ALABAMA STATE EXPENDITURE PLAN (SEP)

Project #8: Aloe Bay/Mississippi Sound Water Quality Enhancement Project

Project Description/Summary

a) The Aloe Bay/Mississippi Sound Water Quality Enhancement Project proposes both the design and implementation (construction) of a new state-of-the-art Biological Nutrient Removal (BNR) wastewater treatment facility on Dauphin Island. Incorporating the latest technologies, the facility will improve both receiving water quality and the general health of the island's surrounding waters, including fishery and shellfish habitats. Known for its family-friendly community, beaches, birds, saltwater marshes, and recreational waters, Dauphin Island is a unique, treasured asset on the Alabama Gulf Coast. With a growing population of long-term residents, outdoor enthusiasts, and nature lovers, and home to Federal and State agencies, the Dauphin Island Sea Lab, and the Alabama Deep Sea Fishing Rodeo, the island's close-knit community shares a passion for both enjoying and protecting its unique natural resources.

   Whether for drinking or discharge, treatment of water is complicated, and sustaining those efforts is exhaustive. The process is further complicated because the utility is physically isolated from the mainland and surrounded by the Gulf of Mexico. With no substantial freshwater-source available, DIWSA designed and built the first municipal reverse osmosis facility in the State, charting new territory for the treatment of drinking water along the upper Gulf Coast. This funding provides a unique opportunity to enhance the receiving waters of Aloe Bay and the Mississippi Sound, and to do so for generations to come. The DIWSA is proposing to integrate long-term sustainability with enhanced wastewater treatment techniques, incorporating environmental awareness and economic stability. This project seeks to reduce the impact on receiving water and improve the overall health of the estuaries in and around Dauphin Island.

   Activities also include the comprehensive administration of this grant, including, but not limited to, project development and oversight, contracting, and sub-recipient monitoring.

   a. **Need**: The Dauphin Island Water & Sewer Authority (DIWSA) owns and operates a 0.98 MGD wastewater treatment facility which provides sewer treatment to the Island's residents and visitors. With increasingly tight regulatory discharge limits, DIWSA has begun plans to replace the facility with a state-of-the-art Water Reclamation Facility (WRF). This new facility will be designed and constructed to serve Dauphin Island's needs for high level wastewater treatment.

      Sewage is processed at the Waste Water Treatment Plant before being discharged into Aloe Bay. Effluent water quality for solids removal, Biochemical Oxygen Demand (BOD) reduction, nitrate and phosphorus removal, and disinfection, are controlled throughout the process and meet current State and EPA permit limits, however, with an aging facility and forward focus on environmental protection, we must address the following infrastructure improvements:

- **Enhanced Solids Removal:** The new facility will replace the influent lift station and headworks screening and grit removal. These improvements will provide improved removal of solids, sand, and grit. Pretreatment process components will consist of influent flow monitoring, influent composite sampling, mechanical and manual screening, screenings washing and dewatering equipment, grit removal and handling equipment, odor control, and septage receiving.
- **Enhanced Biological Nutrient Removal:** The proposed facility will utilize Biological Nutrient Removal (BNR) process as the Best Available Science to protect the marine water resources of Aloe Bay and the Mississippi Sound. BNR processes remove total nitrogen (TN) and total phosphorus (TP) from wastewater using microorganisms under different environmental conditions in the treatment process. Nitrogen and phosphorus are the primary causes of cultural eutrophication (i.e., nutrient enrichment due to human activities) in surface waters. The most recognizable manifestations of this eutrophication are algal blooms that occur during the summer. Chronic symptoms of over-enrichment include low dissolved oxygen, fish kills, murky water, and depletion of desirable flora and fauna. Excessive amounts of nutrients can also stimulate the activity of microbes, such as Pfisteria, which may be harmful to human health. Approximately 25% of all water body impairments are due to nutrient-related causes (e.g., nutrients, oxygen depletion, algal growth, ammonia, harmful algal blooms, biological integrity, and turbidity) (U.S. EPA, National Section 303(d) List Fact Sheet, 2007). Reduction of nitrogen and phosphorus from the waste stream is essential to prevent water body impairment and the new facility will incorporate these elements to provide a state-of-the-art enhanced BNR facility.
- **Improved Disinfection Techniques:** Disinfection is considered to be the primary mechanism for the inactivation/destruction of pathogenic organisms to prevent the spread of waterborne diseases to downstream users and the environment. The current treatment plant uses chlorine disinfection which requires proper dosing, contact time and de-chlorination steps prior to discharge. The use of chlorine currently includes the following limitations: 1. Chlorine is not effective for the inactivation of Giardia and Cryptosporidium, which are pathogens that can harm people, particularly from human contact with the proposed irrigation re-use of treated effluent; 2. Chlorine presents a safety risk to plant staff and the general public; and 3. Chlorine has to be chemically de-chlorinated before discharge to the outfall location, which creates further risk of human safety or chemical contamination of natural waters.
- **Virus Deactivation/Improved Disinfection Techniques:** The proposed facility will implement Ultra-Violet (UV) light systems for enhanced disinfection, virus inactivation, and pathogen removal. UV systems are proficient at deactivation of difficult to treat virus and pathogens like cryptosporidium and giardia. An Ultraviolet (UV) disinfection system transfers electromagnetic energy from a mercury arc lamp to an organism's genetic material (DNA and RNA). When UV radiation

