In 1989, the water and sewer utilities for Marco Island were purchased from the Deltona Corporation by Southern States Utilities. Southern States Utilities additionally purchased and operated the Marco Shores system. The water and sewer utility operation and maintenance was transferred to another private utility operator, Florida Water Services (FWS), in 1994. The City of Marco Island purchased all FWS-owned utilities on and around Marco Island on November 6, 2003. With the exception of the North Marco Utilities sewer infrastructure, the City now owns all utilities on the Island as well as other unincorporated areas of Collier County including Marco Shores, Goodland, Key Marco, and the wastewater utilities on the Isles of Capri. In 2003 about 40% of the island had sewers and centralized treatment primarily in the commercial and resort areas and about 60% of the island, mostly residential areas, had conventional septic systems. The city commissioned a water and wastewater master plan completed in 2005 that discussed installing sewers to replace septic tanks in residential neighborhoods. In 2007 the City initiated a City-wide Septic Tank Replacement Program (STRP) that was completed in 2012. A finding that facilitated approval and acceptance of this program by the island residents was evidence of septic system pollution in the many canals and off beaches detected by finding trace amounts of caffeine in water samples. While the central sewer system serving the commercial areas of Marco Island appears to have been built to promote development, the STRP program was motivated by environmental and health concerns and by the general inappropriateness of septic systems in this relatively dense urbanized island environment with many canals.

3.4.1.3 Fort Myers Beach (Estero Island)

Development on Estero Island, originally named Crescent Beach, was slow until the 1920s when Florida gained national attention as a vacation destination. The 1950s brought tourist development to Fort Myers Beach. In 1978 Lee County acquired and then expanded the Fort Myers Beach WWTP located on Pine Ridge Road. The service area was expanded to eliminate 50 small package plants and thousands of septic systems. Centralized wastewater collection and treatment was extended to Estero Island. While the plant expansion was covered by an EPA grant, a MSBU was established to recover the cost of gravity lines for septic systems. Wastewater is pumped off island to the treatment plant through a pipeline under Estero Bay. The Fort Myers Beach WWTP was expanded again to provide centralized wastewater service to the mainland west of Bass Road. On December 31, 1995 the Town of Fort Myers Beach was incorporated. The Town acquired an on-island private utility that distributed potable water purchased wholesale from Lee County but Lee County provides and maintains the central sewer system. It appears that the primary motivation for replacing septic systems on Estero Island was to allow development. There is no record found that water quality issues initiated the project. The off-island treatment is facilitated by reasonable proximity to a mainland wastewater treatment plant.

3.4.1.4 Long Boat Key

The Town of Longboat Key was incorporated on November 14, 1955. Development started gradually but hit a peak in the 1960's and 1970's. In 1958 Arvida Corp planned a $90 million development program of exclusive waterfront home sites along with water and sewer facilities and commercial buildings. The expectation was to add 12,000 residents to Longboat's then population of 1,200. Town Commissions gradually tightened the zoning and approved the Town's water and sewage program beginning in the 1970's. It was estimated at the time that these utilities would eventually serve a population of 26,000. Wastewater is collected on island and pumped through a pipeline crossing under Sarasota Bay to the Manatee County WWTP in west Bradenton for treatment. It appears that the primary motivation for replacing septic systems on Long Boat Key was development. Off-island treatment was facilitated by reasonable proximity to a mainland wastewater treatment plant.

3.4.1.5 Boca Grande (Gasparilla Island)

Boca Grande was initially developed for phosphate shipping and sport fishing. Boca Grande Pass is one of the deepest natural inlets in Florida and this resource promoted the development of the town of Boca Grande. In 1966 through the efforts of the Boca Grande Women's Club, the Gasparilla Island Water Association, Inc. (GIWA) was formed as a non-profit member owned water and sewer utility. The members of GIWA are property owners on Gasparilla Island and the Boca Grande Causeway that are connected to GIWA's water and sewer system. Islanders serve on the administrative board and operate the system, which has a sewer treatment plant, well fields off the island, and a reverse osmosis water treatment plant. Deep injection wells are used for effluent disposal. GIWA is currently evaluating options for upgrading the WWTP to the AWT level of treatment that will further reduce nutrients in the reuse water delivered to the island golf course. It appears that development of a centralized wastewater collection and treatment system was motivated by the need to clean up the port facilities and unusually forward thinking regarding the protection of near shore water quality.

3.4.1.6 Florida Keys

The Florida Keys (Keys) are a chain of islands extending from the southern tip of the Florida mainland southwest to the Dry Tortugas in portions of both Miami-Dade and Monroe counties. In 1999 due to near shore water quality impacts to a national marine sanctuary and the world's third largest coral barrier reef, the State ordered Monroe County to convert the unincorporated areas of the County to central sewers. In 2000 the U.S. Congress directed the U.S. Army Corps of Engineers to help Monroe County develop and implement a county wide wastewater management (and stormwater management) improvement program. The major study and resulting master planning effort completed in 2000 and updated in 2007 confirmed that nutrients from wastewater were the major contributor to the decline of water quality in the Keys. At the time there were 23,000 private onsite systems and 246 small (package) wastewater treatment plants operating throughout the unincorporated areas of the Florida Keys. An estimated 30% of the onsite system were not permitted and it was estimated that 2800 of those were illegal cesspools. The Florida Keys Aqueduct Authority (FKAA), historically a potable water provider only, was tasked by the State with implementing the wastewater improvement program and therefore became a wastewater utility in the unincorporated areas of Monroe County.

Ultimately 150 to 200 properties were found to be so remote that it was not practical to connect them to a central wastewater system. The FKAA received a $3.7 million alternative technology grant from the EPA to develop an OSTDS that would remove nutrients to a more advanced level. These systems are currently being implemented under a program where the FKAA owns and manages the AWT OSTDS installed on easements granted by the property owners.

In 1979 the City of Key West was mandated by the State to cease ocean outfall of raw sewage and construct a wastewater treatment plant with an ocean outfall for treated effluent. Subsequently, the City expanded wastewater collection and eliminated all remaining septic systems and upgraded the City's treatment plant to advanced wastewater treatment (AWT) technology and constructed a deep injection well to dispose of effluent underground eliminating the ocean outfall.

3.4.2 Centralized Wastewater Treatment Opportunities

The idea of providing a centralized wastewater system on Captiva has been looked at since at least 1996 [*Hartman and Associates study for Tween Waters Inn, June 1996*]. Concepts for a centralized wastewater system can be generalized to: (1) treating all wastewater on-island; (2) treating all wastewater off-island or, (3) treating a portion of wastewater off-island. Treating all or a portion of the wastewater generated on Captiva off-island will require partnering with the City of Sanibel.

Centralized wastewater treatment is performed at a mechanical and biological wastewater treatment plant. Sewage is collected and pumped to the central location. Wastewater treatment plants include provisions for effluent disposal, most often in coastal Florida this is by reuse of reclaimed effluent for irrigation or by disposal in an environmentally secure well. Effluent, even highly treated effluent, is rarely permitted to be discharged to surface waters. For the following discussion it is useful to review the basic levels of mechanical and biological wastewater treatment. Primary treatment was practiced initially with a focus on removal of suspended solids, and was still the level of treatment used by some Florida coastal cities with ocean outfalls until fairly recent times. Secondary treatment adds the removal of biological oxygen demand (BOD) by aerobic biological treatment. Typical permit limits for secondary treatment require 90% removal of BOD and 90% removal of suspended solids (TSS). Most modern WWTPs (but not all package plants) treat to a standard above secondary referred to as advanced secondary. This level includes a higher percentage of BOD and TSS removal and conversion of ammonia nitrogen to less harmful (in terms of oxygen demand on receiving waters) nitrates. However, the effluent of advanced secondary WWTPs still contains nutrients that can cause excessive algae growth and related negative impacts to receiving waters. Tertiary treatment adds various levels of nutrient removal. Because Florida's freshwater resources evolved with very low levels of natural nutrients and are easily impacted, Florida has been a forerunner in the use of tertiary treatment. In Florida this has become known as Advanced Wastewater Treatment (AWT). Because AWT treatment is significantly more costly, this has also resulted in Florida being at the forefront of effluent reuse. This is because the FDEP does not generally require AWT level treatment for effluent that is reused for landscape irrigation rather than discharged to surface waters.

Discussions of alternative concepts for a centralized wastewater collection and treatment system for Captiva Island are as follows.

3.4.2.1 Treat All Wastewater On-Island by Expanding the FGUA WWTP

The South Seas WWTP currently serves the entire South Seas Island Resort property north from Captiva Drive. This plant is operated by the Florida Government Utilities Authority (FGUA). FGUA is a legal entity and public body created by interlocal agreement pursuant to section 163.01(7), Florida Statutes. The FGUA was established pursuant to an interlocal agreement dated February 1, 1999, as amended by a 'First Amended and Restated Interlocal Agreement Relating to Establishment of the Florida Governmental Utility Authority' which was by and between Citrus, Nassau, Polk, and Sarasota Counties, dated as of December 1, 2000 (the "FGUA Interlocal Agreement"). FGUA was established for the purpose of acquiring, owning, improving, operating and maintaining water and wastewater utility facilities. Since the adoption of the FGUA Interlocal Agreement the FGUA membership has changed and is now comprised of Citrus County, Hendry County, Lee County, Pasco County, Polk County, and Marion Counties.

The FGUA does not generally have the mission to expand existing utility systems; however, if directed by their Board, FGUA would take on an expansion of the South Seas WWTP to include additional service areas on Captiva Island. This was conceptually addressed in 2015 in a technical memorandum prepared by staff (FGUA Memorandum dated August 3, 2015) and a summary presentation in a public meeting held in Captiva on December 8, 2015.

FGUA's 2015 conceptual study addressed three options:

1. Expand the FGUA South Seas WWTP to provide the capacity to serve all of Captiva Island.

2. Construct a new more centrally located WWTP at the current site of the Sunset Captiva WWTP sized to serve all of Captiva Island.

3. Construct a new more centrally located WWTP at the current site of the Sunset Captiva WWTP to serve only a portion of Captiva Island leaving out the Estates area which would continue to use onsite wastewater management.

Under these options the existing package WWTPs serving Sunset Captiva, Captiva Shores and the Tween Waters Resort would be eliminated and replaced by connecting to these private collection systems to a lift station that would transfer wastewater to the South Seas WWTP.

At that time the capital costs projected for Options 1 and 2 above were estimated to be about $15,000,000. Option 3 being slightly less at about $12,000,000. The memorandum cautions that these costs are rough estimates and that they do not include administrative costs or the cost of land acquisition.

It should be noted that the existing South Seas WWTP is isolated in a protected natural area and expansion of the facility site if needed would require the purchase of wetland mitigation credits.

Communications with FGUA reveal that there are no plans for expansion. FGUA did provide a copy on an internal technical memorandum addressing options for treating all wastewater generated on Captiva Island including an option to expanding the South Seas WWTP (Option1). The remaining area of Captiva Island, including areas served by existing package plants, accounts for 811 ERC. Using a planning capacity of 240 gpd per ERC (the same as used by Sanibel for their utility expansions) this comes to 194,640 gpd or 0.195 MGD

AADF additional capacity needed. In general terms, the existing WWTP capacity would need to be doubled to about 400,000 gpd. Using conventional technology about one acre of mangrove wetlands would be impacted in order to expand the plant using the current treatment technology (as presented in 2015). However newer technology using a compact Membrane Bioreactor (MBR) might allow the capacity expansion to take place within the existing developed site, or certainly with less than one acre of impacts to wetlands. It is likely that FDEP would require construction of a deep injection well (DIW) for disposal of the additional and any surplus effluent due to limited opportunities to use treated effluent for irrigation. If an intermediate well could be permitted the cost of the effluent disposal well would be reduced. It would require a challenging hydrogeological study and geotechnical analysis of confining layers to confirm that an intermediate disposal well would be environmentally acceptable.

The capital cost for expanding the existing South Seas WWTP would be about $4.5 million (FGUAs 2015 figure escalated at 3% per year) plus $6 million for a new DIW, or about $10.5 million total. (If it could be permitted an intermediate well might cost only $600,000.) This does not include the costs to mitigate mangrove damage and costs to harden the facility to impacts of sea-level rise and storm surge. Using MBR technology the cost to expand and upgrade the existing facility would be about $8 million; however, this may eliminate or significantly reduce impacts to mangroves and ease environmental permitting. Expanding the South Seas WWTP can be assumed to at least double the cost of operations currently about $550,000 per year including $50,000 per year for debt service.

The challenge with expanding the existing FGUA operated South Seas WWTP is the general vulnerability of the site do to its low elevation and exposure, the likely need for a costly Deep Injection Well (DIW) to dispose of the additional effluent, although a less costly intermediate well may be possible, and there is the complication of wetland mitigation if the site is expanded. FGUA reported it is also costly to operate due to the remote location. That said, expanding the South Seas WWTP to have capacity to treat all wastewater on Captiva appears technically feasible. This study did not look at issues that may need to be resolved to transport wastewater collected outside the South Seas Resort through private property. An engineering study addressing the capacity potential and associated costs of expanding the South Seas WWTP would be needed to further evaluate this alternative. This would include risk mitigation, emergency operations, standby power, reliability, effluent quality and effluent disposal.

3.4.2.2 Treat All Wastewater On-Island by constructing a new Advanced WWTP

Any discussion of this option requires identification of a suitable site for either a 400,000 gpd Advanced WWTP to serve the entire island (including the South Seas Service Area) or optionally a 200,000 gpd Advanced WWTP to serve only the areas outside the South Seas Service Area. This would require up to a two acre site for a new WWTP or at least about one acre for a smaller WWTP. No such site would reasonably appear to be available. The largest undeveloped property on Captiva Island is the Rauschenberg Property. Even if the trustees of this property were willing to consider such a transfer of property, the average elevation of this property is 3.11 feet (NAVD 88) and modeling based on projections for sea-level rise predicts tidally induced flooding for portions of this property 285 days per year by 2045, making this a poor choice of site for any permanent facilities. [*Coastal Risk Assessment Rauschenberg Property, Coastal Risk Consulting May 6, 2016*]

The FGUA also addressed a concept for a new on-island WWTP to be constructed at the site of Sunset Captiva package plant. In the 2015 study FGUA projected the cost of a new 250,000 gpd Advanced Secondary WWTP and the associated collection system for the Village, Tween Waters and Estates service areas at about $15 million. Alternatively, the cost for a 400,000 gpd Advanced WWTP with nutrient removal, along with a DIW for effluent disposal, which adds about $6 million to the cost, would be about $16,000,000. Added to this is the cost of the collection system for the three service areas at $15,700,000 (**Exhibit 3**) or a total of $31,700,000. This assumption of 400,000 gpd capacity would address the South Seas Service Area given the concern for site vulnerability of the South Seas WWTP. Operating costs for a new 400,000 gpd WWTP would be about $1,000,000 per year based on factoring FGUAs current operating budget for the South Seas WWTP.

