2023 DRAFT COASTAL MASTER PLAN

PROJECT COSTING TOOL DOCUMENTATION

ATTACHMENT F7

REPORT: VERSION 01

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COASTAL PROTECTION AND RESTORATION AUTHORITY

This document was developed in support of the 2023 Coastal Master Plan being prepared by the Coastal Protection and Restoration Authority (CPRA). CPRA was established by the Louisiana Legislature in response to Hurricanes Katrina and Rita through Act 8 of the First Extraordinary Session of 2005. Act 8 of the First Extraordinary Session of 2005 expanded the membership, duties, and responsibilities of CPRA and charged the new authority to develop and implement a comprehensive coastal protection plan, consisting of a master plan (revised every six years) and annual plans. CPRA's mandate is to develop, implement, and enforce a comprehensive coastal protection and restoration master plan.

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EXECUTIVE SUMMARY

As coastal Louisiana faces increasing threats from flooding and sea level rise, there is a great need to advance our scientific understanding of the coast and how coastal Louisiana will need to adapt to future conditions. The Coastal Protection and Restoration Authority (CPRA) is undertaking this challenge through six-year updates of Louisiana's Comprehensive Master Plan for a Sustainable Coast. This document summarizes the process by which CPRA developed candidate projects for consideration in the 2023 Coastal Master Plan.

The 2023 Coastal Master Plan builds on past progress and establishes a clear vision for the future. It refines past plans by improving the methods used to ensure projects are evaluated as efficiently, consistently, and effectively as possible. These improvements include changes to the costing methodology and project structure, as well as the development of the Project Development Geodatabase (PDG), the Project Development Database (PDD), and an automated Project Costing Tool (PCT). This document is intended to serve as the technical documentation as the PCT is developed for the Louisiana 2023 Coastal Master Plan. It will be a living document subject to revision as various portions of the new tools and processes are developed in 2020.

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LIST OF ABBREVIATIONS

ADCIRC .... ADVANCED CIRCULATION
BS .... BANK STABILIZATION
cfs .... CUBIC FEET PER SECOND
CH .... CHANNEL CREATION
CL .... GAP CLOSURES
CLARA .... COASTAL LOUISIANA RISK ASSESSMENT
CPRA .... COASTAL PROTECTION AND RESTORATION AUTHORITY
DEM .... DIGITAL ELEVATION MODEL
DI .... DIVERSION
EL .... EXISTING LEVEE
ft .... FOOT/FEET
GA .... PROPOSED GATES
GIS .... GEOGRAPHIC INFORMATION SYSTEM
HR .... HYDROLOGIC RESTORATION
ICM .... INTEGRATED COMPARTMENT MODEL
IP .... INTEGRATED PROJECT
LS .... LUMP SUM
MC .... MARSH CREATION
NAVD88 .... NORTH AMERICAN VERTICAL DATUM OF 1988
NS .... NONSTRUCTURAL RISK REDUCTION
O&M .... OPERATIONS AND MAINTENANCE
OR .... OYSTER BARRIER REEF
PCT .... PROJECT COSTING TOOL
PDD .... PROJECT DEVELOPMENT DATABASE
PL .... PROPOSED LEVEES
PSC .... PITTSBURGH SUPERCOMPUTING CENTER
PT .... PLANNING TOOL
PW .... PROPOSED FLOODWALL
QAQC .... QUALITY ASSURANCE QUALITY CONTROL

RR .... RIDGE RESTORATION
SDE .... SPATIAL DATABASE ENGINE
SP .... SHORELINE PROTECTION
SR .... STRUCTURAL RISK REDUCTION
SQL .... STRUCTURED QUERY LANGUAGE
SWAN .... SIMULATING WAVES NEARSHORE
XX .... MISCELLANEOUS QUANTITY

1.0 INTRODUCTION

As Louisiana faces increasing threats from coastal flooding and sea level rise, there is a great need to advance our scientific understanding of the coast and how coastal Louisiana will need to adapt to future conditions. The Coastal Protection and Restoration Authority (CPRA) is undertaking this challenge through six-year updates of Louisiana's Comprehensive Master Plan for a Sustainable Coast. The 2023 Coastal Master Plan builds on past progress and establishes a clear vision for the future. It refines past plans by improving the methods used to ensure projects are evaluated as efficiently, consistently, and effectively as possible.

As discussed in Appendix F: Project Concepts, previous master plan iterations required hundreds of Excel spreadsheets, dozens of CSV files, and over forty unique Esri shapefiles to measure, quantify, calculate, and aggregate project information, which in turn required frequent manual data transfers between different modeling teams. Because the 2023 Coastal Master Plan is intended to tackle the analysis of broader, more complicated projects than previous plans, a new system was devised for defining and assembling the building blocks used to describe a project. This new system streamlines this process by replacing the cumbersome spreadsheets and shapefiles with five primary features:

1. A centrally accessible PostgreSQL database, called the Project Development Database (PDD), which houses tables of relevant project attributes, metadata, bid items, costs, and any project-level outputs that may need to be passed between modeling teams. Custom Structured Query Language (SQL) scripts are used to access data directly from the PDD as needed.
2. A python program, called the Project Costing Tool (PCT), which reads inputs from the PDD, calculates quantities and costs of each feature within a project, and stores values back into the PDD. Additional data processing scripts are used in conjunction with the PCT to define project attributes and to streamline quality assurance and control (QAQC) procedures.
3. An Esri geodatabase, called the Project Development Geodatabase (PDG), which contains the geospatial representations of all projects in three feature classes (for points, polygons, and polylines); in future iterations of the master plan, geospatial data is intended to be integrated into the PDD with a Spatial Database Engine (SDE). While the PDG is the source of truth for all geospatial data at the Element Level, a copy of the PDG also exists, referred to as the Mapping PDG, which joins project-level attributes from the PDD to the Elements as represented in the PDG. The Mapping PDG is automatically re-created every time the PDD or PDG is updated
4. A reporting system (presently using Jaspersoft software) that reads from the PDD to produce project-level cost summaries
5. A web-based user interface used to access the PDD, run the PCT, and produce the cost summary reports

Ultimately, the PDD and PDG act as a central repository for tabular and basic geospatial data used and generated by the four primary master plan modeling teams: the Advanced CIRCulation (ADCIRC) and Simulating WAves Nearshore (SWAN) team, the Integrated Compartment Model (ICM) team, the Coastal Louisiana Risk Assessment (CLARA) model team, and the Planning Tool (PT) team. Basic project attributes and vector-based geospatial data are developed and then read by the ADCIRC/SWAN, ICM, and CLARA models. Additional project attributes are produced by these models and stored back into the PDD. The PCT reads attributes and produces costs, which are in turn read by the PT, along with model outputs from the ICM and CLARA, to prioritize projects and store project-level results back to the PDD (Figure 1). This effort is intended to streamline data generation and transfer, while greatly reducing the number of files and overall file size required for project definition within the master plan.

