

TRI - REGIONAL JETS 2025



Landscape Adaptations to Achieve Restoration Outcomes

Caño Martín Peña
Environmental Restoration Project





Caño Martín Peña (CMP) Environmental Restoration Project (ERP)

Moderator:

Terry Hull, CMP Project Manager, AECOM-BV JV

Speakers:

- Jorge Rivera-Cruz, PhD, PE, CMP Engineering Technical Lead, USACE Caribbean District
- Meredith Allen, CMP Environmental Lead, AECOM-BV JV

MODERATOR



Terry Hull_{PE}

Black & Veatch

CMP Project Manager



- **Sports Teams:** Jacksonville Jaguars, Rocky Top
- **Vacation Spots:** Anywhere with family
- **Did You Know:** I love dogs.
- **Hobbies:** Boating
- **Cooler Project(s):** Caño Martín Peña ERP

SPEAKER



Meredith Allen_{JD}

AECOM

CMP Environmental Lead



- **Sports Teams:** Miami Hurricanes, Savannah Bananas
- **Vacation Spots:** France
- **Did You Know:** I served as a Forestry/Environmental Education Peace Corps Volunteer in Benin, West Africa.
- **Hobbies:** Gardening
- **Cooler Project(s):** Caño Martín Peña ERP & Pearl Harbor DD5 & WPF



SPEAKER

Jorge Rivera^{PhD, PE}
USACE SAA, Structural Engineer



- **Sports Teams:** New York Yankees
- **Vacation Spots:** West coast of Puerto Rico (Rincon beaches)
- **Did You Know:** I played little league baseball (Second baseman)
- **Hobbies:** Play chess
- **Cooler Project(s):** Rio Puerto Nuevo, and Cano Martin Pena



Learning Objectives

- Understand Sea Level Rise considerations for wetland creation design
- Need for close coordination between engineering and environmental for any ecosystem restoration project.



Agenda

- Project Overview
- History
- Scope of Work
- Mangrove Planting Design
- Q&A / Discussion

Project Overview



Project Overview

CANO MARTIN PENA is a 3.5-mile-long tidal channel extending from San Juan Bay to the San José Lagoon. It is an integral part of the San Juan Bay Estuary system



San Juan Metropolitan Area



PROJECT TYPE

Aquatic Ecosystem Restoration

SPONSORS

Puerto Rico Department of Natural and Environmental Resources (DNER) and Corporación del Proyecto ENLACE del Caño Martín Peña.

AUTHORIZATION

- Water Resources Development Act (WRDA) of 2007 authorized project for construction
- ENLACE prepared the Feasibility Report for the CMP-ERP dated February 2016. Assistant Secretary of the Army for Civil Works (ASA-CW) approved the report on 16 MAY 16, in effect authorizing the project for construction.

COST SHARE

AER (65% Fed/35% Non-Fed); Recreation features (50% Fed/50% Non-Fed).

PURPOSE

The Cano Martín Peña Ecosystem Restoration Project (CMP-ERP) aims to re-establish the tidal connection between the San José Lagoon and the San Juan Bay, which would improve dissolved oxygen levels and salinity stratification, increase biodiversity by restoring fish habitat and benthic conditions, and improve the functional value of mangrove habitat within the San Juan Bay Estuary.

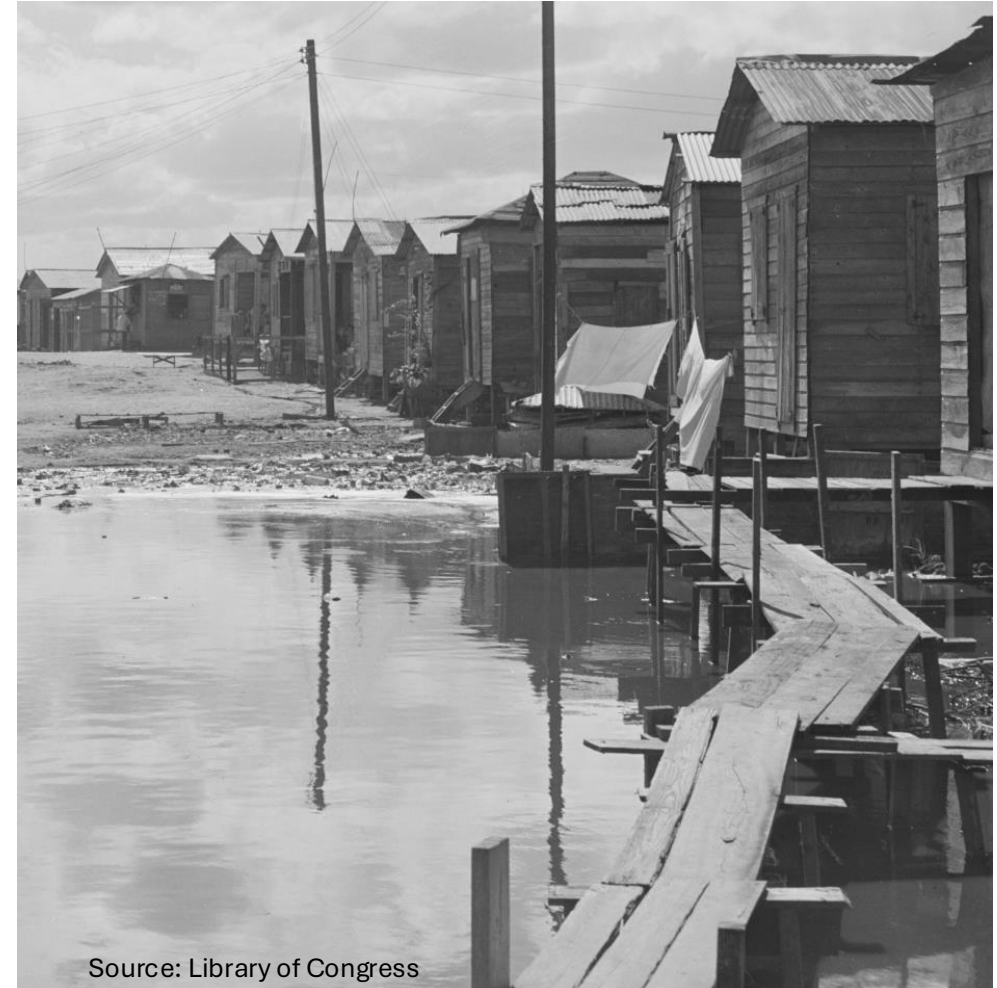


SIGNIFICANT COMMUNITY SUPPORT

The CMP Project is critical for the revitalization of eight communities settled along the Martín Peña tidal channel, and restoration of this system will significantly improve human health and safety in the area by reducing residents frequent contact with highly polluted floodwaters.

History

- Early 1900s - dense mangrove forests lined the canal.
- Starting in the 1920s, the forests began to be cleared and filled for the first urban development, Barrio Obrero Oeste.
- Following the collapse of the sugarcane industry in the late 1920s, thousands of rural farm workers migrated to San Juan in search of work and settled along the canal.
- The mangroves continued to be cleared, and the canal filled for makeshift settlements and later .
- The settlements along the canal were cleared between 1960s and the 1980s, but lack of sanitation services meant the canal was continued to be used for garbage disposal.
- By 2003, decades of filling and disposal of garbage severed the flow to and from the San Jose Lagoon.
- Today the eastern end is about 1 ft deep, 30 ft wide.



Source: Library of Congress

PROJECT IMPLEMENTATION, FEATURES, AND MAP

CONTRACTS

CONTRACT 1 | VEGETATION REMOVAL

STATUS: Completed June 2023, 36 acres vegetation removed.

DEBRIS REMOVAL CONTRACT

STATUS: Completed Oct 2023, 1.5K Tons removed + Modification for additional 3.8K Tons.

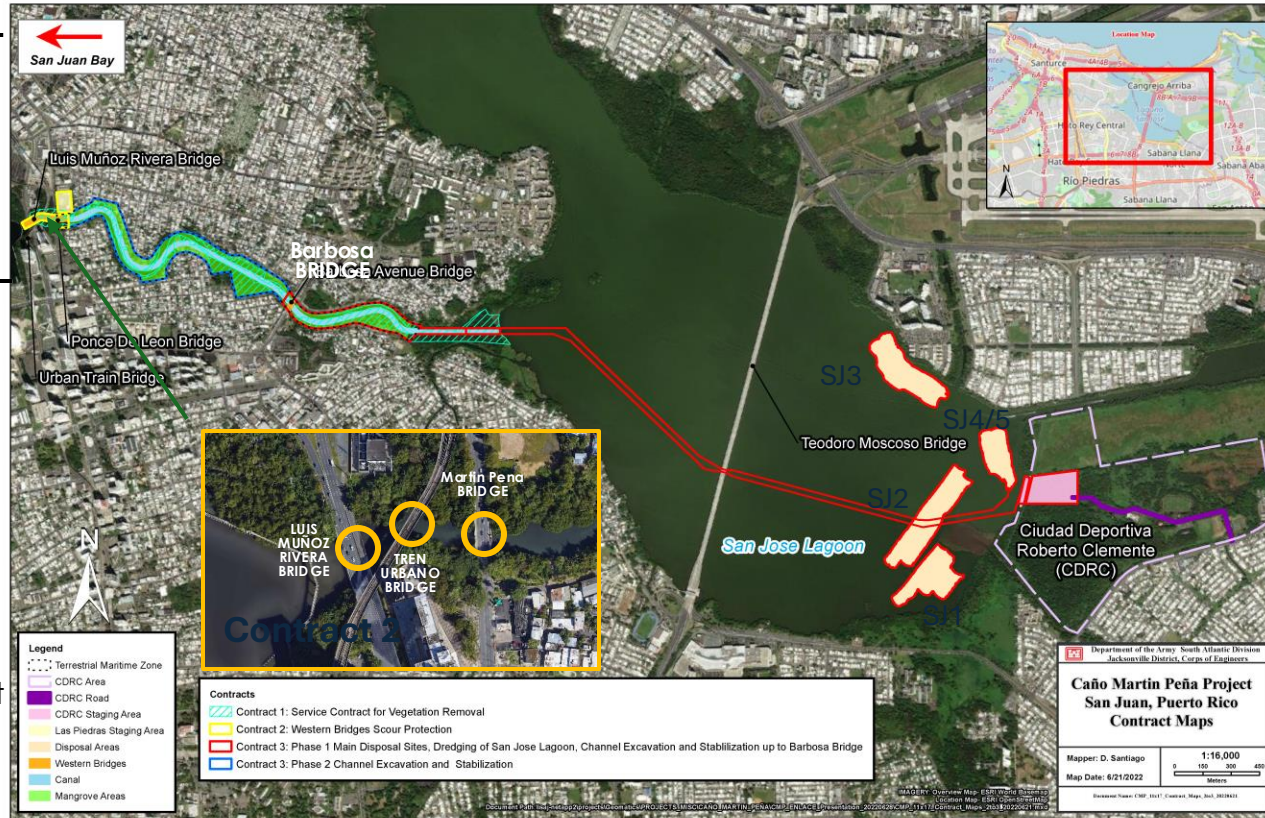
CONTRACT 2 | WESTERN BRIDGES SCOUR PROTECTION.