penetrates the cell wall of an organism, it destroys the cell's ability to reproduce. UV radiation, generated by an electrical discharge through mercury vapor, penetrates the genetic material of microorganisms and retards their ability to reproduce. UV disinfection is effective at inactivating most viruses, spores, and cysts and is a physical process rather than a chemical disinfectant, which eliminates the need to generate, handle, transport, or store toxic/hazardous or corrosive chemicals. There is no residual effect that can be harmful to humans or aquatic life.

- **Suspended Particulate Removal Through Filtration:** The new facility will provide filtration prior to discharge into Aloe Bay. Filtration will reduce suspended solids concentrations discharged to Aloe Bay. Filtration also further reduces phosphorous and nitrogen levels which can adversely affect aquatic life within the receiving waters.
- **Meet Capacity Requirements:** Although the existing facility is permitted to meet current demand and projected demand from future growth, meeting demands from storms and handling the varied flows from seasonal tourist influx can be problematic. The new facility will provide flexibility to adjust to seasonal tourist influx, storm flows, and varied biological loadings associated with these events. The facility will incorporate proper basin sizing and equipment sizing to provide redundancy for peak operations.

Purpose: The purpose of the project is the planning (E&D), and implementation (construction) of a new state-of-the-art Biological Nutrient Removal (BNR) wastewater treatment facility on Dauphin Island to improve water quality in Aloe Bay and to provide long-term protection for the surrounding environment.

Objectives: The primary objectives of this project are:

- Complete construction for a state-of-the art wastewater treatment facility on Dauphin Island; and
- Achieve improved water quality and ensure more reliable service for residents and tourists.

b. This activity is located in the Gulf Coast region and will be carried out in the Aloe Bay/Mississippi Sound area along Dauphin Island in Mobile County, Alabama.

c. This project is anticipated to begin on 7/1/19 and end on 3/31/21 (33 months).

d. This project will be implemented by the Dauphin Island Water and Sewer Authority.

b) The project will assist in the economic and ecological recovery of the Gulf Coast Region by reducing the negative impacts of effluent waste water on estuaries in and around Dauphin Island and by implementing enhanced nutrient removal,

filtration, and high-level disinfection. While not increasing capacity, this facility will provide Dauphin Island with more reliable service, and thus the ability to better manage within a tourist economy.

Eligibility and Statutory Requirements

This activity is located in the Gulf Coast Region and is eligible for Spill Impact Component funding under Category #1 - Restoration and protection of the natural resources, ecosystems, fisheries, marine and wildlife habitats, beaches, and coastal wetlands of the Gulf Coast region (primary). Secondary activities include Category #2 - Mitigation of damage to fish, wildlife, and natural resources; Category #3 - Implementation of a federally approved marine, coastal, or comprehensive conservation management plan, including fisheries monitoring; Category #4 Workforce development and job creation; Category #6 - Infrastructure projects benefiting the economy or ecological resources, including port infrastructure; and Category #10 - Promotion of tourism in the Gulf Coast region, including recreational fishing.

Comprehensive Plan Goals and Objectives

This project is consistent with the following Comprehensive Plan goals:

- Goal 1: Restore and Conserve Habitat – Restore and conserve the health, diversity, and resilience of key coastal, estuarine, and marine habitats;
- Goal 2: Restore Water Quality and Quantity – Restore and protect water quality of the Gulf Coast region's fresh, estuarine, and marine waters;
- Goal 3: Replenish and Protect Living Coastal and Marine Resources – Restore and protect healthy, diverse, and sustainable living coastal and marine resources.
- Goal 4: Enhance Community Resilience – Build upon and sustain communities with capacity to adapt to short- and long-term changes; and
- Goal 5: Restore and Revitalize the Gulf Economy – Enhance the sustainability and resiliency of the Gulf economy.