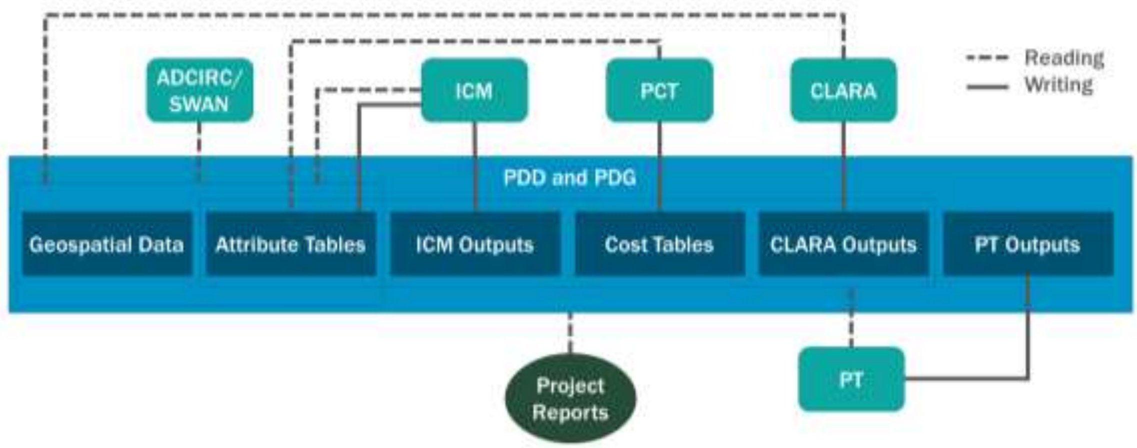

Figure 1. General Workflow for Data Handoffs between Modeling Teams

This document is intended to serve as a framework to define the architectural details of the PCT and other python-based processing tools as they are developed for the Louisiana 2023 Coastal Master Plan. It will be a living document subject to revision as various portions of the new tools and processes are developed in 2020.

1.1 PROJECT ORGANIZATION

As detailed in Appendix F: Project Concepts, there are seven distinct project types evaluated in the master plan, split into two primary categories: Risk Reduction and Restoration. Risk Reduction projects can either be Structural (designated as SR) or Nonstructural (NS), while Restoration projects may fall under one of five categories: Diversions (DI), Hydrologic Restoration (HR), Marsh Creation (MC), Ridge Restoration (RR), and Integrated Projects (IP). Each Project is composed of one or many Elements, and multiple projects may reference the same Element. There are thirteen unique Element Types used to define Restoration and Structural Risk Reduction projects: Proposed Levees (PL), Improvements to Existing Levees (EL), Proposed Floodwalls (PW), Proposed Gates (GA), Channel Creation (CH), Marsh Creation (MC), Gap Closures (CL), Ridge Restoration (RR), Shoreline Protection (SP), Bank Stabilization (BS), Oyster Reef (OR), Miscellaneous Quantity (XX), and Lump Sum (LS). Nonstructural Risk Reduction projects are defined by the CLARA model based on counts of properties that may be floodproofed, elevated, or acquired, and do not follow the same Project-Element relationships defined elsewhere in the PDD.

Each Element has a subgrouping of Components that comprise some feature of that Element. For example, Shoreline Protection rubble mound Elements include geotextile base, riprap, navigational aid, and settlement plate Components. Lists of Components utilized in costing each Element Type are described in detail in Section 2.0.

1.2 REPOSITORY INFORMATION

Python codes related to the PCT and any other master plan processing tools have been developed using Python version 3.7.9 and stored on a private Arcadis GitHub account. Up-to-date, public versions are stored in the MP_PCT repository on the master plan GitHub site (https://github.com/CPRA-MP/MP_PCT). GitHub is a website often used in software development that offers version control and cloud storage for code repositories, allowing for collaborative development among multiple users. The MP_PCT repository is composed of four primary directories, listed below.

1. **Donna**: Contains all codes required to run the PCT
2. **ChannelTool**: Contains tools developed to determine paths and average depths for access and flotation channels
3. **DredgeMob**: Contains tools developed to determine sediment pipeline lengths between Elements and borrow areas
4. **DataProcessing**: Contains general data processing scripts, such as those used to verify accuracy of updates the PDD or PCT or to create operation regime graphics

2.0 PCT

This section describes the architecture of the PCT, including the requirements, file structure, hard-coded constants, and specific calculations and Component Codes that the PCT references in estimating Component quantities and costs for each Element. The PCT is currently deployed on the Pittsburgh Supercomputing Center (PSC) system in the /opt/repositories/pct directory on the vm007.bridges2.psc.edu virtual machine and can be triggered manually or via a call in the web based PDD/PCT user interface.

2.1 REQUIREMENTS AND STRUCTURE

A list of Python packages required to run the PCT outside of the standard python library is shown in Table 1.

Table 1. Required Python Packages for PCT

Library	Version	Description
pandas	1.1.1	Open source data analysis and manipulation tool; used to manipulate data from the PDD in a table-like format
SQLAlchemy	1.3.21	SQL toolkit and Object Relational Mapper; used in conjunction with psycopg to access data in the PDD
psycopg2	2.8.4	The most popular PostgreSQL database adapter for Python; used in conjunction with psycopg to access data in the PDD
numpy	1.19.1	Fundamental package for scientific computing with Python; used for various geometric and algebraic calculations.

The PCT comprises several individual Python files, including six files referencing constant lookup values, four function libraries, and one file for executing the model (Table 2).

Table 2. PCT File Names

Category	File (.py)	Description
Constant Lookup Values	AttributeName	List of all attributes field names strings populated by the PCT
	ComponentCode	List of all component code strings used by the PCT
	Constants	List of all constants used by the PCT
	CostTypes	List of all cost types (e.g., contingency, mobilization, etc.) used by the PCT
	FieldNames	List of all field names of tables in the PDD used by the PCT
	TableNames	List of all table names in the PDD used by the PCT
Function Libraries	CostModules	Contains a group of CostModule classes and subclasses used as the templates to calculate component quantities for each Element type; utilizes functions from Geometry and MP23Library
	Geometry	Contains all geometry-related functions used in the PCT
	MP23Library	Contains all non-geometric and non-SQL functions used in the PCT
	SQLFunctions	Contains all SQL-related functions used in the PCT
Model	RunDonna	Runs the PCT. Reads data from the PDD using functions from SQLFunctions, calls CostModules to obtain Component quantities, applies functions from MP23Library to apply unit costs and cost percentages, and writes results back into the PDD using functions from SQLFunctions.

2.2 CONSTANTS

The PCT uses a library of hard-coded constants (defined in *Constans.py*) to estimate Component quantities and Element attributes (Table 3). Because MC sediment unit costs are dependent on the distance to the borrow source, additional constants (the slope and intercept of the curves defined in Figure 12 of Appendix F: Project Concepts) related specifically to the MC sediment unit costs are also defined in *Constants.py* and are summarized in Table 4.