Martín Peña, Tren Urbano, and Luis Muñoz Rivera

STATUS: Awarded Sep 2024, Construction started Jan 2025. Expect completion in Oct 2026

SCOPE

- Excavation of ~25K CY of material from the western end of the channel
- Construction of 115-foot-wide by 6.5-foot-deep channel at western end.
- Installation of riprap at the channel bottom and the side slopes to prevent scour
- Steel sheet pile walls will be installed at the eastern end of CNT 2



CONTRACT 3 PHASE 1 | CHANNEL EXCAVATION & STABILIZATION From Eastern end of the CMP to Barbosa Bridge

STATUS: Awarded 30 Sep 2025

SCOPE

- Develop Material management Area (MMA) at (CDRC)
- Disposal pits preparation
- Dredging 0.9 mile from access channel to Barbosa Bridge
- Bank stabilization to include sheet pile
- Barbosa Bridge scour protection
- Moscoso Bridge fenders

CONTRACT 3 PHASE 2 | CHANNEL EXCAVATION & STABILIZATION From Barbosa Bridge to eastern end of CNT2

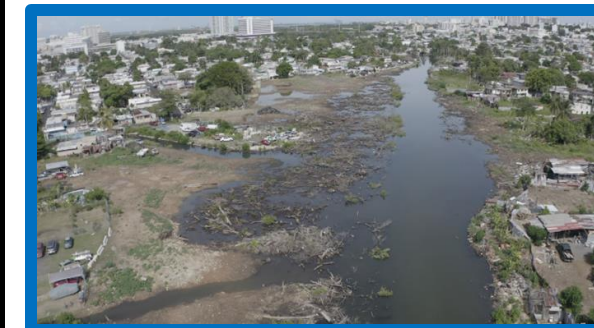
STATUS: 90% Design. Expected Award June 2029

SCOPE

- 1 mile channel dredging from Barbosa bridge to eastern end of CNT2
- Bank stabilization to include sheet pile
- ~ 35 acres Mangrove/wetland restoration for entire channel
- Recreation features



Contract 3: Phase 1



Contract 3: Phase 2

Contract 3 Phase 2 Overview



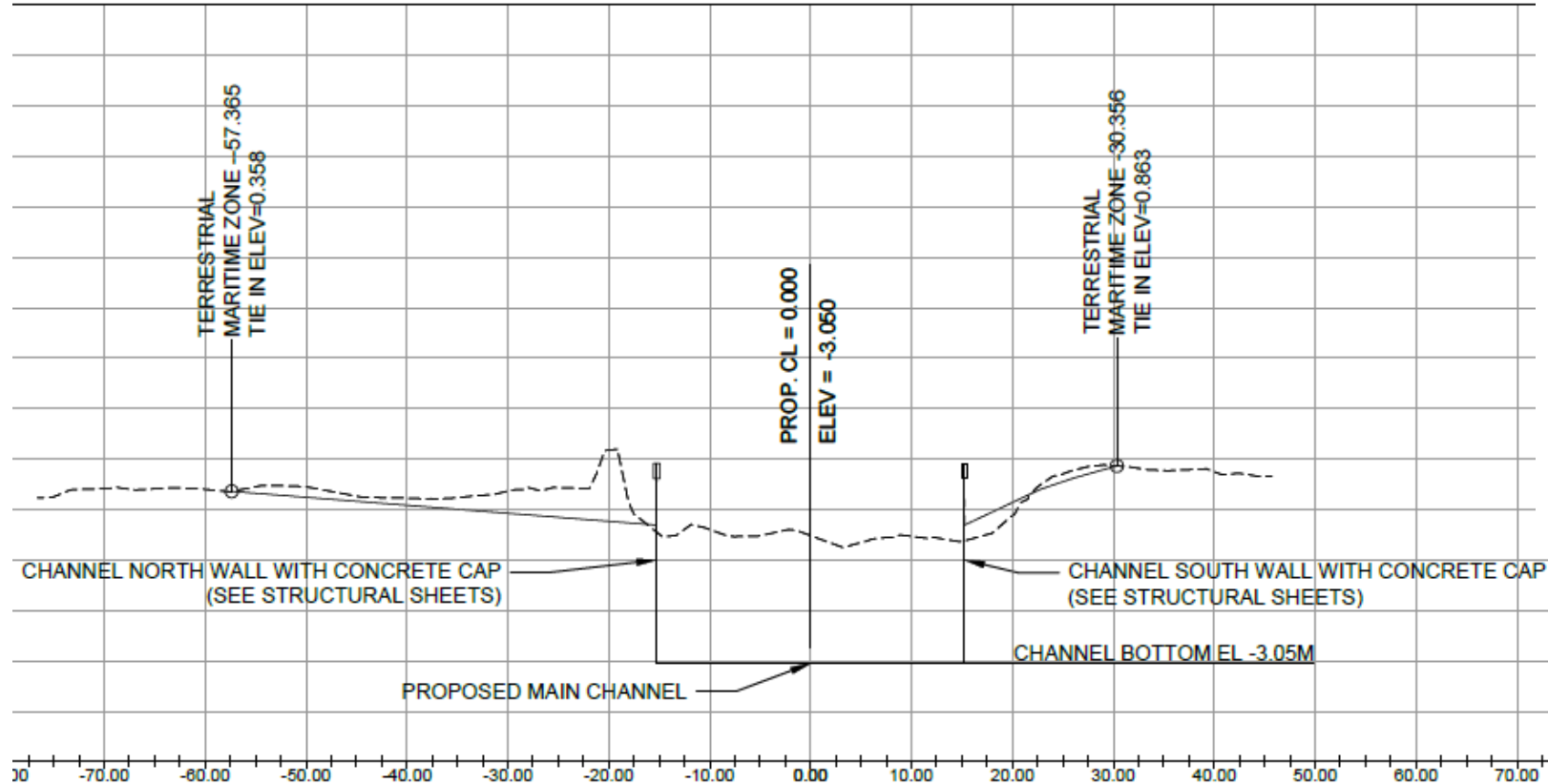
- Channel Improvements
- Recreation Features along Entire Channel
- Mangrove/Wetland Restoration



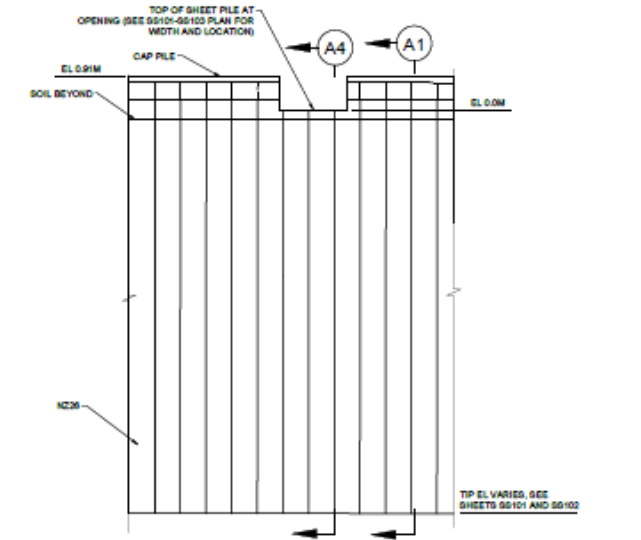
Main Channel Dredging from Martin Pena Bridge to Barbosa Bridge

- Dredging of 1,550 meters (1 mile) long channel
- Rectangular cross section (30.5 x 3.1 m)
- Steel sheet pile channel walls with concrete cap (12 m)
- Estimated dredged volume ~ 137K cubic meters
- Expected higher trash and debris. Separation of solid waste from sediments will be performed by a metal sieve.
- After screening and removal of solid waste, the remaining dredged material will be transported by shallow-draft barges and bottom dumped in a controlled manner at the SJ1 disposal pit.
- The solid waste will be transported to the MMA, and then, trucks will haul material to an approve landfill.

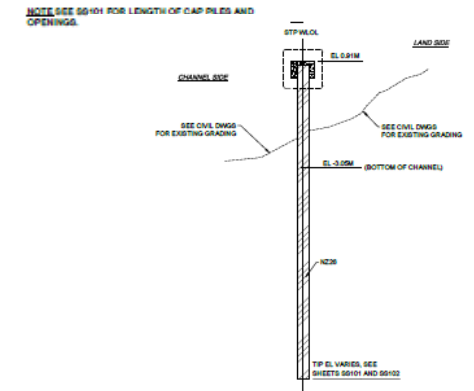
Channel Walls



- Approximately 1-mile long channel
- Rectangular cross section (30.5 x 3.1 m)



E4 TYPICAL SHEET PILE SECTION
SCALE: 1:75



A3 TYPICAL CHANNEL WALL SECTION AT CAP PILE
SCALE: 1:75

Barrio Obrero Marina

Barrio Obrero

Buena Vista (Santurce)

Parada 27

Las Monjas

Buena Vista (Hato Rey)

Cantera

Israel Bitumul

--- APPROXIMATE NEIGHBORHOOD
BOUNDARY

LEGEND

- (A) RECREATIONAL PARK WITHOUT TRAIL
- (B) RECREATIONAL PARK WITH TRAIL
- (C) RECREATIONAL ACCESS PARK TYPE A
- (D) RECREATIONAL ACCESS PARK TYPE B

LEGEND

- (A) RECREATIONAL PARK WITHOUT TRAIL
- (B) RECREATIONAL PARK WITH TRAIL
- (C) RECREATIONAL ACCESS PARK TYPE A
- (D) RECREATIONAL ACCESS PARK TYPE B
- (E) LINEAR PARK

NOTE: ONLY ONE OF THESE PARKS WILL BE BUILT. TWO POTENTIAL LOCATIONS WERE SHOWN ON THIS PLAN TO SOLICIT FEEDBACK. ON THE PREFERRED LOCATION, ONCE THE PREFERRED LOCATION IS SELECTED, THEN THE OTHER PARK SITE WILL BE REMOVED FROM THE PROJECT.

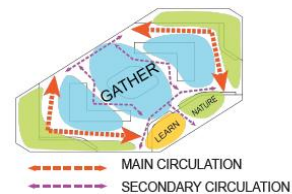
Recreation Features Plan Layout

(6) Recreational Park without Trail

A

~2,000 sq ft, 186 m²

No directly connected to the Caño



SHADED SEATING



OUTDOOR CLASSROOM



GATHERING SPACE



GROUP SEATING

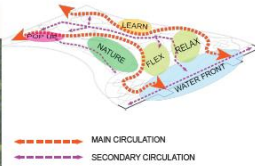


(6) Recreational Park with Trail

B

~3,000 sq ft , 279 m2

Directly connected to the Caño



BOARDWALK /
WATER VIEWS



FISHING



RAIN GARDEN



OPEN PLAZA



POP UP MARKET / FOOD AREA



OUTDOOR CLASSROOM



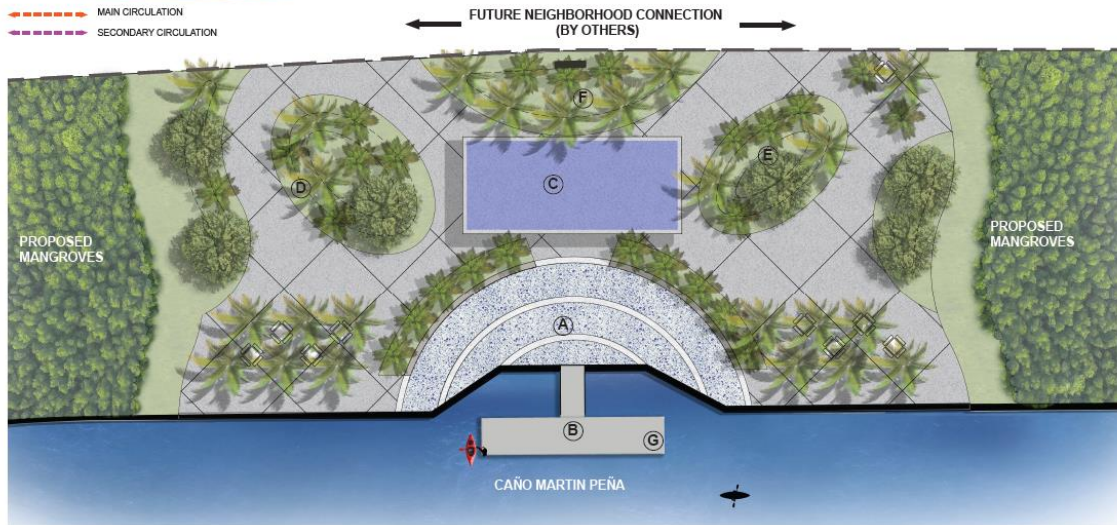
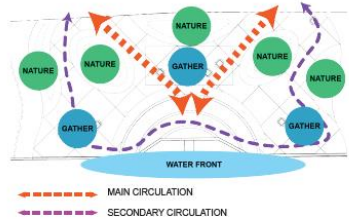
FLEXIBLE SPACE