Constructing a new WWTP on Captiva does not appear to be a reasonable alternative for further study due to severely limited or non-existent siting opportunities. Other factors to consider are effluent disposal, residuals (sludge) hauling and limited effluent reuse opportunities. Because the South Seas Resort relies on effluent from the South Seas WWTP for irrigation, if that facility was replaced by a new on-island wastewater treatment plant an irrigation well would need to be constructed at a cost estimated to be $160,000; a forcemain with associated storage and pumping to return treated irrigation quality effluent from the new facility to the South Seas Resort could be provided but would cost more than an irrigation well. Finally if the new WWTP served the entire island, there would be a cost to demolish the existing South Seas WWTP and remediate the site. This cost is estimated to be about $200,000 plus financial impacts. Although it is outside the scope of this study it can be assumed that there is a substantial debt service associated with the South Seas WWTP that would need to be equitably retired. A new on-island WWTP would need to be owned and operated by a managing utility, either Lee County Utilities or the FGUA, or by a newly established wastewater management district.

3.4.2.3 Partnering with the City of Sanibel to Treat Wastewater

The City of Sanibel owns two wastewater treatments plants, the Donax WRF and the Wulfert Point WWTP. The Wulfert Point WWTP is permitted but is currently dormant. The city has invested its resources into the larger and better located Donax WRF. Donax WRF process Unit 1 was constructed in 1995 and Process Units 2 and 3 were constructed in 2003 coinciding with the expansions of Sanibel's central sewer system. Sanibel has plans to upgrade this facility to Advanced Wastewater Treatment (ATW) standards with effluent having total nitrogen (TN) less than 3.0 mg/L and total phosphorous (TP) less than 1.0 mg/L. Sanibel also has plans to construct a DIW to increase options for effluent disposal. It appears the upgrade to AWT is on the City's own initiative and is not currently required by the FDEP. Sanibel is motivated to upgrade Donax to AWT because the City has found high nitrogen in water samples that indicate that the current irrigation with reclaimed advanced secondary effluent contains nutrients that eventually migrate to ground water and then to near shore and inland water (primarily the Sanibel River). As stated, the City does not operate the Wulfert Point WWTP and has no plans or interest in placing it in operation.

A meeting was held on December 14, 2017 with representatives of Sanibel's public works and engineering departments to discuss the technical feasibility of Sanibel extending the service area of their wastewater system into Captiva. This is already the case as Sanibel treats sewage from Turner Beach the Lee County park facility located on the south end of Captiva.

Regarding the closer Wulfert WWTP located on the north end of Sanibel, it was explained that Sanibel has no plans to place this plant back in operation. They have plans to use the site for tanks to store reclaimed water.

They expressed that operating two WWTPs would increase their costs and staffing requirements. To even consider using the Wulfert site they would require that a new WWTP be constructed that provides AWT level treatment. This would be costly and using the FGUA analysis likely cost as much as $15 million. It would also have significant political hurdles with likely opposition from Sanibel's local residents as it is located in a residential neighborhood. The new customers on Captiva Island would need to absorb the full share of the greater operating costs for inefficiency of operating two WWTPs.

Sanibel representatives expressed that they would consider accepting some new wastewater flow pumped to Sanibel's Master Pumping Station (MPS) No. 1 located on the northerly end of Sanibel off Sea Spray Lane. Wastewater would then be transferred to the Donax WRF through Sanibel's existing transmission system. Modifications to increase the capacity of MPS No. 1 and transmission mains may be needed.

Conditions for Partnering with Sanibel to provide wastewater service:

1. Sanibel would treat the customers on Captiva Island just like they treat customers on Sanibel Island. Customers would pay the same rates and user fees and pay the same connection or impact fee to buy their share of the capacity in the existing Donax. This charge is about $5,000. Also, just as Sanibel's own residents have done in a series of wastewater expansion projects over the years, the new customers would be obligated to pay an assessment for the cost of constructing the expanded collection system needed transport sewage to the City's closest master pumping station, the Sea Spray Pumping Station designated as MPS No. 1. The terms of repayment would be the same as offered to Sanibel residents, pre-paid or billed in 20 annual installments with interest, currently 3.5%, tied to the low interest State Revolving Fund (SRF) funding used to finance the construction of wastewater infrastructure.

2. The assessment and the connections fees would be based on the Equivalent Residential Connections served (ERC). ERCs are a measure of wastewater volume and a single ERC is based on the average wastewater generated by a single-family residence. Sanibel has found that the value of 240 gallons per day (gpd) per ERC is a good predictor of actual wastewater flow on Sanibel. Sanibel has developed factors for estimating the equivalent ERCs for commercial and multifamily properties.

3. The new collection system would be owned by Sanibel and maintained by Sanibel and would be built to their standards for utility construction. Under such a scenario Sanibel would finance, engineer, and construct the system, mostly in public Right of Way (ROW).

4. Sanibel's utility staff felt that the Donax facility had capacity for the serving the Village and Tween Waters service areas based on the ERC tabulation and projected flows presented at the meeting but cautioned that any flows above that level would require an engineering capacity analysis and evaluation of the cost impacts to both the Donax WRF and to the effluent disposal system before they would be able to evaluate a proposal to accepting more wastewater. Impacts and the associated costs to the pumping and transmission system would also need to be evaluated.

5. Sanibel's representatives also cautioned that their comments are based on general technical feasibility and that implementing such a plan would require approval of Sanibel's elected officials.

3.4.3 Proposed Alternative for Centralized Wastewater Collection and Treatment

For comparison to onsite wastewater management, the most feasible scenario for centralized wastewater collection and treatment appears to be a system of partial on-island treatment maintaining the existing collection and treatment system for the South Seas Island Resort (South Seas Service Area) with off island treatment provided by partnering with Sanibel. This could be refined further by considering off island treatment only for the more densely developed Village and Tween Waters service areas, while maintaining and advancing the application of performance based onsite systems for the Estates Service Area.

To test the feasibility of this concept both technically and economically, a conceptual design for a central wastewater system serving the Village and the Tween Water service areas was developed with the Estates service area as an option. It is based on conventional gravity sewers and liftstations. Construction of the forcemains would use direction drill technology to avoid open trench construction on Captiva Drive and under Wulfert Channel. Liftstations would be designed to resist damage from flooding and storm surge. The Captiva Master Pumping Station would have standby power. Smaller pumping stations would have quick connectors for portable generators. The collection system would be designed for saturated ground conditions and would be constructed leak tight.

The Estates Service Area is included as an option. The thought is that this area appears to have a number of properties that already have performance based onsite systems and because the properties are larger and the ROW more congested constructing conventional gravity sewers would be costlier and more disruptive.

This concept also excludes the South Seas Service Area, although in the case of both the Estates and the South Seas areas, consideration is given to connecting those areas in the future without the need to rebuild any parts of the collection system that might be constructed for the Village and Tween Waters service areas.

This plan eliminates the three package WWTPs currently located within these areas. In this concept the existing private collection systems are connected directly to lift stations. For this study the existing collection systems for the Tween Waters Inn, Sunset Captiva and the Captiva Shores Condominiums are assumed to remain privately owned and maintained, avoiding the need to reconstruct them to meet Sanibel's utility standards if different. This assumption would be reviewed if a program were to proceed to an engineering phase. (See Figures 1 through 12.) If the existing private collection systems meet standards and are incorporated in the program, an equitable adjustment could be made on the assesments for these properties.

The option that includes the Estates service area is based on the use of low-pressure systems versus a gravity collection system. Low pressure sewer systems are more economical and less disruptive to construct in low-density areas. This option incorporates a second low pressure forcemain that could be constructed at a future date by directional drill parallel to the new high pressure forcemain that connects the collection system for the central service areas to a Captiva Master Pumping station located on the south end of Captiva. Providing the parallel second low pressure forcemain also facilitates a scenario where the Estate properties have the option to connect to the central system using grinder pumps or keep their onsite performance based system. (See Figures 13 - 15 for the Estates Service area.)

Low-pressure systems use grinder pumps to reduce the solids and pressurize the system and therefore can be built with smaller wastewater lines that are not as deep, or on a specific grade. (See Figure 16 illustrates the typical connection to a low pressure system using a grinder pump.) These can be installed by direction drilling which reduces the surface disruption caused by open cut construction needed for gravity sewers on a grade. Properties on the north end of Sanibel are also served by low-pressure systems maintained by the City.

The gravity lines in the Village area should be sized to accept added flow from the South Seas service area if ever needed at a future date; or, if temporarily needed because of operational problems with the FGUA WWTP.

With wastewater originating on Captiva being ultimately treated at the Donax WRF, the reclaimed effluent would be utilized in Sanibel's reclaimed system for irrigation quality water. In that sense the effluent becomes a water resource benefiting the City of Sanibel.

Note, the scope of this study did not include communications with property owners or investigations of the conceptual siting of liftstations or any construction not in public Right of Way (ROW). The conceptual locations shown in Figures 1 through 12 are approximations based on engineering judgement, review of aerial maps, and publicly available property information.

3.4.4 Projected Cost for a Centralized Wastewater System based on Partnering with Sanibel

A concept for centralized wastewater collection system serving the Village and Tween Waters service areas is shown in Figures 1 through 12. A breakdown of the projected capital cost for this system is provided in **Exhibit 3**. The projected capital cost for constructing a collection system and extending a force main on Sanibel connecting to Sanibel's MPS No. 1 is $11,193,390. As presented in **Exhibit 2**, this would serve 412 ERCs for the Village and 227 ERCs for the Tween Waters service areas for a total of 639 ERCs assuming that the existing package wastewater treatment plants are also taken out of service and that the ERCs for their service areas included. This represents a capital cost per ERC of $17,517 for the collection system.

The cost of adding the Estates Service Area is $4,504,344. As presented in **Exhibit 2** this would serve 172 ERCs based on capacity requirements (**Exhibit 2**). This represents a cost per ERC of $26,188 for the collection system. In the Estates service area, the grinder pumps associated with the low pressure collection system are owned and maintained by the utility but maintenance easements are required from the property owners to allow access. Sanibel uses grinder pumps to serve properties in the portion of their service areas where it is not cost effective to extend gravity collection.

Note, the 172 ERCs is based on factoring the size of the residence, with larger residences having more than the one ERC associated with a typical single-family home. The assessment methodology used in Sanibel for capital recovery assigns one ERC to each residential property regardless of the size of the property. Using that model the cost per ERC based on 112 ERC is $40,217. The use of the assessment method based on one ERC per residence tends to favor larger residences that calculate to have 2 or more ERC based on the size of the residence.

In addition to the capital cost for the collection and transmission system, customers connecting to the existing central sewer system would be required to buy their share of existing capacity in Sanibel's transmission and treatment systems (this is a connection or impact fee). Communications with representatives of Sanibel suggested using $5,000 per residential connection (or per ERC for commercial properties connecting to the system) for the impact fee. This is rounded up from the current impact fee of $4,386.21 per ERC or connection (Resolution 16-033) and is slightly conservative. The actual connection or impact fee would be set by an impact fee study for each service area, but is expected to be close to this $5,000 figure.

To be complete, property owners would also be responsible for on-property costs for abandonment of their existing septic system and constructing the on property 4-inch side sewer to the ROW. Sanibel suggests that property owners benefitting from Sanibel's own utility expansion programs plan on a cost of $2,000 to abandon their existing septic tank. Added to this is the cost of extending the on-property wastewater connection to the ROW, sometimes referred to as the side sewer. Combined these costs can be reasonably assumed to be not more than about $7,000 per residence. The utilities impact fee and the assessment can be paid up front or can be financed over the 20-year life of the bond issue used to fund the construction of the collection system. Because low interest financing is used for public infrastructure construction the financing option is generally attractive to property owners. It may be possible to develop a program collectivize the individual owners on property costs and include those in the financing program. These owner costs might also be eligible for grant funding, as explained in Section 4.1.

Because of the higher cost of serving the Estates area with a central system, it is suggested that the Estates Service Area could also be addressed by a program with comparable water quality benefits by promoting conversion of all properties to the use of advanced OSTDS technology with nutrient removal. The advanced OSTDS are reported by the FKAA to cost between $27,000 and $38,000, including installation of a shallow effluent disposal well, depending on the property. This cost appears reasonable as reported but it is noted that FKAA may have purchasing power that is not available to individual property owners. In Monroe County the FKAA manages these individual systems as a component of a central system; however, for this discussion, it is assumed that the property owner would bear the cost of operation and maintenance. At this time, because they are new, the FKAA was not able to provide O&M costs for these systems.

Note, for the financial comparison presented in Section 4 of this study a figure of $36,000 is used for the cost to a property owner for a new advanced performance based OSTDS meeting the advanced-secondary PBTS level of treatment which is currently the highest level that has been permitted by the DOH in Lee County; a cost figure of $38,000 is used for the Best Available Technology as implemented by the FKAA in the Florida Keys.

Customers connected to the central system would pay the user charges for wastewater service the same as Sanibel residents and Sanibel commercial connections. Residential user charges are a fixed charge paid monthly or quarterly. Commercial user charges are based on a fixed charge based on the size of the installed water meter and a variable charge based on potable water consumption data provided by the Island Water Association (IWA). Current user charges are established in City of Sanibel Resolution 17-047 effective October 2017.

3.4.4.1 Include the South Seas Service Area

It is interesting to look at the impact on the cost per ERC if Sanibel would agree to consider accepting the flow from the existing South Seas WWTP. A benefit is that the South Seas Resort already has a collection system and wastewater infrastructure that does not need to be constructed. The cost for adding the South Seas service area flow of approximately 200,000 gpd can be conceptualized as an additional $9,627,000 as developed in the following table:

Impact fee for 200,000 gpd (200,000 /240 x $5,000)	$4,167,000
Upsize the transmission on Captiva	$500,000
Upsize the transmission on Sanibel	$600,000
200,000 gpd AWT expansion at Donax @ $20 / gallon	$4,000,000
Abandon and mitigate the South Seas WWTP site	$200,000
Irrigation Well for South Seas Resort	$160,000
Cost share a DIW at Donax	$1,000,000
TOTAL	**$10,627,000**

Total ERCs for the South Seas service area can be estimated as 200,000 gpd / 240 gpd = 833 ERC. Added to the 811 ERC as developed in **Exhibit 2** for the Village, Tween Waters, and Estates service areas provides a total of 1,644 ERC to account for all of the wastewater flow generated on Captiva.

If South Seas donated their collection system to a Captiva-wide program, conceptually the total cost per ERC for all ERCs (1,644) for a Captiva-wide wastewater program would be:

$11,193,390 (Village and Tween Waters collection and transmission)
$4,504,344 (Estates collection and transmission)
$4,055,000 (Village, Tween Waters and Estates impact fee @ 811 x $5,000)
$10,627,000 (as conceptualized above including impact fee)
Total Program Cost = $30,379,734

For 1,644 ERCs the cost per ERC for the complete program is $18,500. *(Not including owner paid property specific costs like septic abandonment and side sewer if needed.)*

It should be noted that a potentially significant cost not included above is the financial impact of retiring debt on the South Seas WWTP. This may require calling utility bonds prematurely and could be significant. This potential financial impact will need to be evaluated to consider this alternative further.

