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STORMWATER MASTER PLAN

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STORMWATER MASTER PLAN: VISION, GOALS, AND OBJECTIVES

VISION AND GOALS

» The Stormwater Master Plan seeks to improve the performance of the current Port of Corpus Christi stormwater infrastructure through an in-depth analysis that alleviates current capacity and flooding issues and plans for future stormwater management needs as the Port continues to grow and develop.

Goals of the Stormwater Master Plan are as follows:

1. **Reduce Flooding Potential in the Inner Harbor**
2. **Improve the Quality of Stormwater Discharged to the Inner Harbor and Nueces and Corpus Christi Bays**
3. **Increase Stormwater System Resiliency**
4. **Implement Cost-Effective Stormwater Management Solutions**
5. **Use Innovative Technology To Achieve Stormwater Management**
6. **Use A Flexible And Adaptive Stormwater Planning Effort**

OBJECTIVES

» The Stormwater Master Plan will result in proposed improvements that alleviate flooding and water quality issues by achieving 7 key objectives.

Key objectives include:

1. **Utilizing existing data and obtaining current stormwater infrastructure data.**
2. **Performing a comprehensive inventory of existing stormwater infrastructure.**
3. **Developing a "living" database to track and organize data regarding stormwater infrastructure.**
4. **Utilizing UAV-mounted LiDAR to obtain current elevation data and high-resolution aerial imagery.**
5. **Developing an advanced hydraulic and water quality modeling of the stormwater system optimized to regional rainfall and field conditions.**
6. **Identifying proposed stormwater system improvement projects to increase stormwater runoff capacity and improve water quality in a cost-effective manner.**
7. **Creating a drainage criteria manual to guide stormwater management of future development.**

SECTION 2

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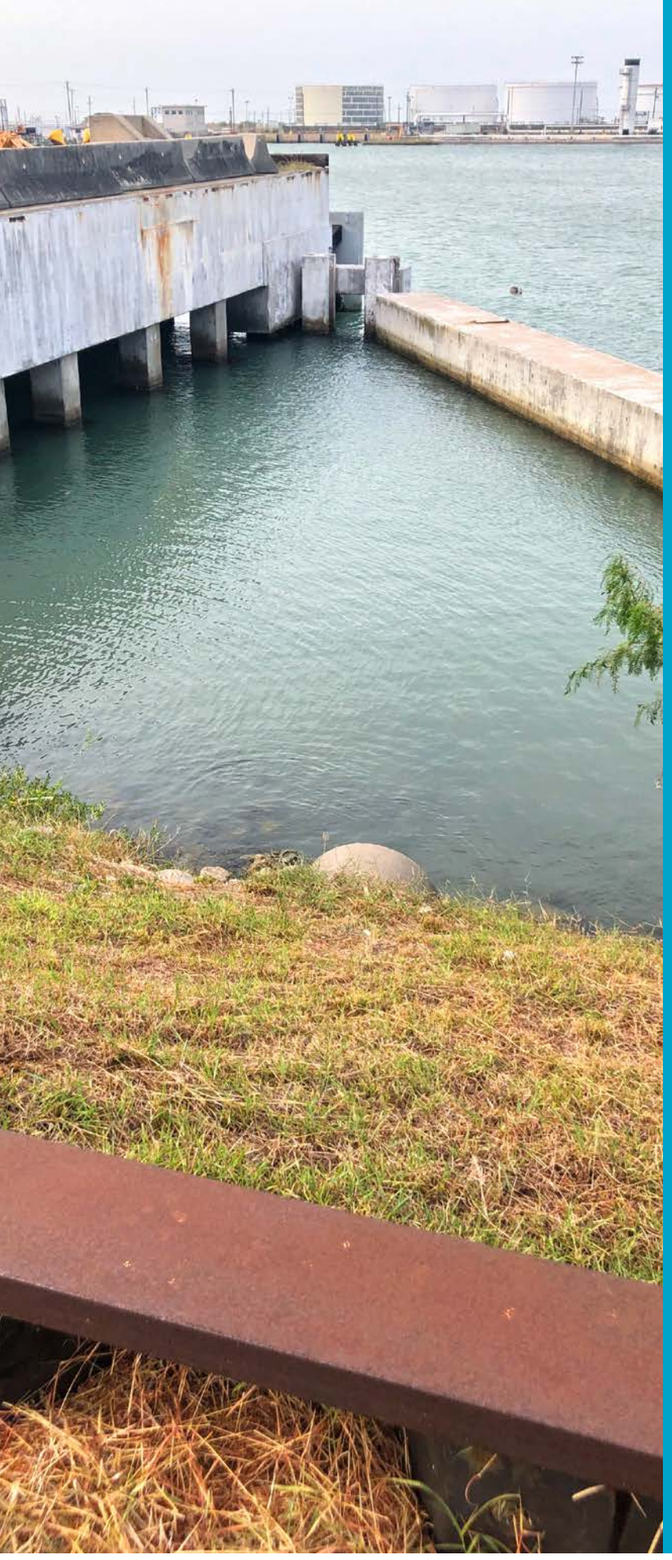
PROCESS AND APPROACH

