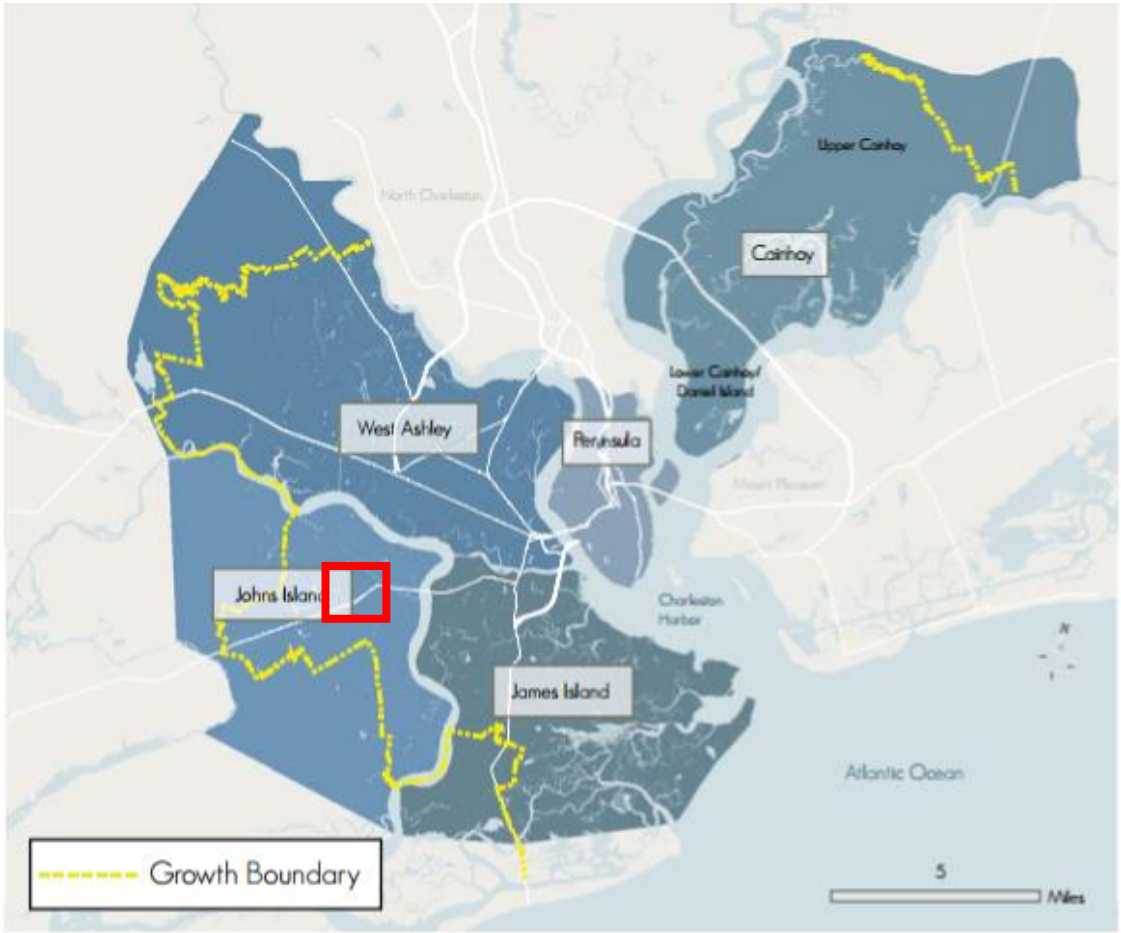
Implementing Ecological Solutions to Resolve Chronic Neighborhood Flooding

October 5, 2023

WK DICKSON
community infrastructure consultants

Barberry Woods
Site Location



Barberry Woods Flood History

2008

October 2015

During Rain Event

2- Days After Rain

August 2017

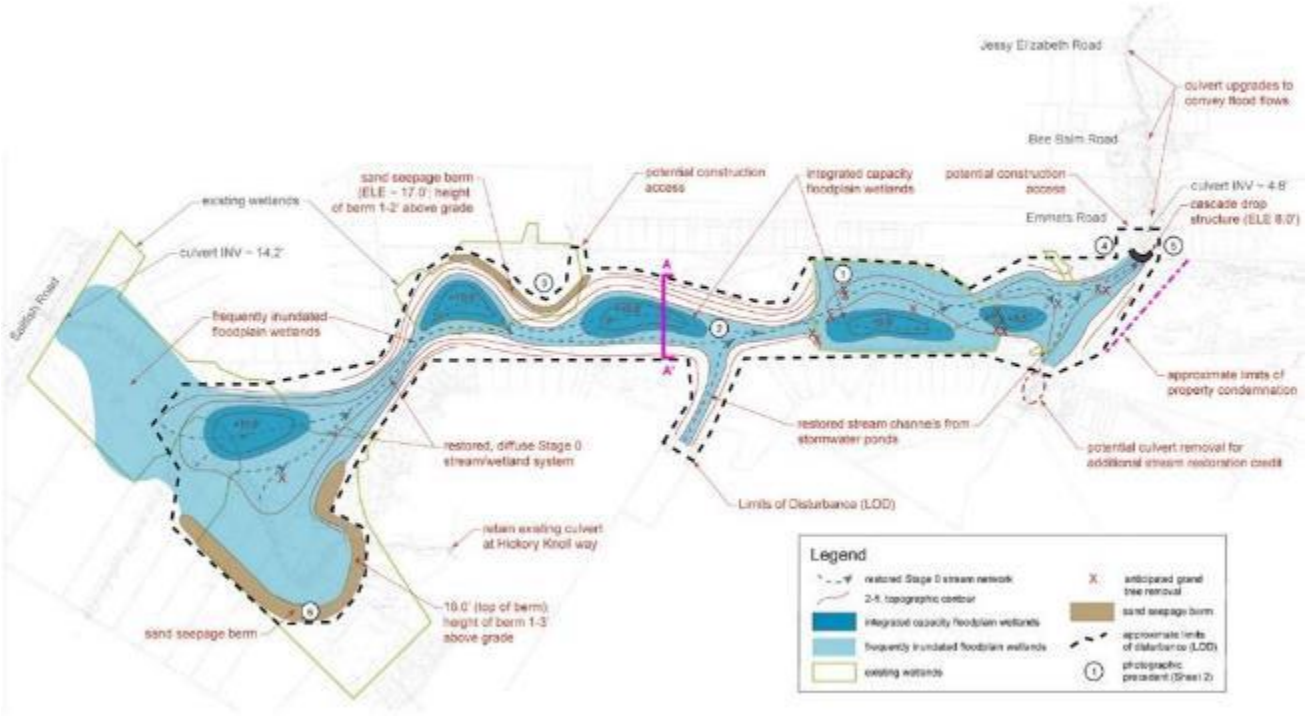
July 2018

July 2021 Rain Bomb (~2 in)