It can be seen that if all parties were in agreement including the Captiva property owners, the owners of resorts using on island treatment plants, the FGUA, Lee County, and the City of Sanibel, a comprehensive Captiva-wide wastewater improvement program *Captiva Wastewater Improvement Program* done in partnership with Sanibel could be cost effective and would address all wastewater management concerns, including concerns related to the existing location and high cost of operating the South Seas WWTP. All treatment plants on Captiva Island would be eliminated and all wastewater treatment, high quality effluent, and residuals management could be performed centrally and more efficiently at Sanibel's Donax Water Reclamation Facility. Conceivably a program that addresses all of Captiva Island could contribute to the cost

of Sanibel's goals of providing AWT level treatment at the Donax WRF leading to a high level of environmental protection for Sanibel-Captiva near shore water quality.

4.0 FINANCIAL COMPARISON OF WASTEWATER MANAGEMENT ALTERNATIVES

4.1 INTRODUCTION AND ASSUMPTIONS

This section compares the financial impacts of onsite wastewater management to centralized wastewater management. This discussion will focus on a typical residential property. The cost to an individual property owner for an onsite wastewater management system is very dependent on the property and a wide range of costs have been reported. For the purpose of the cost comparison an owner's cost of $36,000 is assumed as an average cost of a new ATU or PBTS type OSTDS. The annual maintenance contract for an ATU or PBTS OSTDS is reported as $800 per year.

For the centralized alternatives the project cost and therefore the cost per ERC (the cost to a residential property) is dependent on the scope of the project and the number of ERC served. The annual costs are taken as the unified annual residential rate charged by the utilities currently operating in Sanibel-Captiva. This is $1,060 per year for the FGUA owned and operated South Seas WWTP and $778 per year for City of Sanibel.

An important distinction is that the service charges for utilities include provision for funding on-going operations indefinitely. The owner of an OSTDS will eventually need to replace that system. If a 20-year life is assumed, the straight line depreciation cost could be assumed to be $1,800 per year on a $36,000 investment. This cost is not compared directly but should be considered by property owners.

If a centralized system is implemented, property owners will have site costs that they will be responsible for. This is the cost to abandon an existing septic system and the cost to extend a wastewater line on the owner's property to the public system. This is sometimes referred to as the side sewer and it is the property owner's responsibility to engage a plumber to make this connection. For this comparison the cost to the owner to abandon an existing OSTDS is assumed to be $2,000, and the cost of the side sewer is assumed to be $5,000.

The City of Sanibel currently charges customers connecting to the City's wastewater system a connection fee of $4,386.21 pursuant to the City's adopted Resolution #16-033. For purposes of the Financial Comparison a rounded connection fee of $5,000 per ERC is assumed and is included in the capital cost of the centralized alternatives. For the alternative of transporting wastewater to Sanibel, the assessment for the capital project costs and Sanibel's connection fee can be financed over a 20 year period at a rate consistent with the low interest State Revolving Fund (SRF) financing that is assumed for wastewater infrastructure improvements.

FDEP 319 Grant Funding for Water Quality Restoration might be available to help off-set the owner's cost for connecting to a public wastewater collection system. If eligible, this grant funding can cover 60% of the cost of making the connection to the utility owned system for infrastructure that is not in the public ROW. This may include lateral piping (side sewer), connection fees, on-property grinder pump stations, and septic tank abandonment. Because the eligible costs identified in the Financial Comparison are the connection fee ($5,000), side sewer ($5,000) and septic system abandonment ($2,000) 319 Grant funding up to $7,200 (60%) may be available to property owners. These grants are based on water quality improvements and are not based on financial need.

The projected cost of a collection system constructed on Captiva Island is provided in **Exhibit 3**. This is approximately $15,700,000 including the Village, Tween Waters, and Estates service areas, including pumping stations and a forcemain across Wulfert Channel connecting to Sanibel's Master Life Station No. 1 on Sea Spray Lane. For the alternative of including the wastewater flow from the South Seas service area, it is assumed that the existing collection system will be incorporated into the wastewater program.

A cost that is not included in the Financial Comparison of the two alternatives that consider removal of the South Seas WWTP from service is the possible financial impact of retiring this facility. Due to uncertainty associated with the integration of the customers served by this facility into another utility system there may be transaction costs that have not been identified. Such costs may be associated with currently outstanding debt that may or may not be callable. Related to this is the potential for similar financial impacts to the owners of the existing package WWTPs located on Captiva Island. The hard cost of decommissioning these existing wastewater treatment plants has been considered in the conceptual costs presented.

For purposes of the Financial Comparison the flow from the South Seas service area is rounded to 200,000 gpd. And the flow for the remaining service areas combined is rounded to 200,000 gpd. For the Village, Tween Waters and Estates service areas the total ERCs are taken from **Exhibit 2** (811 ERCs). For the South Seas Service area the ERCs are assumed as 200,000 gpd / 240 gpd per ERC = 833 ERCs. Therefore, the total ERCs assumed for all of Captiva Island is 1,644.

4.2 FINDINGS OF THE FINANCIAL COMPARISON

Based on the assumptions noted, **Exhibit 4** provides a computation of the cost per ERC for the wastewater alternatives discussed in this study and provides a summary of the Financial Comparison.

Setting aside depreciation expense for OSTDS it is apparent that the annual cost to a residential property owner between an OSTDS and the typical user charges from a wastewater utility are not substantially different.

The potential cost to owners connecting to a public system for the assessment for utility construction, connection fees, and owner's site costs, is comparable to the owner's cost for a new advanced OSTDS and potentially less costly.

If all parties involved could come to agreement as discussed in Section 3.4.4.1 the alternative of eliminating all wastewater treatment plants on Captiva Island and transporting all wastewater to Sanibel's Donax WRF for centralized treatment should be investigated in more detail as it appears to be the most cost-effective long term strategy. The comparative low cost per ERC is because the South Seas Service Area already has a collection system that could be incorporated into a Captiva-wide wastewater program. However, the cost of retiring the existing debt service for the South Seas wastewater system is not known and has not been considered in this study.

4.3 SENSITIVITY TO ERC ASSUMPTIONS FOR RESIDENTIAL PROPERTIES

The determination of ERCs for the OSTDS parcels is developed in **Exhibit 2**. Residential homes with 3 bedrooms or less are assumed to represent 1.0 ERC, while larger homes with 4 to 9 bedrooms were calculated as representing 1.5 to 3.0 ERCs.
Although the residential ERCs were adjusted for larger dwellings to estimate the wastewater flow by service area, Sanibel currently charges all residential units the same connection fee and quarterly service charges implying each residential unit is considered 1.0 ERC for billing purposes. A residential unit is considered either a single family home or an apartment / condo unit, both are considered 1.0 ERC for purposes of paying the connection fees and the service charges.

The methodology for assessing OSTDS parcels for billing purposes under Sanibel's billing system would produce a lower number of ERCs. **Exhibit 2** shows that the majority or 67% of the residential units within the Village and Tween Waters service areas are 3 bedrooms or less, while only a minority or 31% of the residential units within the Estates Service Area are 3 bedrooms or less. Assuming that most of the larger residential units within the Village and Tween Waters service areas are likely to be multi-unit condos or apartments as noted in **Exhibit 1**, then the ERC determination within the Village and Tween Waters service areas would be comparable to what is assumed in the Financial Comparison. However, the Estates Service Area has 112 individual properties that account for 172 ERCs in terms of wastewater capacity (See Exhibits 1 and 2). The actual assessment for each property may be based on the cost to serve this area divided by 112, rather than the cost shown in **Exhibit 4** presented as the cost per ERC. Large residences would benefit from this inequity at the expense of the more conventionally sized residences.

4.4 QUALITATIVE FACTORS NOT COMPARED

There are factors that property owners may want to consider in making decisions about future wastewater management on Captiva Island that have not been quantified in the Financial Comparison. These are the apparent differences between OSTDS and centralized wastewater management in the risk to property owners for unforeseen financial impacts and the value of indirect economic factors.

Risks that may be relevant to property owners that were not valued in the Financial Comparison include:

1. Risk of Increased Regulation**:** There is a risk that changes in wastewater treatment and disposal regulations could result in additional costs under any alternative. However, it is more likely that a centralized wastewater treatment facility operated by a public utility could better address, manage and spread such risk over a larger customer base compared to an individual property owner required to address such risks independently.

2. Risk of Premature Failure or Repairs: There is a risk that due to poor maintenance, general failure, or severe weather conditions, that an advanced OSTDS may require costly repairs or improvements prior to the end of the assumed 20-year useful life of the system. The same can be said for centralized wastewater management; however, for a public utility such repairs and replacements can be spread over a larger customer base and may not immediately impact user charges. Also, public utilities can obtain emergency funding and financing at a lower cost than individuals, further lowering the financial impact of an emergency on individual properties.

3. Risk of Sea-Level Rise: Sea-level rise, and the associated rise in the land side water table could impair the ability of the advanced OSTDS from properly treating and disposing of wastewater. Therefore sea-level rise would impact properties with onsite systems to a greater degree than a utility owned central system. Any new utility infrastructure to collect wastewater on Captiva would be designed to mitigate the impact of sea-level rise, as well as impacts of storm surge and power outages.

Economic factors that individual property owners may consider that were not valued in the Financial Comparison could include:

1. The depreciation cost of a privately owned OSTDS systems.

2. The higher value of property that is not required to set aside space for a drainfield.

3. The age and condition of the owners existing OSTDS system. The owner of an aging and low technology OSTDS will benefit more from a conversion to central sewer than the owner of a new advanced OSTDS.

In summary, each property owner will have unique and differing considerations in making a decision on available wastewater management alternatives.

5.0 SUMMARY OF FINDINGS

There appears to be two feasible approaches for wastewater management on Captiva Island at this time. The first is to continue with the status quo. The existing onsite systems (OSTDS), as well as the existing treatment plants, do comply with current DOH and FDEP regulations. Existing OSTDS that do not currently have permits will eventually fall under the DOH regulations as they are replaced. Likely many of these, possibly all of them, will be required to advance beyond a conventional septic system due to site limitations or other factors. The existing on-island wastewater treatment plants are monitored by the FDEP and are subject to monthly reporting, annual performance reviews, and must be re-permitted every 5 years. The FDEP aggressively enforces operation of these plants for compliance with the permit requirements.

However, even the advanced secondary performance based onsite treatment systems (PBTS), currently the highest level permitted in Lee County, do not match the nutrient removal performance that can be achieved in an advanced wastewater treatment plant. In the long term, existing onsite systems that rely on drainfields for effluent disposal, whether conventional or performance based, may require replacement due to higher water tables. It is not unreasonable to assume that over time all OSTDS located on Florida barrier islands will be required to provide some level of nutrient removal.

The AWT level PBTS technology that is mandated by FAC 64E-6 for the Florida Keys has the benefit of significantly reducing nutrient in the effluent that, if discharged to a drainfield, could migrate to near shore waters. The challenge of implementing this technology is the aggressive monitoring and management required. In the Florida Keys this is done by the FKAA, and the cost of these systems is also subsidized by grants. A utility owned and managed program to implement AWT level PBTS technology would require legislation at the State level to be enforceable. Unless such a program was mandated it would not have the funding that has facilitated implementation of best available OSTDS technology in the Florida Keys.

The alternative to onsite (decentralized) wastewater management is to construct a centralized wastewater collection, transmission, and treatment system. A technically feasible approach to implementation of a centralized wastewater system is to partner with the City of Sanibel to provide wastewater service to Captiva Island by extending the service area of Sanibel's wastewater utility. Sanibel has experience in septic replacement programs and utility expansions. Politically this would require an inter-local cooperation between Lee County and the City of Sanibel, as well as the universal support of Captiva property owners. That said, other communities like Town of Fort Myers Beach and the Town of Long Boat Key, were able to arrange for off-island wastewater treatment by another utility. And in the case of Long Boat Key partially in another County.

An obvious question which may be addressed by an inter-local agreement is Sanibel's authority to compel property owners outside of Sanibel to connect to Sanibel's system. This is important because if there are properties that do not connect, the capital and operating costs are not shared equitably for a common environmental benefit. It is noted that the 2017 Florida Statutes Chapter 381 Public Health, FS 381.00655(1)(a) requires that the owner of a properly functioning onsite sewage treatment and disposal system (OSTDS) must connect to an available publicly owned sewerage system within 365 days after written notice that the system is operational. The owner of an improperly functioning OSTDS must connect to an available publicly owned sewerage system within 90 days.

Under reasonable assumptions it appears that by partnering with Sanibel the cost of extending a centralized collection system, especially for the currently unsewered areas of Captiva Island and the areas served by the three existing WWTPs, is comparable to the long-term cost (including future replacement costs) of an OSTDS based wastewater management alternative for the average residential property.

The other possibility for implementing a centralized wastewater system is to expand the South Seas WWTP to have capacity for the entire island. This also appears technically feasible. Under this scenario the Captiva wastewater system would be managed by the FGUA. If a decision was made to advance development of a centralized wastewater system then a more detailed study of the comparative costs and complications of expanding the Donax WRF or alternatively the South Seas WWTP and associated transmission lines would be justified. It is apparent that building a new wastewater treatment plant on Captiva Island would not be cost-effective and in any case the required site has not been identified.

A centralized wastewater collection system with the associated transmission pumping and piping, and the required expansions to either the Donax WRF or the South Seas WWTP, would require a minimum of five years to fully implement.

The findings of the Financial Comparison suggest generally that the long-term costs are reasonably comparable between the alternatives of on-site or central wastewater management. Although property specific cost-benefit will depend on individual circumstances. Taking the general view that the onsite (de-centralized) and centralized approaches are not too different financially, and can both be configured to meet regulatory and resiliency objectives, other factors besides cost may dominate future decisions. It is significant that implementation of a centralized alternative will require the acceptance and the cooperation of several political jurisdictions as well as majority support of Captiva property owners.

Until alternative wastewater concepts are more fully developed it appears more realistic to exclude the South Seas Service Area from discussion. This may simplify an already complex decision. This is justified because the South Seas Island Resort property is already served by a collection system and a functioning utility managed wastewater treatment plant. In the short term, this facility can be maintained by FGUA to meet the regulatory requirements established by the FDEP for environmentally responsible operation. This may include the eventual construction of a well for effluent disposal, or investments to bring the facility up to Advanced Wastewater Treatment (AWT) standards. If the South Seas Service Area is initially excluded from the centralized concept, it is suggested that the design of a collection system for the Village Service Area include sizing the gravity mains such that future flow from the South Seas Service Area could be accommodated without reconstruction. Further, a conveniently located manhole leading to the gravity collection system should be included to facilitate the use of temporary emergency bypass pumping in the event of an emergency at the South Seas facility. This would avoid the scenario where raw wastewater or substandard effluent must be transported by tank truck through congested roadways on Captiva and Sanibel to Sanibel's Donax WRF.

CONTRIBUTORS TO THIS STUDY

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Note: The accuracy of the cost projections used for comparing alternatives in this report are based on AACE 18R-97 Class 4 (Study or Feasibility Phase) should be taken as a range of -30% to +50%.