- Planning Challenges
- Planning Approach
- Stormwater Infrastructure



PLANNING CHALLENGES

Challenges faced in implementation of the Port of Corpus Christi Stormwater Master Plan may be summarized in the following four categories:

Significant Flood Hazard and Climate Variability

- Significant portions of the property owned and managed by the Port are at risk from flood hazards due to tidal influence, storm surges, and flat terrain. Impacts from climate variability, including increased rainfall intensity or volume and, increased risk of tropical disturbances and sea-level rise exacerbate the risks from flooding. The Stormwater Master Plan must account for these challenges as part of the planning process.

Adapting to Changing Port Priorities

- The Port faces many competing economic, technical, and political priorities as it grows, requiring flexibility in implementation of the Stormwater Master Plan. Understanding these priorities is enhanced where the right information at hand for data-informed planning decisions that will enable the Port to prioritize stormwater infrastructure needs.

Future Development for Port Property

- Given the dynamic business environment of the Coastal Bend and the Port, future development and tenant usage are challenging to predict. Site development can alter stormwater infrastructure and, therefore, runoff conveyance patterns significantly. Increasing development generally causes an increase in peak stormwater flow and often becomes a source of additional pollutants. The Stormwater Master Plan must inform development decisions to effectively manage stormwater runoff and minimize risks from adverse stormwater impacts associated with development.

Stormwater Management System Maintenance

- The Port operates a significant amount of stormwater infrastructure located over a large area. Known stormwater conveyance pipes, channels, culverts, drainage inlets and other associated infrastructure must be inspected and maintained on a regular basis to maximize useful life and preserve stormwater management capacity. Developing a system to efficiently track stormwater infrastructure location and condition is critical to identification and resolution of maintenance concerns.

The Stormwater Master Plan process and approach are driven by the challenges faced by the Port in managing stormwater quantity and quality. Understanding these challenges ensures critical issues are addressed in the planning process.

PLANNING APPROACH

The planning process for the Stormwater Master Plan involved four major tasks designed to assess current conditions, evaluate future conditions and issues, and develop a potential plan for the future.

Gather Data on System Capacities

» To determine the capacity of the Port stormwater system, existing drainage infrastructure was characterized by exploring available data and historical records. Previous planning studies were reviewed, site-specific water-quality and quantity data were utilized in the development of the overall analysis. Using gathered data, hydraulic and water quality models were developed to evaluate pollutants of concern.

Conduct an Inventory of Existing Infrastructure

» An inventory of existing stormwater infrastructure was performed and the assembled data imported int the Port's Geographical Information System (GIS) format for reference and analysis. The inventory included open channels, drainage ditches, and stormwater pipe inlets and networks. Information on the condition of the infrastructure, size, erosion and vegetation conditions, and environmental concerns, if any, was gathered. This information will be used as a condition baseline for future infrastructure inspections.

Analyze the Stormwater System

» Runoff volume and water quality aspects of the stormwater system were analyzed using gathered data and advanced engineering tools. The analysis determined stormwater runoff conditions and projections of pollutant discharges to create capacity baselines for stormwater infrastructure rehabilitation or for future infrastructure development. The study area was divided into 10 subbasins. Analysis of the subbasins included:

- **Flood hazard for the 100-year storm event**
- **Flood hazard in a hurricane level flood event**
- **Flood hazard for future development conditions**
- **Tidal impacts to stormwater runoff volume**
- **Sea-level rise impacts to stormwater runoff**
- **Water quality impacts for existing and future Port development**

Proposed improvements to the stormwater system were developed and grouped into projects based on the analyses. Projects include both traditional stormwater BMPs and green infrastructure elements. Additional results from the analyses will be used in the planning process for future development at the Port.