16-Hours after Rain Bomb

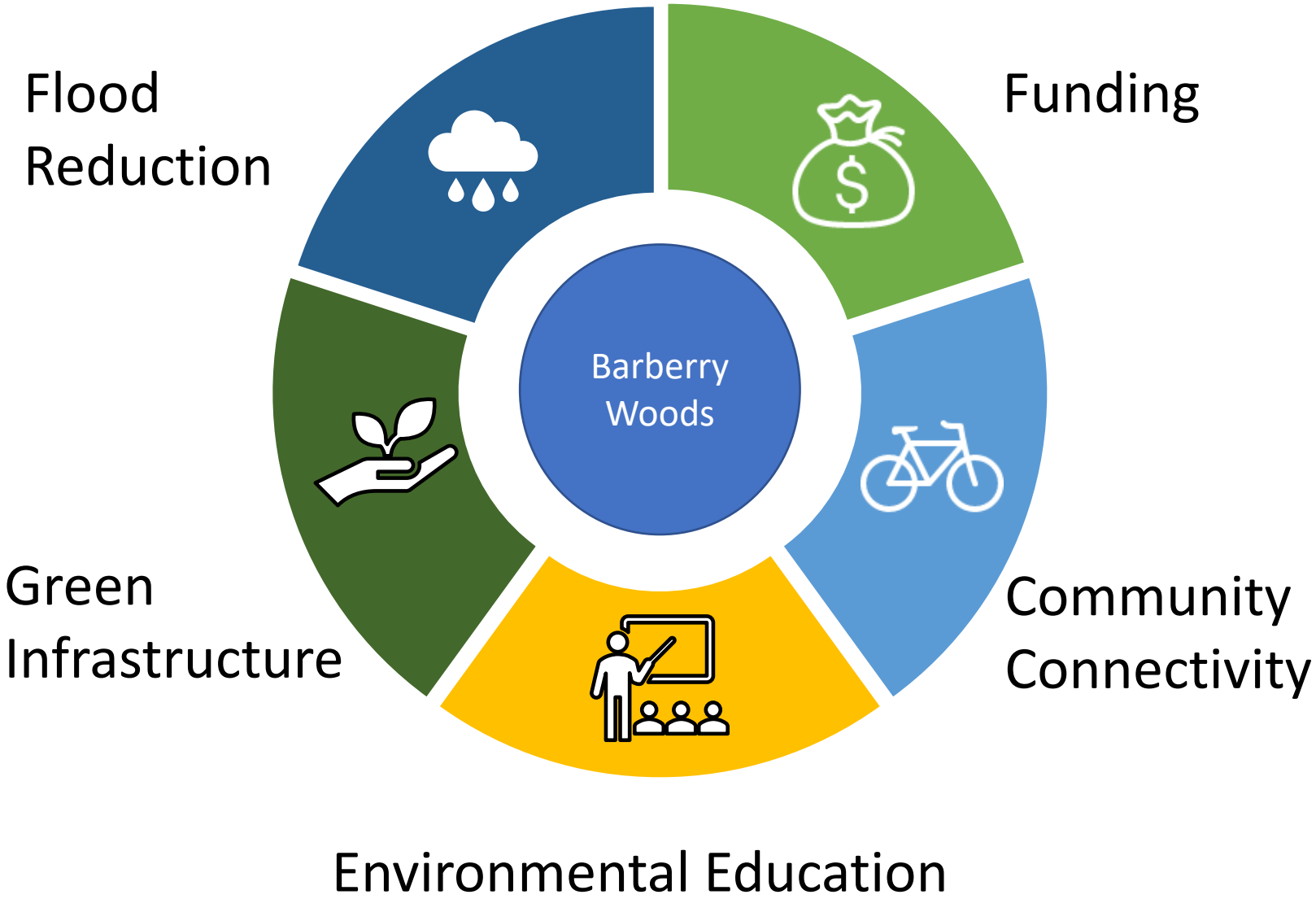
Initial Study and Project Selection

- Davis & Floyd Johns Island Flood Risk Assessment
- WK Dickson Johns Island Restoration Plan
  - Funded by NFWF
- This project was selected because of recommendations by the Flood Risk Assessment and Restoration Plans

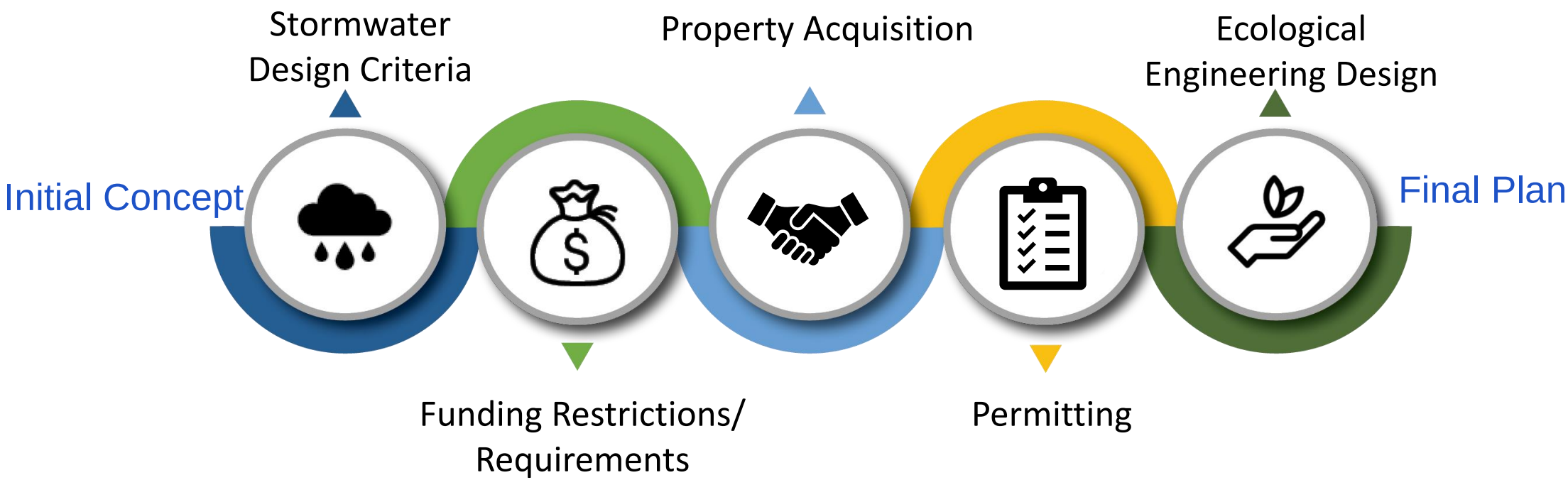


Multiple Benefits –
Slow, store and slowly convey water across the landscape

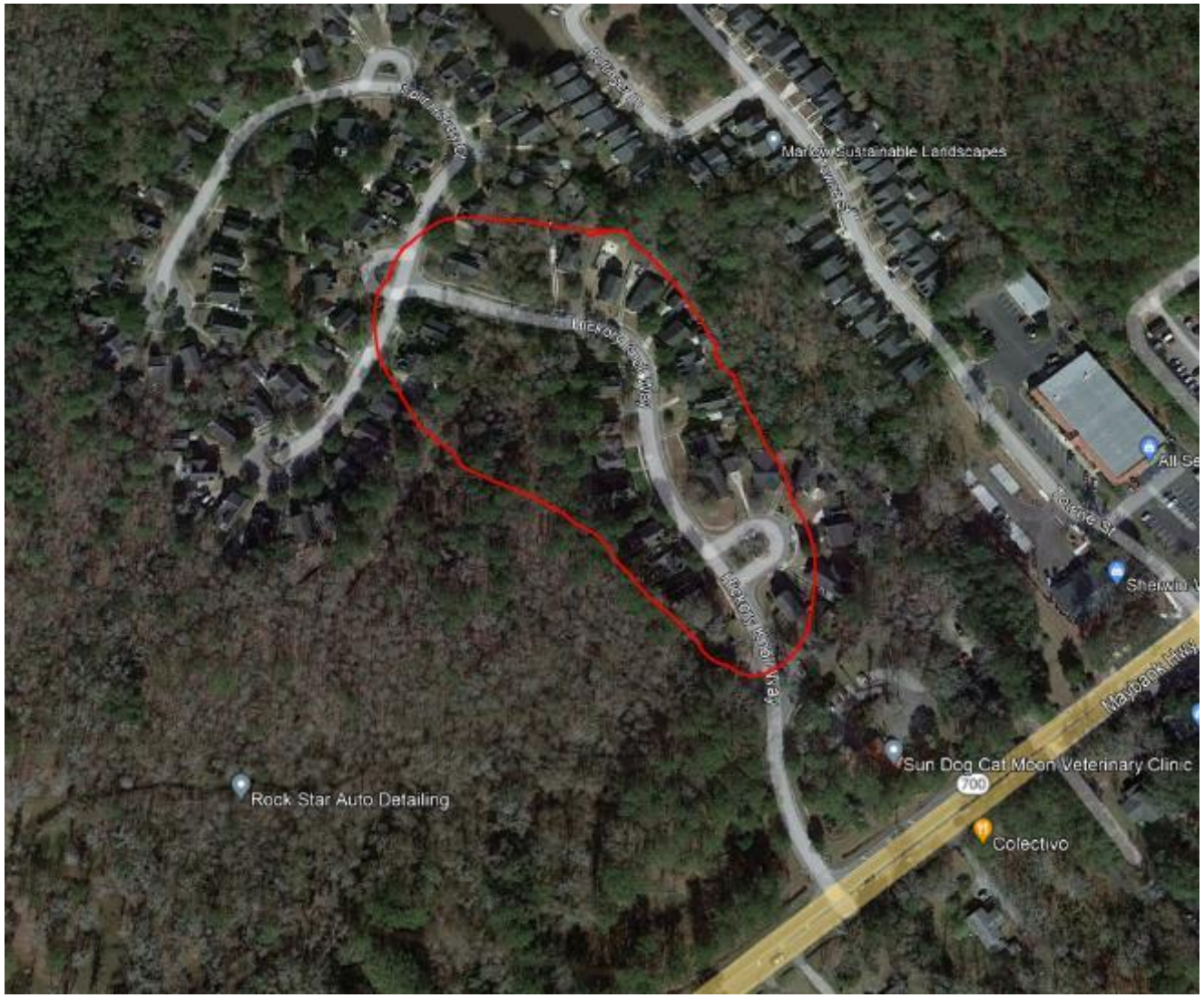
Multi-Layer Benefits



Project Development Curve



Stormwater Design Criteria



- Using the City of Charleston's Stormwater Design Standards Manual (January 2020)
- Flooding reduction goal of reducing overtopping elevation on Hickory Knoll Way.

Stormwater Design Criteria

2019 **3.4.2 Rainfall and Design Storms**

2020 The 24-hour duration precipitation depths corresponding to various probabilities for
2021 exceedance in any given year are shown in **Table 3-1** and are to be used for projects within the
2022 City. These values contain a 10 percent safety factor to account for uncertainties in the design
2023 process and the increasing intensities of storms.

2024 **Table 3-1. 24-hour design storm precipitation data for Charleston, South Carolina**

Probability Exceedance	100%	50%	20%	10%	4%	2%	1%
Return Frequency (Year)	1	2	5	10	25	50	100
Precipitation (inches)	3.8	4.6	6.1	7.2	8.7	9.9	11.3

Stormwater Design Criteria

3.7 Sea Level Rise

The City has adopted a sea level rise strategy to accommodate future sea level rise and storm surge. The Flood and Sea Level Rise Strategy (City of Charleston 2019b) can be found at:

https://www.charleston-sc.gov/slr

To accommodate sea level rise and storm surge, all designs shall use 5.5 feet NAVD88 datum tailwater elevation as a boundary condition with roadway elevation no less than 7.5 feet NAVD88. If the developer/designer desires to design a lower road elevation, they shall develop a hydrologic and hydraulic model, using computational methods or software approved by the City's Department of Stormwater Management, that demonstrates the performance of the roads during a 1 percent AEP, 24-hour storm event that coincides with a storm surge elevation of 5.5 feet NAVD88.