(6) Recreational Access Park - Type A



Largest park, 0.3 to 0.5 acres
Directly connected to the Caño



OPEN SPACE / LAWN



FISHING



KAYAKING



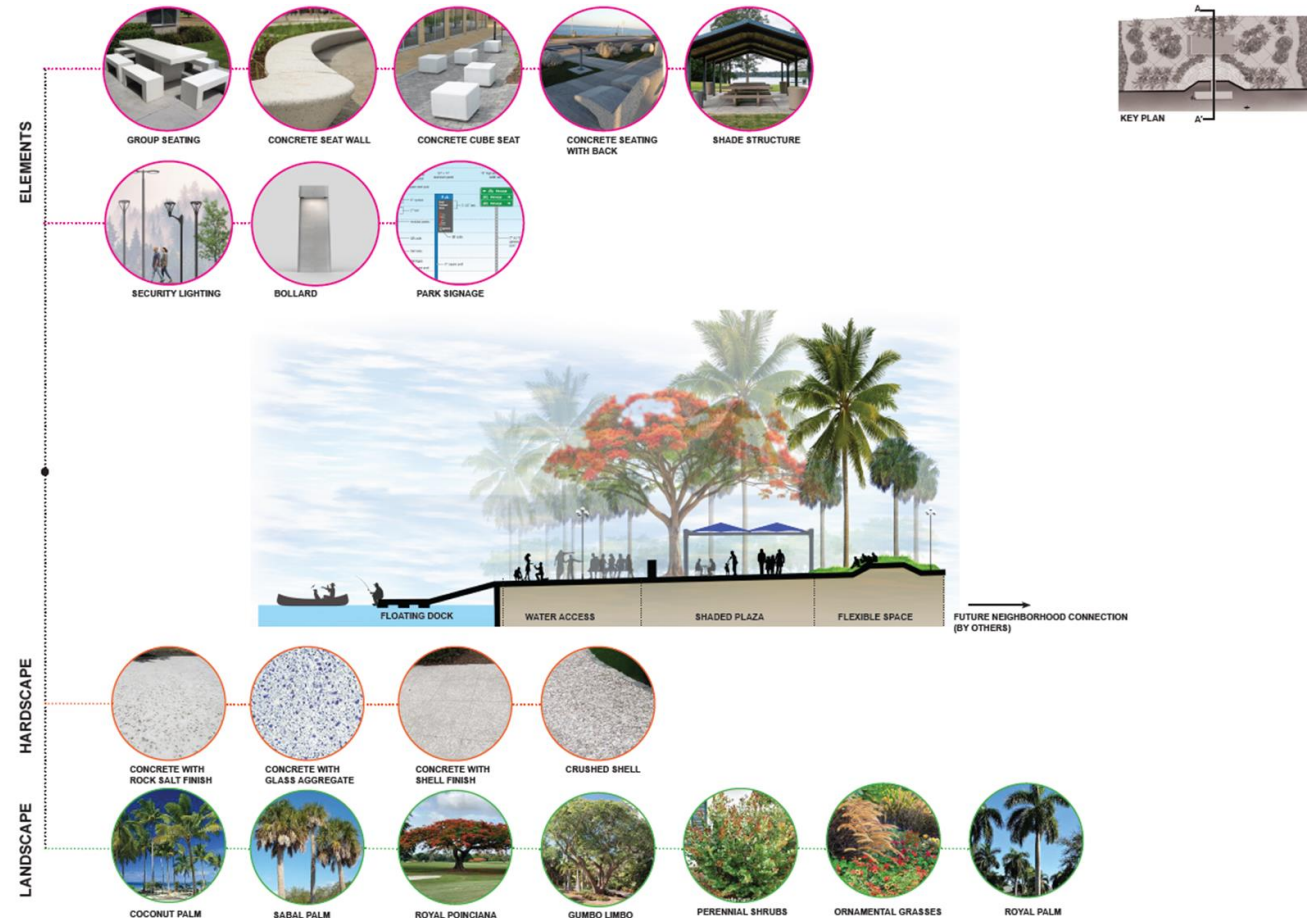
WALKWAY ALONG WATER



SHADED AREAS



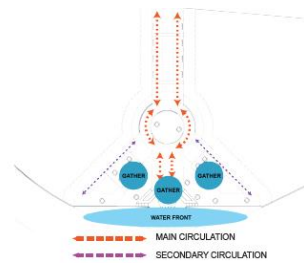
GROUP SEATING



(3) Recreational Access Park - Type B

Largest park, 0.3 to 0.5 acres
Directly connected to the Caño

D



SHADED AREAS



GROUP SEATING



BOARDWALK ALONG WATER



OPEN SPACE / LAWN



PICNIC AREA



FISHING



PERFORMANCE AND STAGE

ELEMENTS



SWING BENCH



GROUP SEATING



CONCRETE SEAT /
TABLE



CONCRETE SEAT WALL



CONCRETE CUBE SEAT



CONCRETE SEATING
WITH BACK



SHADE STRUCTURE



SECURITY LIGHTING



PARK SIGNAGE



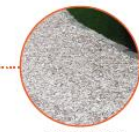
HARDSCAPE



CONCRETE SAND
BLASTED FINISH



COLORLED CONCRETE



CRUSHED SHELL

LANDSCAPE



COCONUT PALM



SABAL PALM



ALEXANDER PALM



ROYAL POINCIANA



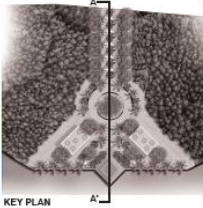
MAHOGANY TREE



SEAGRAPE



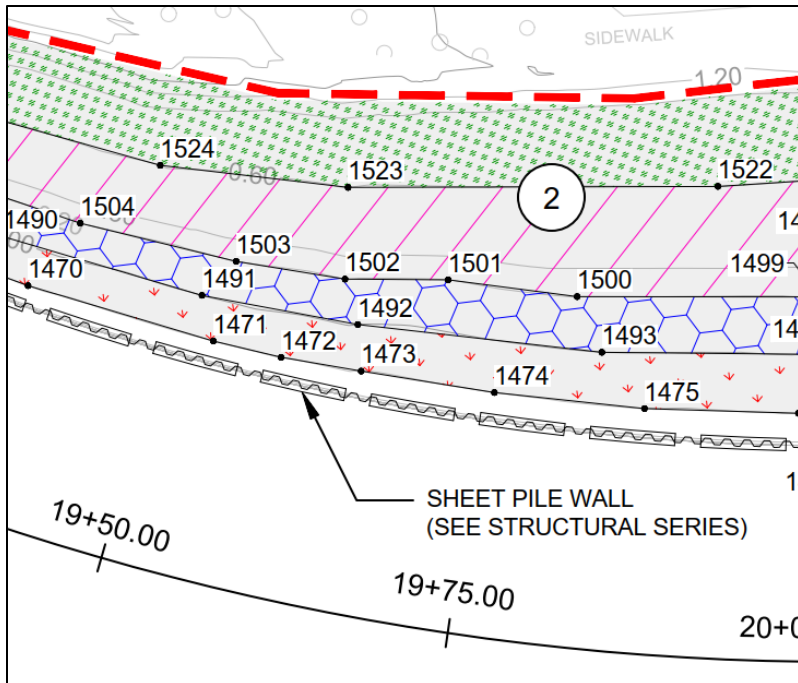
DWARF COCCOLUP



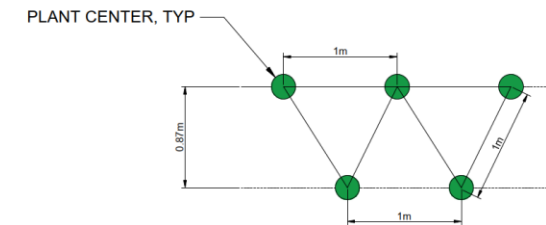
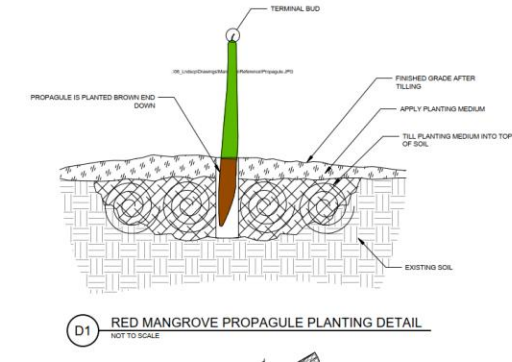
KEY PLAN

The CMP Ecosystem Restoration Project includes approximately 34 acres of mangrove restoration:

- Mangrove plantation behind the proposed sheet-pile walls will be included in CNT3 Phase 2.
- Channel sheet pile walls will include 1.8 m wide x 0.38 m high openings spaced between 6 and 9 meters along the length of the channel.
- The four target mangrove species proposed for planting in the mangrove beds include red mangrove, black mangrove, white mangrove, and buttonwood mangroves.



ZONE	ELEVATION	SPECIES
	ZONE A -0.2 M TO 0.0 M	RED MANGROVE (<i>RHIZOPHORA MANGLE</i>)
	ZONE B 0.0 M TO 0.2 M	BLACK MANGROVE (<i>AVICENNIA GERMINANS</i>)
	ZONE C 0.2 M TO 0.6 M	WHITE MANGROVE (<i>LAGUNCULARIA RACEMOSA</i>)
	ZONE D 0.6 M TO CWL	BUTTONWOOD (<i>CONOCARPUS ERECTUS</i>)
	SHEET PILE WALL (SEE S SERIES)	
	PARK (SEE LS SERIES)	



F2 TYPICAL PLANT AND PROPAGULE SPACING
NOT TO SCALE

MANGROVES

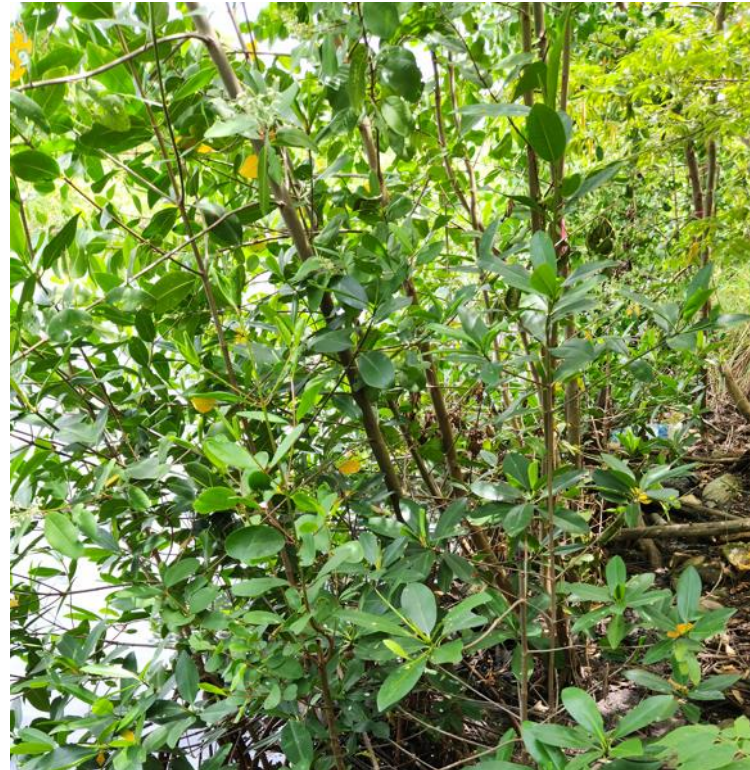




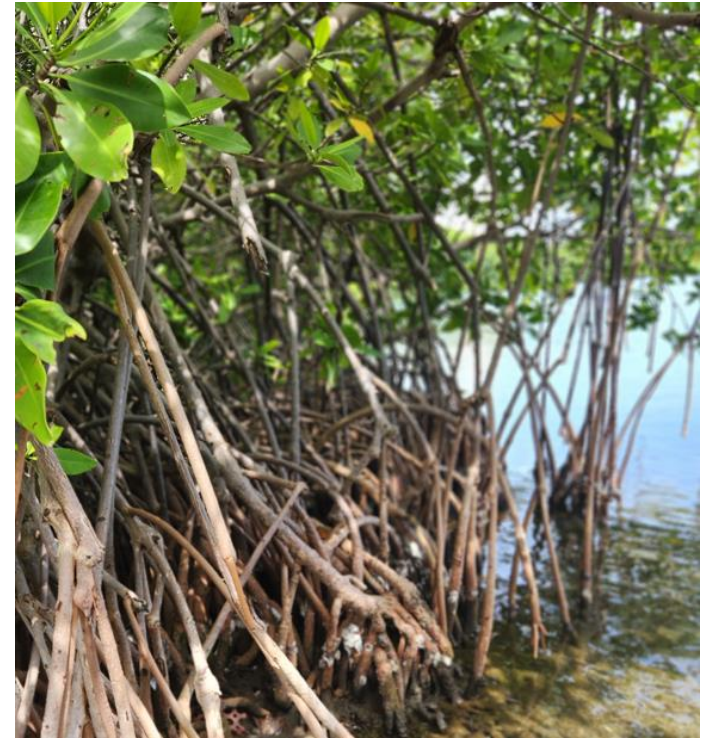
Black mangroves
(*Avicennia germinans*)