Table 3. Constants used in the PCT

Parameter	Value	Unit	Application	Element Type
Draft Requirement	8	ft	Depth of access channel and flotation channels	BS, RR, OR, SP
Flotation Channel Bottom Width	80	ft	Bottom width of flotation channels	BS, RR, OR, SP
Access Channel Bottom Width	60	ft	Bottom width of access channels	BS, RR, OR, SP
Default Channel Slope	3	H:V	Side slope used in channel Jerry volumes	BS, CH, RR, OR, SP
Pipeline Crossing Width	100	ft	Opening width allowed at pipeline crossings to calculate effective length	OR, SP
Fish Dip Length	50	ft	Length of a fish dip within a channel. Used to calculate total fish dip length and effective length	OR, SP
Fish Dip Spacing	1,000	ft	Space between fish dips along a channel. Used to calculate total fish dip length and effective length	OR, SP
Fish Dip Height	1.5	ft	Height of fish dip used to calculate the fish dip rock volume	SP
Settlement Percentage	20	%	Percentage settlement expected, used to calculated adjusted crest elevation	SP
Settlement Plate Spacing	1,000 50	ft acre	Spacing of settlement plates; 1 plate per 1000 ft (linear) or 1 plate per 50 acres (area) to estimate construction costs	MC, SP
Navigational Aid Spacing	1,000	ft	Navigational aids spaced 1 per 1,000 ft to estimate construction costs	OR, SP
Geotextile Panel Length	100	ft	Width of a geotextile panel. Used to calculate geotextile area for construction costs	CH, OR, SP
Geotextile Panel Overlap	5	ft	Length of overlap between geotextile panels. Used to calculate geotextile area for construction costs.	CH, OR, SP
Geotextile Panel	5	ft	Length of geotextile overhang at each end of	CH, OR, SP

Parameter	Value	Unit	Application	Element Type
Overhang			geotextile length. Used to calculate geotextile area for construction costs.	
Geotextile Overage	1.05	ft	Additional geotextile area to be included in geotextile area for construction costs	CH, OR, SP
Riprap Lift 1 Percentage	50	%	Additional percentage riprap volume added during first lift to maintain design elevation	SP
Riprap Lift 2 Percentage	25	%	Additional percentage riprap volume added during second lift to maintain design elevation	SP
Riprap Lift 3 Percentage	10	%	Additional percentage riprap volume added during third lift to maintain design elevation	SP
Sediment Lift Percentage	20	%	Additional percentage of sediment needed to maintain design elevation	BS
Cut-to-Fill Ratio	1.5	N/A	Factor applied to estimated volume of sediment to account for initial settlement and loss during mobilization	BS
Minimum Planting Elevation	1.5	ft	Elevations below minimum planting elevation do not receive plantings	RR
Planting Percentage	60	%	Percentage of surface area that has plantings.	RR, MC
RR Lift Number	3	Count	Number of lifts expected as part of O&M calculations for construction type and plantings	RR
Toe Depth Below Ground	1	ft	Depth of armoring required beneath the stream channel bottom	BS
Riprap Tons per Cubic Yard	1.55	Tons	Conversion to calculate unit weight, used in Riprap Factor	SP, CH
Rock Overage Percentage	10	%	Additional rock used to calculate Riprap Factor	OR, SP
Riprap Factor	0.06315	N/A	Calculation of: Riprap Tons per Cubic Yard / 27 Cubic Feet per Cubic Yard * (Rock Overage Percentage + 1). Used to calculate component	SP, CH

Parameter	Value	Unit	Application	Element Type
			riprap volume (large and small).	
Overbuild Percentage	25	%	Overbuild height for proposed levees to determine construction crest elevation	PL, RR
Structural Superiority	1	ft	Additional height added to crest elevation for structural superiority to determine design elevation	PW
Clear and Grub Depth	0.5	ft	Depth across the levee footprint that will be cleared and grubbed	PL, EL
Closure Opening Width	40	ft	Width of a closure opening	CL
Closure Opening Height	8	ft	Height of a closure opening	CL
SP Lift Number	3	Count	Number of lifts required for access channel and flotation channels O&M	SP
Dredge Quantity	1	Count	Number of 30” cutterhead dredges used in the dredge mobilization module	MC, RR
Buggy Excavator Count	16	Count	Number of buggy excavators used per Cell within each MC Element; used in the dredge mobilization module	MC, RR
Dredge Pump Distance	25,000	ft	Maximum dredging distance before a booster is required; used in the dredge mobilization module	MC, RR
Booster Spacing	15,000	ft	Spacing between boosters to estimate the booster count for dredge mob estimates; used in the dredge mobilization module	MC, RR
Pontoon Line Distance	3,000	ft	Pontoon line distance per Marsh Creation cell; used in the dredge mobilization module	MC, RR
Extra Pipe Factor	10	%	Additional pipe factored into shoreline pipe mobilization; used in the dredge mobilization module	MC, RR
Marsh Buggy	16	Count	Count of marsh buggy	MC, RR

Parameter	Value	Unit	Application	Element Type
Excavator			excavators per Marsh Creation cell; used in the dredge mobilization module	

Table 4. MC Sediment Unit Cost Parameters

Sediment Type	Slope	Intercept
River Sand	0.6288	3.8689
Interior Mixed Sediment	0.4241	1.4279
Offshore Mixed Sediment	0.2415	5.6747
Offshore Sand Hopper	0.3078	11.488

2.3 COMPONENT TEMPLATES

The following sections describe the component lists and calculation assumptions used in the *CostModules* classes (found in *CostModules.py*) to determine component quantities for each Element of a given Element Type. Appendix F: Project Concepts provides additional element- and project-level assumptions, along with detailed information about how component quantities are converted to costs. The *Project Development Database Technical Documentation* (Sprague, 2021b) details the structure of the attribute tables in the PDD used as inputs to the PCT and referenced throughout this document.

PROPOSED LEVEES (PL) AND IMPROVEMENTS TO EXISTING LEVEES (EL)

Table 5 summarizes the specific component calculations used to derive construction and O&M costs for PL and EL elements.

Table 5. Component Calculations Summary for EL and PL Elements

Component	Component Code	Component Category	Quantity Calculation Assumptions
Levee embankment and compaction	From inputted LeveeCode (LEVLOW, LEVMED, LEVHIGH, LEVXHIGH)	Construction	Volume of a prism defined by input slopes, base elevation, berm top and bottom elevations, crest width, and length parameters. An additional 25% overbuild is added to the height of the levee. The volume of any existing levee is calculated similarly and subtracted out of the volume of the proposed levee, if applicable.
Clearing and Grubbing	CLG	Construction	Volume of a rectangular prism covering the proposed levee footprint with a 0.5-foot grubbing depth. In the case of an existing levee, the clearing and grubbing volume is based on the surface area of the existing levee, plus any additional area in the proposed levee footprint outside of the existing levee footprint.
Levee Covering	From inputted CoveringCode (PLNTT, HPTRM)	Construction	Surface area of the levee feature.
Turf over Inspection Area	PLNTT	Construction	Rectangular area defined by the inputted inspection corridor widths and the length of the levee
Stormwater Pollution Prevention Plan	SWPPP	Construction	Twice the length of the proposed levee to account for a silt fence placed on either side of the levee
Access road:	CRS	Construction	Rectangular area defined by the inputted access

Component	Component Code	Component Category	Quantity Calculation Assumptions
crushed stone			road width and the length of the levee
Access road: woven geotextile	GTW	Construction	Rectangular area defined by the inputted access road width and the length of the levee. Woven geotextile (in the form of multiple 100-foot panels) is assumed to be placed under the crushed stone, with 5 feet of overlap along each panel and 5 feet over overhang along each end of the access road, with an additional 5% of panel area to account for overage.
Levee Maintenance	OMLA	O&M	Rectangular area defined by the total levee footprint width (including inspection corridor) and the length of the levee

PROPOSED FLOODWALLS (PW)

Table 6 summarizes the specific component calculations used to derive construction and O&M costs for PW elements.