Stormwater Design Criteria

3.9.4 1 Percent Probability of Exceedance Storm Event Analysis

Construction, development, and redevelopment activities that disturb 1 acre or more shall include a hydrologic/hydraulic analysis to determine the impacts of the proposed development during the 1 percent AEP, 24-hour storm event.

For the 1 percent AEP Storm Event Analysis, the project shall not:

- Increase the likelihood of dwelling flooding and property damage above current conditions.
- Increase water surface elevations or reduce system capacity in the stormwater system and facilities upstream or downstream of the project. An increase or reduction shall be based on a comparison with pre-development conditions (with more stringent requirements potentially applied in special protection areas).
- Increase erosion potential and pollutant loads that would adversely impact the quality of receiving waters.

No-Rise WSELs Obtained

Table 4A: Upstream Crossings WSEL Analysis (ft)

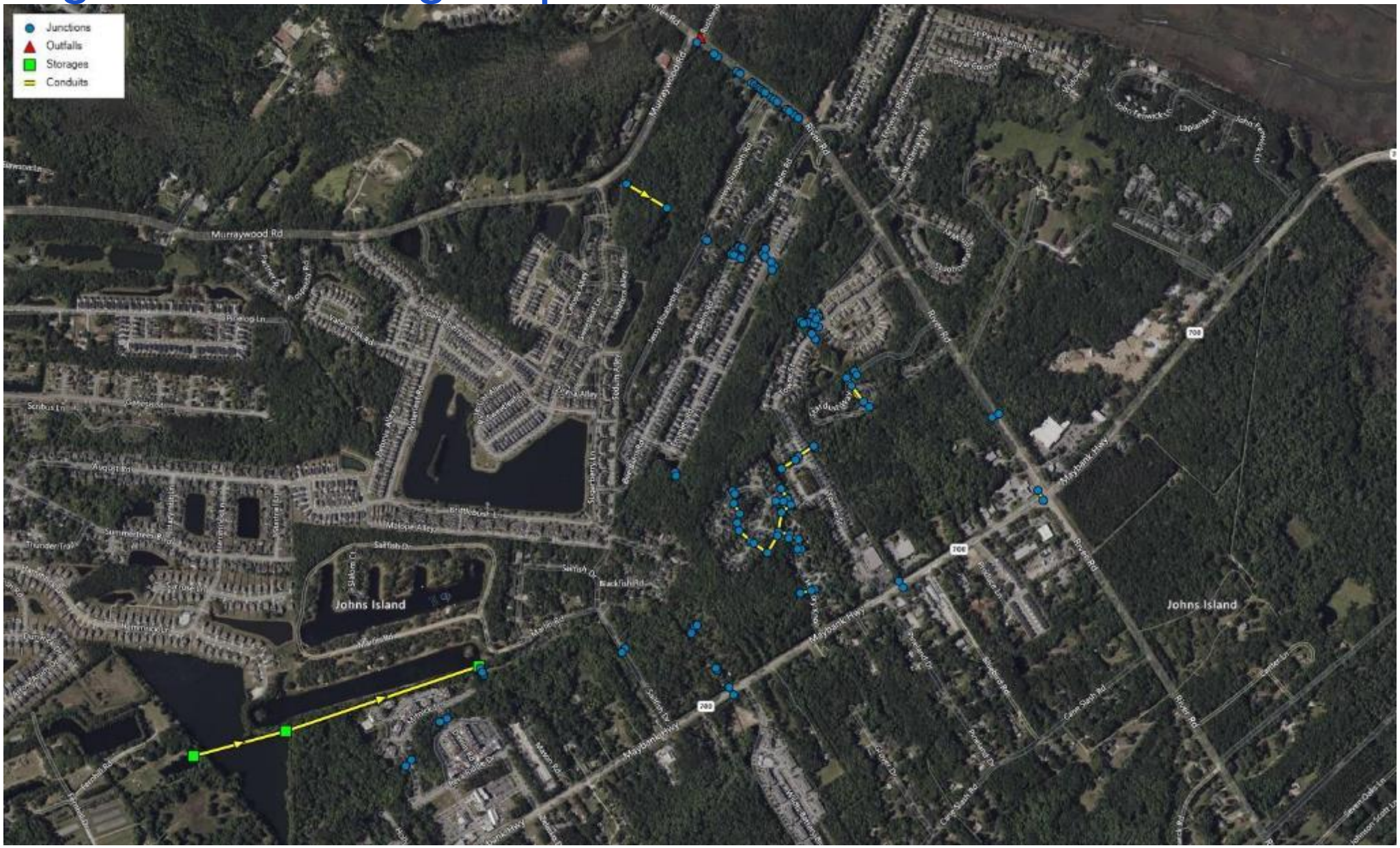
Exceedance Probability Storm	50%	10%	4%	2%	1%
Upstream Towne Street					
Existing	11.91	12.22	12.45	12.62	12.83
Proposed	11.79	12.03	12.21	12.40	12.61
Diff.	**-0.12**	**-0.19**	**-0.24**	**-0.22**	**-0.22**
Downstream Towne Street					
Existing	11.83	12.08	12.29	12.46	12.67
Proposed	11.76	11.96	12.12	12.30	12.53
Diff.	**-0.07**	**-0.12**	**-0.17**	**-0.16**	**-0.14**
Upstream Sailfish Road					
Existing	17.12	17.86	18.13	18.28	18.38
Proposed	17.12	17.86	18.12	18.27	18.37
Diff.	**0.00**	**0.00**	**-0.01**	**-0.01**	**-0.01**
Downstream Sailfish Road					
Existing	16.13	16.50	16.67	16.82	17.03
Proposed	16.02	16.33	16.53	16.75	17.02
Diff.	**-0.11**	**-0.17**	**-0.14**	**-0.07**	**-0.01**

Table 4B: Downstream Crossings WSEL Analysis (ft)

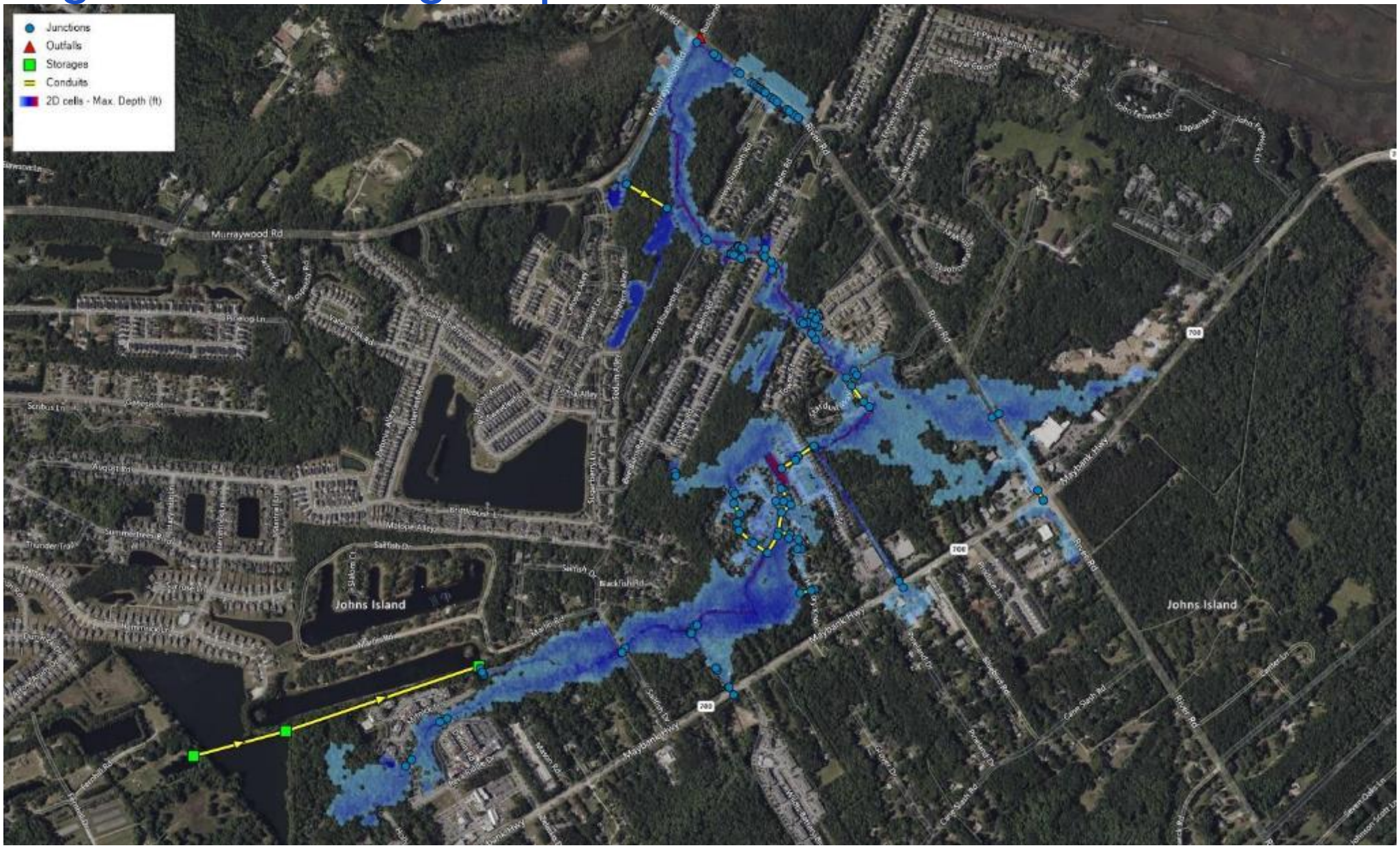
Exceedance Probability Storm	50%	10%	4%	2%	1%
Downstream Emmets Road					
Existing	10.09	10.44	10.63	10.79	10.96
Proposed	10.09	10.42	10.60	10.77	10.96
Diff.	**0.00**	**-0.02**	**-0.03**	**-0.02**	**0.00**
Upstream Bee Balm Road					
Existing	8.95	9.50	9.80	10.07	10.34
Proposed	8.94	9.48	9.76	10.02	10.32
Diff.	**-0.01**	**-0.02**	**-0.04**	**-0.05**	**-0.02**
Downstream Bee Balm Road					
Existing	8.85	9.28	9.50	9.66	9.82
Proposed	8.85	9.27	9.47	9.63	9.80
Diff.	**0.00**	**-0.01**	**-0.03**	**-0.03**	**-0.02**
Upstream Jessy Elizabeth Road					
Existing	8.60	8.95	9.13	9.28	9.42
Proposed	8.60	8.92	9.10	9.24	9.39
Diff.	**0.00**	**-0.03**	**-0.03**	**-0.04**	**-0.03**
Downstream Jessy Elizabeth Road					
Existing	8.09	8.63	8.87	9.04	9.20
Proposed	8.06	8.59	8.81	8.98	9.15
Diff.	**-0.03**	**-0.04**	**-0.06**	**-0.06**	**-0.05**
Upstream River Road (1)					
Existing	5.50	5.52	5.52	5.53	5.54
Proposed	5.50	5.50	5.50	5.50	5.50
Diff.	**0.00**	**-0.02**	**-0.02**	**-0.03**	**-0.04**