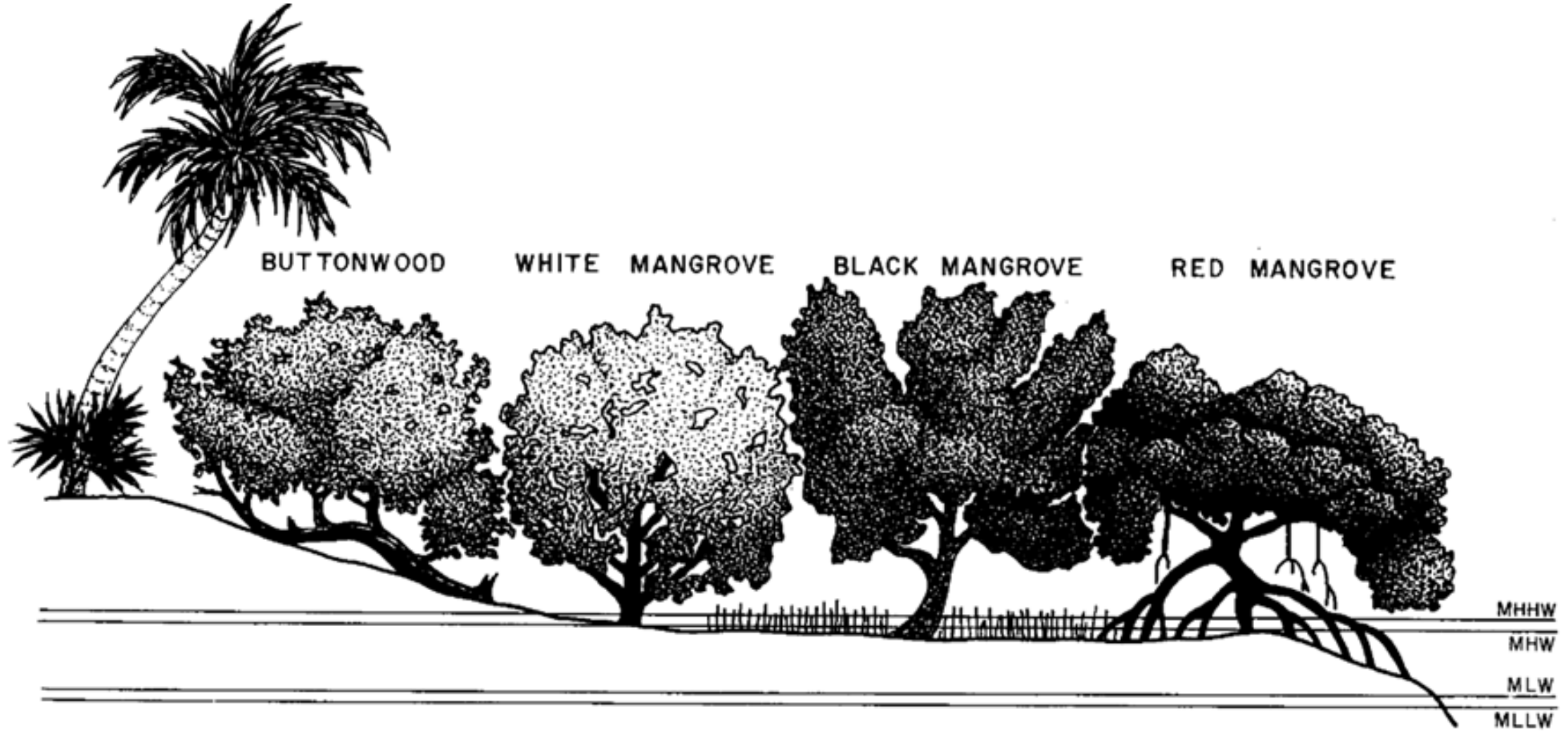


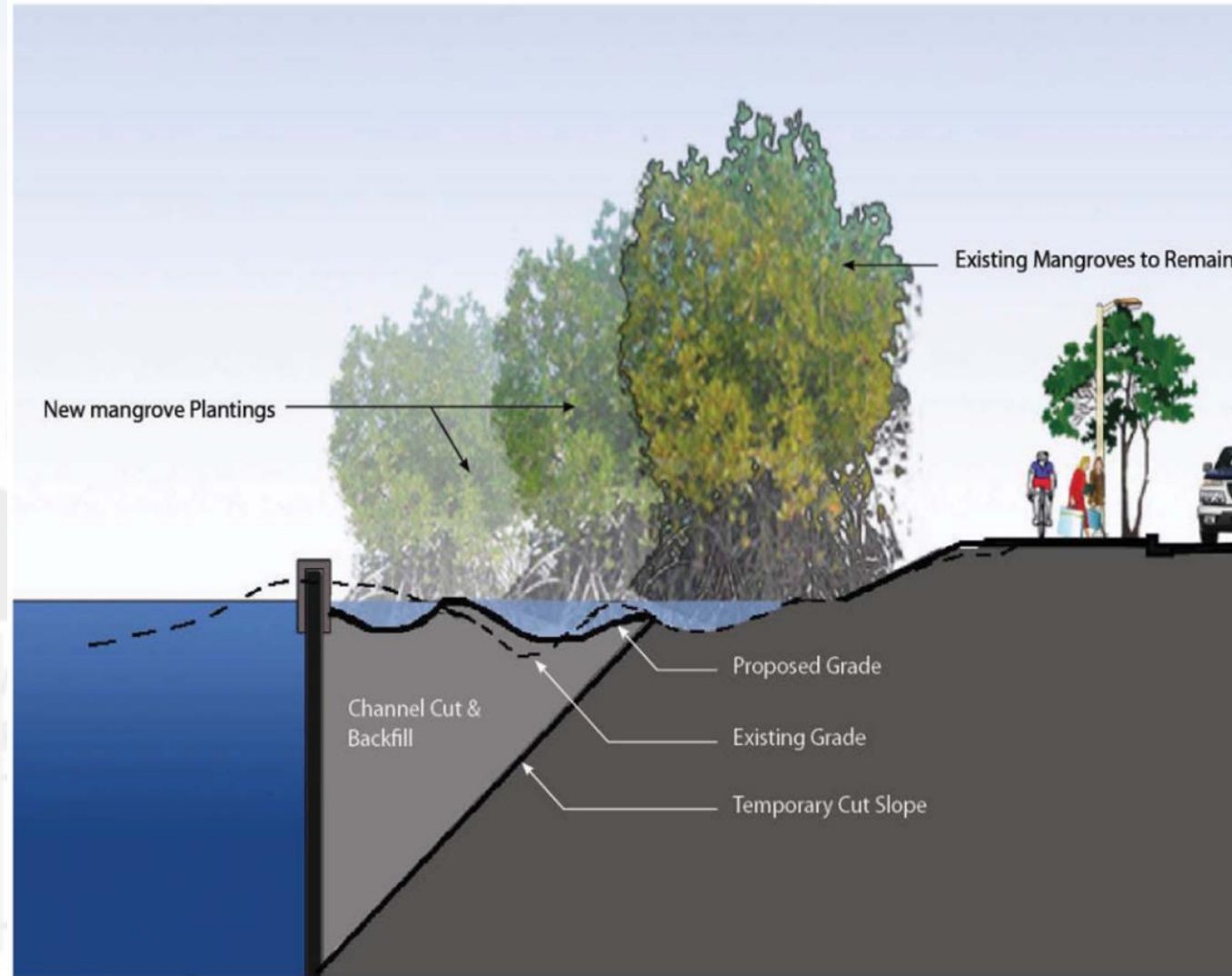
White Mangroves
(*Laguncularia racemosa*)



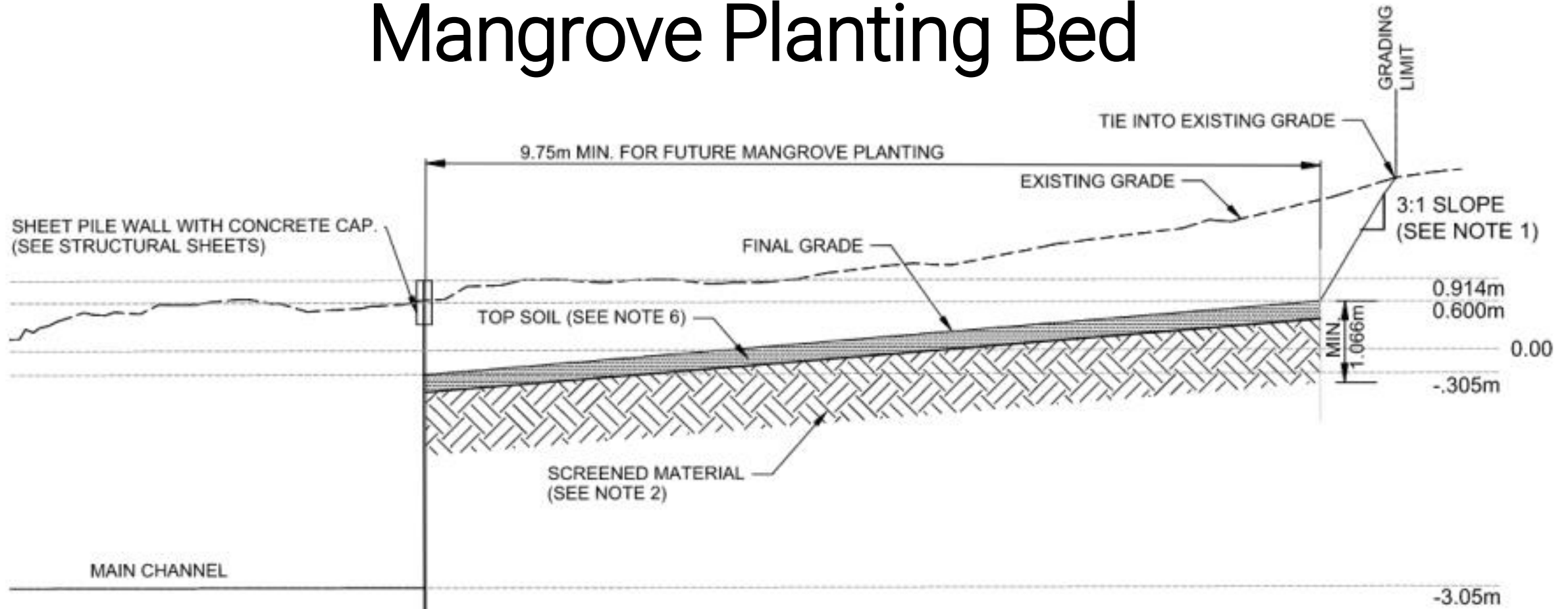
Red Mangroves
(*Rhizophora mangle*)



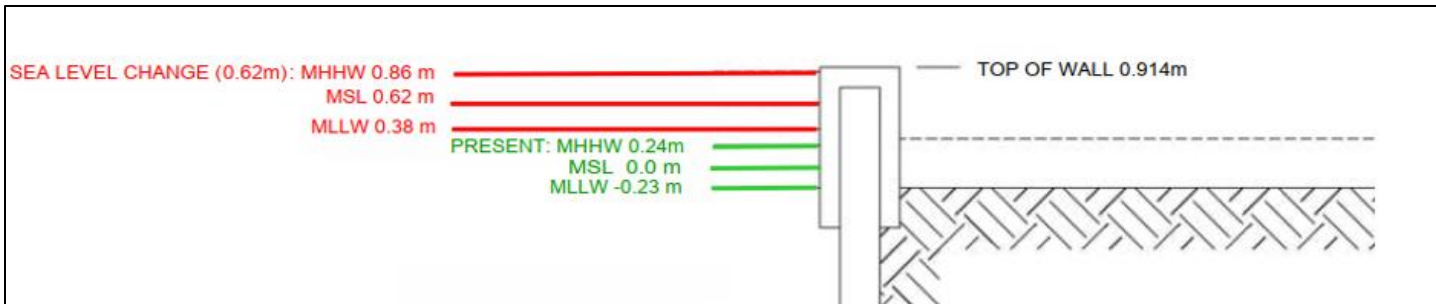




Mangrove Planting Bed



Challenge 1 -Would white mangroves survive at elevations in excess of 0.7 meters in elevations?