EXHIBITS

Exhibit 1
Captiva Island Service Areas

Area	DOR DESCRIPTION (1)	# Parcels	# Baths	# Bedrooms
South Seas	Orphanages, Non-Profit Service	4	8	11
	Hotel Motel	1	121	0
	Condominium	463	919	886
	Multi-Family Less Than 10 -	1	162	160
	Single Family Residential	79	232.5	251
	Vacant Residential	4		
	Vacant Commercial	1		
	Total	**553**	**1442.5**	**1308**
The Village	Churches, Temples	2	3	2
	Commercial, Mixed Use	2	4	1
	Orphanages, Non-Profit Service	4	7	8
	Hotel Motel	4	41.5	38
	Condominium	44	92	94
	Multi-Family Less Than 10 -	9	33	43
	Single Family Residential	147	495	515
	Restaurants, Cafeterias	1	2	3
	Stores, One Story	5	3	0
	Utility	1	2	0
	Total	**219**	**682.5**	**704**
	Sunset Captiva WWTP - Condominium	**10**	**22**	**24**
	Sunset Captiva WWTP - Single Family Residential	**20**	**41**	**124**
	Captiva Shores WWTP - Single Family Residential	**58**	**129**	**54**
	Total	**88**	**192**	**202**
Tween Waters Stretch	Multi-Family Less Than 10 -	9	41	46
	Single Family Residential	38	142	138
	Total	**47**	**183**	**184**
	Tween Waters WWTP - Hotel Motel	**1**	**142.5**	**139**
The Estates	Multi-Family Less Than 10 -	49	258	269
	Single Family Residential	63	247	244
	Total	**112**	**505**	**513**
Black	Parcels currently served by OSTDS (2)	**378**	**1370.5**	**1401**
Blue	Parcels currently served by a collection systems and WWTP	**642**	**1777**	**1649**

(1) Descriptions from Lee County Property Appraiser's Database

(2) Assumes (1) OSTDS for each developed parcel

Exhibit 2

Equivalent Residential Connection (ERC) for Village, Tween Waters and Estates

Establishment	Unit	ERC Factor	The Village* Units	Total ERCs	Village Average Daily Demand (gpd)	Tween Water* Units	Total ERCs	Tween Waters Average Daily Demand (gpd)	The Estates Units	Total ERCs	The Estates Average Daily Demand (gpd)
Residential and resort housing: (including single-family residential, residential duplexes, residential triplexes, condominiums and timeshare development)	1-Bedroom	1.000	12	12	2,880	2	2	480	1	1	240
	2-Bedroom	1.000	120	120	28,800	4	4	960	11	11	2,640
	3-Bedroom	1.000	79	79	18,960	12	12	2,880	23	23	5,520
	4-Bedroom	1.500	51	77	18,360	16	24	5,760	25	38	9,000
	5-Bedroom	1.500	24	36	8,640	7	11	2,520	21	32	7,560
	6-Bedroom	2.000	5	10	2,400	3	6	1,440	12	24	5,760
	7-Bedroom	2.000	2	4	960	3	6	1,440	13	26	6,240
	8-Bedroom	2.000	1	2	480				6	12	2,880
	9-Bedroom	3.000							2	6	1,440
Commercial:											
Auditorium/meeting rooms	Per seat	0.019				150	3	684			
Barber/beauty shop	Per opt. sta.	0.340									
Food service:											
Restaurant/cafeteria	Per seat	0.113	145	16	3932	175	20	4746			
Restaurant (24 hours)	Per seat	0.189									
Restaurant ("fast food")	Per seat	0.057									
Bar/cocktail lounge	Per seat	0.075									
Deli, bakery, meat market	Per 100 sq. ft.	0.170	4	0.7	163						
Restaurant (carry out)	Per 100 sq. ft.	0.210									
Hotel/motel: (not including food service banquet and meeting rooms, and guest laundry)	Per room	1.000	38	38	9120	139	139	33360			
Motel (See hotel)											
Office building: (not including food service and retail space)	Per 100 sq. ft.	0.038	29	1	263	28	1	251			
Service station:											
Open 16 hrs./day or less	Per water closet	1.040									
Open more than 16 hrs./day	Per water closet	1.132									
Theater:	Per seat	0.012									
Dinner theater:	Per seat	0.075									
Trailer park (overnight):	Per space	0.377									
Dentist office:	Per dentist	0.943									
	Per wet chair	0.755									
Doctor office:	Per doctor	0.943									
Church:	Per seat	0.011	120	1.3	317						
Schools (middle and high)	Per student	0.075									
Schools (elementary, day care and nursery):	Per student	0.028									
Schools (boarding):	Per student	0.472									
Laundry (self-service)	Per machine	1.510									
Retail Store: (Add remaining fixture units)	Per restroom	1.500	10	15.0	3600						
Automotive repair and maintenance stores:		0.500									
Total ERCs & Average Daily Demand:				**412**	**98,875**		**227**	**54,521**		**172**	**41,280**

General Notes

(a) For purposes of calculating and imposing the sewer connection fee provided for pursuant to Section 70-109 of this chapter, the ERC factor for any particular

(b) One equivalent residential connection (ERC) shall, for purposes of this section, have an assigned value of 1.00. One ERC is hereby established and determined to be equal to a flow of 240 gallons per day, average annual basis (240 GPD), or such other value as may be later approved or determined by the city or the state department of environmental protection. The total equivalent residential connection value for an establishment shall be calculated by multiplying the ERC factor listed in this section by the number of units, and shall be rounded up to the nearest 0.5 ERC factor.

(c) For all establishments not listed in subsection (a) of this section, the total equivalent residential connection (ERC) value shall be determined by multiplying the number of fixture units, as published in the Standard Plumbing Code, by 30, and then dividing that numerator by 240. For example:

$$\text{Total ERC value} = \frac{\text{Number of fixture units x 30}}{\text{240 GPD/ERC}}$$

The sewer connection fee shall be determined by using the following formula: Total ERC value × connection fee per ERC = sewer connection fee. In no event shall the total ERC value used to calculate a sewer connection fee for any separate establishment be less than 1.00.

(d) The ERC schedule in this section applies to establishments being connected to a central wastewater system including the city sewer system. For establishments utilizing septic tanks and package wastewater treatment plants for wastewater disposal, the design wastewater flow shall be determined by the city.

(e) Industrial or process water customers will be considered on a case-by-case basis by the city. Such customers shall pay fees based upon both flow, waste strength and constituents. No toxic, hazardous, or other wastes will be accepted which may, in the city's opinion, potentially cause adverse impacts to golf courses, groundwater, treatment facilities of any part of the complete wastewater system.

Sanibel, FL (Code 1981, § 19-85; Ord. No. 97-12, § 2, 6-17-1997; Ord. No. 00-21, § 1, 9-19-2000; Ord. No. 00-24,§ 1, 11-7-2000)

EXHIBIT 3

CAPTIVA ISLAND

CENTRALIZED WASTEWATER COLLECTION SYSTEM

OPINION OF PROBABLE COST

March 2018

PART 1 -CAPTIVA LIFT STATION #1 SERVICE AREA (VILLAGE SERVICE AREA)

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL
Mobilization (Max 3% Total Base Bid)	1	LS	$ 33,000.00	$ 33,000.00
Performance and Payment Bond Premiums and Insurance (1.5%)	1	LS	$ 16,500.00	$ 16,500.00
Maintenance of Traffic (1%)	1	LS	$ 11,000.00	$ 11,000.00
Field Layout, and Record Drawings (Minimum 1% of Total Base Bid)	1	LS	$ 11,000.00	$ 11,000.00
Closeout (Minimum 1.5% of Total Base Bid Price)	1	LS	$ 16,500.00	$ 16,500.00
Manhole 0'-6' Cut	15	EA	$ 5,500.00	$ 82,500.00
Manhole 6'-9' Cut	7	EA	$ 7,500.00	$ 52,500.00
12" PVC Gravity Main 6'-9' Cut	720	LF	$ 95.00	$ 68,400.00
8" PVC Gravity Main 0'-6' Cut	3860	LF	$ 65.00	$ 250,900.00
8" PVC Gravity Main 6'-8' Cut	1000	LF	$ 75.00	$ 75,000.00
6" PVC, DR-26 Double Service Laterals to Building Sanitary	50	EA	$ 1,750.00	$ 87,500.00
6" Single Service Laterals	30	EA	$ 1,400.00	$ 42,000.00
Grinder Lift Station System (Simplex, w/4' Diam. FRP Wetwell)	1	EA	$ 20,000.00	$ 20,000.00
1 1/2" HDPE FM Piping (From Grinder Pump Stations) (HDD Assumed) & 2" Valve	360	LF	$ 14.00	$ 5,040.00
Captiva Lift Station #1 (Duplex) System	1	LS	$ 85,000.00	$ 85,000.00
4" PVC Force Main (Open Cut)	420	LF	$ 40.00	$ 16,800.00
Restoration	11360	LF	$ 20.00	$ 227,200.00
			PART 1 SUB-TOTAL	$ 1,100,840
			Engineering and Administrative Costs (30%)	*$ 330,252*
			PART 1 TOTAL	**$ 1,431,092**

PART 2 -CAPTIVA LIFT STATION #2 SERVICE AREA (VILLAGE SERVICE AREA)				
DESCRIPTION	**QTY**	**UNIT**	**UNIT COST**	**TOTAL**
Mobilization (Max 3% Total Base Bid)	1	LS	$ 27,300.00	$ 27,300.00
Performance and Payment Bond Premiums and Insurance (1.5%)	1	LS	$ 13,650.00	$ 13,650.00
Maintenance of Traffic (1%)	1	LS	$ 9,100.00	$ 9,100.00
Field Layout, and Record Drawings (Minimum 1% of Total Base Bid)	1	LS	$ 9,100.00	$ 9,100.00
Closeout (Minimum 1.5% of Total Base Bid Price)	1	LS	$ 13,650.00	$ 13,650.00
Manhole 0'-6' Cut	11	EA	$ 5,500.00	$ 60,500.00
Manhole 6'-9' Cut	7	EA	$ 7,500.00	$ 52,500.00
12" PVC Gravity Main 6'-9' Cut	1560	LF	$ 95.00	$ 148,200.00
8" PVC Gravity Main 0'-6' Cut	1600	LF	$ 65.00	$ 104,000.00
8" PVC Gravity Main 6'-8' Cut	600	LF	$ 75.00	$ 45,000.00
6" PVC, DR-26 Double Service Laterals to Building Sanitary	25	EA	$ 1,750.00	$ 43,750.00
6" Single Service Laterals	10	EA	$ 1,400.00	$ 14,000.00
Grinder Lift Station System (Simplex, w/4' Diam. FRP Wetwell)	1	EA	$ 20,000.00	$ 20,000.00
1 1/2" HDPE FM Piping (From Grinder Pump Stations) (HDD Assumed) & 2" Valve	395	LF	$ 14.00	$ 5,530.00
Captiva Lift Station #2 (Duplex) System	1	LS	$ 85,000.00	$ 85,000.00
4" PVC Force Main (Open Cut)	1,885	LF	$ 40.00	$ 75,400.00
Restoration	8348.3	LF	$ 20.00	$ 166,966.67
Hookup to Ex. Sunset Captiva SS System, and Demo Sunset Captiva WWTP	1	EA	$ 30,000.00	$ 30,000.00
			PART 2 SUB-TOTAL	$ 923,647
			Engineering and Administrative Costs (30%)	*$ 277,094*
			PART 2 TOTAL	**$ 1,200,741**

PART 3 -CAPTIVA LIFT STATION #3 SERVICE AREA (VILLAGE & NORTH TWEEN WATERS STRETCH SERVICE AREA)				
DESCRIPTION	**QTY**	**UNIT**	**UNIT COST**	**TOTAL**
Mobilization (Max 3% Total Base Bid)	1	LS	$ 21,930.00	$ 21,930.00
Performance and Payment Bond Premiums and Insurance (1.5%)	1	LS	$ 10,965.00	$ 10,965.00
Maintenance of Traffic (1%)	1	LS	$ 7,310.00	$ 7,310.00
Field Layout, and Record Drawings (Minimum 1% of Total Base Bid)	1	LS	$ 7,310.00	$ 7,310.00
Closeout (Minimum 1.5% of Total Base Bid Price)	1	LS	$ 10,965.00	$ 10,965.00
Manhole 0'-6' Cut	8	EA	$ 5,500.00	$ 44,000.00
Manhole 6'-9' Cut	0	EA	$ 7,500.00	$ -
12" PVC Gravity Main 6'-9' Cut	0	LF	$ 95.00	$ -
8" PVC Gravity Main 0'-6' Cut	2040	LF	$ 65.00	$ 132,600.00
8" PVC Gravity Main 6'-8' Cut	360	LF	$ 75.00	$ 27,000.00
6" PVC, DR-26 Double Service Laterals to Building Sanitary	4	EA	$ 1,750.00	$ 7,000.00
6" Single Service Laterals	20	EA	$ 1,400.00	$ 28,000.00
Grinder Lift Station System (Simplex, w/4' Diam. FRP Wetwell)	2	EA	$ 20,000.00	$ 40,000.00
1 1/2" HDPE FM Piping (From Grinder Pump Stations) (HDD Assumed) & 2" Valves	520	LF	$ 14.00	$ 7,280.00
Captiva Lift Station #3 (Duplex) System	1	LS	$ 85,000.00	$ 85,000.00
6" PVC Force Main (Open Cut)	3,080	LF	$ 50.00	$ 154,000.00
Restoration	6026.7	LF	$ 20.00	$ 120,533.33
Hookup to Ex. Captiva Shores SS System, and Demo Captiva Shores WWTP	1	EA	$ 30,000.00	$ 30,000.00
			PART 3 SUB-TOTAL	$ 733,893
			Engineering and Administrative Costs (30%)	*$ 220,168*
			PART 3 TOTAL	**$ 954,061**

PART 4 -CAPTIVA LIFT STATION #4 SERVICE AREA (TWEEN WATERS STRETCH SERVICE AREA)				
DESCRIPTION	**QTY**	**UNIT**	**UNIT COST**	**TOTAL**
Mobilization (Max 3% Total Base Bid)	1	LS	$ 60,000.00	$ 60,000.00
Performance and Payment Bond Premiums and Insurance (1.5%)	1	LS	$ 30,000.00	$ 30,000.00
Maintenance of Traffic (1%)	1	LS	$ 20,000.00	$ 20,000.00
Field Layout, and Record Drawings (Minimum 1% of Total Base Bid)	1	LS	$ 20,000.00	$ 20,000.00
Closeout (Minimum 1.5% of Total Base Bid Price)	1	LS	$ 30,000.00	$ 30,000.00
Manhole 0'-6' Cut	8	EA	$ 5,500.00	$ 44,000.00
Manhole 6'-9' Cut	4	EA	$ 7,500.00	$ 30,000.00
12" PVC Gravity Main 6'-9' Cut	1680	LF	$ 95.00	$ 159,600.00
8" PVC Gravity Main 0'-6' Cut	880	LF	$ 65.00	$ 57,200.00
8" PVC Gravity Main 6'-8' Cut	480	LF	$ 75.00	$ 36,000.00
6" PVC, DR-26 Double Service Laterals to Building Sanitary	4	EA	$ 1,750.00	$ 7,000.00
6" Single Service Laterals	30	EA	$ 1,400.00	$ 42,000.00
Grinder Lift Station System (Simplex, w/4' Diam. FRP Wetwell)	17	EA	$ 20,000.00	$ 340,000.00
1 1/2" HDPE FM Piping (From Grinder Pump Stations) (HDD Assumed) & 2" Valves	6180	LF	$ 14.00	$ 86,520.00
Captiva Lift Station #4 (Duplex) System	1	LS	$ 120,000.00	$ 120,000.00
8" PVC & HDPE Force Main (Open Cut & HDD)	10,020	LF	$ 80.00	$ 801,600.00
Restoration	15180	LF	$ 20.00	$ 303,600.00
Hookup to Ex. Tween Waters Inn SS System, and Demo Tween Waters Inn WWTP	1	EA	$ 30,000.00	$ 30,000.00
			PART 4 SUB-TOTAL	$ 2,217,520
			Engineering and Administrative Costs (30%)	*$ 665,256*
			PART 4 TOTAL	**$ 2,882,776**