(1) Per City SWDSM River Road experiences direct tidal influence (NAVD 5.5ft)

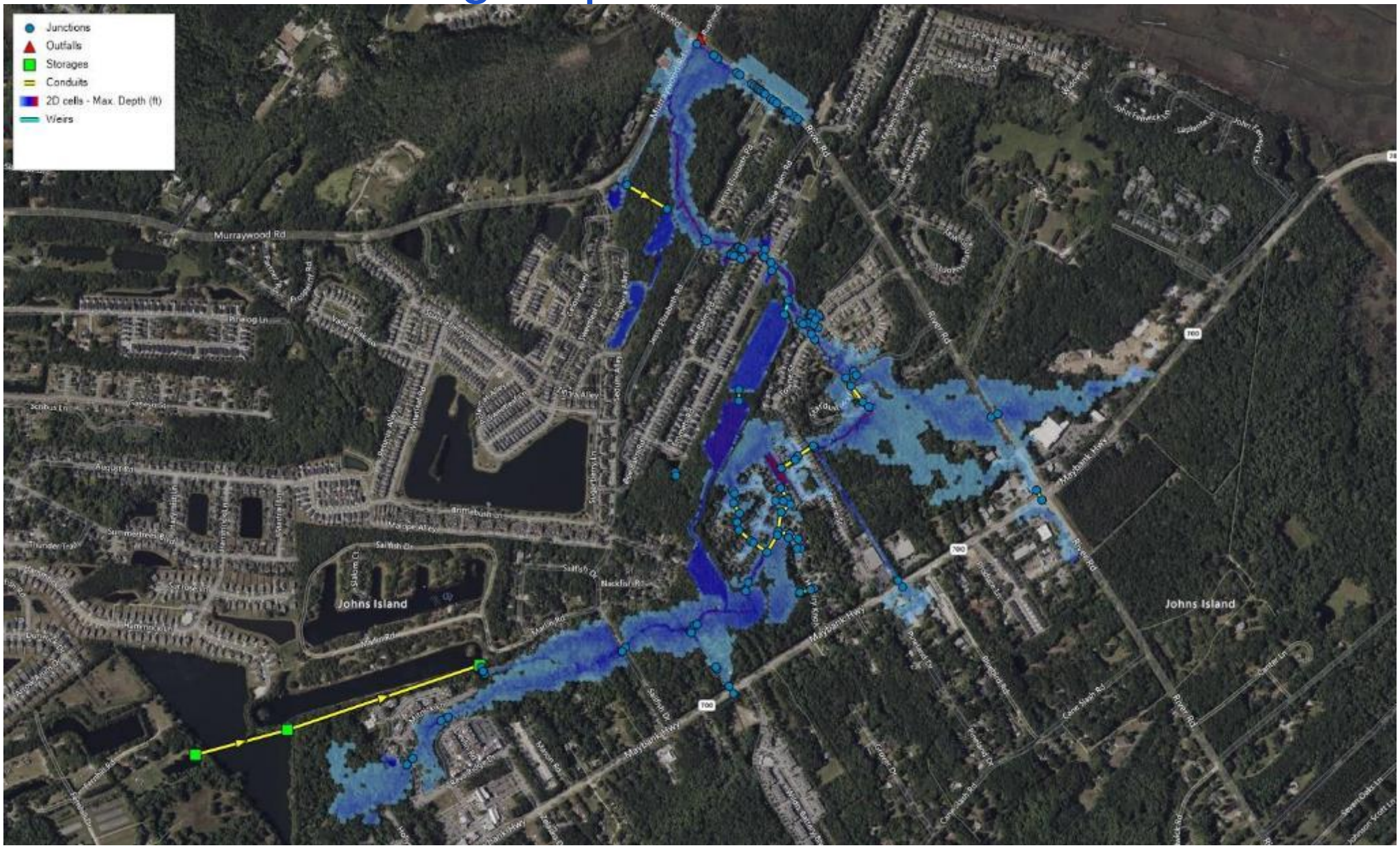
Existing Max Ponding Depth – 10% AEP



Existing Max Ponding Depth – 10% AEP



Proposed Max Ponding Depth – 10% AEP



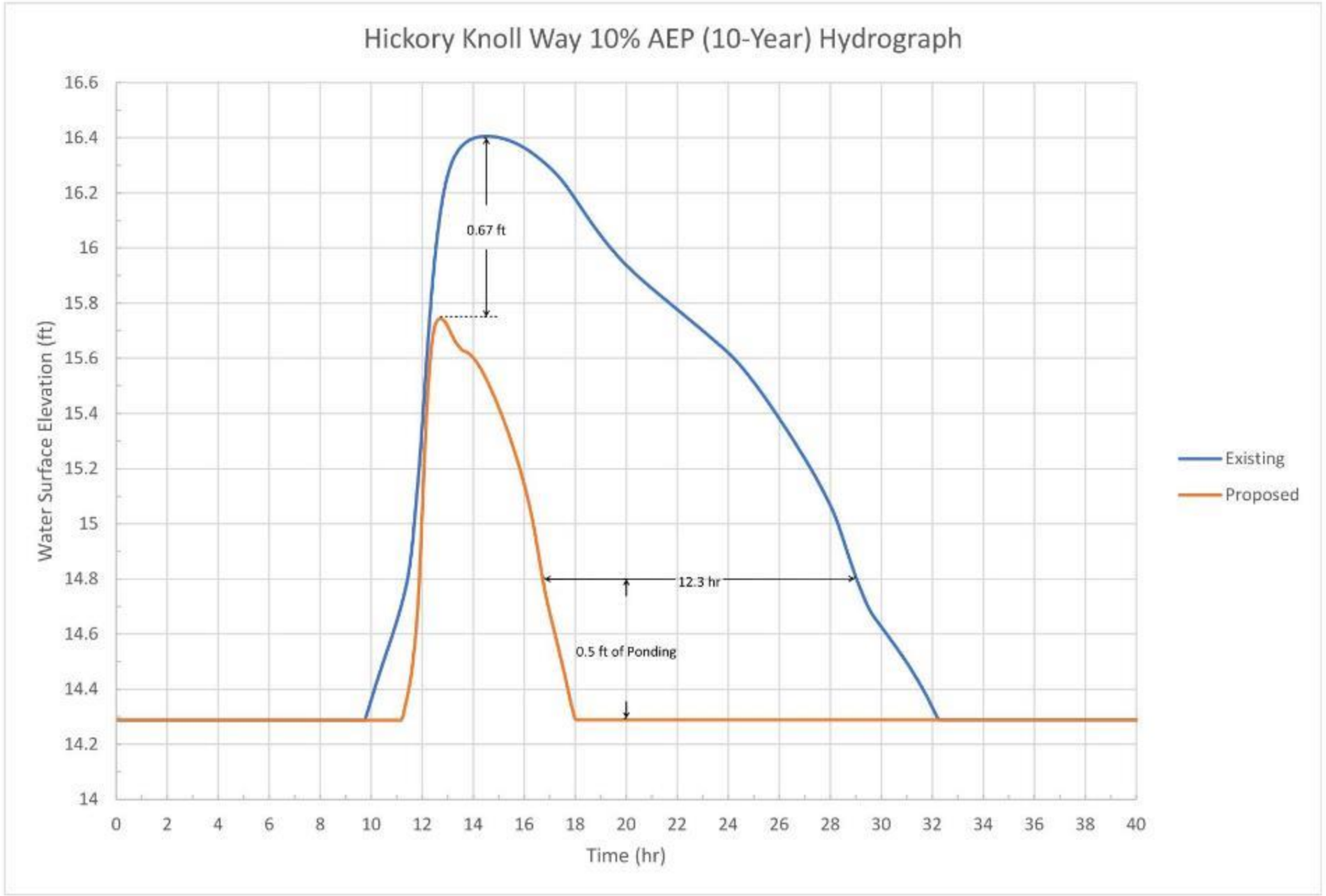
Hickory Knoll Way – Only Ingress/Egress

Table 2: WSEL at Hickory Knoll Way (ft)