2016 EIS Adjustments (+.62 m) for Sea Level Change

2024 Scope of Work - Restoration of the disturbed mangrove fringe would be accomplished by grading the site behind the channel walls to **between EL -0.305 meters and EL 0.914 meters**, and planting with red, white, and black mangroves.

Elevations on PRVD02

Station: 9755371, San Juan, La Puntilla, San Juan Bay, PR

T.M.: 0

Epoch: 1983-2001

Status: Accepted (Oct 19 2011)

Datum: PRVD02

Units: Meters

Control Station:

Datum	Value	Description
MHHW	0.246	Mean Higher-High Water
MHW	0.166	Mean High Water
MTL	-0.002	Mean Tide Level
MSL	0.000	Mean Sea Level
DTL	0.006	Mean Diurnal Tide Level
MLW	-0.171	Mean Low Water
MLLW	-0.234	Mean Lower-Low Water
PRVD02	0.000	Puerto Rico Vertical Datum of 2002



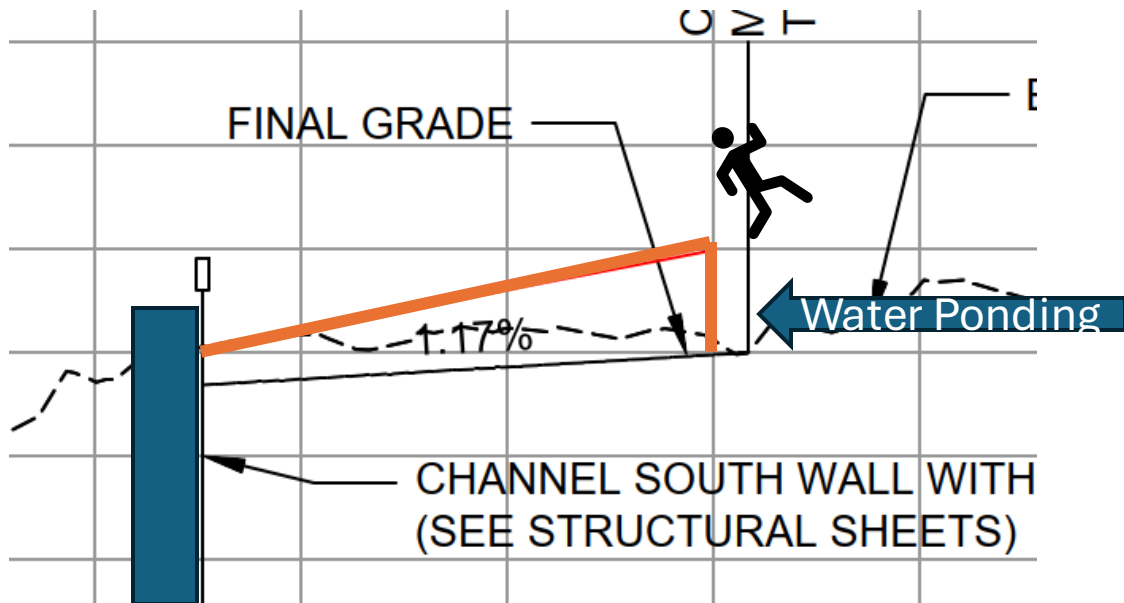
Challenge 1- Answer

- White Mangrove may not be able to establish in elevations above 0.7PRVD
- Based on discussions with USACE , incorporated Buttonwood (**Conocarpus erectus**) to upper reaches of the planting beds.
- Basis of Determination
 - Buttonwood is a native transitional forest species found on perimeter of mangroves.
 - Buttonwood is tolerant of both dryer conditions and urban environment making it a good buffer to the surrounding community.
 - Even if water levels rise in the future, the nature of this system is that the mangroves would migrate into the buttonwood areas and buttonwood would die out allowing for long term adaptation of habitat without functional loss

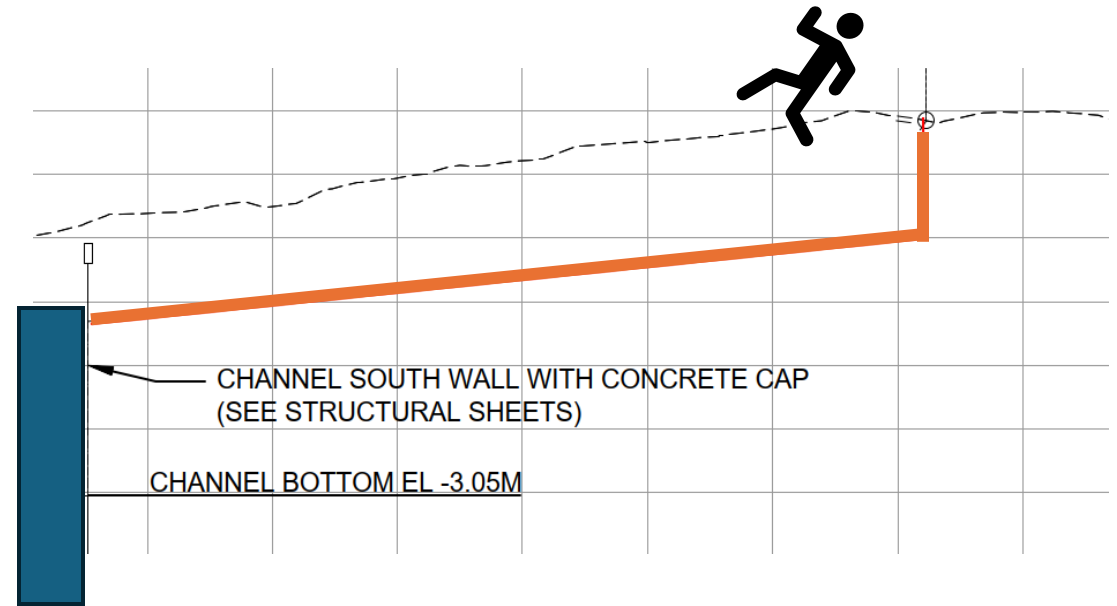
2024 Scope of Work - Restoration of the disturbed mangrove fringe would be accomplished by grading the site behind the channel walls to **between EL -0.305 meters and EL 0.914 meters**, and planting with red, white, and black mangroves.

Challenge 2 –How to Transition Mangroves into areas just outside project limits?