Table 6. Component Calculations Summary for PW

Component	Component Code	Component Category	Quality Calculation Assumptions
Concrete	CC	Construction	Volume of two rectangular prisms (for the base and for the stem) defined by input elevations, length, thickness, and base parameters
Foundation Piles (H-Piles)	FPHP	Construction	Linear feet of piles defined by input pile length, pile spacing, and pile rows
Sheetpile Cutoff Wall	SPCW	Construction	Rectangular area defined by length of PW Element and inputted sheetpile length

Component	Component Code	Component Category	Quality Calculation Assumptions
Three-Bulb Water stop	WS	Construction	Length of PW Element
Excavation	EXC	Construction	Rectangular prism of wall base defined by input length, base width, and base thickness
Clearing and grubbing	CLG	Construction	Volume of the proposed wall footprint (including inspection area) with a 0.5-foot grubbing depth
Stormwater Pollution Prevention Plan	SWPPP	Construction	Cost calculated as twice the length of the proposed wall
Access road: crushed stone	CRS	Construction	Rectangular area defined by the inputted access road width and the length of the wall
Access road: woven geotextile	GTW	Construction	Rectangular area defined by the inputted access road width and the length of the wall. Woven geotextile (in the form of multiple 100-foot panels) is assumed to be placed under the crushed stone, with 5 feet of overlap along each panel and 5 feet over overhang along each end of the access road, with an additional 5% of panel area to account for overage.
Inspection	OMIN	O&M	Length of PW Element
Floodwall Maintenance	OMFM	O&M	Length of PW Element

PROPOSED GATES (GA)

Table 7 summarizes the specific component calculations used to derive construction and O&M costs for GA elements.

Table 7. Component Calculations Summary for GA

Component	Component Code	Component Category	Quantity Calculation Assumptions
Gate	From inputted GateCode, see Gate table for full list of options	Construction	Inputted number of gates
Gate Maintenance	OMMG	O&M	Inputted number of gates

CHANNEL CREATION (CH)

Table 8 summarizes the specific component calculations used to derive construction costs for CH elements.

Table 8. Component Calculation Summary for CH

Component	Component Code	Component Category	Quantity Calculation Assumptions
Channel	From inputted ChannelCode (CHCVD, CHCVE, CHID, CHIE, CHOD, CHOE)	Construction	Volume of a trapezoidal prism defined by input slope, elevation, crest width, and length parameters. Channel Type (excavation or dredging) is specified by the last letter of the component code (E or D, respectively). If an existing channel is present in the input table, the excavation and dredging are modified to incorporate the difference in geometry.
Scour Protection	From inputted ScourProtection Code (ACB,	Construction	Surface area of the trapezoidal prism channel. If the scour protection is riprap, the volume of riprap is calculated based on the input riprap thickness.

Component	Component Code	Component Category	Quantity Calculation Assumptions
	RPSM)		
Geotextile	From inputted GeotextileCode (GTW, GTNW)	Construction	Rectangular area covering the bottom width of the channel. Woven geotextile (in the form of multiple 100-foot panels) is assumed to be placed along the channel bottom, with 5 feet of overlap along each panel and 5 feet over overhang along each end of the channel, with an additional 5% of panel area to account for overage.
Clearing and Grubbing	CLG	Construction	Volume equal to the channel footprint multiplied by a standard clearing and grubbing depth of 0.5 feet, if the input ChannelCode specifies excavation

MARSH CREATION (MC) AND BORROW OPTIONS

Table 9 summarizes the specific component calculations used to derive construction and mobilization costs for MC elements.

Table 9. Component Calculation Summary for MC

Component	Component Code	Component Category	Quantity Calculation Assumptions
Settlement Plates	STPL	Construction	One per 50 acres of inputted MarshArea
Vegetative Planting	From inputted MarshVegetationCode (PLNTB, PLNTF, PLNTS)	Construction	60% of the inputted MarshArea
Marsh Creation	SedimentCode in BorrowOptionsSedimentType table, linked from inputted BorrowSource (OSS, RS, MIXF)	Construction	Inputted MarshVolume

Component	Component Code	Component Category	Quantity Calculation Assumptions
Containment Dike	CND	Construction	Inputted DikeLength
Subline and Pontoon Pipe Mobilization	SLPPM	Mobilization	Inputted DredgeSublinePrelay plus an additional 3,000 feet per Cell within the Element
Subline Pipe Prelay	SLPPL	Mobilization	Inputted DredgeSublinePrelay
Subline Pipe Pickup	SLPPU	Mobilization	
Shoreline Pipe Mobilization	SHPM	Mobilization	Inputted DredgeShorelinePrelay plus an additional 10% of the overall summed fill-to-borrow distance for all Cells
Shoreline Pipe Prelay	SHPPL	Mobilization	
Shoreline Pipe Pickup	SHPPU	Mobilization	Inputted DredgeShorelinePickup
30-inch Dredge	DR30	Mobilization	Always equal to one
Booster Pump	BP	Mobilization	One per 15,000 feet over 25,000 feet of the average fill-to-borrow distance for all cells, multiplied by the number of Cells within the Element
Marsh Excavator	MRBE	Mobilization	Sixteen per Cell

GAP CLOSURES (CL)

Table 10 summarizes the specific component calculations used to derive construction costs for CL elements.

Table 10. Component Calculation Summary for CL

Component	Component Code	Component Category	Quantity Calculation Assumptions
Sheetpile Wall	MCL	Construction	Area equal to three times the depth at the closure (CrestElevation – BaseElevation) multiplied by the inputted Length, minus a 40-foot by 8-foot rectangular area if ClosureOpen is True. Sheet piles are assumed to follow a general rule of 1/3 of their total length sticking up in a cantilever fashion (either in water or air) and 2/3 of their total length buried, as measured from the channel invert.

RIDGE RESTORATION (RR)

Table 11 summarizes the specific component calculations used to derive construction costs for RR elements. If an RR Element has an inputted Ridge Component code of OMIXF or RS, a dredge mobilization costs are itemized as is done for MC Elements; otherwise, the standard mobilization percentage is applied.

Table 11. Component Calculation Summary for RR

Component	Component Code	Component Category	Quantity Calculation Assumptions
Ridge	From inputted ConstructionCode (RCBK, RCMB, OMIXF, RS)	Construction	Volume of a trapezoidal prism defined by input slope, base elevation, crest elevation, crest width, and length parameters, and a borrow-fill ratio of 1.5. An additional 25% overbuild is added to the height of the ridge.

Component	Component Code	Component Category	Quantity Calculation Assumptions
Vegetative Planting	PLNTS	Construction	60% of the surface area from elevation from +1.5 feet NAVD88 up to the crest elevation
Hardwood Planting	PLNTH	Construction	Surface area of crest, defined by crest width and ridge length
Access Channel	CHA	Construction	Volume of a trapezoidal prism with inputted length and elevation, an 8-foot depth, 3H:1V side slopes, and a bottom width of 60 feet
Subline and Pontoon Pipe Mobilization	SLPPM	Mobilization	Inputted DredgeSublinePrelay plus an additional 3,000 feet per Element, as applicable
Subline Pipe Prelay	SLPPL	Mobilization	Inputted DredgeSublinePrelay, when applicable
Subline Pipe Pickup	SLPPU	Mobilization	
Shoreline Pipe Mobilization	SHPM	Mobilization	Inputted DredgeShorelinePrelay plus an additional 10% of the overall fill-to-borrow distance, when applicable
Shoreline Pipe Prelay	SHPPL	Mobilization	
Shoreline Pipe Pickup	SHPPU	Mobilization	Inputted DredgeShorelinePickup, when applicable
30-inch Dredge	DR30	Mobilization	Always equal to one, when applicable
Booster Pump	BP	Mobilization	One per 15,000 feet over 25,000 feet of the average fill-to-borrow distance, when applicable
Marsh Excavator	MRBE	Mobilization	Sixteen per Element

SHORELINE PROECTION (SP)

Table 12 summarizes the specific component calculations used to derive construction and O&M costs for SP elements.