Exceedance Probability Storm	50%	10%	4%	2%	1%
Existing	16.03	16.41	16.58	16.76	17
Proposed	15.32	15.74	15.91	16.06	16.22
Diff.	**-0.71**	**-0.67**	**-0.67**	**-0.7**	**-0.78**

Table 3: Depth Duration >0.5 ft at Hickory Knoll Way (hr)

Exceedance Probability Storm	50%	10%	4%	2%	1%
Existing	14.72	17.67	19.14	20.21	22.99
Proposed	2.47	4.86	6.07	6.82	5.84
Diff.	**-12.25**	**-12.81**	**-13.07**	**-13.39**	**-17.15**

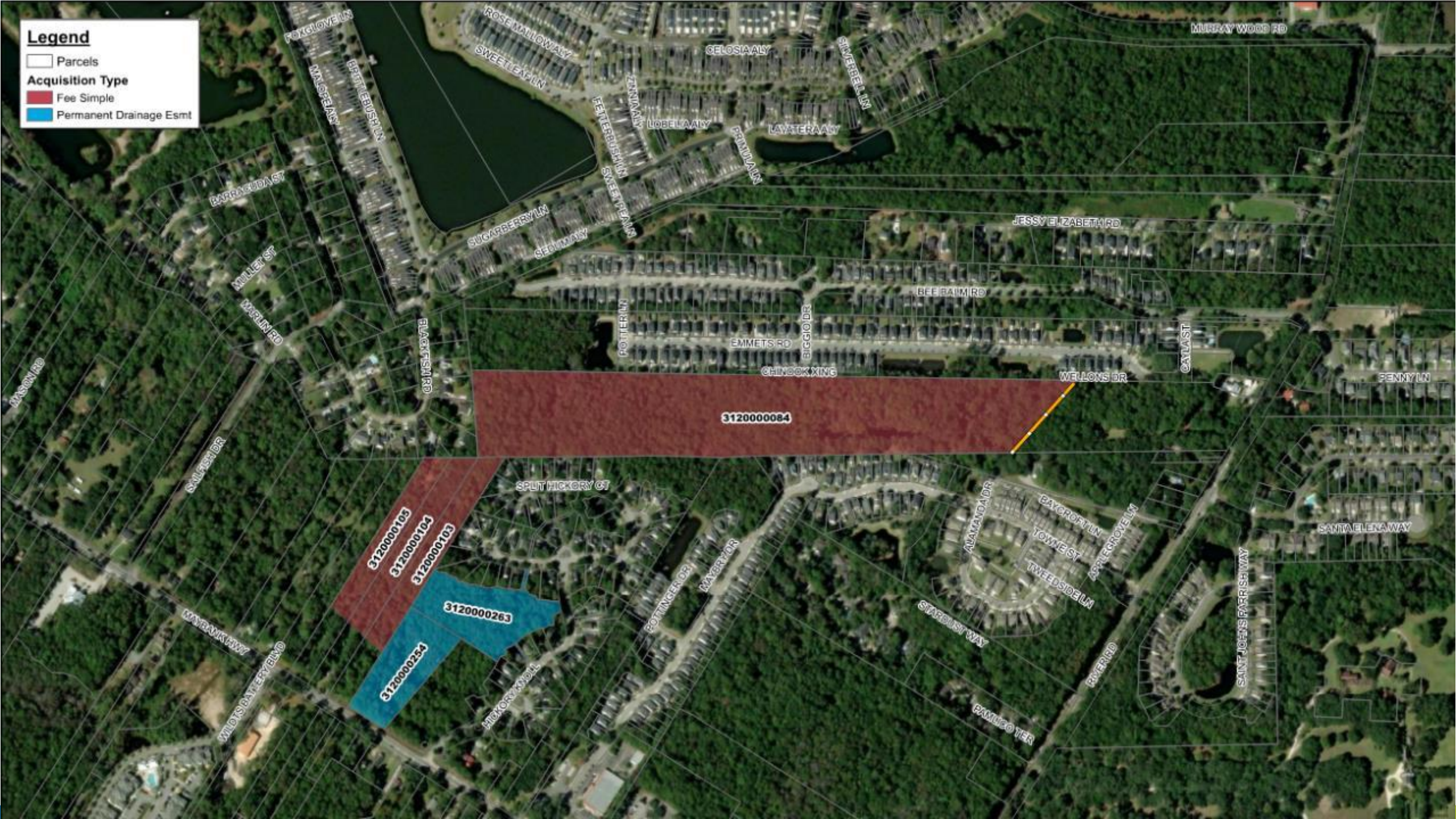

Hickory Knoll Way 10% AEP (10-Year) Hydrograph
Water Surface Elevation (ft)
16.6
16.4
16.2
16
15.8
15.6
15.4
15.2
15
14.8
14.6
14.4
14.2
14
0.67 ft
12.3 hr
0.5 ft of Ponding
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
Time (hr)
Existing
Proposed

Project Funding

- NFWF Grant
  - WK Dickson Johns Island Restoration Plan
- Dedicated Stormwater Capital Project Fund
  - Design Fees
- City Funding and South Carolina Conservation Bank
  - Design Fees and Lot Acquisitions
- South Carolina Office of Resilience (SCOR) ARPA funds through ASIP Grants
  - Construction Fees (must expend all funds by December 2026)

Funding Restrictions/ Requirements

- Estimated Total Project Costs:
  - **Strategic Retreat Plan: ~$19,300,000.00**
  - **Full Concept Plan: ~$16,800,000.00**
  - **60% Updated Plan: ~$8,748,00.00**
  - **90% Updated Plan: ~$7,670,000.00**
- **Total Project Costs include construction, plant materials and property acquisition costs.**


Legend
Parcels
Acquisition Type
Fee Simple
Permanent Drainage Esmt
3120000084
3120000105
3120000104
3120000103
3120000263
3120000254
FOXGLOVE LN
ROSE MALLOW ALY
SWEET LEAF LN
CELOSIA ALY
SILVERBELL LN
MURRAY WOOD RD
MALOPE ALY
PAINTBRUSH LN
ZINNIA ALY
FEVERBUSH LN
LOBELIA ALY
LAYATERA ALY
PRIMULA LN
SWEETVETCH LN
BARRACUDA ST
SUGARBERRY LN
SEDUM ALY
JESSY ELIZABETH RD
MILLET ST
MARLIN RD
BEE PALM RD
POTTER LN
BIGGIO DR
EMMETS RD
CATLA ST
BLACKFISH DR
CHINOOK XING
WELLONS DR
PENNY LN
JASON RD
SAILFISH DR
SPLIT HICKORY CT
AMARYLLA DR
BAYCROFT LN
TOYNE ST
TWEEDSIDE LN
APPLEGROVE LN
SANTA ELENA WAY
POTTINGER DR
MAYBRYER
STAPLEHURST WAY
SAINT JOHNS PARRISH WAY
MAYBANK HWY
WILDLIFE BAILEY BLVD
HICKORY KNOLL
RIVER RD
PAMLICO TER

Permitting

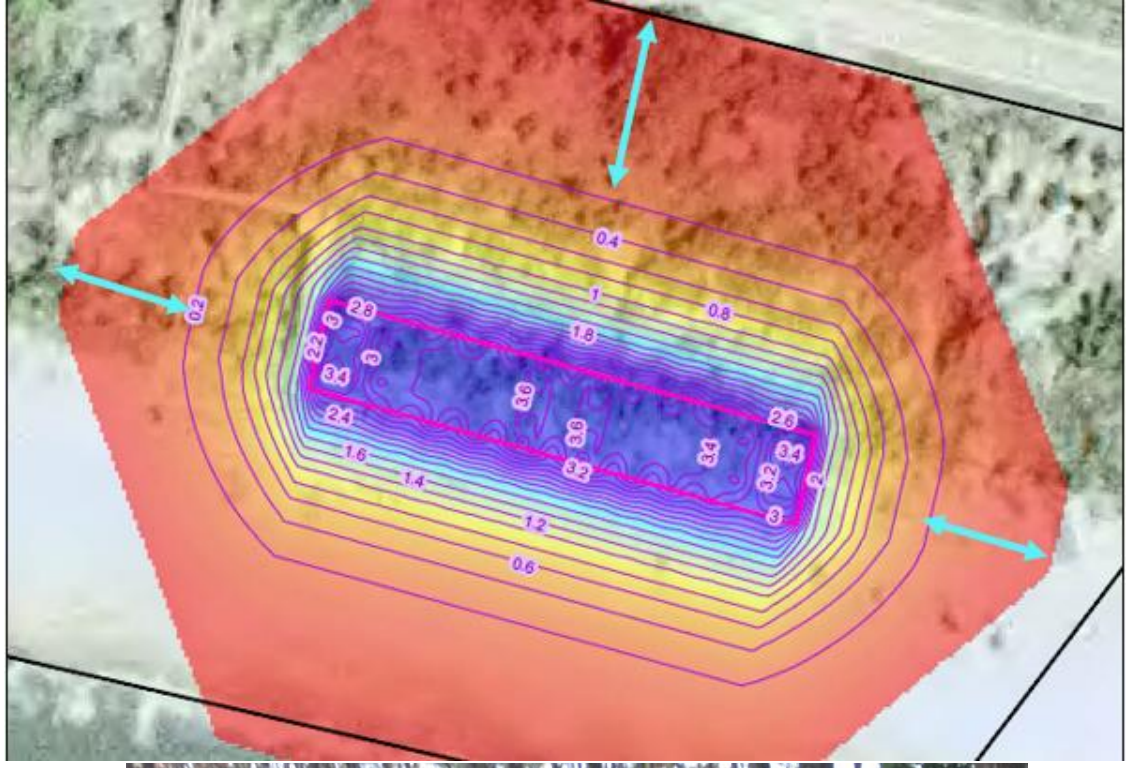
Permit Approach Plan
City of Charleston - Barberry Woods Drainage Project
January 2021