MTZ existing Elevation Lower



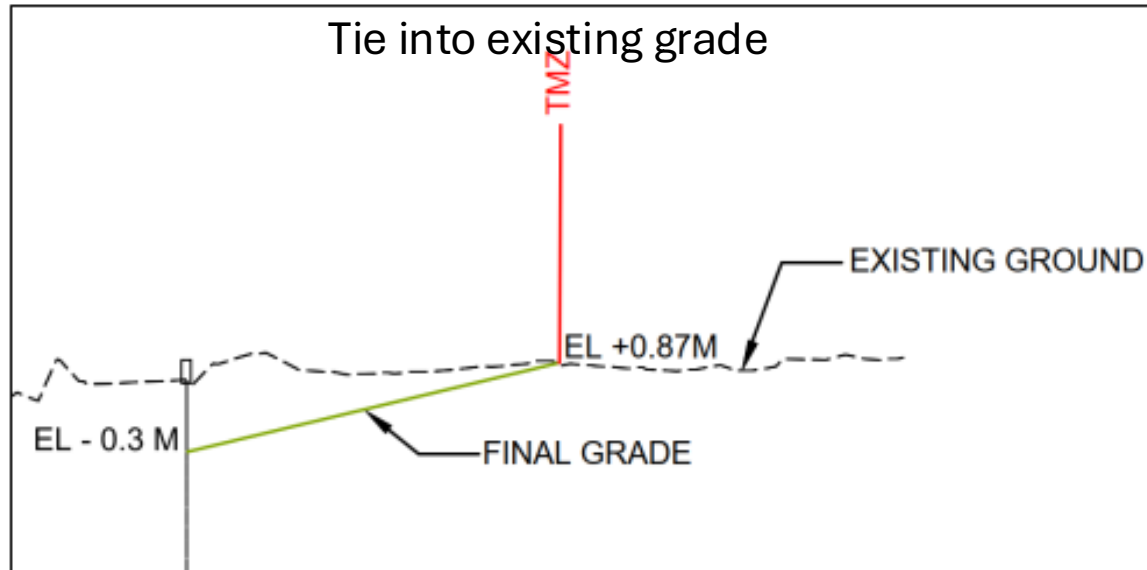
MTZ existing Elevation Higher



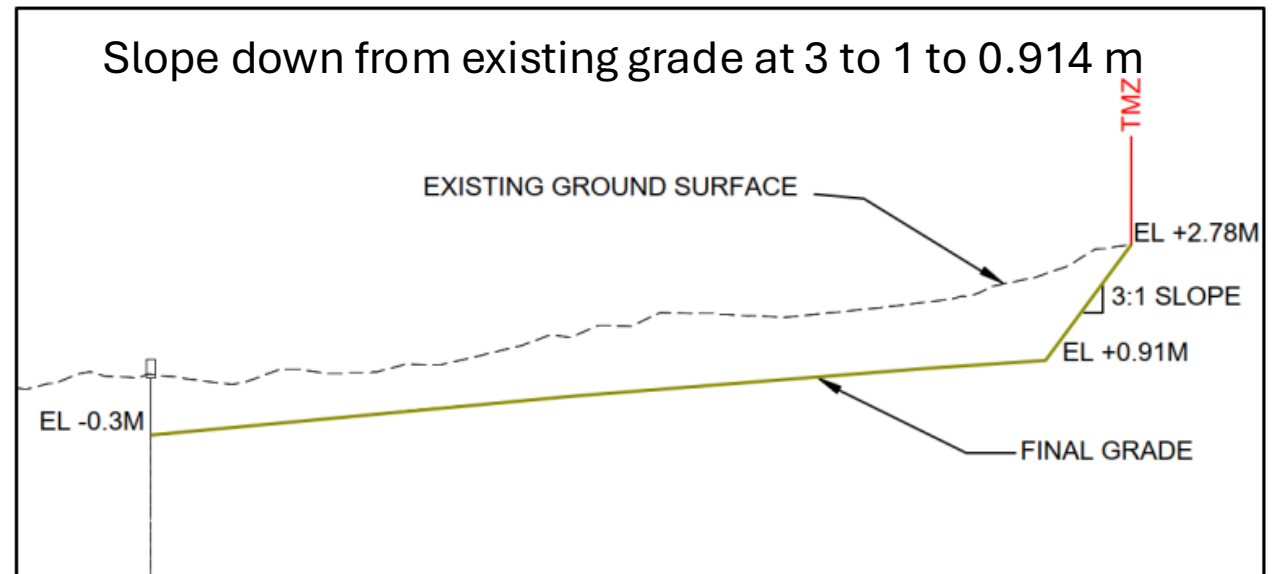
Challenge 2 – Answer

Tie Into Existing Grades

When elevation at MTZ is less than 0.914 m



When elevation at MTZ Greater than 0.914 m



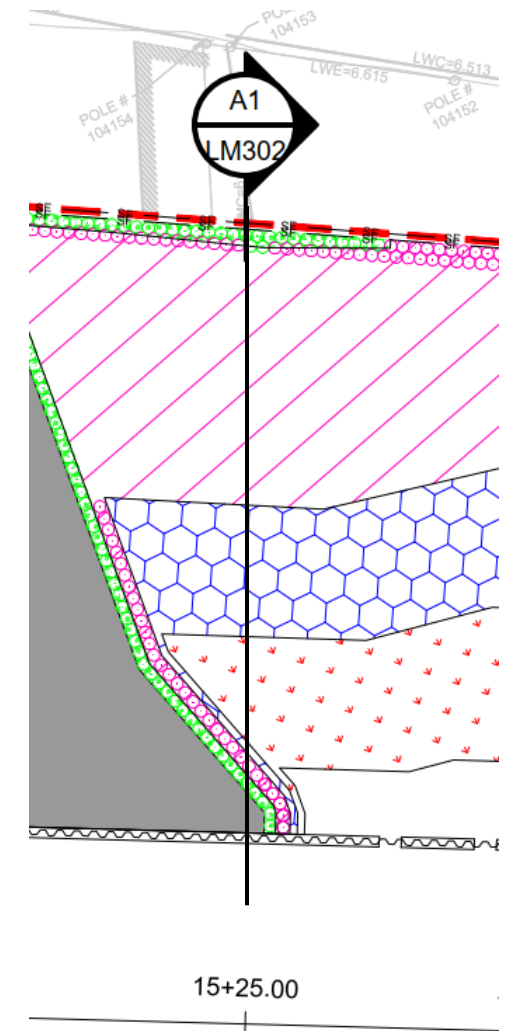
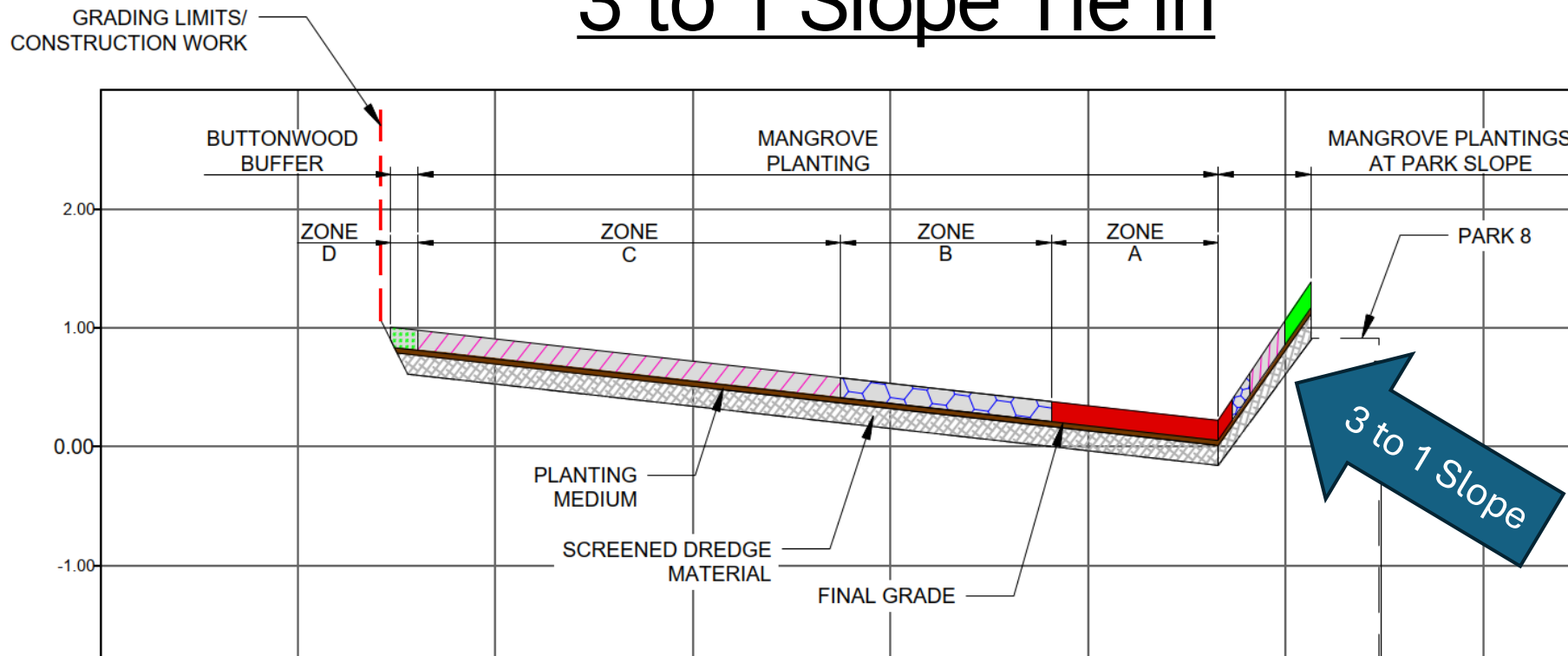
Challenge 3—How are we going to transition from the Mangroves to the adjacent parks?



- Elevation of Parks was set at the same elevation of the top of the sheet pile walls (0.914m).
- Resulted in large drop off from parks to adjacent planting areas
- Increased possible need for sheet pile wall which would increase costs

Challenge 3 – Answer

3 to 1 Slope Tie In

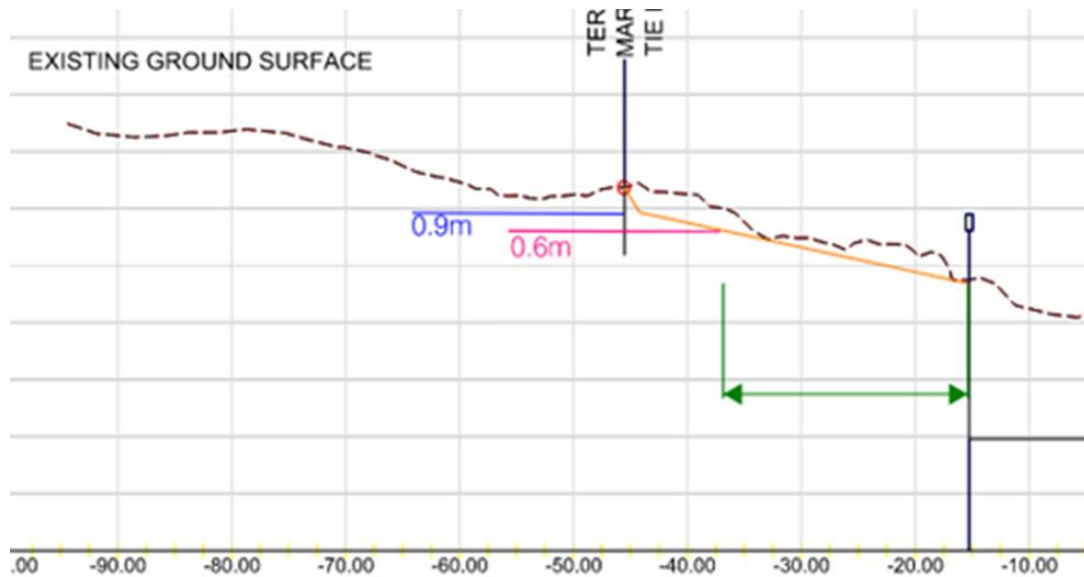


Challenge 4 –How to recover mangrove acreage lost in design progresses.

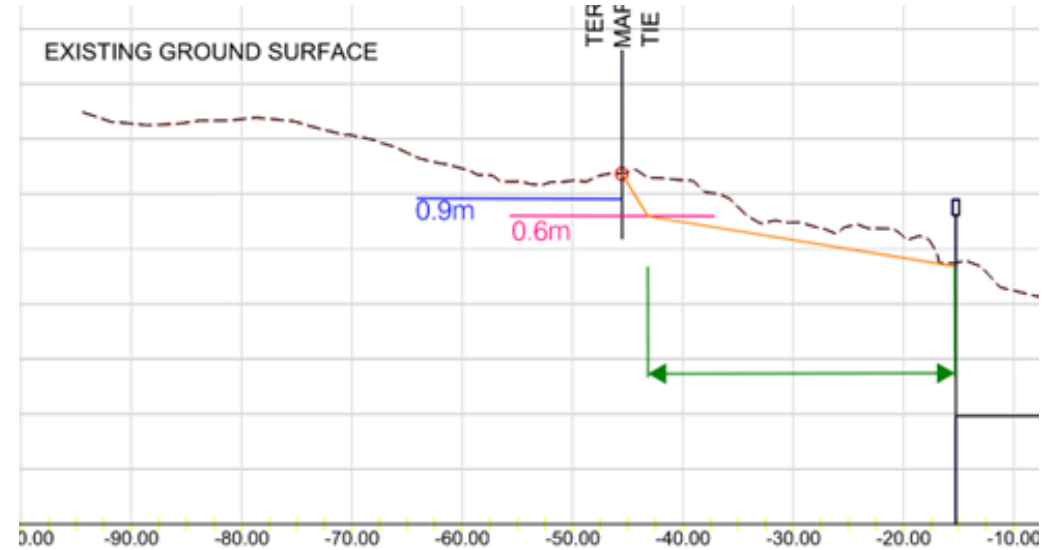
- EIS proposed mangrove restoration acreage was based on estimates.
- Without detailed design, difficult to understand effects of side slopes and other transitions.
- Incorporation of changes resulting from Challenge 1 (additional of transitional buttonwood habitat); Challenge 2 (Transition to existing grade); and Challenge 3 (Transition to parks) slowly chipped away at Mangrove Restoration total acreage.

Challenge 4 – Answer

Adjust the Slopes to increase total area of mangroves



Phase I Existing grade down to 0.9 meter



Phase II Existing grade down to 0.6 meter

Challenge 5 – Are elevations below 0 MSL too Low for Mangrove Establishment

- Scope of Work – Set Planting Bed range from -0.305 to +0.914m
- H&H Study
 - Identified a target range of 0.05 m – 0.20m for planting beds
 - Noted -Red mangrove roots can extend into water up to 0.45m deep.
- Rio Puerto Nuevo
 - Set mangrove beds a 0 MSL
 - During planting, shifted elevation to slightly higher range of 0.34m to 0.41m based off surrounding mangroves.