PART 5 - CAPTIVA MASTER PUMP STATION & FORCE MAIN TO SANIBEL MPS #1 (@ SEASPRAY)				
DESCRIPTION	**QTY**	**UNIT**	**UNIT COST**	**TOTAL**
Mobilization (Max 3% Total Base Bid)	1	LS	$ 90,000.00	$ 90,000.00
Performance and Payment Bond Premiums and Insurance (1.5%)	1	LS	$ 45,000.00	$ 45,000.00
Maintenance of Traffic (1%)	1	LS	$ 30,000.00	$ 30,000.00
Field Layout, and Record Drawings (Minimum 1% of Total Base Bid)	1	LS	$ 30,000.00	$ 30,000.00
Closeout (Minimum 1.5% of Total Base Bid Price)	1	LS	$ 480,000.00	$ 480,000.00
Captiva Master Lift Station (Duplex) System [Generator/Electrical Bldg./Odor Control]	1	LS	$ 300,000.00	$ 300,000.00
8" HDPE Force Main (Mostly HDD)	17,100	LF	$ 100.00	$ 1,710,000.00
Restoration	1720	LF	$ 20.00	$ 34,400.00
8" FM Connection to Ex Sanibel MPS#1 Wetwell	1	EA	$ 15,000.00	$ 15,000.00
Upgrades to Sanibel Transmission and MPS (estimate from TetraTech)	1	EA	$ 900,000.00	$ 900,000.00
			PART 5 SUB-TOTAL	$ 3,634,400.00
			Engineering and Administrative Costs (30%)	*$ 1,090,320.00*
			PART 5 TOTAL	**$ 4,724,720.00**

PART 6 - FUTURE PHASE - ESTATES SERVICE AREA				
DESCRIPTION	**QTY**	**UNIT**	**UNIT COST**	**TOTAL**
Mobilization (Max 3% Total Base Bid)	1	LS	$ 90,000.00	$ 90,000.00
Performance and Payment Bond Premiums and Insurance (1.5%)	1	LS	$ 45,000.00	$ 45,000.00
Maintenance of Traffic (1%)	1	LS	$ 30,000.00	$ 30,000.00
Field Layout, and Record Drawings (Minimum 1% of Total Base Bid)	1	LS	$ 30,000.00	$ 30,000.00
Closeout (Minimum 1.5% of Total Base Bid Price)	1	LS	$ 45,000.00	$ 45,000.00
Grinder Lift Station System (Simplex, w/4' Diam. FRP Wetwell)	120	EA	$ 20,000.00	$ 2,400,000.00
1 1/2" HDPE FM Piping (From Grinder Pump Stations) (HDD Assumed) & 2" Valves	21600	LF	$ 14.00	$ 302,400.00
4" HDPE Low Pressure Force Main - Collect/Transport all Grinder Lift Stations (HDD)	7,970	LF	$ 60.00	$ 478,200.00
Restoration	1614	LF	$ 20.00	$ 32,280.00
6" FM Connection to CAPTIVA Master Pump Station	1	EA	$ 12,000.00	$ 12,000.00
			PART 6 SUB-TOTAL	$ 3,464,880
			Engineering and Administrative Costs (30%)	*$ 1,039,464*
			PART 6 TOTAL	**$ 4,504,344**

			PARTS 1-5 TOTAL	**$ 11,193,390**

			PARTS 1-6 TOTAL	**$ 15,697,734**

EXHIBIT 4: ESTIMATED COSTS PER TYPICAL RESIDENTIAL UNIT [1]

Line No.	Description	On-site Wastewater Management		Centralized Collection and Treatment			
		Alternative 1	Alternative 2	Alternative 1 - All Treatment on Captiva		Alternative 2 - Interconnect with Sanibel	
		Current Technology OSTDS	Best Available Technology	Option 1 - Expand South Seas to 0.4 MGD	Option 2 - Construct New 0.4 MGD WWTP	Option 1 - Connect Village, Tween Waters and Estates	Option 2 - Option 1 + South Seas
	Affected Equivalent Residential Connections (ERCs) [2]:						
	Villages, Tween Waters and Estates [3]:						
1	Estimated ERCs served by OSTDS	527	527	527	527	527	527
2	Estimated ERCs served by package WWTPs	284	284	284	284	284	284
3	Total ERCs	811	811	811	811	811	811
4	South Seas ERCs [4]	N/A	N/A	N/A	833	N/A	833
5	Total ERCs Affected	**811**	**811**	**811**	**1,644**	**811**	**1,644**
	Initial Infrastructure Costs:						
6	New / Replacement Cost of OSTDS System	0 - $36,000	$38,000	N/A	N/A	N/A	N/A
7	R&R Cost of Package Plants	Unknown	Unknown	N/A	N/A	N/A	N/A
8	Collection System Costs [5]	N/A	N/A	$15,700,000	$15,700,000	$15,700,000	$15,700,000
9	Purchase of Land for WWTP	N/A	N/A	N/A	Unknown	N/A	N/A
10	WWTP Capital Costs	N/A	N/A	$4,500,000	$16,000,000	N/A	N/A
11	Deep Injection Well	N/A	N/A	$6,000,000	included in above	N/A	N/A
12	Decommission South Seas WWTP	N/A	N/A	N/A	$360,000	N/A	$360,000
13	Outstanding FGUA South Seas Debt	N/A	N/A	N/A	N/A	N/A	Unknown
14	Additional Capital Contributions to Sanibel [6]	N/A	N/A	N/A	N/A	N/A	6,100,000
15	Sanibel Connection Fees [7]	N/A	N/A	N/A	N/A	$4,055,000	$8,220,000
16	Total Initial Infrastructure Costs	Varies by Prop.	Varies by Prop.	$26,200,000	$32,060,000	$19,755,000	$30,380,000
	Initial Costs per ERC:						
17	1.0 ERC / 1-3 bedrooms	$36,000 [8]	$38,000 [8]	$32,300	$19,500	$24,400	$18,500
18	1.5 ERC / 4-5 bedrooms	$54,000 [8]	$57,000 [8]	$48,450	$29,250	$36,600	$27,750
19	2.0 ERC / 6-8 bedrooms	$72,000 [8]	$76,000 [8]	$64,600	$39,000	$48,800	$37,000
20	3.0 ERC / 9 bedrooms	$108,000 [8]	$114,000 [8]	$96,900	$58,500	$73,200	$55,500
	Other Costs Considerations - OSTDS Parcels Only:						
21	OSTDS Decommission Costs	Varies $1k-$2k	Varies $1k-$2k	Varies $1k-$2k	Varies $1k-$2k	Varies $1k-$2k	Varies $1k-$2k
22	Installation of Private Lines / Tap In per ERC	N/A	N/A	Varies / $5k Est.	Varies / $5k Est.	Varies / $5k Est.	Varies / $5k Est.
23	Total Other Costs per ERC / Residential Unit	**Varies $1k-$2k**	**Varies $1k-$2k**	**Varies $6k-$7k Est.**	**Varies $6k-$7k Est.**	**Varies $6k-$7k Est.**	**Varies $6k-$7k Est.**
24	**Annual Operations Costs / Sewer Bill per Residential Unit [9]**	**$800 OSTDS**	**$1,000 OSTDS**	**$1,060**	**$1,060**	**$778**	**$778**

Footnotes:

[1] Conceptual amounts shown are presented in today's $ and do not include any assumed lending or financing costs.

[2] Amounts shown reflect the estimated ERCs by service area that would be directly affected by each alternative or option.

[3] Amounts shown derived from Exhibit 1 and Exhibit 2 and estimated based on level of service of 240 gallons per day (GPD), which is assumed to be characteristic of a 1-3 bedroom home.

[4] ERCs estimated based on the assumed capacity of the South Seas WWTP at 0.2 MGD divided by the level of service per ERC at 240 GPD.

[5] Amounts shown derived from Exhibit 3.

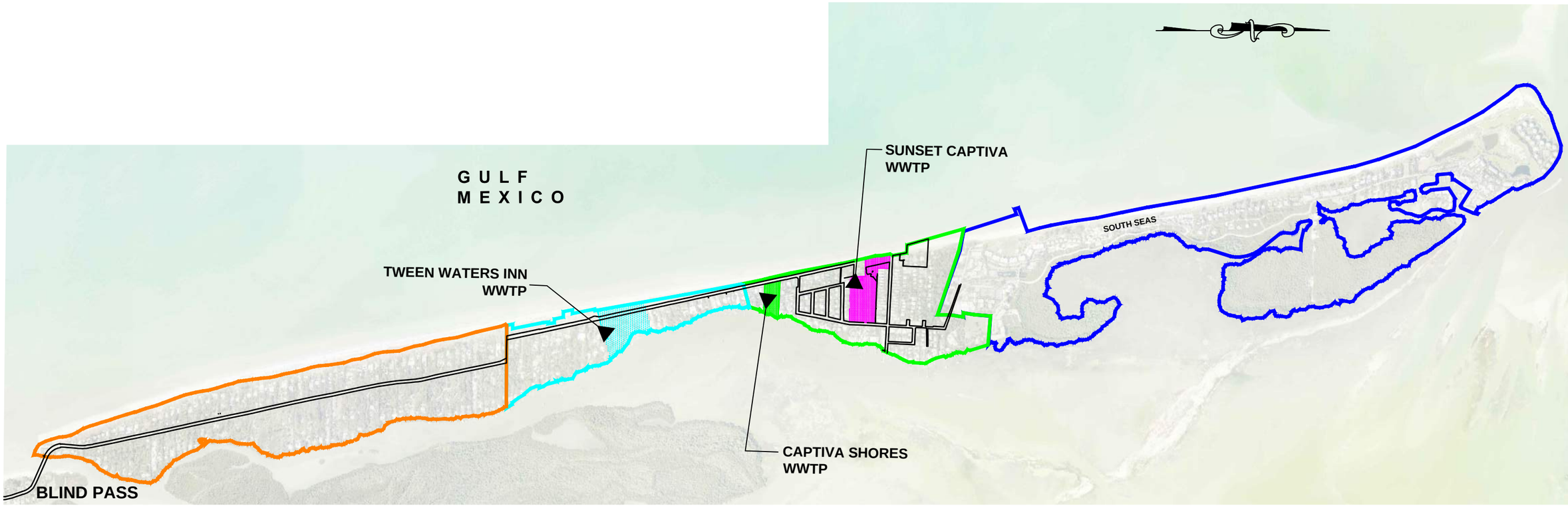
[6] It is likely that Sanibel would incur additional capital costs above the normal connection / impact fees to take all flow from Captiva.

[7] Assumes $5,000 per ERC. Note that the City charges the same charge per residential unit therefore connection fee amounts shown may be overstated.

[8] Replacement costs for OSTDS systems range materially contingent upon the on-site specific conditions and requirements for an individual homeowner. Amounts assumed herein may vary materially from the actual cost a contractor may charge the individual customer.

[9] The annual operating expense amounts shown (i.e., $1,060) for the centralized collection and treatment Alternative 1 are estimated and based on: a) the wastewater rates charged by the FGUA for customers served by the South Seas WWTP on Captiva island; and b) average monthly use of 5,000 gallons per month. The annual sewer bill amounts shown (i.e., $778) for the centralized collection and treatment Alternative 2 are estimated and based on the current residential quarterly charges reported by the City of Sanibel for wastewater service.

FIGURES



LEGEND

- SOUTH SEAS SERVICE AREA
- THE VILLAGE SERVICE AREA
- TWEEN WATERS STRETCH SERVICE AREA
- ESTATES SERVICE AREA

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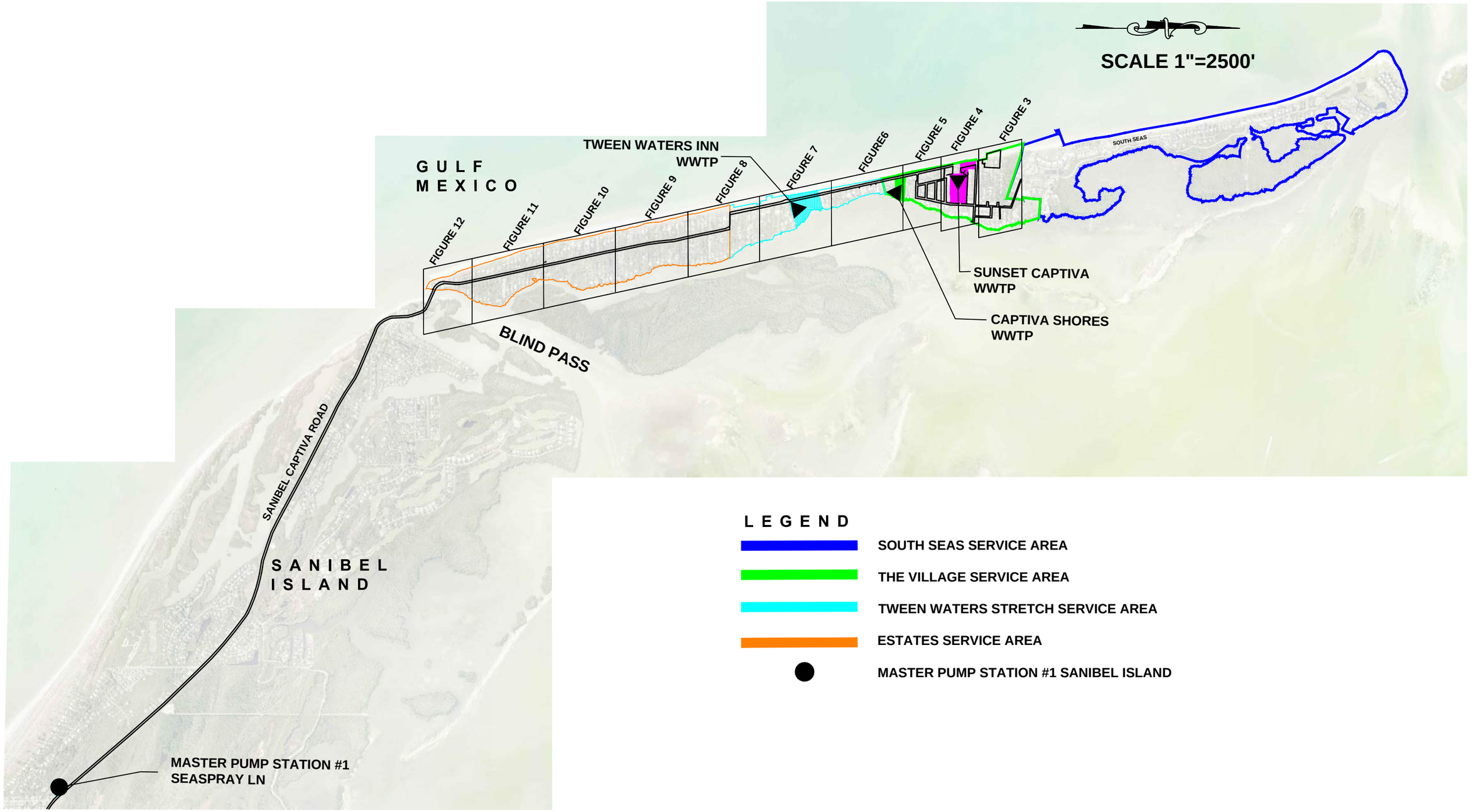
CAPTIVA ISLAND WASTEWATER ALTERNATIVE STUDY
CENTRAL SYSTEM CONCEPT