Table 12. Component Calculation Summary for SP

Component	Component Code	Component Category	Quantity Calculation Assumptions
Shoreline Protection	From inputted RiprapCode (RPSM, RPLG)	Construction	Volume of a trapezoidal prism defined by input slope, base elevation, crest elevation, crest width, and effective length parameters, a rock tons-to-cubic yard ratio of 1.55 and a 10% rock spillage value (i.e., 10% of rock volume assumed to spill into adjacent areas). The height of the rock feature was increased by 20% to account for settlement. Fish-dips were assumed to be spaced every 1,000 feet, and the volume of a rectangular prism of 50 feet in length, 1.5-ft height, and the width of the shoreline protection feature was added to the total volume. No rock was placed over pipeline crossings.
Settlement Plates	STPL	Construction	One per 1,000 linear feet
Navigational Aids (Small)	NAVS	Construction	One per 1,000 linear feet
Woven Geotextile	GTW	Construction	Rectangular area covering the footprint of the rock feature. Woven geotextile (in the form of multiple 100-foot panels) is assumed to be placed along the feature, with 5 feet of overlap along each panel and 5 feet over overhang along each end of the channel, with an additional 5% of panel area to account for overage.
Access Channel	CHA	Construction	Volume of a trapezoidal prism with inputted length and elevation, an 8-foot depth, 3H:1V side slopes, and a bottom width of 60 feet
Flotation Channel	CHF	Construction	Volume of a trapezoidal prism with inputted length and elevation, an 8-foot depth, 3H:1V side slopes, and a

Component	Component Code	Component Category	Quantity Calculation Assumptions
			bottom width of 80 feet
Element Lift	From inputted RiprapCode (RPSM, RPLG)	O&M	A total of 85% (50% for Lift 1, 25% for Lift 2, 10% for Lift 3) of the volume of the shoreline protection feature
Access Channel	CHA	O&M	Three times the quantity for access channels
Flotation Channel	CHF	O&M	Three times the quantity for flotation channels

BANK STABILIZATION (BS)

Table 13 summarizes the specific component calculations used to derive construction and O&M costs for BS elements.

Table 13. Component Calculation Summary for BS

Component	Component Code	Component Category	Quantity Calculation Assumptions
Bank Stabilization	BS	Construction	Volume of a trapezoidal prism defined by input slope, base elevation, crest elevation, crest width, and length parameters, and a borrow-fill ratio of 1.5
Armoring	From input ArmorType (HPTRM, ACB)	Construction	Surface area of the trapezoidal prism plus area one foot below the bottom of the feature on the flood side slope
Access Channel	CHA	Construction	Volume of a trapezoidal prism with inputted length and elevation, an 8-foot depth, 3H:1V side slopes, and a bottom width of 60 feet
Bank Stabilization	BS	O&M	20% of the volume of the ridge to counteract settlement, assuming one ridge lift
Armoring	From input	O&M	Equal to the initial armoring area, assuming one ridge lift

Component	Component Code	Component Category	Quantity Calculation Assumptions
	ArmorType (HPTRM, ACB)		
Access Channel	CHA	O&M	Three times the quantity for access channels

OYSTER BARRIER REEF (OR)

Table 14 summarizes the specific component calculations used to derive construction costs for OR elements.

Table 14. Component Calculation Summary for OR

Component	Component Code	Component Category	Quantity Calculation Assumptions
Oyster Reef	OR	Construction	EffectiveLength
Navigational Aids (Medium)	NAVM	Construction	One per 1,000 linear feet
Geotextile	GTW	Construction	Rectangular area covering the footprint of the oyster reef feature. Woven geotextile (in the form of multiple 100-foot panels) is assumed to be placed along the feature, with 5 feet of overlap along each panel and 5 feet over overhang along each end of the channel, with an additional 5% of panel area to account for overage.
Access Channel	CHA	Construction	Volume of a trapezoidal prism with inputted length and elevation, an 8-foot depth, 3H:1V side slopes, and a bottom width of 60 feet
Flotation	CHF	Construction	Volume of a trapezoidal prism with inputted length and

Component	Component Code	Component Category	Quantity Calculation Assumptions
Channel			elevation, an 8-foot depth, 3H:1V side slopes, and a bottom width of 80 feet

MISCELLANEOUS (XX AND LS)

Table 15 summarizes the specific component calculations used to derive construction and O&M costs for XX and LS Elements.

Table 15. Component Calculation Summary for XX and LS

Element Type	Component	Component Code	Component Category	Quantity Calculation Assumptions
XX	Miscellaneous Component	From inputted ComponentCode	Construction	Quantity (direct input)
LS	Miscellaneous Component	LS	Construction	Quantity (direct input)
XX	Pump Station Repair	OMPS, OMPSC	O&M	If input is pump station, Quantity (direct input)

3.0 CHANNEL TOOLS

This section summarizes the arcpy tools developed to determine paths and average depths for access and flotation channels required for BS, RR, OR, and SP Elements for the 2023 Coastal Master Plan. These tools utilize the statewide 15-meter topobathymetric digital elevation model (DEM) to determine paths of minimal dredging from each Element to navigable water (access channel) and paths parallel to each Element used for barges to place material along the linear feature (flotation channel).

Access channels are drawn between each Element and navigable waters. The navigable waters polygon was manually created using the DEM, federal navigable waters, and manually identified shipping channels. These channels were identified by either continuing channels only partially resolved by the DEM, or through knowledge of shipping pathways. Manually identified channels were all assumed to be 600 feet wide. Discontinuous pockets of deep water were not included in the navigable waters feature class, but access and flotation channels may use these areas with no associated dredging costs. Draft requirements for calculating access and flotation channels are set to -8 feet NAVD88 with a water surface elevation of 0 feet NAVD88 and do not consider regional variations in water surface elevations.

Figure 2 shows the results of the Channel Tools, where the Element-parallel flotation channels (blue) are connected to navigable waters (grey) by access channels (red) where necessary. The northern Element does not require an access channel because it intersects navigable waters.

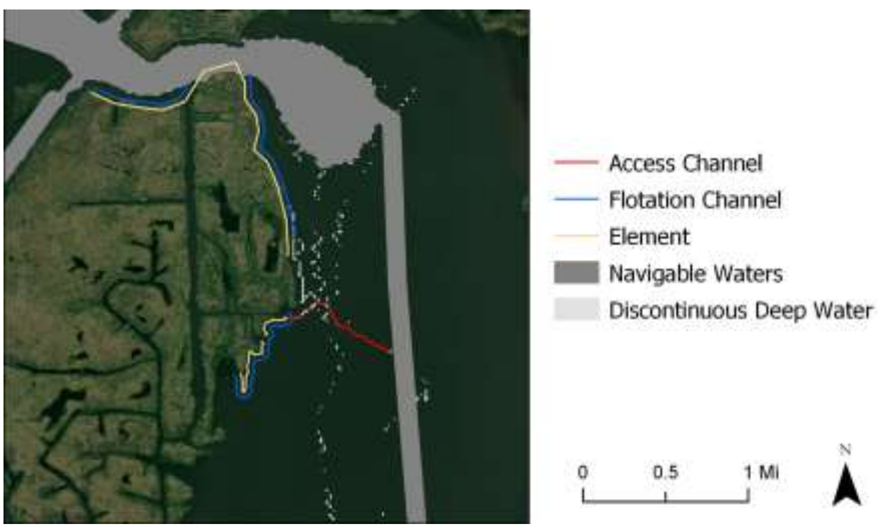

Figure 2. Example Access and Flotation Channels

Flotation and Access Channel tools are written using the arcpy library associated with ArcGIS Pro version 2.7.0 and require an Advanced ArcGIS license with the Spatial Analyst toolbox. These tools are run locally through a python console or directly in ArcGIS Pro, but are not available on the PSC virtual machine due to Esri licensing limitations.