The goal of the Stormwater Capital Projects Plan is to implement the grey and green infrastructure projects with the **highest flood hazard reduction as well as the greatest improvements to water quality**.

Develop Potential Improvements

» Stormwater Capital Projects Plan (SCPP) was created using the proposed improvements identified in the previous step. Various improvements have different impacts to the overall system and the goal of the SCPP is to implement the infrastructure improvement projects with the highest flood hazard reduction and the greatest improvements to water quality. Projects were developed by grouping improvements and then ranking by specific criteria. These criteria are weighted to develop an overall project score. This weighting can be modified if desired to look at various planning scenarios. The projects that have the greatest potential benefit for the budget spent rank the highest.

The Port SCPP provides current information to make data-informed decisions about projects to be implemented. The SCPP was developed to implement stormwater projects in an a la carte manner. The overall project area was divided into 10 subbasins and further divided into 58 smaller catchment areas. Each catchment represents a drainage area, allowing the Port to evaluate potential stormwater impacts from development projects within these areas and understand improvements that need to be made for future development. These development projects are prioritized based on a number of factors in order to allow the Port to focus on the projects that will have the greatest positive impact to the system at large.

» Catchment level exhibits and GIS data contain the results of the analysis performed for the Stormwater Master Plan (SWMP). This data allows project drainage impacts to be identified and planning to occur in advance to continue the development of Port infrastructure that fits into the overall SWMP.

The reference data displayed in the Stormwater Capital Projects Plan is stored in GIS format. This data will be updated with regular maintenance inspection updates and as new development projects are completed the Port may dynamically manage this information regarding the stormwater system in order to always have an accurate picture of the stormwater system. The SWMP is designed to not just be book collecting dust on the shelf but an integral part in planning, implementing and maintaining Port infrastructure.



STORMWATER INFRASTRUCTURE

Industrial development along streams, drainage ditches, channels and floodplains can alter the capacity of a channel to convey water discharge. Bridges, culverts, and other traditional types of stormwater infrastructure is a critical component of stormwater management as a whole. However, over-reliance on traditional stormwater infrastructure can create significant issues. Sediment and debris carried by stormwater can further constrict traditional stormwater infrastructure and magnify flooding. Small drainage channels can be filled with sediment or become clogged with debris, because of undersized culverts. Although channels can be engineered to convey stormwater quickly downstream, the benefits of this approach must be balanced by evaluating the stormwater system as a whole. In some cases, other approaches, such as green infrastructure, should be considered.

Impacts from high tides, even outside of a storm event, can be significant for Port operations. When combined with stormwater runoff, the result can be crippling. The Stormwater Master Plan has incorporated tidal analysis into modeling for storm events in order to better understand potential impacts posed and to develop better approaches to stormwater management. The results of this analysis may be used as a planning tools to mitigiate this risk to Port assets.

The Stormwater Master Plan was developed to not only improve the overall stormwater system but to create tools to assist in implementation of such improvements. The following are examples of such tools developed for the Plan. To a large extent, these tools come out of the analysis of the Port's existing stormwater system.

» 100-Year Design Standard

In evaluating the stormwater system, a 100-year or 1% annual exceedance probability design standard was selected. This means based on probabilities and historical storm measurements there is a 1% chance each year that a storm event will exceed the design of the system. Although industrial stormwater design can be designed to a lower standard, allowing for some limited flooding, the Port's stormwater master plan has focused on the higher standard for design in order to address the significant impact that flooding can have on Port operations.

» Tidal Impacts Zones

When you have a stormwater system that drains directly to the coast the tides can impact the ability of that system to convey runoff. At high tide the additional water reduces the ability of the system to drain. It is important to understand the tidal effects to plan projects accordingly.

» Sea-Level Rise Risk Zones

Sea-level rise poses a significant risk to Port operations; and while there is much debate on the magnitude and timeline of sea-level rise, it is imperative that the Port prepare now for this eventuality. The Stormwater Master Plan identifies through advanced hydraulic analysis zones at the Port that are at risk due to sea-level rise.

» Hurricane Flood Hazard Zones

To increase resiliency in the stormwater system, hurricane flood hazard zones were identified through advanced hydrologic and hydraulic modeling. The ability to superimpose a major hurricane event to analyze a "what if" scenario allows for additional planning and more information in the project planning process for an emergency level flood event.