FIGURE 1



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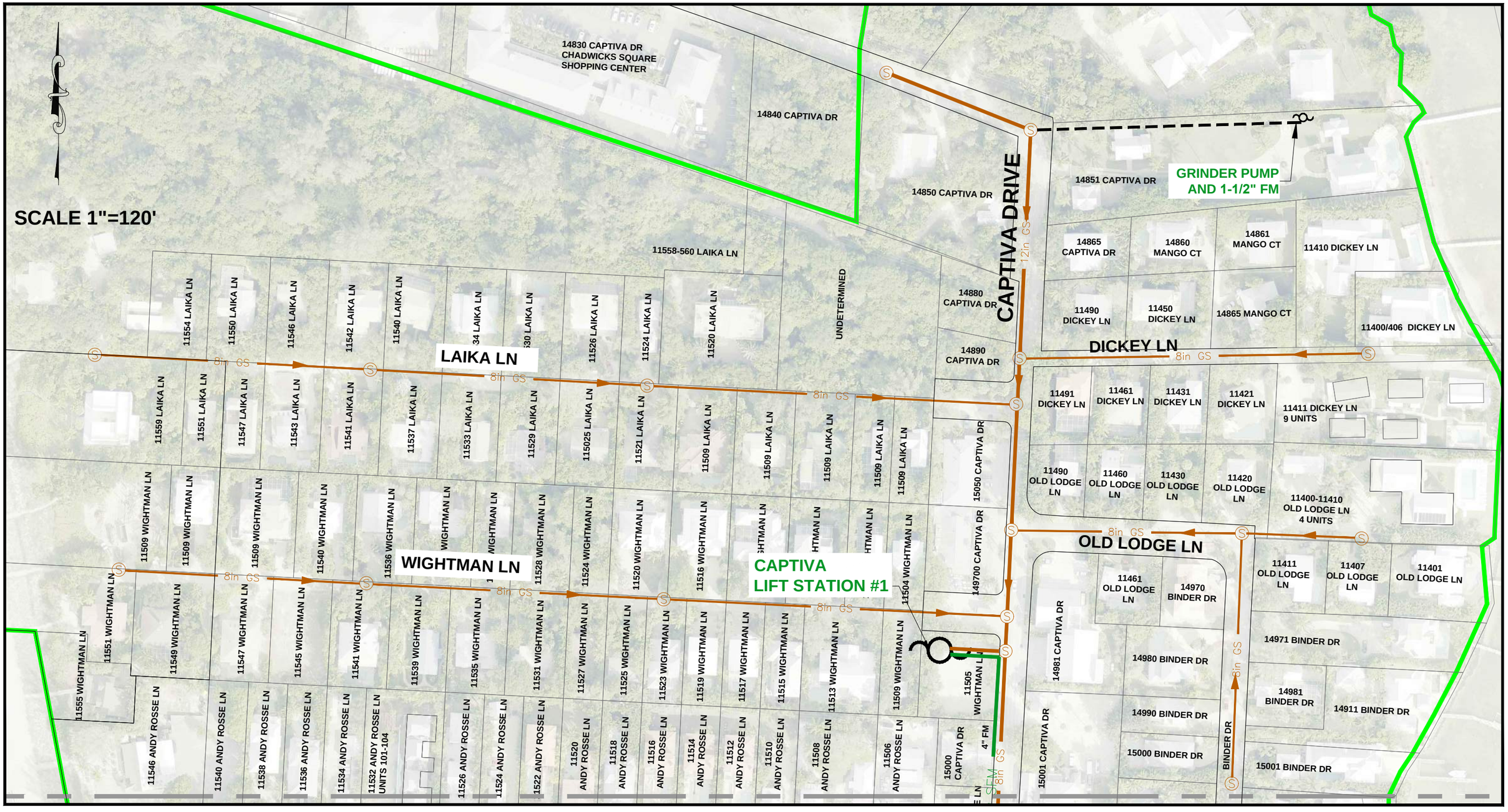
CAPTIVA ISLAND WASTEWATER ALTERNATIVE STUDY
CENTRAL SYSTEM CONCEPT

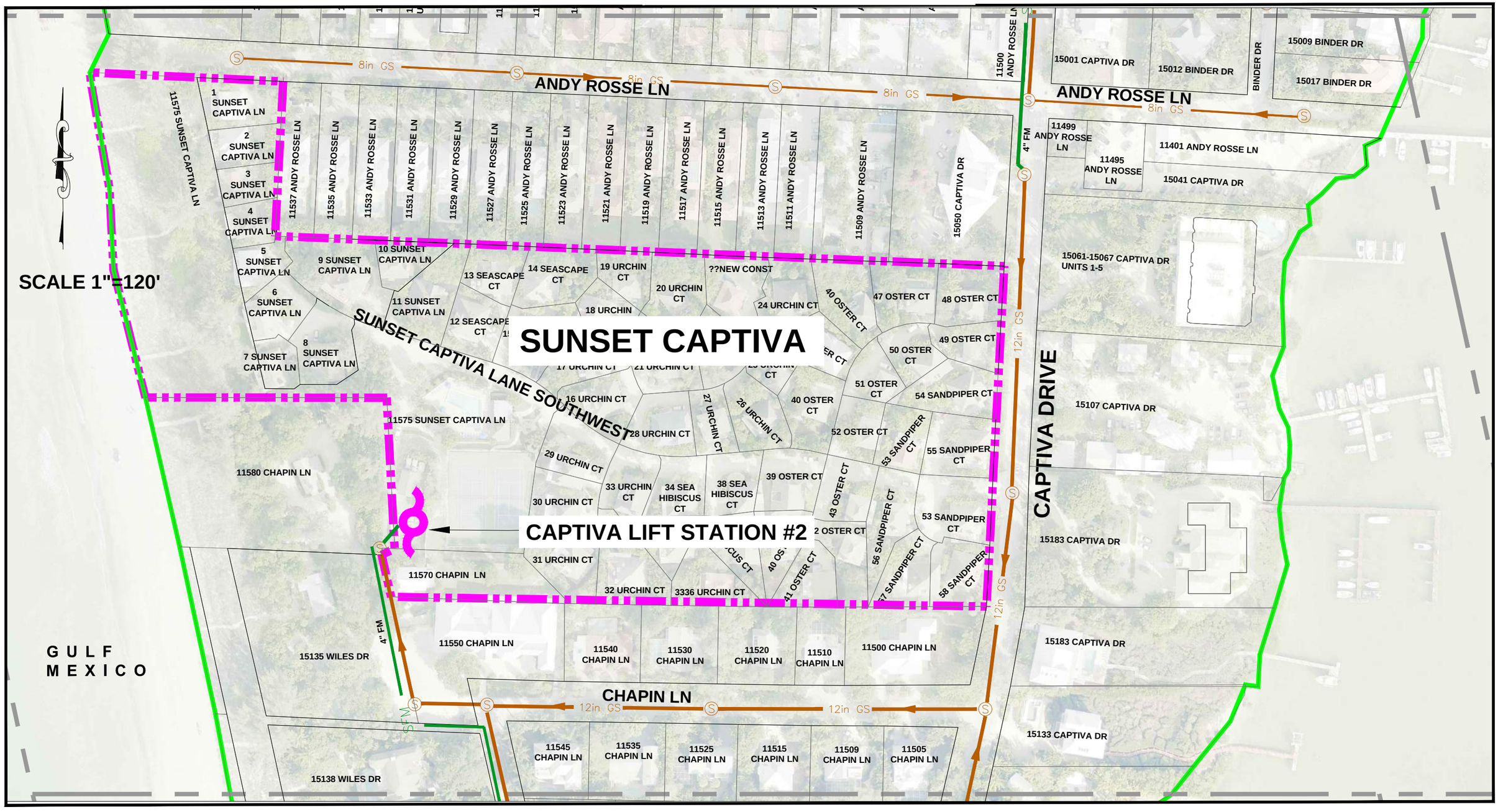
FIGURE 2



MATCH SHEET FIGURE 4

TKW CONSULTING ENGINEERS® TKW Project No.: 16926.00	CAPTIVA ISLAND WASTEWATER ALTERNATIVE STUDY CENTRAL SYSTEM CONCEPT	VILLAGE SERVICE AREA	FIGURE 3

MATCH SHEET FIGURE 3

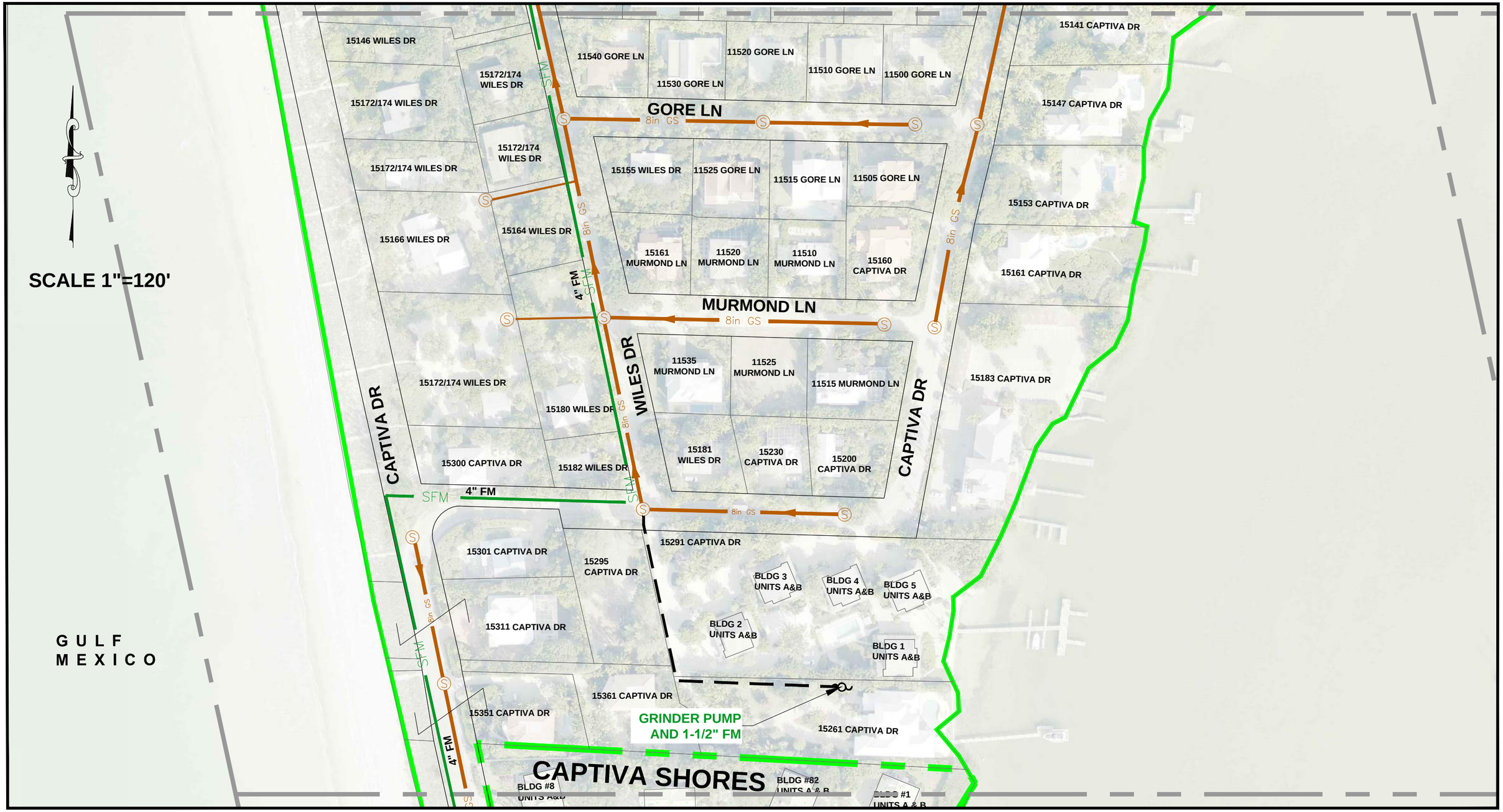


MATCH SHEET FIGURE 5

TKW CONSULTING ENGINEERS	TKW Project No.: 16926.00	CAPTIVA ISLAND WASTEWATER ALTERNATIVE STUDY CENTRAL SYSTEM CONCEPT	VILLAGE SERVICE AREA