The *ChannelTool* directory in the MP_PCT repository contains six python files required to produce access and flotation channel features. The *Inputs.py* file defines file paths to the required Lines feature class from the PDG, the statewide DEM, the navigable waters polygon feature class, along with other constants used in the tool, such as the 8-foot draft requirement. The *Functions.py* is used to define common functions that are referenced by the remaining four scripts that are used in serial to create the AccessChannel and FlotationChannel feature classes, which define the alignment and average existing elevation of each path for each Element. These four scripts are run in the following order, and are each described in detail later in this section:

1. **AccessPreprocessing.py** Processes the DEM at the state level to determine a path of least dredging between navigable waters and any other location; only needs to run if the DEM or navigable waters input are updated.
2. **FlotationPath.py** Generates flotation paths along SP and OR Elements.
3. **AccessPath.py** Generates access paths to BS and RR Elements and SP and OR flotation paths.
4. **ExportData.py** Determines access and flotation channels by removing areas with discontinuous deep water, and extracts lengths and average depths.

Access Preprocessing

The *AccessPreprocessing.py* script creates rasters to determine the path of least dredging between navigable waters and any other location in the DEM below 0 feet NAVD88. This script needs to be run once before producing access and flotation channels, but only needs to be re-run if the DEM or the navigable waters feature class are updated. Outputs of *AccessPreprocessing.py* include the following three rasters and one polygon feature class, used as inputs in the *AccessPath.py* and *ExtractAttributes.py* scripts:

- **PathRast**: A raster indicating areas that access paths can be drawn (between 0 and -8 feet NAVD88)
- **CostRast**: A raster indicating the dredging depth associated areas in the *PathRast* output
- **BacklinkRast**: A raster indicating the direction of travel for the path of least dredging to navigable water for any area along the coast
- **DeepPoly**: Polygon feature class of all areas below -8 feet NAVD88.

Flotation Path

The *FlotationPath.py* script creates flotation channel paths parallel to each SP and OR Element.

Flotation paths are offset 55 feet from the Element centerline and are drawn even in navigable waters where dredging is not required (these sections are later removed in *ExtractAttributes.py*). The tool draws the flotation channel on the side of the Element adjacent to open water, which is always on the right side of Elements in the 2023 Coastal Master Plan. Outputs of *FlotationPath.py* include the following feature class, used in *ExtractAttributes.py*:

- **FlotationPath:** A line feature class representing preliminary flotation path alignments

Access Path

The *AccessChannel.py* script uses the rasters created in *AccessPreprocessing.py* to create access paths based on the path of least dredging between each Element and navigable water. Like in *FlotationPath.py,* access paths may be drawn in areas where dredging is not required, but these sections are later removed in *ExtractAttributes.*py. The tool bases paths on both distance and required dredging. Due to local bathymetry, the chosen path may not be the shortest distance path. The tool creates an access path for each Element in a project, but there may be some instances in which connecting to an adjacent Element's flotation channel produces a shorter channel, which would not be captured by the *AccessChannel.py* tool. Outputs of *AccessPath.py* include the following feature class, used in *ExtractAttributes.py*:

- **AccessPath**: A line feature class representing preliminary access path alignments

Extract Attributes

The *ExtractAttributes.py* script uses the *FlotationPath* and *AccessPath* feature classes produced in the previous two scripts, along with the *DeepPoly* feature class produced in the *AccessPreprocessing.py* script to remove pieces of flotation and access paths located in deep water (areas below -8 feet NAVD88) and determine final channel length and average existing elevation for each access and flotation channel. In some instances, the entire path drawn by the *FlotationChannel.py* or *AccessChannel.py* may be in deep water, and thus deleted by *ExtractAttributes.py*. The final outputs of the Channel Tool are produced via *ExtractAttributes.py*, and include:

- **FlotationChannel**: A line feature class representing final flotation path alignments, with Element number, length, and average existing elevation (feet NAVD88) attributes
- **AccessChannel:** A line feature class representing final access path alignments, with Element number, length, and average existing elevation (feet NAVD88) attributes

4.0 DREDGE MOBILIZATION TOOL

This section summarizes the arcpy tool developed to determine sediment mobilization paths between Elements and borrow areas for all MC Elements and some RR Elements considered in the 2023 Coastal Master Plan. This tool utilizes the master plan's statewide land/water initial conditions raster, along with user-specified allowed paths (paths that a dredge pipeline can traverse that are too small to be resolved in land/water raster) to determine the shortest path between each applicable borrow source and groups of MC cells within each project. Once the path reaches each group, it fans out to reach each cell within that group, and then is directed to the farthest edge of that cell. The same land/water raster is used to determine over-land and over-water path distances for use in dredge mobilization cost calculations. The tool calculates attributes for subline prelay, shoreline prelay, and shoreline pickup distances, that are in turn stored in the PDD.

Dredge mobilization pathways are based on groupings (called GIS groups) of MC cells within each Element. A GIS group may represent the same aggregation of cells as an Element, or an Element may be broken into multiple GIS groups if some cells within an element are closer to a different borrow source than the rest of the cells. Dredge mobilization pathways between borrow sources and GIS groups (known as GIS group paths) are drawn for each appropriate borrow source based on defined regions (Figure 3). GIS group paths are drawn to the GIS group from each interior or river borrow source within its region, as well as from the nearest offshore borrow source.

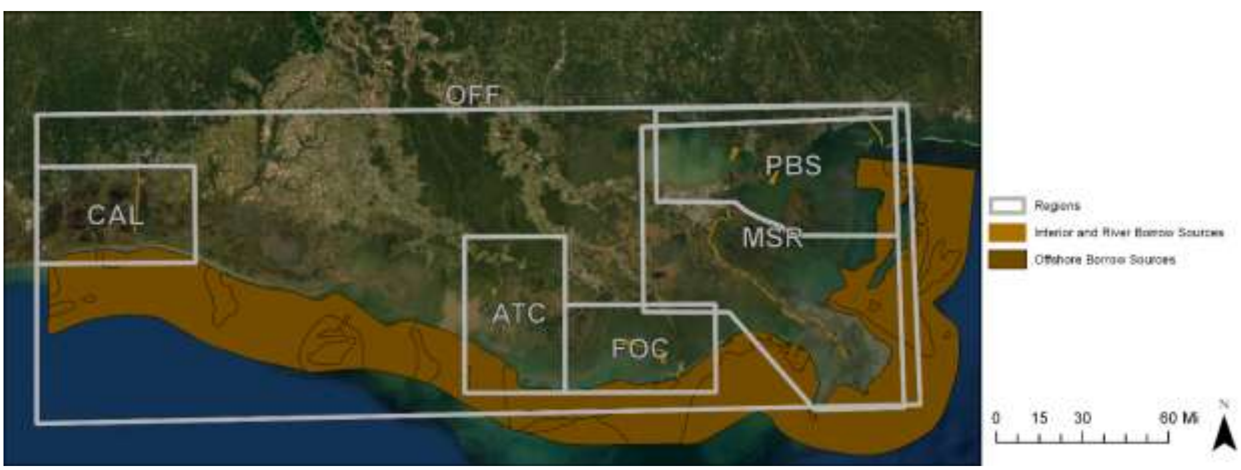

Figure 3. Defined Borrow Regions

An example output of the dredge mobilization tool is shown in Figure 4. GIS group paths (red) connect borrow sources (grey) to the closest edge of each marsh creation GIS group (tan). To-cell paths (blue) connect the end of the GIS group path to the closest edge of each cell, and in-cell paths (black) connect to the farthest edge of each cell.