This project supports the following Comprehensive Plan objectives:

- Objective 1: Restore, Enhance, and Protect Habitats - Restore, enhance, and protect the extent, functionality, resiliency, and sustainability of coastal, freshwater, estuarine, wildlife, and marine habitats;
- Objective 2: Restore, Improve, and Protect Water Resources – Restore, improve, and protect the Gulf Coast region's fresh, estuarine, and marine water resources by reducing or treating nutrient and pollutant loading; and improving the management of freshwater flows, discharges to and withdrawals from critical systems;
- Objective 3: Protect and Restore Living Coastal and Marine Resources – Restore and protect healthy, diverse, and sustainable living coastal and marine resources including finfish, shellfish, birds, mammals, reptiles, coral, and deep benthic communities; and
- Objective 5: Promote Community Resilience – Build and sustain Gulf Coast communities' capacity to adapt to short- and long-term natural and man-made

hazards, particularly increased flood risks associated with sea-level rise and environmental stressors. Promote ecosystem restoration that enhances community resilience through the re-establishment of non-structural, natural buffers against storms and flooding.

Major Milestones

a) Milestone 1: Complete bids for E&D

b) Milestone 2: Complete design including effluent design criteria

c) Milestone 3: Permitting

d) Milestone 4: Complete bids for Construction

e) Milestone 5: Project closeout

Success Criteria/Metrics/Outcomes

The anticipated outcome of the Aloe Bay/Mississippi Sound Water Quality Enhancement Project will be:

- The construction of a Water Reclamation Facility to replace existing outdated facility

Table 9. Proposed Projects Success Criteria/Metrics/Outcomes

Activity	Anticipated Project Success Criteria/ Metrics	Short-term Outcomes	Long-term Outcomes
Construction of a WRF to replace existing facility on Dauphin Island	Completed E&D w/ effluent design criteria Complete Construction of one WRF Quantifiable TSS, NH3, and CBOD load reduction to Aloe Bay Quantify disinfection of 4-log virus reduction Develop monitoring plan to assess water quality improvements	Reduce impact of effluent waste on estuaries in and around Dauphin Island Load reduction of Total Suspended Solids (TSS), Ammonia (NH3), and Carbonaceous Biological Oxygen Demand (CBOD) to Aloe Bay	Improved water quality More reliable service for local residents and tourists

ALABAMA STATE EXPENDITURE PLAN (SEP)

Monitoring and Evaluation

a) Submission of final E&D to ADCNR for review and approval

b) Provide evidence to ADCNR that all required permits were obtained (including SHPO)

c) Submit results of bid process to ADCNR prior to awarding contracts

d) ADCNR will conduct periodic onsite reviews

e) Submission of quarterly and final reports

f) Post construction monitoring as required

Best Available Science

The proposed Dauphin Island treatment facility will utilize Biological Nutrient Removal (BNR) process as the Best Available Science to protect natural resources of Aloe Bay and the Mississippi Sound. BNR removes total nitrogen (TN) and total phosphorus (TP) from wastewater through the use of microorganisms under different environmental conditions in the treatment process (Metcalf and Eddy, 2003).

Nitrogen and phosphorus are the primary causes of cultural eutrophication (i.e., nutrient enrichment due to human activities) in surface waters. The most recognizable manifestations of this eutrophication are algal blooms that occur during the summer. Chronic symptoms of over-enrichment include low dissolved oxygen, fish kills, murky water, and depletion of desirable flora and fauna. Excessive amounts of nutrients can also stimulate the activity of microbes, such as Pfisteria, which may be harmful to human health (U.S. EPA, 2001). Approximately 25% of all water body impairments are due to nutrient-related causes (e.g., nutrients, oxygen depletion, algal growth, ammonia, harmful algal blooms, biological integrity, and turbidity) (U.S. EPA, 2010).

Total effluent nitrogen comprises ammonia, nitrate, particulate organic nitrogen, and soluble organic nitrogen. The biological processes that primarily remove nitrogen are nitrification and denitrification (Jeyanayagam, 2005). During nitrification, ammonia is oxidized to nitrite by one group of autotrophic bacteria, most commonly Nitrosomonas (Metcalf and Eddy, 2003). Nitrite is then oxidized to nitrate by another autotrophic bacteria group, the most common being Nitrobacter. Denitrification involves the biological reduction of nitrate to nitric oxide, nitrous oxide, and nitrogen gas (Metcalf and Eddy, 2003). Both heterotrophic and autotrophic bacteria are capable of denitrification. The most common and widely distributed denitrifying bacteria are Pseudomonas species, which can use hydrogen, methanol, carbohydrates, organic acids, alcohols, benzoates, and other aromatic compounds for denitrification (Metcalf and Eddy y, 2003). In BNR systems, nitrification is the controlling reaction because ammonia oxidizing bacteria lack functional diversity, have stringent growth requirements, and are sensitive to environmental conditions (Jeyanayagam, 2005). Note that nitrification by itself does not actually remove nitrogen from wastewater. Rather, denitrification is needed to convert the oxidized form of nitrogen (nitrate) to nitrogen gas. Nitrification occurs in the presence of oxygen under

aerobic conditions, and denitrification occurs in the absence of oxygen under anoxic conditions.