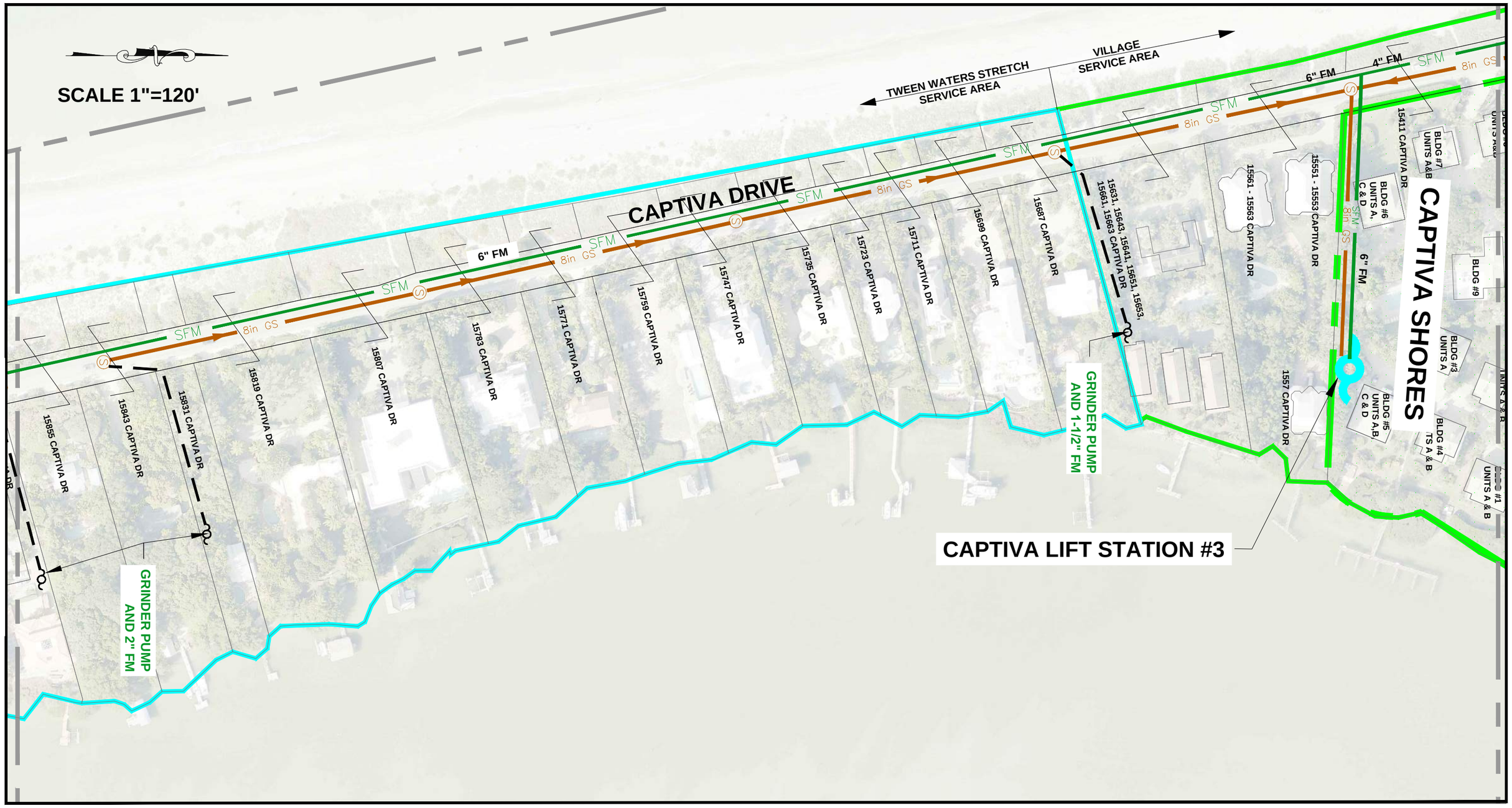
FIGURE 4

MATCH SHEET FIGURE 4



MATCH SHEET FIGURE 6

TKW CONSULTING ENGINEERS	TKW Project No.: 16926.00	CAPTIVA ISLAND WASTEWATER ALTERNATIVE STUDY CENTRAL SYSTEM CONCEPT	VILLAGE SERVICE AREA	FIGURE 5



TKW CONSULTING ENGINEERS	TKW Project No.: 16926.00	CAPTIVA ISLAND WASTEWATER ALTERNATIVE STUDY CENTRAL SYSTEM CONCEPT	VILLAGE SERVICE AREA AND TWEEN WATERS STRETCH SERVICE AREA	FIGURE 6

GULF MEXICO

SCALE 1"=120'

CAPTIVA DRIVE

CAPTIVA LIFT STATION #4

TWEEN WATERS INN

GRINDER PUMP AND 1-1/2" FM

GRINDER PUMP AND 2" FM (TYP)

6" FM

8" FM

8" FM

SFM

8in GS

12in GS

15867 CAPTIVA DR

15879 CAPTIVA DR

15891 CAPTIVA DR

15899 CAPTIVA DR

15903 CAPTIVA DR

15951 CAPTIVA DR

16083 CAPTIVA DR

16095 CAPTIVA DR

16141 CAPTIVA DR

16143 CAPTIVA DR

PALM FLOWER LN

13550 PALM FLOWER LN

13470 PALM FLOWER LN

11551 PAIGE CT

11550 PAIGE CT

11541 PAIGE CT

11531 PAIGE CT

11590 PAIGE CT

MATCH SHEET FIGURE 8

MATCH SHEET FIGURE 6

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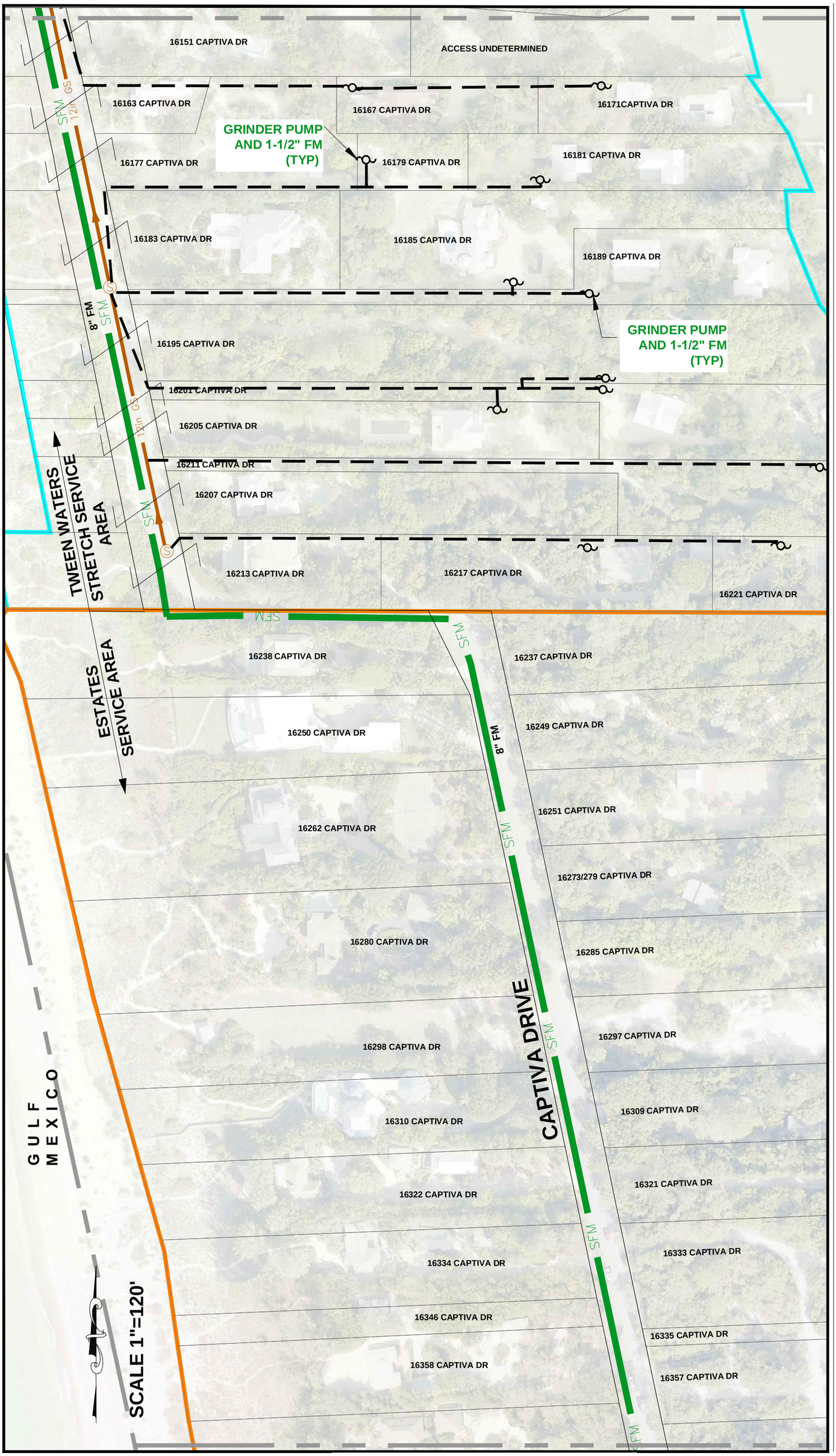
CAPTIVA ISLAND WASTEWATER ALTERNATIVE STUDY
CENTRAL SYSTEM CONCEPT

TWEEN WATERS STRETCH SERVICE AREA

FIGURE 7

MATCH SHEET FIGURE 7



MATCH SHEET FIGURE 9

FIGURE 8

TWEEN WATERS STRETCH SERVICE AREA AND THE ESTATES

CAPTIVA ISLAND WASTEWATER ALTERNATIVE STUDY
CENTRAL SYSTEM CONCEPT

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TKW CONSULTING ENGINEERS

CONSULTING ENGINEERS

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CAPTIVA ISLAND WASTEWATER ALTERNATIVE STUDY
CENTRAL SYSTEM CONCEPT

ESTATES SERVICE AREA

FIGURE 9

MATCH SHEET FIGURE 11

MATCH SHEET FIGURE 9

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CAPTIVA ISLAND WASTEWATER ALTERNATIVE STUDY
CENTRAL SYSTEM CONCEPT

ESTATES SERVICE AREA

FIGURE 10

MATCH SHEET FIGURE 12

MATCH SHEET FIGURE 10

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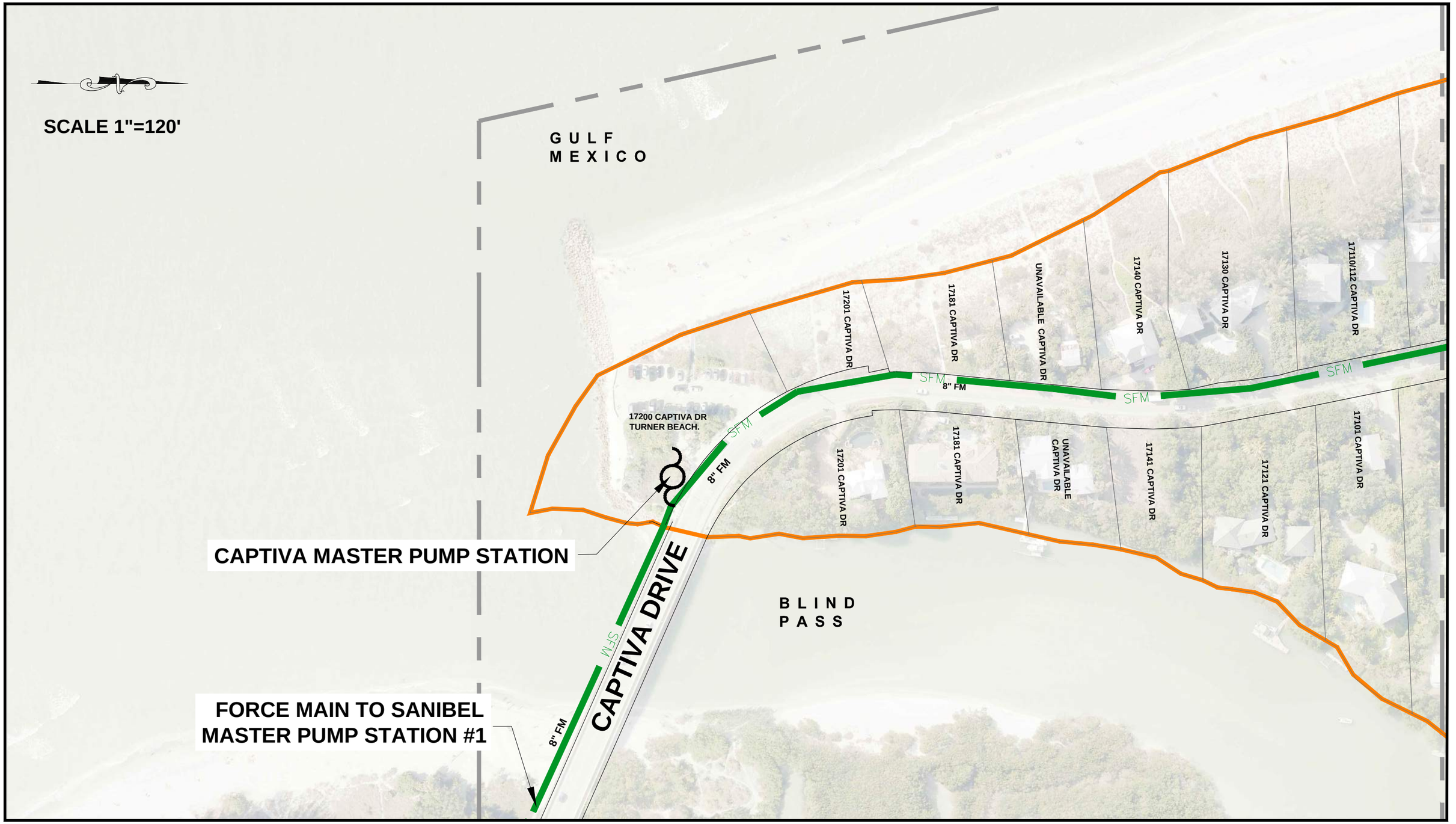
CAPTIVA ISLAND WASTEWATER ALTERNATIVE STUDY
CENTRAL SYSTEM CONCEPT

ESTATES SERVICE AREA

FIGURE 11

SCALE 1"=120'

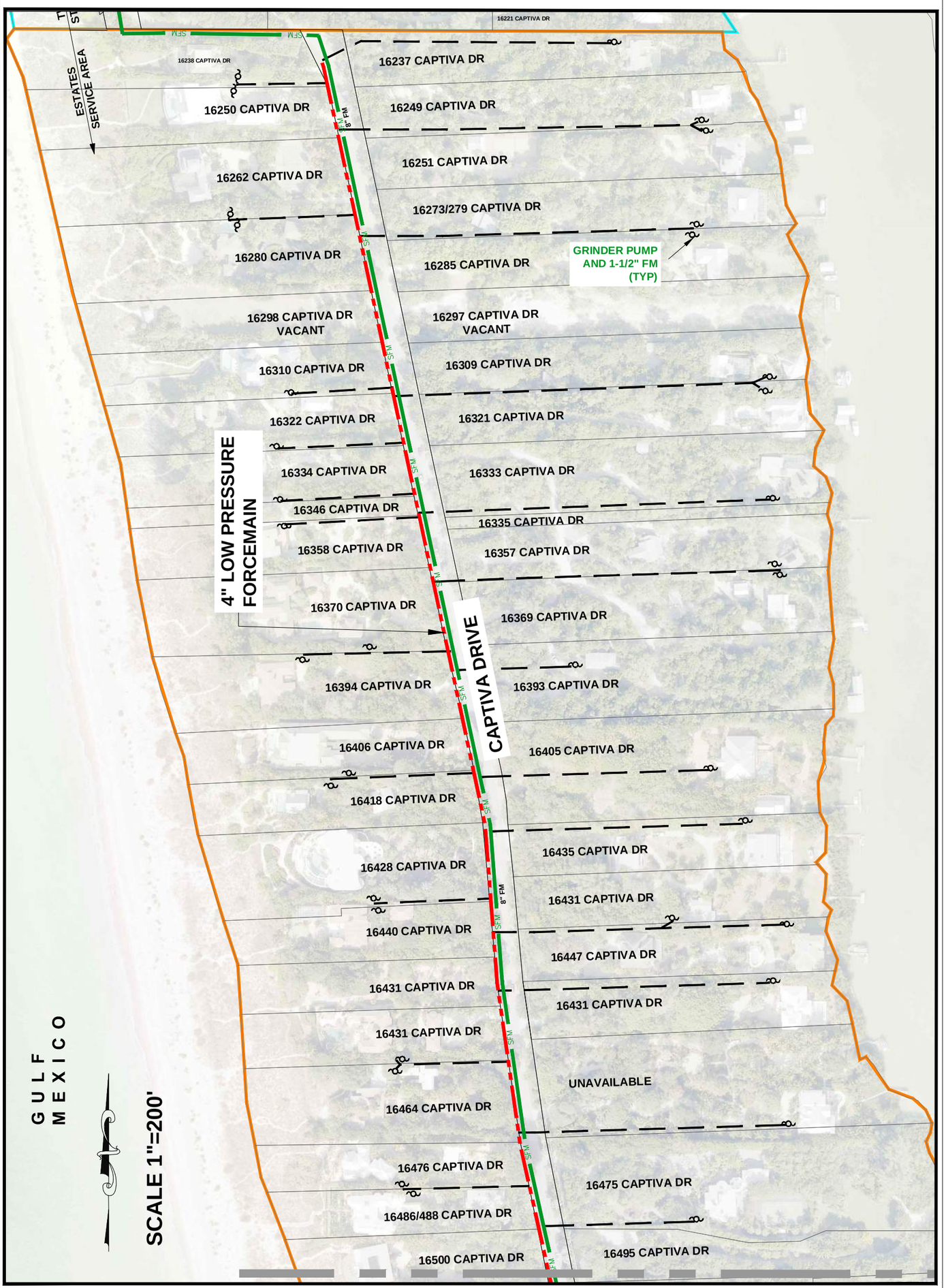


MATCH SHEET FIGURE 11

TKW CONSULTING ENGINEERS	TKW Project No.: 16926.00	CAPTIVA ISLAND WASTEWATER ALTERNATIVE STUDY CENTRAL SYSTEM CONCEPT	ESTATES SERVICE AREA