» Reduction of Flood Mitigation

It is estimated by the National Institute of Building Sciences that an increase in design requirements minimums yields a 1:4 cost to benefit ratio. This estimate is based across multiple industries and includes both public and private development.

The risk of damages and disruptions to Port operations can be lowered through effective flood mitigation measures. These mitigation measures can be assumed to yield a greater costs to benefit ratio as described above given the Port's high value to the nation. In addition, improvements to safety and reduction in flood damage, along with a quicker recovery after a flood event increase the resiliency of the Port.

» Hurricane Resiliency

There is no such thing as a "floodproof" system. However, with proper planning, resiliency can be built into the system. In 2017, Hurricane Harvey redefined what a hurricane can do to the Gulf Coast. As part of the Stormwater Master Plan an analysis of a Harvey-level event determined the most vulnerable areas of potential impact to be integrated into the planning process.

» Sea-Level Rise Adaptation

Sea-level rise decreases the performance of the overall stormwater system and increases potential flood risk by magnifying the impacts from tides and storm surges. The Stormwater Master Plan identifies areas at risk due to future sea level rise by utilizing the best available data specific to the Corpus Area of the Gulf Coast.

BENEFITS OF GREEN INFRASTRUCTURE

Green infrastructure offers an alternative to traditional stormwater infrastructure with numerous potential benefits. **Consider the following benefits:**

» Water Quality Improvements

Effective removal of pathogens, excess nutrients, sediment, and heavy metals.

» Sustainable Design

A necessary component of sustainable design is the ability to build today while thinking about the needs of tomorrow. This approach reduces the negative effects on our environment on multiple levels allowing for effective use of renewable materials and minimizing waste.

» Reduces Stormwater Runoff

Green infrastructure is designed primarily for smaller, more frequent events to improve water quality. But it also has additional distributed benefits of reducing overall stormwater volume, which can help improve performance of traditional stormwater infrastructure in larger events.

» Climate Resiliency

With the uncertainty of climate impacts over the next century the Port can hope for the best while planning for the worst. Anticipating and adapting to a variable climate will assist in reducing this future risk.

» Habitat Improvement and Green Space

Green space and wildlife habitats connect wildlife populations and reduce erosion. Even small areas of green space , as created with Green Infrastructure, can provide benefits to birds, mammals, and insects.

Section 502 of the Clean Water Act defines green infrastructure as "...the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate, or evapotranspiration stormwater and reduce flows to sewer systems or to surface waters. "Green infrastructure is a cost-effective, resilient approach to managing wet-weather impacts that provides many community benefits. While traditional stormwater infrastructure—conventional piped drainage and water treatment systems , for example—is designed to move urban stormwater away from the built environment efficiently, green infrastructure reduces and treats stormwater at its source while delivering environmental, social, and economic benefits. (EPA)

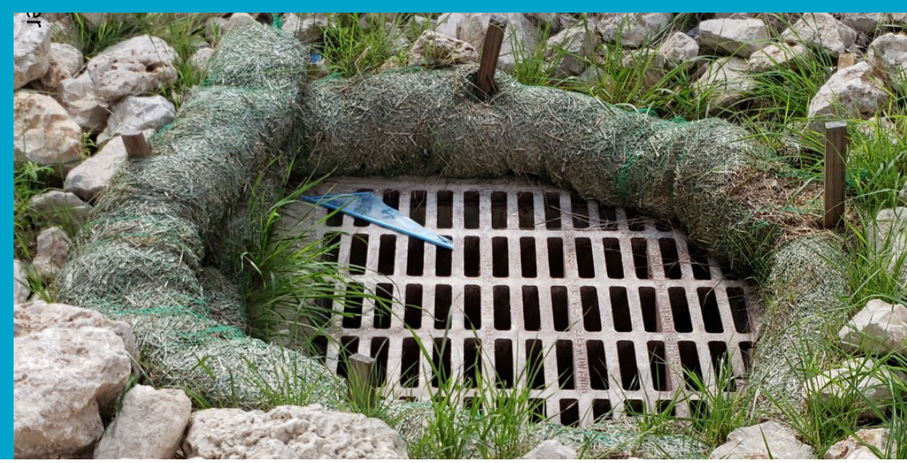
Stormwater runoff is a major cause of water pollution. When rain falls on developed or heavily trafficked areas, the water cannot soak into the ground as it should. Stormwater is conveyed through ditches, gutters, storm drain, and other engineered collection systems and is discharged ultimately into the Inner Harbor. The stormwater runoff often carries trash, hydrocarbons, heavy metals, and other pollutants.