Total effluent phosphorus comprises soluble and particulate phosphorus. Particulate phosphorus can be removed from wastewater through solids removal. To achieve low effluent concentrations, the soluble fraction of phosphorus must also be targeted. Biological phosphorus removal relies on phosphorus uptake by aerobic heterotrophs capable of storing orthophosphate in excess of their biological growth requirements. The treatment process at Dauphin Island will be designed to promote the growth of these organisms, known as phosphate-accumulating organisms (PAOs) in mixed liquor. Under anaerobic conditions, PAOs convert readily available organic matter [e.g., volatile fatty acids (VFAs)] to carbon compounds called polyhydroxyalkanoates (PHAs). PAOs use energy generated through the breakdown of polyphosphate molecules to create PHAs. This breakdown results in the release of phosphorus (WEF and ASCE/EWRI, 2006). Under subsequent aerobic conditions in the treatment process, PAOs use the stored PHAs as energy to take up the phosphorus that was released in the anaerobic zone, as well as any additional phosphate present in the wastewater. In addition to reducing the phosphate concentration, the process renews the polyphosphate pool in the return sludge so that the process can be repeated (Jeyanayagam, 2005). Some PAOs use nitrate instead of free oxygen to oxidize stored PHAs and take up phosphorus. These denitrifying PAOs remove phosphorus in the anoxic zone, rather than the aerobic zone (Jeyanayagam, 2005). Phosphorus will also be removed from wastewater through chemical precipitation. Chemical precipitation primarily uses aluminum and iron coagulants or lime to form 2 chemical floes with phosphorus. These floes are then settled out to remove phosphorus from the wastewater (Viessman and Hammer, 1998).

This project is consistent with the values and recommendations set forth in the MBNEP's Comprehensive Conservation and Management Plan 2013-2018, available on the MBNEP website.

Design of Municipal Wastewater Treatment Plants: WEF Manual of Practice No. 8 and ASCE Manual and Report on Engineering Practice No. 76, 1992.

Jeyanayagam, Sam. 2005. True Confessions of the Biological Nutrient Removal Process. Florida Water Resources Journal: January 2005.

Viessman, Warren. Hammer, Mark J. 1998. Water Supply and Pollution Control.

Metcalf & Eddy. 2003. Wastewater Engineering: Treatment and Reuse. 4th Edition, McGraw-Hill, New York.

U.S. EPA. 2010. National Section 303(d) List Fact Sheet, which is available on U.S. EPA's website.

U.S. EPA. 2001. Memorandum: Development and Adoption of Nutrient Criteria into Water Quality Standards. Available on the U.S. EPA website.

Water Environment Federal (WEF) and American Society of Civil Engineers (ASCE)/Environmental and Water Resources Institute (EWRI). 2006. Biological Nutrient Removal (BNR) Operation in Wastewater Treatment Plants. McGraw Hill: New York.

U.S. EPA. August 2010. Nutrient Control Design Manual (EPA/600/R-10/100), available on the U.S. EPA website.

U.S. EPA. 2007. Biological Nutrient Removal Processes and Costs. This document is available from the EPA website.

Additional BAS review may be required at the grant application stage.

Budget/Funding

a) Estimated cost of the project and amount to be requested from Spill Impact Component Funds: $11,845,000 (25%-35% - Planning, 75%-65% - Implementation). While it is noted that funding available under a grant award cannot exceed the amount described in the SEP for this project, the percentages listed in this section are estimated and will be more clearly cultivated in the grant application.

b) No additional funding has been requested for this project.

Partnerships/Collaboration (if applicable)

Not applicable at this time.

Leveraged Resources (if applicable)

Not applicable at this time.

Funds Used As Non-Federal Match (if applicable)

Not applicable at this time.

Other

Not applicable at this time.

ALABAMA STATE EXPENDITURE PLAN (SEP)

Figure 8. The Aloe Bay/Mississippi Sound Water Quality Enhancement Project will be implemented on Dauphin Island, Alabama.