Regulatory Agency	Potential Permits Required	Anticipated Processing Timelines	Costs/ Fees	Contacts	Notes
USACE Charleston District	Section 404 of the CWA: *Nationwide (NWP) 27 or an*Individual Permit (IP)	NWP 3 to 6 months IP 6- 12 Months	No fees	Charleston District Office 69-A Hagood Avenue Charleston, SC 29403 SAC.RD.Charleston@usace.army.mil	An NWP 27 is for Aquatic Habitat Restoration, Enhancement, and Establishment Activities. If the project does not qualify for the NWP 27 , an IP will be required.
SCDHEC	Section 401 of the CWA:Water Quality Certification for a *NWP or *IP	NWP 3 to 6 months IP 6- 12 Months	$100 or $1000 based on permit	SCDHEC 401 Certification Program managers : Logan Ress and Eliza Thorne	A SCDHEC 401 water Quality certification will be issued with an NWP 27 authorization. SCDHEC will require their own 30-day public notice and internal review for an IP.
FEMA	*No Rise Certification * Conditional Letter of Map Revision (CLOMR) *Letter of Map Revision (LOMR)	No-Rise 30-60 days CLOMR 90 to 120 days LOMR 90 to 120 days (after construction)	*No Rise Cert: Local Fees * CLOMR:$6500 *LOMR: $8,000	Permit contacts will be determined based on floodplain impacts.	Permit will be determined based on floodplain impacts.
SCDHEC- OCRM	Coastal Zone Consistency (CZC) and NPDES Coverage for Construction Activities	90 days	$100 / per distrubed acre	Chris Stout; (843) 953-0691	The CZC and NPDES Coverage for Construction Activities will be submitted together.
Charleston County	Site Plan Permit Package (SWPPP and Erosion Control Drawings)	90 days	Refer to SCDHEC permit fee of $100 / disturbed acres	stormwater@charlestoncounty.org, 843-202-7639	Erosion Control & Encroachment Drawings with Technical Specifications will be included with the On-Site Storm Water Pollution Prevention Plan (OS-SWPPP).
City of Charleston	*Site Plan Permit Package (SWPPP and Erosion Control Drawings) *Tree Ordinance	90 days	$40 fee plus possible plan review fee which is 50% of valuation of project	permits@charleston-sc.gov,	In additon to the land disturbance permit Removal of trees within an OCRM Critical Line Buffer are regulated as outlined in Section 54-347.1 and 54-348 of the City of Charleston Zoning Ordinance.
South Carolina Department of Transportation	Encroachment Permit	30 Days	No Fees	SCDOT EPPS	The application and site plans will be submitted online through the SCDOT EPPS website. It is recommended to call SCDOT prior to the online submission in order to verify site plan requirements (843-740-1655).

USACE IP - Wetland Mitigation

Required Wetland Mitigation Credit Worksheet						
FACTOR	**AREA 1**	**AREA 2**	**AREA 3**	**AREA 4**	**AREA 5**	**AREA 6**
Lost Type	Type A	Type A	Type A	Type A	Type C	Type A
Priority Category	Tertiary	Tertiary	Tertiary	Tertiary	Tertiary	Tertiary
Existing Condition	Fully Functional	Fully Functional	Fully Functional	Fully Functional	Very Impaired	Fully Functional
Duration	Over 10 Years	Over 10 Years	Over 10 Years	Over 10 Years	Over 10 Years	Over 10 Years
Dominant Impact	Fill	Fill	Dredge	Fill	Dredge	Fill
Cumulative Impact	1.0 - 2.99 Acres	1.0 - 2.99 Acres	1.0 - 2.99 Acres	< 0.25 Acre	3.0 - 9.99 Acres	< 0.25 Acre
Sum of Factors	11.5	11.5	11	11.1	6.3	11.1
Impacted Area	1.22	.46	.84	0.07	3.62	0.05
R x AA=	14.03	5.29	9.24	0.777	22.806	0.555

Required Wetland Mitigation Credits = Σ (R x A) = **52.698**



2-D Sub-Surface Modeling

- Identify any potential groundwater impacts to surrounding neighborhoods.
- Guide the wetland design to promote infiltration and surface/subsurface interaction.
- Allow the team to more effectively convey how we are slowing, storing and infiltrating water.

Ecological Engineering Design – Groundwater 2-D Modeling

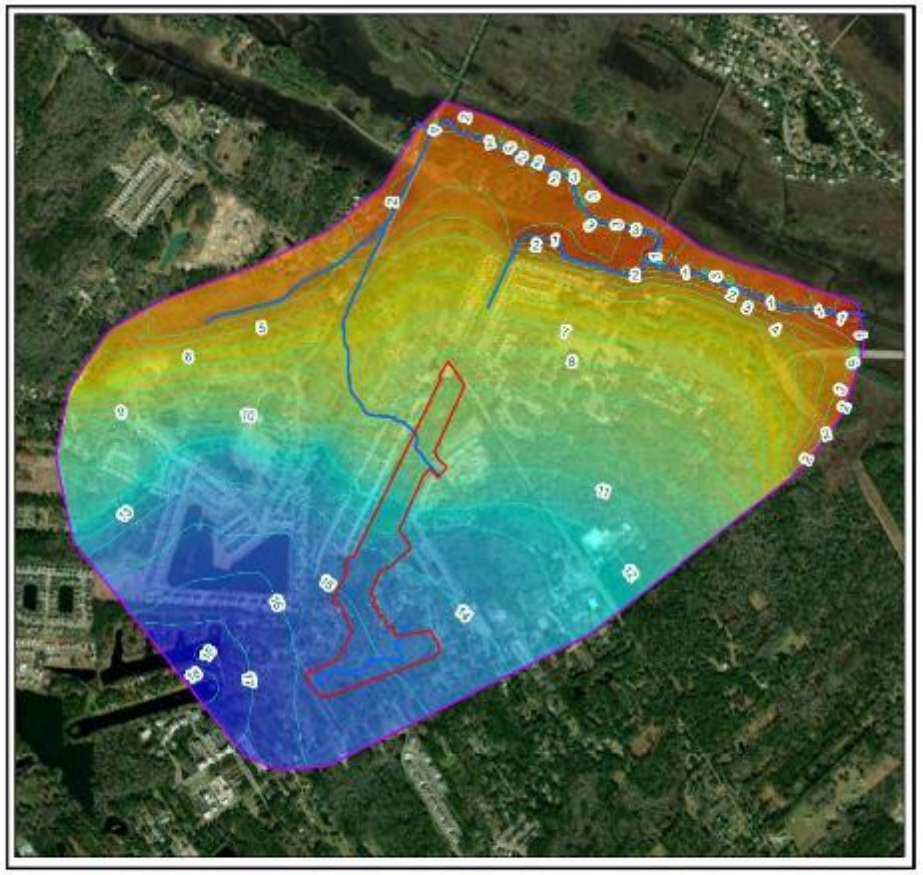


Figure 11: Calibrated Model Groundwater Equipotential Map

Barberry Woods Site
Johns Island, South Carolina

Legend

- Subject Site
- MODFLOW Model Extent
- Modeled Stream
- Groundwater Equipotential Contour (C.I. = 1 ft)

Groundwater Elevation (ft amsl)