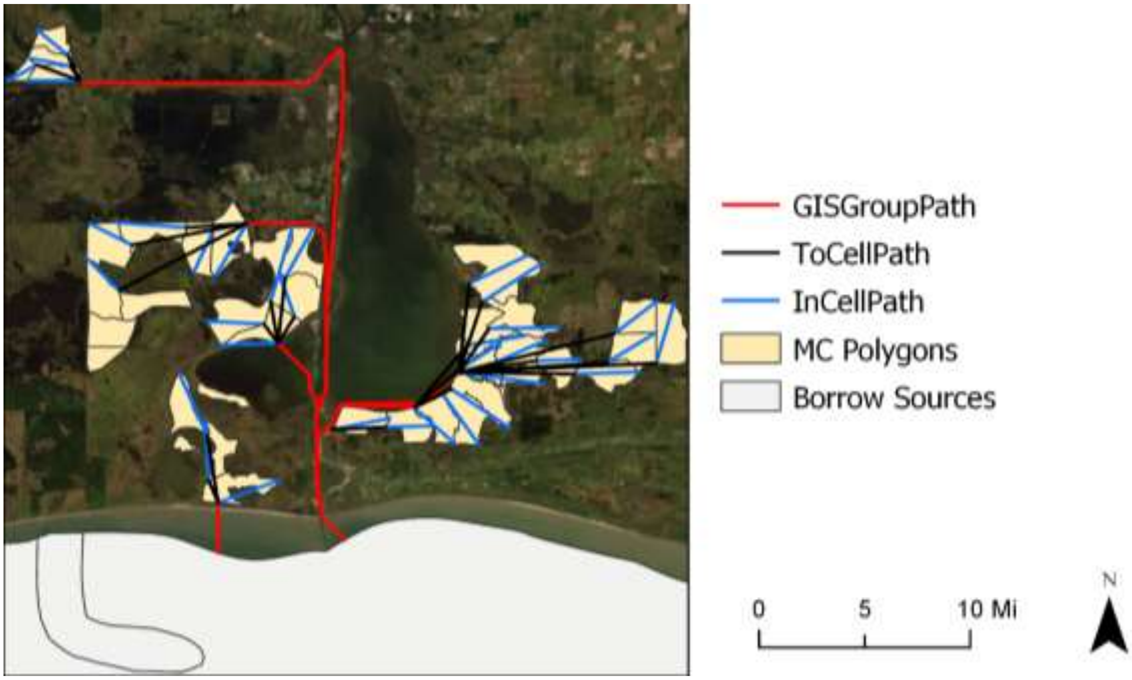

Figure 4. Dredge Mobilization Tool Outputs

The Dredge Mobilization tool is written using the arcpy library associated with ArcGIS Pro version 2.7.0 and requires an Advanced ArcGIS license with the Spatial Analyst toolbox, along with the additional packages outlined in Table 16. These tools are run locally through a python console or directly in ArcGIS Pro, but are not available on the PSC virtual machine due to Esri licensing limitations.

Table 16. Required Python Packages for the Dredge Mobilization Tool

Library	Version	Description
arcpy	Corresponding to ArcGIS Pro version 2.7.0	ESRI's proprietary library for geoprocessing functions
arcgis	1.8.3	Used to import geospatial data as pandas objects
pandas	1.1.1	Open-source data analysis and manipulation tool; used to manipulate data in a table-like format
numpy	1.19.1	Fundamental package for scientific computing with Python; used for various

		geometric and algebraic calculations.

The *DredgeMob* directory in the MP_PCT repository contains seven python files required to produce dredge mobilization pathways. The *Inputs.py* file defines input file paths and any constants used in the tool. Inputs include the Polygons_cells feature class from the PDG, the statewide land/water raster, the borrow source and borrow regions polygon feature classes, and the allowed paths line feature class. The *Functions.py* file is used to define common functions that are referenced by the remaining five scripts. These scripts are used in serial to create the *ElementPath* output feature class, which defines the alignment and relevant attributes of each dredge mobilization path. These five scripts are run in the following order, and are each described in detail later in this section:

1. **Preprocessing.py:** Processes the land/water raster at the state level to determine the shortest path to each borrow source for any given location within a borrow region.
2. **GISGroupPath.py:** Generates the shortest distance path either over water or along allowed paths from each GIS group to each applicable borrow source.
3. **CellPath.py:** Generates in-cell and to-cell paths for each cell, based on each GIS group path.
4. **CalculateAttributes.py:** Calculates dredge mobilization attributes (subline prelay, shoreline prelay, shoreline pickup) based on lengths of paths over land and water.
5. **ExportData.py:** Formats outputs for the PDD and PDG.

Preprocessing

The *Preprocessing.py* script creates rasters to determine the shortest path over water or along manually specified allowed paths between borrow sources and any given location within a borrow region. This tool produces output rasters for each borrow source clipped to their applicable region. This script needs to be run once before producing dredge mobilization pathways, but only needs to be re-run if the land/water raster, borrow source feature class, or allowed paths feature class are updated. Outputs of *AccessPreprocessing.py* include the following three rasters and one polygon feature class, used as inputs in the *GISGroupPath.py* and *CalculateAttributes.py* scripts:

- **PathRasters:** A set of rasters indicating areas the dredge mobilization pathway can travel to reach any borrow source, generated for each borrow source
- **DistanceRasters:** A set of rasters indicating the distance (along the corresponding *PathRasters*) to the target borrow area, generated for each borrow source
- **BacklinkRasters:** A set of rasters indicating the direction to travel to reach the target borrow area, generated for each borrow source
- **WaterPoly:** A polygon feature class of water extents used to calculate overland distance

GIS Group Path

The *GISGroupPath.py* script determines the shortest paths between each GIS group and each borrow source using the outputted *PathRasters, DistanceRasters,* and *BacklinkRasters* from the *Preprocessing.py* script. Paths are generated to each GIS Group from every available borrow source within a region; for example, if a region has 3 borrow sources, projects in that region will be assigned a path to each of the three sources, as well as to the nearest offshore source. GIS group paths do not cross any land that is not allowed via the *AllowedPaths* feature class. To account for discrepancies between the extents of the MC cells and the land/water interface, GIS groups are buffered, and paths are drawn to the buffered extent and then connected to the original GIS group by a straight line. Outputs of *GISGroupPath.py* include the following feature classes, used in subsequent steps of the Dredge Mobilization tool:

- **GISGroupPath:** A line feature class representing preliminary GIS group path alignments

Cell Path

The *CellPath.py* script creates the paths that fan out to reach each cell within a GIS group (called the to-cell paths) and paths that are directed to the farthest edge of each cell (called the in-cell paths). Unlike GIS group paths, to-cell paths and in-cell paths can travel anywhere and are simply a straight line between points. The MC cell at the fanout point (i.e., the cell that the GIS Group Path intersects) does not require a to-cell path. Outputs of *CellPath,py* include the following feature classes, used in subsequent steps of the Dredge Mobilization tool:

- **ToCellPath:** A line feature class representing the paths from the end of GIS group path to each corresponding MC cell
- **InCellPath**: A line feature class representing the paths from the end of the to-cell path to the farthest edge of each corresponding MC cell

Calculate Attributes

The *CalculateAttributes.py* script compares the outputs from *GISGroupPath.py* and *CellPath.py* to the *WaterPoly* feature class produced in the *Preprocessing.py* script to determine the length of each path that lies either over land or over water. In-cell paths are always classified as over-land pipe, even if they overlap the *WaterPoly* feature class. No new output feature classes or rasters are created with this tool, but new attributes are added to the *ToCellPath* and *InCellPath* feature classes and used in subsequent calculations in the *ExportAttributes.py* script.