The Port is a national leader in implementing Environmental Precepts. Currently working hard to integrate many existing stormwater best management practices to improve stormwater water quality. The addition of green infrastructure adds another tool in the toolbox to continue to effectively manage stormwater water quality at the Port.

Green infrastructure uses vegetation, soils, and other elements to mimic natural processes. The integration of green infrastructure into the overall stormwater management sytem at the Port can provide better wildlife habitat, improve and support flood protection, and result in cleaner water.

STORMWATER BEST MANAGEMENT PRACTICES

While Green Infrastructure has many benefits there are potential scenarios were outside factors may determine a better water quality solution. The Port will continue to implement Stormwater Best Management Practices (BMPs) as an integral part of the Stormwater Master Plan. Stormwater BMPs are devices, practices or methods to improve water quality. These BMPs are typical divided into two categories structural BMPs and non-structural BMPs. Both categories of BMPs are currently being implemented at the Port and will continue to be a vital component to managing stormwater.



SECTION 3

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FUTURE DIRECTION AND IMPLEMENTATION

The core of the Stormwater Master Plan is made up of appendices containing maps, technical analyses, capital improvement plans, maintenance guidelines, and design criteria associated with stormwater management for the Port. These appendices provide information necessary for making critical decisions for Port operations or development to a wide range of Port leaders, staff, and other stakeholders with either responsibility for managing stormwater on Port property or an interest in what must be done to manage it. To assist in understanding where to go, the following table provides a guide to navigating the Stormwater Master Plan.

If you are interested in:	Try this Plan Component	
	Component Title	**Description**
Infrastructure budgeting	**Stormwater Capital Projects Plan**	The Stormwater Capital Projects Plan (SCPP) contains prioritized list of infrastructure projects to be developed by the Port. Cost estimate information is intended to be used in budgeting planning efforts. Port staff can plan and budget drainage components into any type of improvement project at the Port. These projects focus on capacity and condition improvement in traditional stormwater infrastructure and on water quality improvement through both Green Infrastructure and traditional water quality Best Management Practices. Green infrastructure elements specific to land use and runoff characteristics are identified and prioritized as standalone projects within the SCPP. This is designed to help the Port staff plan and implement green infrastructure projects in a cost-effective manner to obtain the greatest amount of pollutant removal.
Making decisions on priorities necessary for future development.	**The Stormwater Viewer**	The The Stormwater Viewer (Viewer) is a tool assist Port staff in managing the underlying data of the Stormwater Master Plan. The Viewer references the condition assessment data obtained through regular inspections, identifying maintenance, structural or other potential environmental issues of the stormwater system. Data layers containing proposed grey and green infrastructure projects, tidal influence zones, flood risk areas, zones impacted by hurricanes and sea level rise are available to supplement the decision-making process. The Viewer allows Port staff to make data-informed decisions utilizing the latest inspection and maintenance information. In addition, the Viewer can have multiple access levels allowing certain users to view the data but not modify but also may allow the Port Geographic Information Systems (GIS) staff full access to manage and update the data as needed. This flexibly is essential for maintaining the quality and management of the stormwater data.
Infrastructure design requirements	**Drainage Criteria Manual**	To guide development on Port property, a drainage criteria manual has been created to ensure that development is aligned with the Stormwater Master Plan. Engineering specifications for development projects at the Port are outlined so that the Port staff and others have a reference as Port development and expansion projects are implemented. The drainage criteria manual contains a decision-making guide that promotes and prioritizes the use of green infrastructure and water quality best management practices where practical to do so.
Data needs Recommendations for future SCPP development **Understanding project prioritization process**	**Stormwater Viewer Data and Tools Maintenance Manual**	This maintenance manual outlines what and how the GIS data should be collected and stored so that the Port staff can automatically update the project prioritization to incorporate this new information. The manual also describes in detail the project prioritization process and automation scripts used in the GIS data portal.
Additional technical details regarding analysis	**Technical Report**	This report was developed as a reference to the hydrologic, hydraulic and water quality analysis performed. Includes details on topographic survey, land use and soil types, rainfall events including development of a hurricane level scenario, tidal conditions, sea-level rise, water quality and green infrastructure feasibility analysis.