High : 16.16

Low : -2.08

0 750 1,500 3,000 Feet

N

ECS Project No. 49-12243

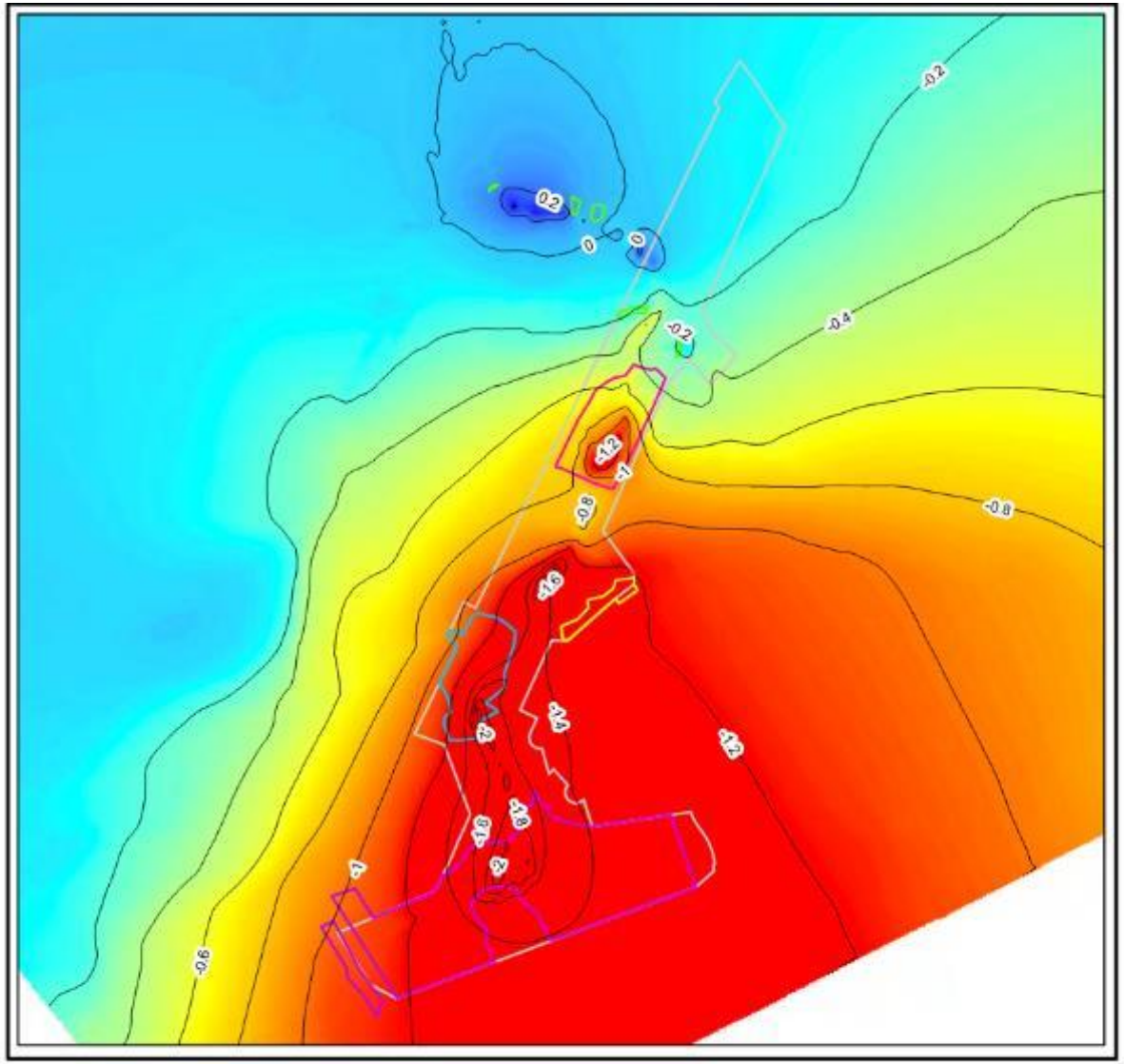


Figure 3: PS1-Predicted Groundwater Level Change from Existing Conditions

Ecological Engineering Design

ECS Project No. 49-12243
May 13, 2021

PS2-predicted groundwater flooding was predicted to occur at undeveloped areas where seasonal flooding may already be occurring and at areas in the immediate vicinity of existing surface water features. Of the 82 land parcels where ECS was asked to evaluate the potential for 2-year storm event groundwater flooding, flooding was predicted at four of the 82 parcels. Of these four parcels, one parcel (parcel 3120000300 at 2975 Split Hickory Court) appears to contain a residential structure. Flooding is predicted at the northern and eastern margins of this parcel but not at the location of the parcel's structure. It is important to note that surface water flooding was also predicted at the northern margin and adjoining the eastern margin of this parcel. The three remaining parcels where some degree of flooding was predicted (parcels 3131400159, 3120000091, and 3120000263) do not appear to contain structures, based on Charleston land parcel records.

Ecological Engineering Design

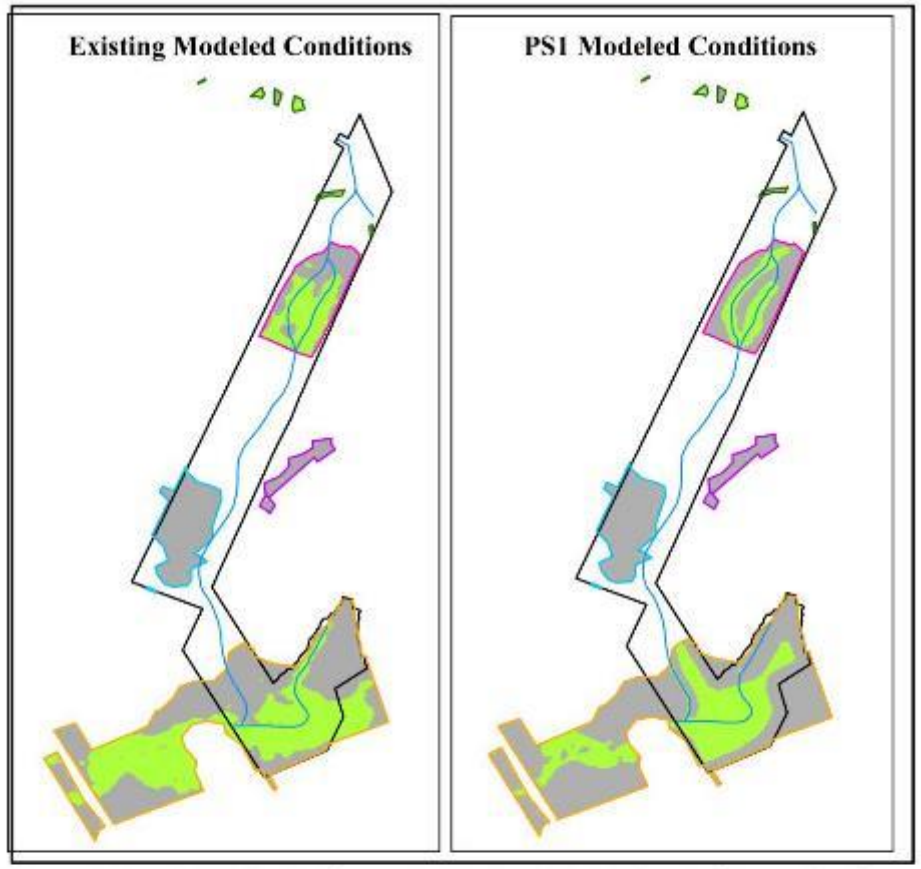


Figure 5: Model-Predicted Groundwater Levels Relative to Ground Surface

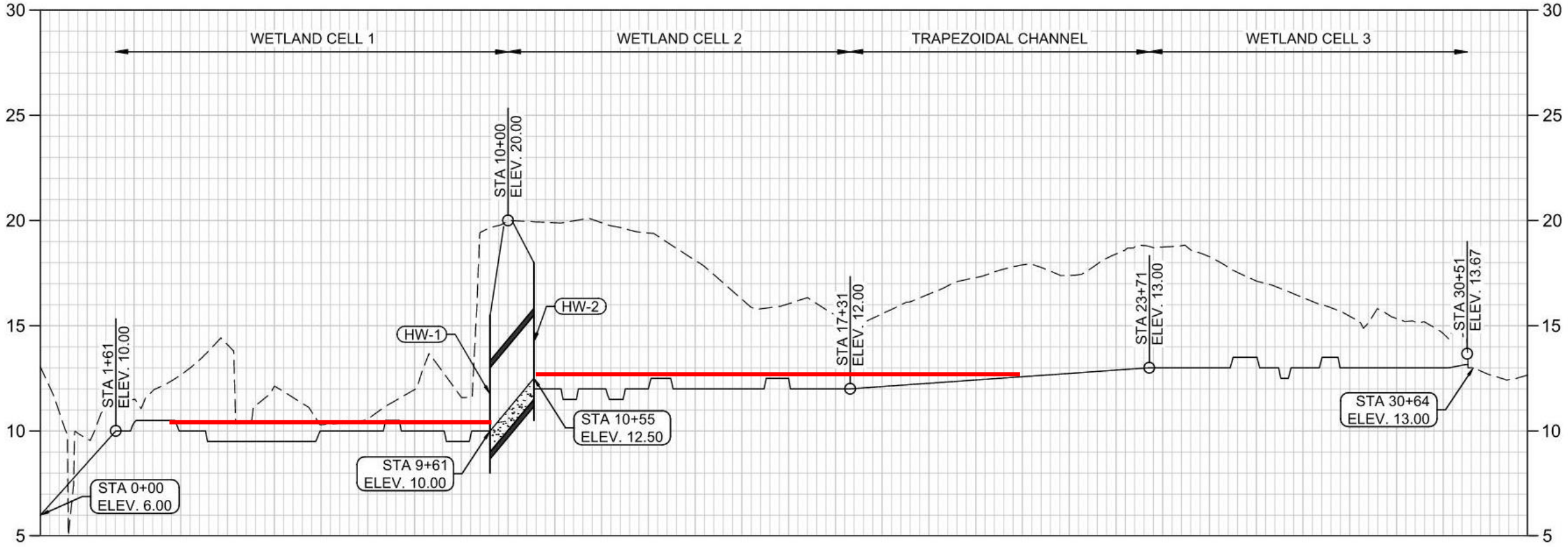
Table 1: Summary of Predictive Simulation PS1 Impacts to Wetlands.

Wetland Group	PS1 Groundwater Level Change from Existing Conditions[a] (feet)	PS1 Wetland Area where Groundwater Level Exceeds Ground Surface (% *change from existing conditions in parentheses*)
Wetland 1	-0.56 to -0.99	30.4% *(-14.0%)*
Wetland 2	-0.83 to -2.02	0.7% *(+0.3%)*
Wetland 3	-1.55 to -2.01	0.0% *(-1.6%)*
Wetland 4	-0.70 to -3.24	40.6% *(-14.6%)*
Wetland 5	-0.15 to -0.72[b]	40.3% *(-17.1%)*

[a]Negative values indicate a decline in groundwater levels from existing conditions.