Challenge 5 –Answers Confirm Existing Elevations



Challenge 5 –Answers Confirm Existing Elevations





Challenge 5 –Answers

Revisit Rio Puerto Nuevo



Challenge 5 –Answers

Final Project Element Elevation Targets

Project Element	Target Elevation (meters)
Top of Sheet Pile Wall	0.914
Top of Sheet Pile Opening	0.00
Planting Bed at Sheet Pile	-.305
Upper Limit of Planting Bes	Phase I (0.914) Phase II (0.6)
Bottom of Channel	-3.048

Zone	Species	Elevation Range (meters)
A	Red Mangrove	-0.2 to 0.0
B	Black Mangrove	0.0 to 0.2
C	White Mangrove	0.2 to 0.6
D	Buttonwood	0.6 to 0.9

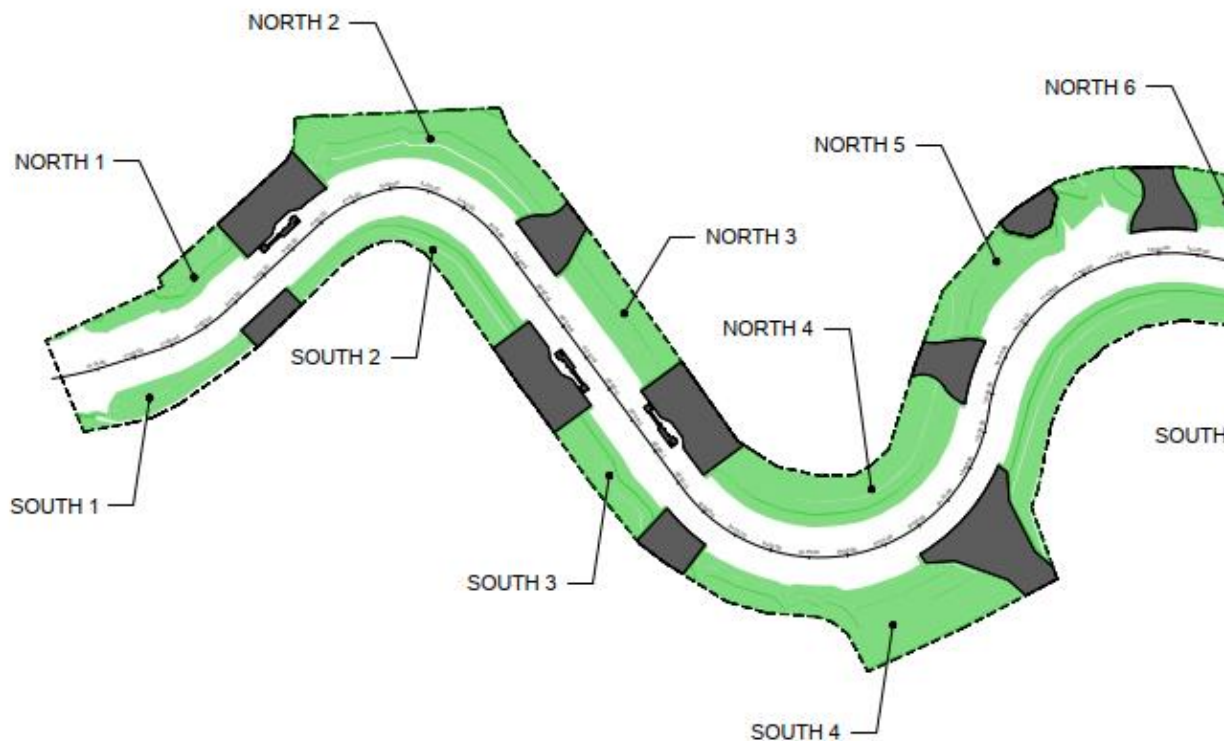
Red – Changed from 0.914m during Pre-Construction Engineering and Design (PED) to recapture some of lost mangrove planting area to recreational parks



Challenge 6—How is the contractor going to understand how to construct this?

Challenge 6 Answers

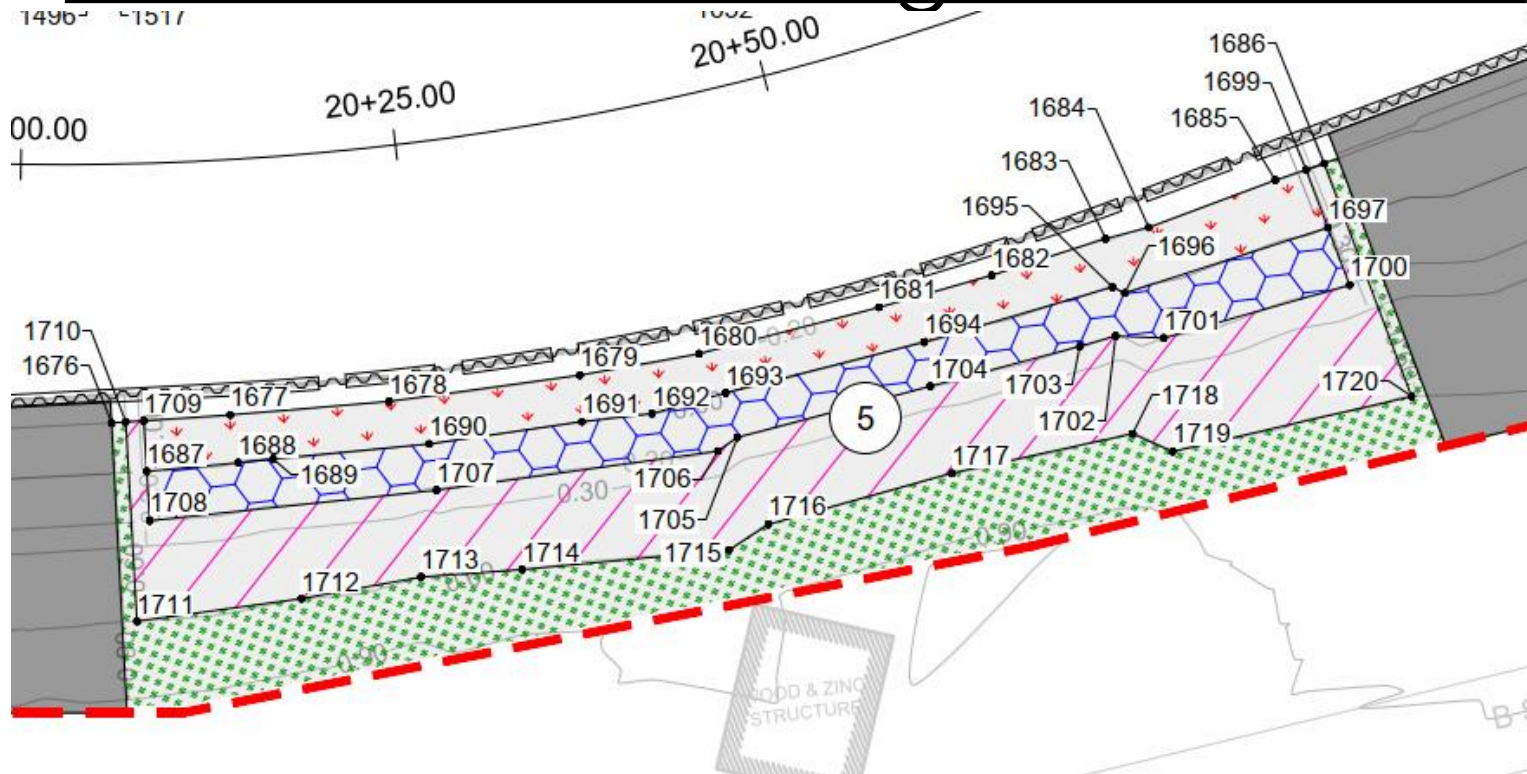
Define Mangrove Planting Areas



AREA 1		AREA 2		AREA 3	
TREE/SAPLING		TREE/SAPLING		TREE/SAPLING	
Black Mangrove	50	Black Mangrove	22	Black Mangrove	21
White Mangrove	135	White Mangrove	486	White Mangrove	282
Buttonwood	28	Buttonwood	153	Buttonwood	67
SEED/PROPAGULE		SEED/PROPAGULE		SEED/PROPAGULE	
Red Mangrove	1,285	Red Mangrove	1,425	Red Mangrove	829
Black Mangrove	780	Black Mangrove	2,730	Black Mangrove	1,414
White Mangrove	1,042	White Mangrove	6,569	White Mangrove	2,739

Challenge 6 Answers

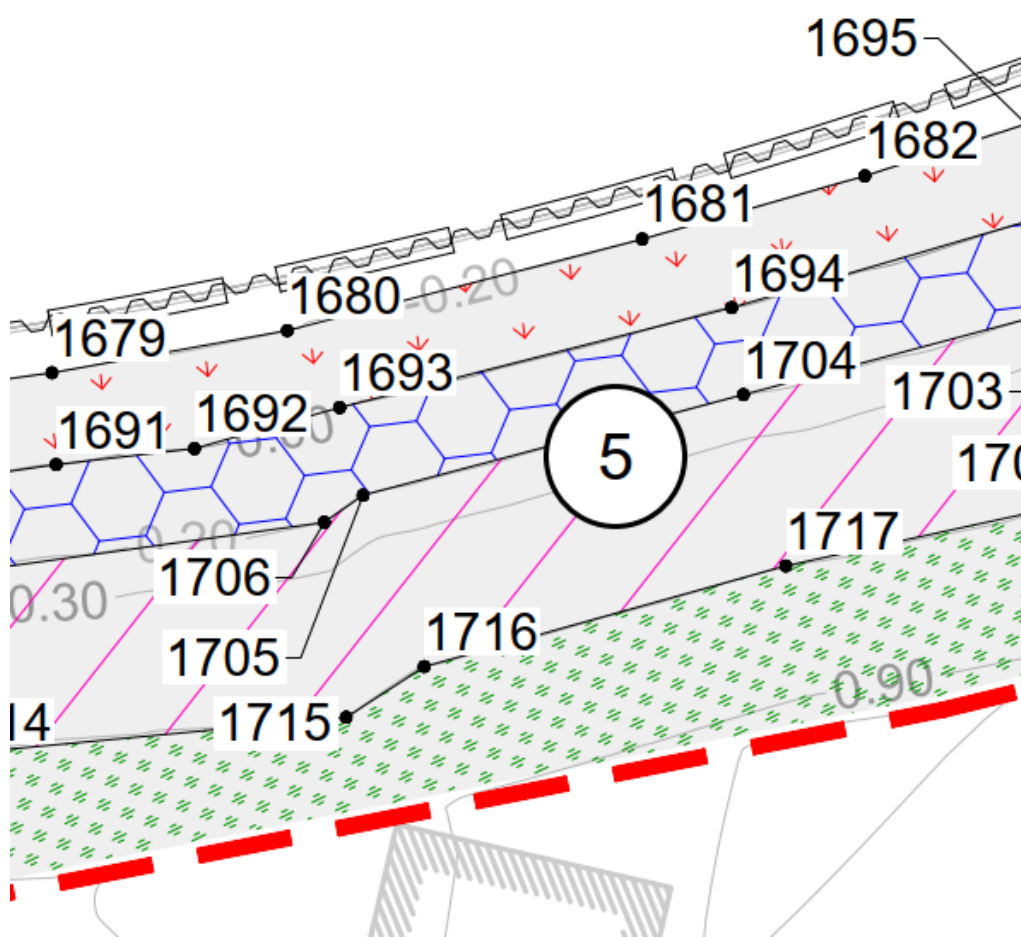
Demarcate Mangrove Zones



LEGEND

	<u>ZONE</u>	<u>ELEVATION</u>	<u>SPECIES</u>
	ZONE A	-0.2 M TO 0.0 M	RED MANGROVE (RHIZOPHORA MANGLE)
	ZONE B	0.0 M TO 0.2 M	BLACK MANGROVE (AVICENNIA GERMINANS)
	ZONE C	0.2 M TO 0.6 M	WHITE MANGROVE (LAGUNCULARIA RACEMOSA)
	ZONE D	0.6 M TO CWL	BUTTONWOOD (CONOCARPUS ERECTUS)
	SHEET PILE WALL (SEE S SERIES)		
	PARK (SEE LS SERIES)		
	CONSTRUCTION WORK LIMIT LINE		
	STAKE COORDINATE POINT		

Mangrove Zoning Plans Cont.