FIGURE 12

NORTH BOUNDARY OF THE ESTATES SERVICE AREA



MATCH SHEET FIGURE 14

FIGURE 13

THE ESTATES SERVICE AREA

CAPTIVA ISLAND WASTEWATER ALTERNATIVE STUDY
CENTRAL SYSTEM CONCEPT

TKW Project No.: 16926.00

TKW CONSULTING ENGINEERS®

MATCH SHEET FIGURE 15

SCALE 1"=200'

GULF
MEXICO

4" LOW PRESSURE
FORCEMAIN

16512 CAPTIVA DR
16530 CAPTIVA DR
16548 CAPTIVA DR
16560/562 CAPTIVA DR
16572 CAPTIVA DR
16590 CAPTIVA DR
16596 CAPTIVA DR
16600 CAPTIVA DR
16620 CAPTIVA DR
16632 CAPTIVA DR
CAPTIVA GULF WAY RW
16646 CAPTIVA DR
UNAVAILABLE
CAPTIVA DR
16682 CAPTIVA DR
16706 CAPTIVA DR
16718 CAPTIVA DR
16730 CAPTIVA DR
16742 CAPTIVA DR
16760 CAPTIVA DR
16770 CAPTIVA DR
16778 CAPTIVA DR
16790 CAPTIVA DR
16798/802 CAPTIVA DR
16814 CAPTIVA DR
16828 CAPTIVA DR
16838 CAPTIVA DR
16850 CAPTIVA DR
16849 CAPTIVA DR
16841 CAPTIVA DR
16825 CAPTIVA DR
16813 CAPTIVA DR
16801 CAPTIVA DR
16791
CAPTIVA
ISLAND
WATER
ASSOC INC
16789
CAPTIVA DR
16785 CAPTIVA DR
16777 CAPTIVA DR
16737 CAPTIVA DR
16727 CAPTIVA DR
16721 CAPTIVA DR
16723 CAPTIVA DR
16715 CAPTIVA DR
16697 CAPTIVA DR
16669 CAPTIVA DR
16665 CAPTIVA DR
16645 CAPTIVA DR
16623 CAPTIVA DR
16615 CAPTIVA DR
VACANT
16611 CAPTIVA DR
16595 CAPTIVA DR
16585 CAPTIVA DR
16575 CAPTIVA DR
OSPREY WAY
3599 OSPREY WAY
16543 CAPTIVA DR
16525 CAPTIVA DR
16531 CAPTIVA DR
16507 CAPTIVA DR
3590 OSPREY WAY
3591 OSPREY WAY
16476 CAPTIVA DR

SFM
8" FM

MATCH SHEET FIGURE 13

CONSULTING ENGINEERS®

TKW Project No.: 16926.00

CAPTIVA ISLAND WASTEWATER ALTERNATIVE STUDY
CENTRAL SYSTEM CONCEPT

THE ESTATES SERVICE AREA

FIGURE 14

MATCH SHEET FIGURE 14

SCALE 1"=200'

GULF
MEXICO

CAPTIVA MASTER PUMP STATION

FORCE MAIN TO SANIBEL
MASTER PUMP STATION #1

4" LOW PRESSURE
FORCEMAIN

CAPTIVA DRIVE

17200 CAPTIVA DR
TURNER BEACH.

17201
CAPTIVA DR
VACANT

17181
CAPTIVA DR
VACANT

17201
CAPTIVA DR

17181
CAPTIVA DR

UNAVAILABLE

17140 CAPTIVA DR

17130 CAPTIVA DR

17110/112 CAPTIVA DR

17078/080 CAPTIVA DR

17050 CAPTIVA DR

17030 CAPTIVA DR

17020 CAPTIVA DR

16980 CAPTIVA DR

16970 CAPTIVA DR
VACANT

16950 CAPTIVA DR
VACANT

16910 CAPTIVA DR

UNAVAILABLE CAPTIVA DR

16886 CAPTIVA DR

16874 CAPTIVA DR

16862 CAPTIVA DR

17141
CAPTIVA DR
VACANT

17121
CAPTIVA DR

17101 CAPTIVA DR

17081 CAPTIVA DR

17050 CAPTIVA DR

17041 CAPTIVA DR

17021 CAPTIVA DR

17001 CAPTIVA DR

16989 CAPTIVA DR
VACANT

16979 CAPTIVA DR

16969 CAPTIVA DR

16915 CAPTIVA DR

16897 CAPTIVA DR

16891 CAPTIVA DR

16879 CAPTIVA DR

16861 CAPTIVA DR

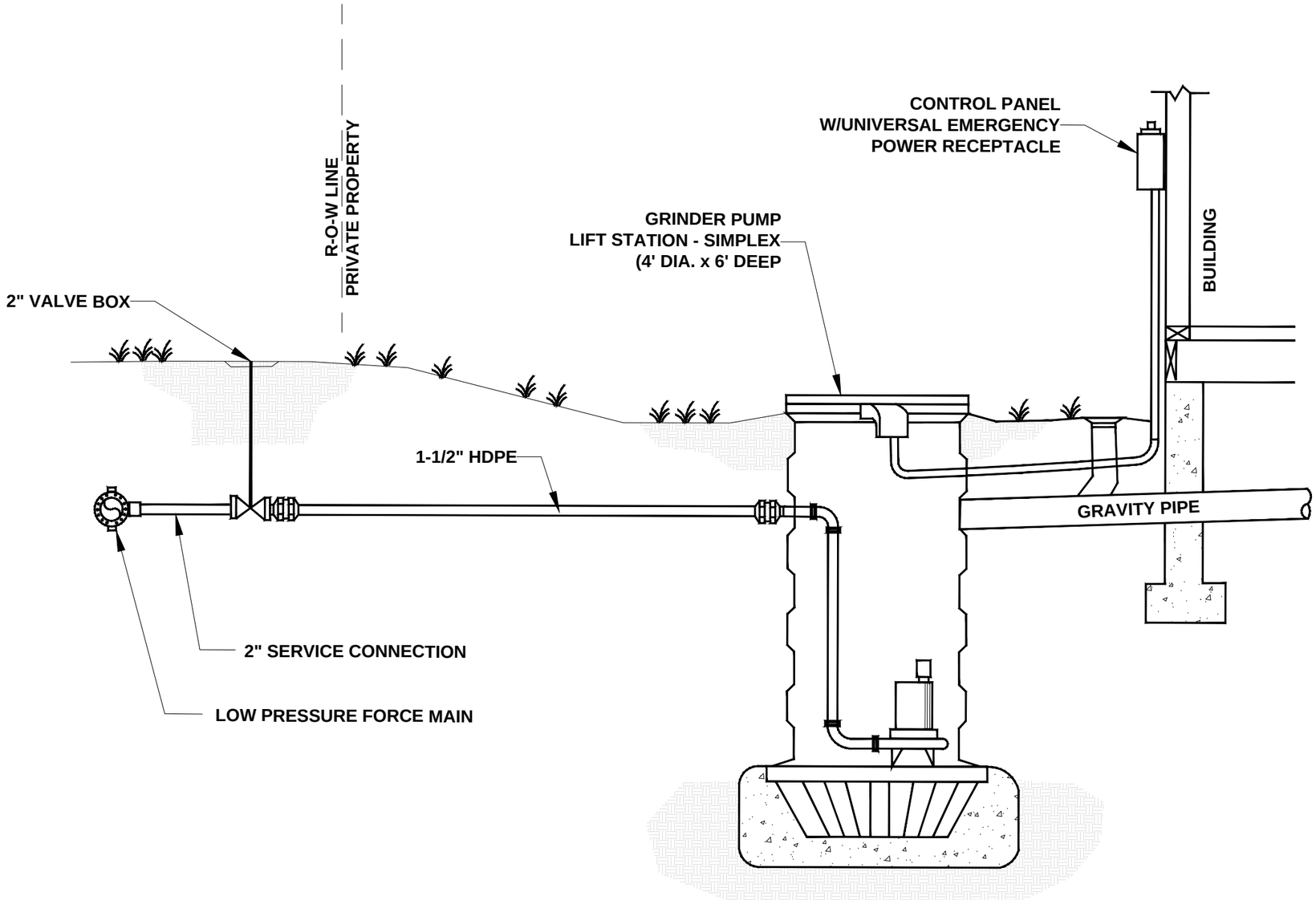
SFM

8" FM

MATCH SHEET FIGURE 14

TKW CONSULTING ENGINEERS	TKW Project No.: 16926.00	CAPTIVA ISLAND WASTEWATER ALTERNATIVE STUDY CENTRAL SYSTEM CONCEPT	THE ESTATES SERVICE AREA

FIGURE 15



CONSULTING ENGINEERS

TKW Project No.: 16926.00

CAPTIVA ISLAND WASTEWATER ALTERNATIVE STUDY
CENTRAL SYSTEM CONCEPT

GRINDER PUMP LIFT STATION SYSTEM (LOW PRESSURE SEWER)

FIGURE 16

APPENDICIES

APPENDIX A

FKAA Onsite Treatment and Disposal System (OSTDS) Program

The Florida Keys has been implementing central sewer systems since completion of the master planning in 1999. However, it was known that some areas, and isolated properties in the Keys, it would not be practical to construct centralized sewer systems. In these locations an alternative was proposed that is intended to match the environmental benefit of central sewers on water quality. The FKAA was tasked as the public utility that could implement the wastewater program in the unincorporated areas for the Florida Keys for unincorporated Monroe County.

FKAA has been installing Advanced Secondary PBTS w/Nutrient Reduction over the past five years in accordance with the special chapter under FAC 64E-6, Part II Florida Keys. This unique FKAA public utility program, which has received supplemental funding via an EPA Grant which funds up to 75% of the costs, has evolved over the past few years and has been a partnering effort with the EPA, DOH, the OSTDS industry, and FKAA. Several Best Available Technology (BAT) OSTDS systems that comply with the DOH requirements of Advanced Secondary PBTS with additional nutrient removal have been installed and certified and tested in relatively remote portions of the FKAA service area over the past few years under this program. FKAA makes wastewater service "available" to remote private single family or multifamily dwelling complex landowners by executing a utility easement and then provides installation of an FKAA OSTDS that is certified, operated, and maintained by FKAA. FKAA charges a one-time up-front assessment of $4,500 to each customer in this program, and then charges a typical wastewater connection fee and then bills the property owner monthly under its typical wastewater service rates that are based on a flat rate and a usage rate component.

FKAA Typical OSTDS System Components

Although this FKAA program has only been active for the past few years, FKAA and the OSTDS industry have developed a best available technology OSTDS system that is comprised of the following components:

500 GPD or 750 GPD capacity Advanced Secondary PBTS Treatment Units that are comprised of two to three buried tanks that perform necessary flow equalization, nitrate removal in the anoxic zone, followed by aeration and then settling treatment functions. A typical single family home requires a 500 GPD unit, and a typical duplex or small multifamily complex requires a 750 GPD unit.

Additional nutrient removal is accomplished by adding a two-tank effluent up-flow filter to the system above that uses a Light Expanded Clay Aggregate (LECA) media to polish and remove Phosphorous down to the required effluent of 1 mg/L total Phosphorous.

Because of land constraints, FKAA and property owners realized that the most cost-effective and preferred effluent disposal method for the treated effluent is a shallow injection well. The typical shallow injection well in the Florida Keys is connected to the unconfined Biscayne aquifer known to be productive in terms of permissivity and flow capacity, and FKAA has found that a well 4" in diameter and cased to 60' deep with an open borehole down to 90 feet below land surface is sufficient. The underlying aquifer is also saline and injection is not a threat to fresh ground water resources. A properly designed and certified drainfield could be used for effluent disposal in lieu of a shallow injection well;

however, FKAA determined that land constraints for a drainfield are challenging and not as cost-effective to construct and maintain as a small diameter shallow injection well. Using a well for effluent disposal also eliminates concern for drainfields in area that may experience flooding or a high water table.

FKAA Typical OSTDS System Manufacturers

The current preferred vendor is the BIOMICROBICS "FAST" System, either the MicroFast 0.5 or MicroFast 0.75 Models (depending on capacity).

NORWECO and PURIFLOW provide comparable systems, but according to FKAA have had some challenges with certifying operational performance and producing effluent meeting the requirement of FAC 64E-6.017 (4) Minimum level of waste treatment of effluent meeting 10 mg/L BOD, 10 mg/L TSS, 10 mg/L TN and 1 mg/L TP.

At this time, FKAA has found that the only reliable and effective effluent filter prior to shallow well injection that has successfully removed Phosphorous to required low level without chemical addition is the use of Lightweight Expanded Clay Aggregate (LECA) media.

FKAA Typical OSTDS System Costs

According to FKAA, bids received for these FKAA OSTDS PBTS systems with additional nutrient removal and including the shallow injection well have ranged from about $27,000 to $38,000 to furnish and install, with a figure of $35,000 being typical.

Since the FKAA/EPA program is in its initial stages, FKAA does not yet have enough history or data to determine typical estimated monthly operational and maintenance costs for these systems.

FKAA – Public Utility Ownership and O&M

The FKAA program is unique because the FKAA owns and maintains the onsite systems with access to private property granted by maintenance easements. They inspect the installed systems on a quarterly basis to confirm they are meeting treatment goals and are operating correctly.

Each of these OSTDS systems is regulated through a two-year Monroe County DOH operating permit and requires an accompanying maintenance agreement for quarterly maintenance contracted out by FKAA to local Septic Hauling companies. FKAA reported that the typical Septic Company maintenance agreement outsourced by FKAA costs about $800 for a two-year maintenance contract. Eventually as this FKAA program evolves, FKAA may perform its own maintenance on OSTDS's with in-house staff.

FKAA and the DOH have determined that the effectiveness of these advanced OSTDS systems in the long-term will require public utility ownership, enforcement, operations and maintenance by FKAA. Properties that are required to upgrade to an FKAA advanced OSTDS benefit from the economy of scale provided through a public utility, for financing, construction, operation, and maintenance.

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