Export Data

The *ExportData.py* script combines the *GISGroupPath, ToCellPath,* and *InCellPath* feature classes into a single *ElementPath* feature class and determines the subline prelay, shoreline prelay, and shoreline pickup attributes at the Element level. The subline prelay length is equal to sum of the lengths of the GIS group and to-cell paths that traverse over water. The shoreline prelay length is equal to sum of the lengths of the GIS group, to-cell, and in-cell paths that traverse over land, while the shoreline pickup length is equal to the sum of just the over-land GIS group and to-cell paths. These attributes are ultimately stored in the *BorrowOptions* table in the pct schema of the PDD.

Additionally, this script determines the preferred borrow source for each Element, defined as the borrow source which provides sediment to the MC Element at the lowest overall cost. The preferred borrow source is ultimately stored as an attribute in the *Attributes_MC* table in the pct schema of the PDD. Outputs of *ExportData.py* include the following:

- **ElementPath:** A line feature class representing the combined GIS group and cell paths from a borrow source to all cells within an MC Element
- **Attributes_MC.csv:** A csv file mirroring the structure of the *Attributes_MC* table, used to import dredge mobilization attributes into the PDD
- **BorrowOptions.csv**: A csv file mirroring the structure of the *BorrowOptions* table, used to import dredge mobilization attributes into the PDD

5.0 DATA PROCESSING TOOLS

The *DataProcessing* directory in the MP_PCT repository contains three python files used for general QAQC of the PDD, PCT, and PDG, including *ComparePGAndExcel.py*, *MirrorPostGres.py,* and *TransferPGtoGDB.py*. Additionally, the *OperationRegime_Graphics.py* is used to produce plots describing the operation regime of each DI project, for use in project-level cost summaries. These scripts are described in more detail later in this section.

A list of Python packages required to run the Data Processing tools is shown in Table 17. These tools are typically run locally through a python console. All tools except *TransferPGtoGDB.py* are available on the PSC virtual machine.

Table 17. Python Packages Used in Data Processing

Library	**Version**	**Description**
arcpy	Corresponding to ArcGIS Pro version 2.7.0	ESRI's proprietary library for geoprocessing functions; used in GIS tools
arcgis	1.8.3	Used to import geospatial data as pandas dataframe objects
matplotlib	3.3.1	Used to create operation regime graphics for project summary reports
xlrd	1.2.0	Used to read and format information from Microsoft Excel files
openpyxl	3.0.5	Used in conjunction with pandas and xlrd to read, format, and write information to/from Microsoft Excel files

QAQC

QAQC procedures are utilized to conform to a specified standard or requirement after changes are made to the PCT. A Python script, *ComparePGAndExcel.py*, is used to automate the process of comparing tabular data in an archived Excel workbook version of the PDD to the live version of the PDD. This script outputs an Excel workbook that highlights any differences between values in the archived Excel tables and values in the current PDD tables, including attribute tables, background tables, metadata, and outputted cost tables produced by the PCT. For numerical values, a percent difference is also calculated between the old and new values to provide contextual information on the changed values.

Once the data comparison workbook is produced, differences are investigated to ensure that changes were implemented correctly, that all reported differences were expected, and that the numerical value differences are with an acceptable range or percent difference. If errors regarding the changes, or other errors are found, additional edits are made and the QAQC process is repeated. Once all differences are reconciled, a new archive Excel workbook is created using another Python script, *MirrorPostGres.py*. The archived Excel workbook is used as the new baseline for future comparisons.

Once data is archived, attributes in feature classes within the PDG are synced with the PDD using a script called *TransferPGtoGDB.py*. This script pulls the latest metadata attributes from the PDD, compares the list of Elements in the PDD with those in the PDG, transfers relevant attributes to the feature classes within the PDG, creates the Mapping PDG by joining Element- and Project-level data, and produces an additional QAQC workbook archiving any differences that may exist between the two data sources. Once again, if discrepancies between the PDG and PDD are discovered, the QAQC process is repeated until errors are resolved.

The Master Plan team has developed a *Software Configuration Management Policy* (available upon request), which contains a more detailed description of the QAQC process for the PCT and other tools developed for the 2023 Master Plan.

Operation Regime Plots

Graphics depicting the operation regime of Diversion projects are created via the *OperationRegime_Graphics.py* script and are included in the Project Cost Summaries. An example operation regime graphic is shown in Figure 5.

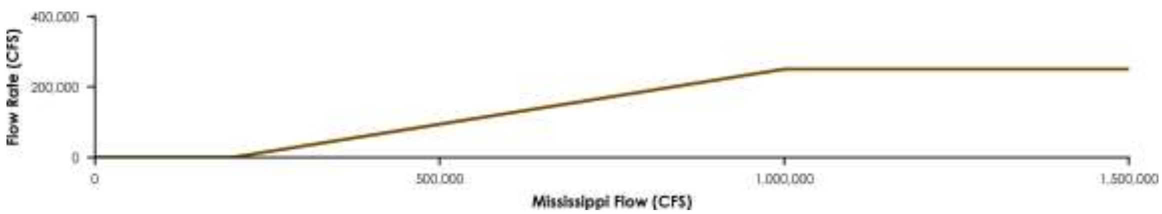

Figure 5. Operation Regime Graphic Example

To create these plots, operation regime information is pulled from the PDD, saved in an Excel file (*MP23 Operations Regime Graphics.xlsx*), and translated into data points representing key features of the plot, such as the x- and y-coordinate bounds, axis labels, and rating curve inflection points. Most graphics require a minimum of four inflection points to fully represent the rating curve but will vary depending on the complexity of the system.

Operation regime plots are graphed by river flow (x-axis) and flow rating (y-axis) where the river flow x-axis is standardized across all graphics based on the source from which water is being diverted. The x-axis spans from the minimum river flow (0 CFS) to the maximum river flow estimated from USGS Stream Gage data (Mississippi River or Atchafalaya River) or maximum operation rate (Bonnet Carre Spillway). The y-axis spans from zero to the maximum value needed to represent the highest point on the flow rating curve. Once data points and labels are compiled, the *OperationRegime_Graphics.py* script sets the figure components and pulls data in from the Excel file to create one graphic for each diversion. Graphics are saved in a location accessible to the Jaspersoft program, which in turn loads each graphic for inclusion in Project Cost Summaries for Diversion projects.

6.0 REFERENCES

Sprague, H, Nelson, T. Weikmann, A, Norman, D, Gong, D. (2021a). 2023 Coastal Master Plan: Appendix F: Project Definition. Version I. (pp xx-xx or p. x.). Baton Rouge, Louisiana: Coastal Protection and Restoration Authority.

Sprague, H., Nelson, T., Weikmann, A., Gong, D., & Norman, D. (2021b). 2023 Coastal Master Plan: Project Database Development, Technical Documentation. Version I. (pp. xx-xx or p. x). Baton Rouge, Louisiana: Coastal Protection and Restoration Authority.