SHEET KEYNOTES

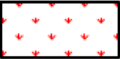
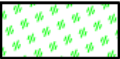
- 1 NORTH 9 PLANTING AREA
- 2 NORTH 10 PLANTING AREA
- 3 NORTH 11 PLANTING AREA
- 4 SOUTH 8 PLANTING AREA
- 5 SOUTH 9 PLANTING AREA

SOUTH 9 PLANTING AREA

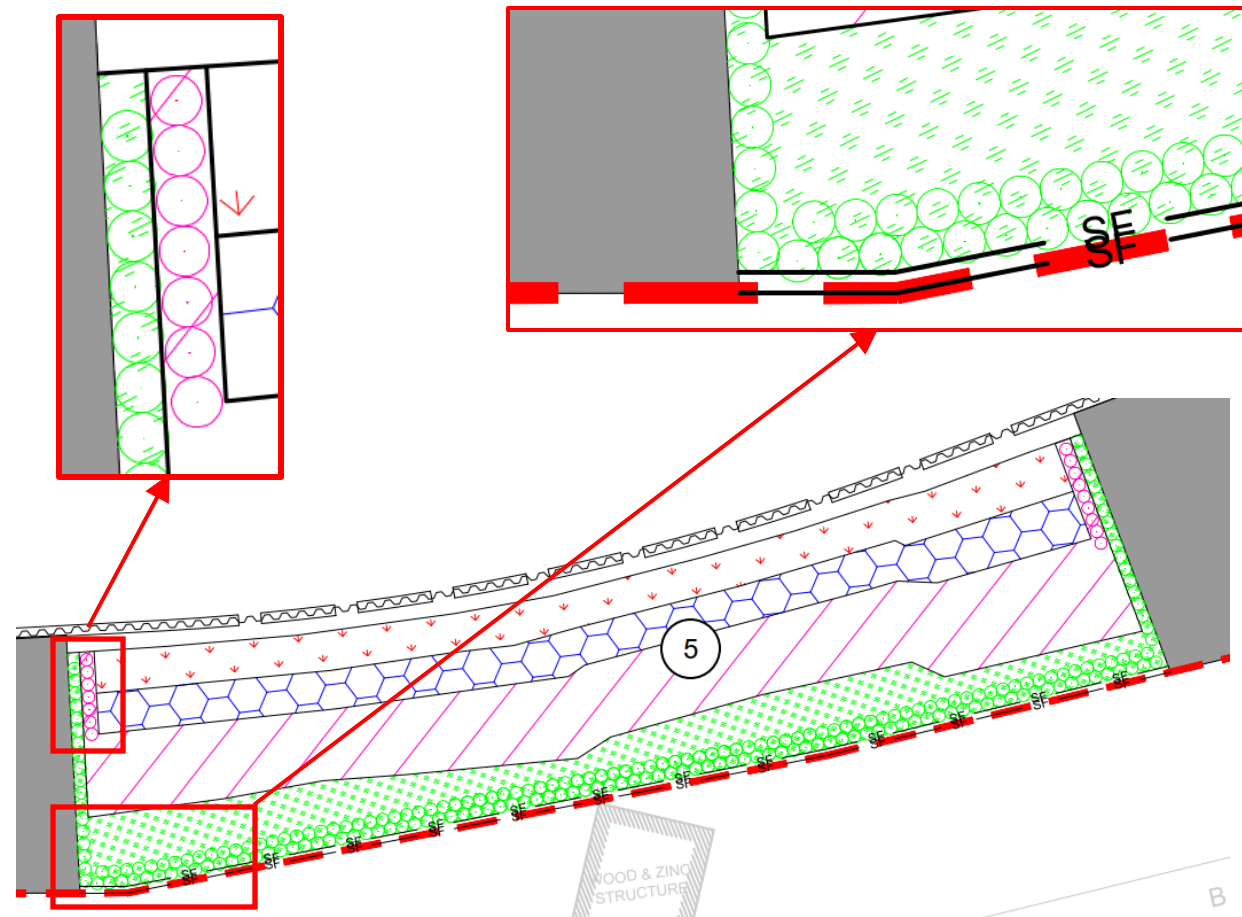
POINT #	NORTHING	EASTING
1676	265906.71	240921.67
1677	265906.29	240929.58
1678	265905.91	240940.20
1679	265906.12	240953.03
1680	265906.59	240961.08
1681	265908.22	240973.34
1682	265909.44	240981.05
1683	265910.96	240988.88
1684	265911.35	240991.82
1685	265913.47	241000.57
1686	265914.19	241003.93

Challenge 6 Answers

LEGEND

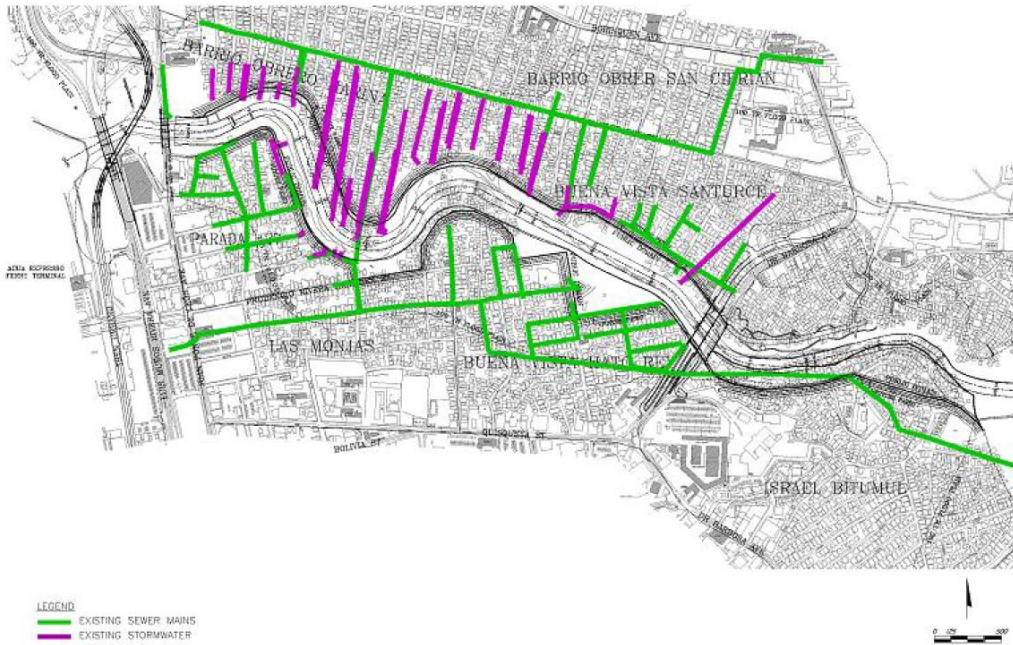
	ZONE	SPECIES	PLANTING METHOD
	ZONE A	RED MANGROVE	DIRECT PLANTING PROPAGULES
	ZONE A	RED MANGROVE	DIRECT PLANTING PROPAGULES
	ZONE B	BLACK MANGROVE	DIRECT PLANTING CONTAINERIZED SAPLING
	ZONE B	BLACK MANGROVE	BROADCAST SEEDING
	ZONE C	WHITE MANGROVE	DIRECT PLANTING CONTAINERIZED SAPLING
	ZONE C	WHITE MANGROVE	BROADCAST SEEDING
	ZONE D	BUTTONWOOD	DIRECT PLANTING CONTAINERIZED SAPLING
	ZONE D	BUTTONWOOD	DIRECT PLANTING CONTAINERIZED SAPLING
	DOUBLE SILT FENCE		

Mangrove Planting Plans



Challenge 7 What Happens Post Construction?

Post Construction Concerns



Current Lack Stormwater Management System



History of Littering/Refuse

Post Construction Concerns (Cont.)

Water Infrastructure Section

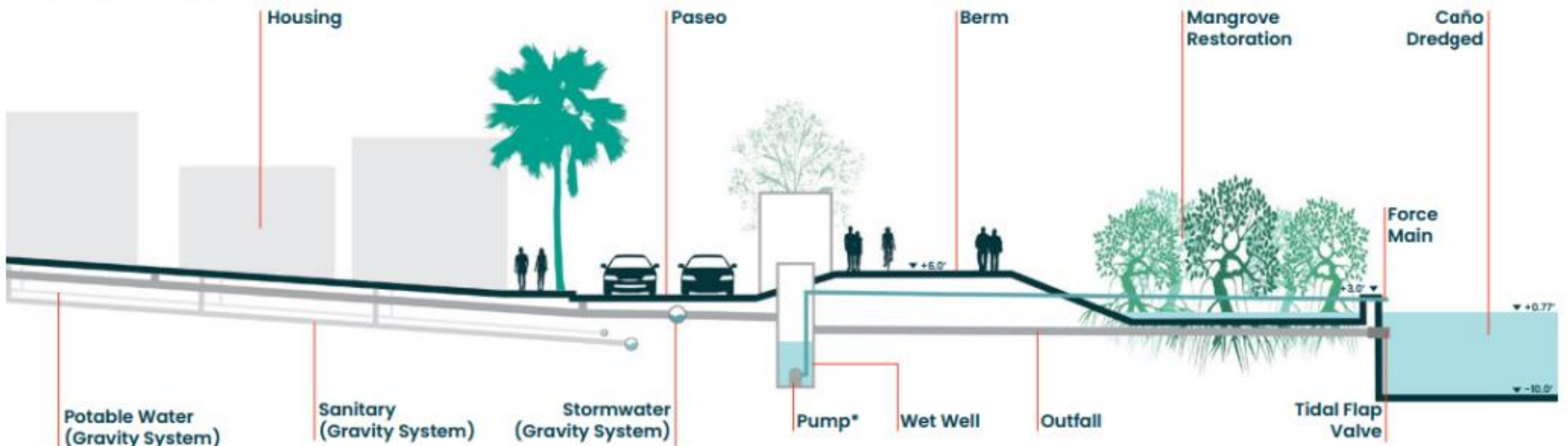


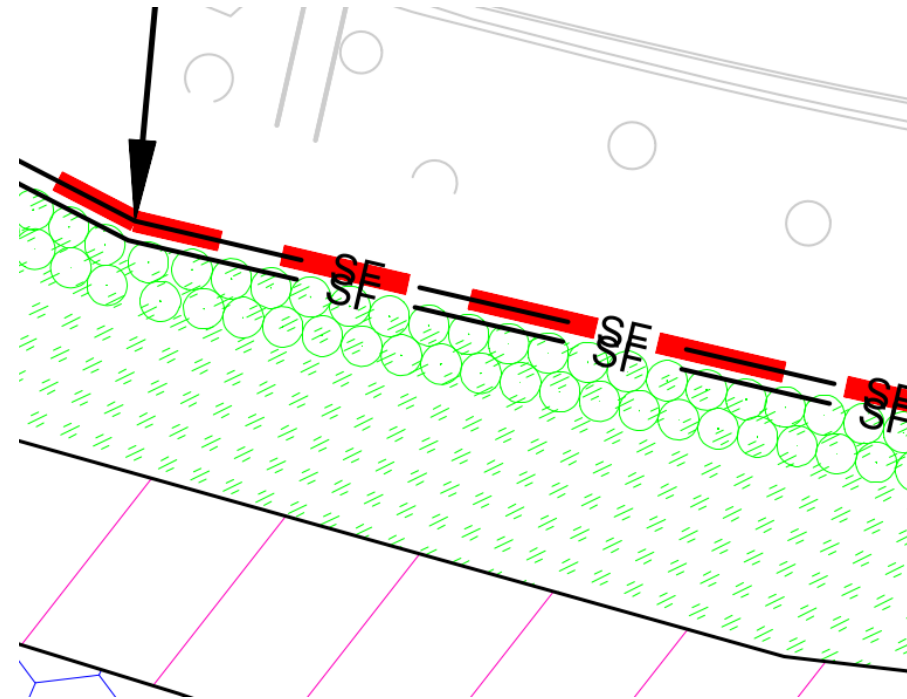
Figure 72. Water Infrastructure: storm, sanitary, and potable. Source: Arcadis, OLIN, 2022

*Stormwater system is designed as a gravity system. The pumps operate only when capacity or tidal conditions dictate.



Challenge 7 – Answers

Add Interim Protection Measures



Source: Rose Erosion Control Services

- Installation of Double Silt Fence with Haybales/Coconut fiber between.

Planting of Minimum of two rows of containerized plants along construction work limit

Challenge 7 –Answers

Monitoring & Adaptive Management

- Non Federal Sponsor (ENLACE and Puerto Rico DNR)
 - Obligation to initiate ecosystem monitoring
 - Mangrove Restoration requires minimum 5 years of monitoring
 - Success of Mangrove restoration requires a showing that:
 - At least 85% of planted trees are alive;
 - 85% of vegetative cover is composed of native, desirable species;
 - Hydroperiod (hydrological connectedness and frequency of inundation/saturation) is correct for planted species; and
 - There is an observed increase of wildlife utilization.
 - If performance falls below certain threshold, the Adaptive Management Plan must be implemented.

Q&A / Discussion



TRI - REGIONAL JETS 2025