SAILFISH ROAD
WETLAND CELL 3
LINEAR WETLAND
PEDESTRIAN BRIDGE
PEDESTRIAN PATH WITH EDUCATIONAL SIGNAGE
WETLAND CELL 2
WETLAND CELL CONNECTION
BEE BALM ROAD
EMMETS ROAD
WETLAND CELL 1
EXISTING STREAM CONNECTION WITH ROCK TOE
BARBERRY WOODS
SPLIT HICKORY COURT
CONVEYANCE PIPE
SAND SEEPAGE BERM
MULCH MAINTENANCE PATH
WOODY HABITAT FEATURES, TYP.
BOULDER CASCADE
MAYBANK HIGHWAY
HICKORY KNOLL WAY
TOWNE STREET
TOWNE STREET
0 60' 180'
N

Final Design – Flow Schematic Profile



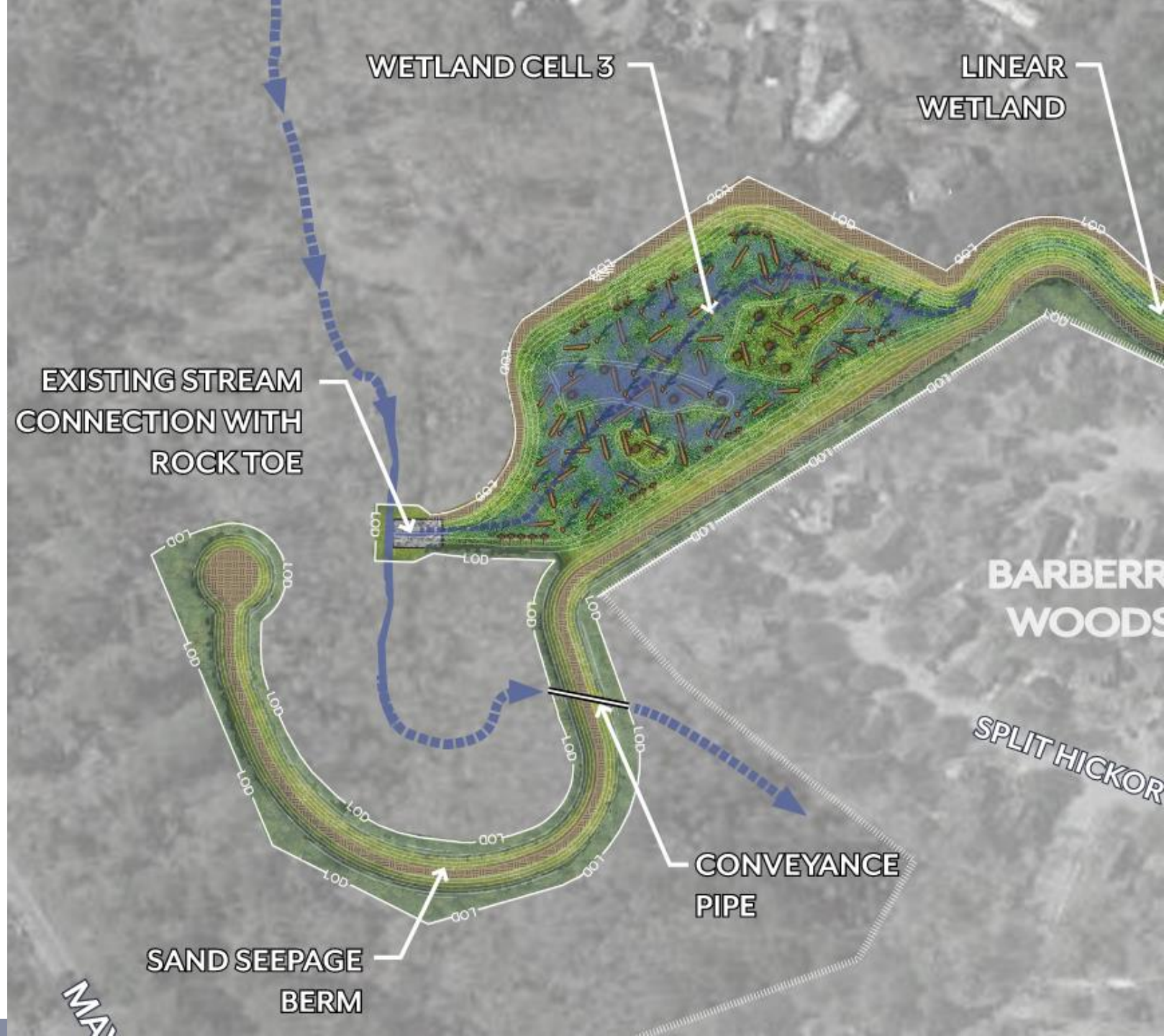
On average, Wetland Cell 2 will have 6” deeper standing water compared to Wetland Cell 1.

-Stream Baseflow will flow through Sand Seepage Berm Drainage Pipe.

-Flood overflow will access Wetland Cell 3.

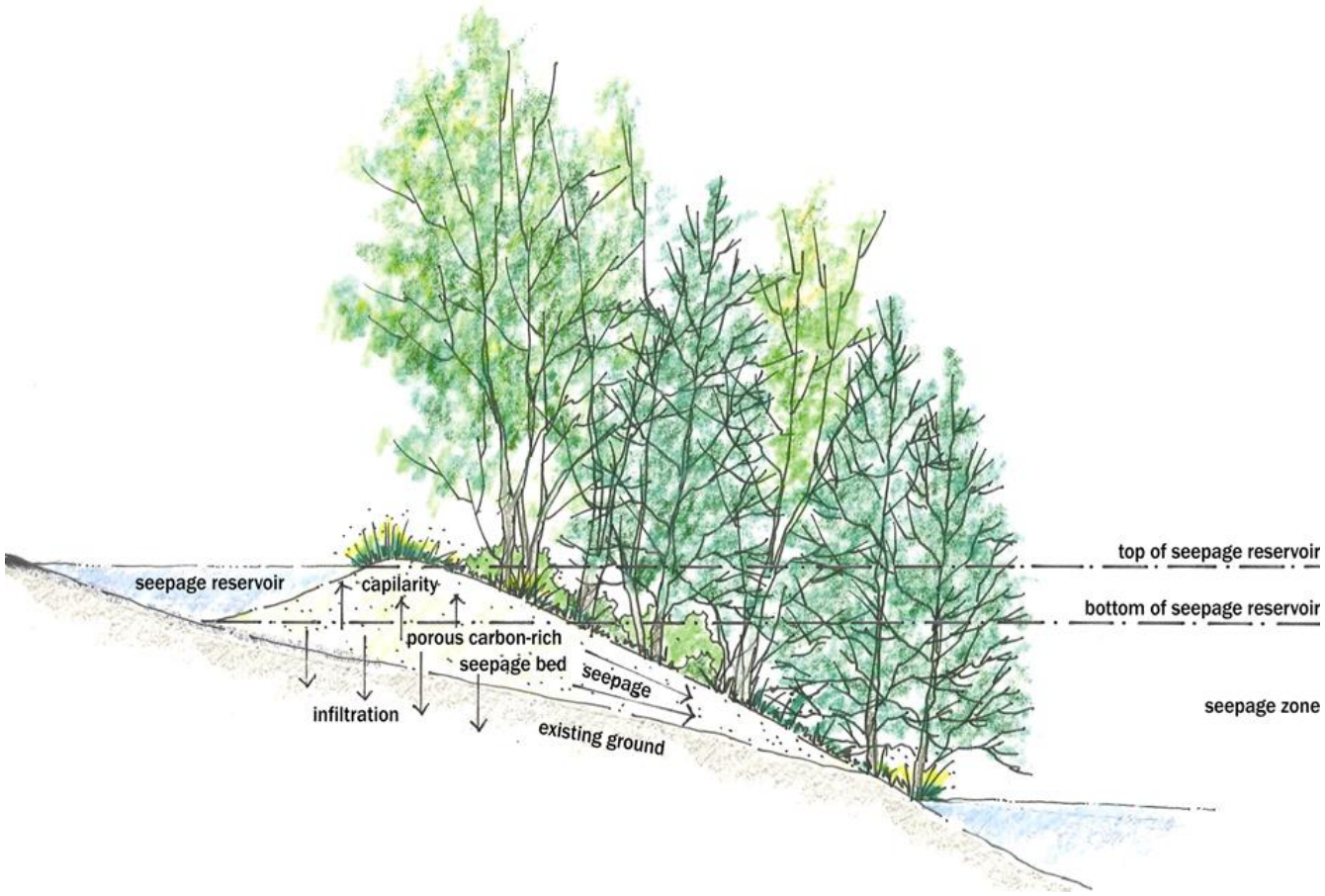
Wetland Cell 3:
-Footprint area-> 2.62 acres

-2-yr storm flow depth-> 2.7 feet



Multiple Benefits

Diversion and Sand Seepage Berms



Sand Seepage Wetland Concept, Biohabitats

Lizard Hill, Biohabitats

Wetland Cell 2:

- footprint area-> 3.65 acres
- 2-yr storm flow depth-> 2.6 feet

The design includes a pedestrian path and bridge:

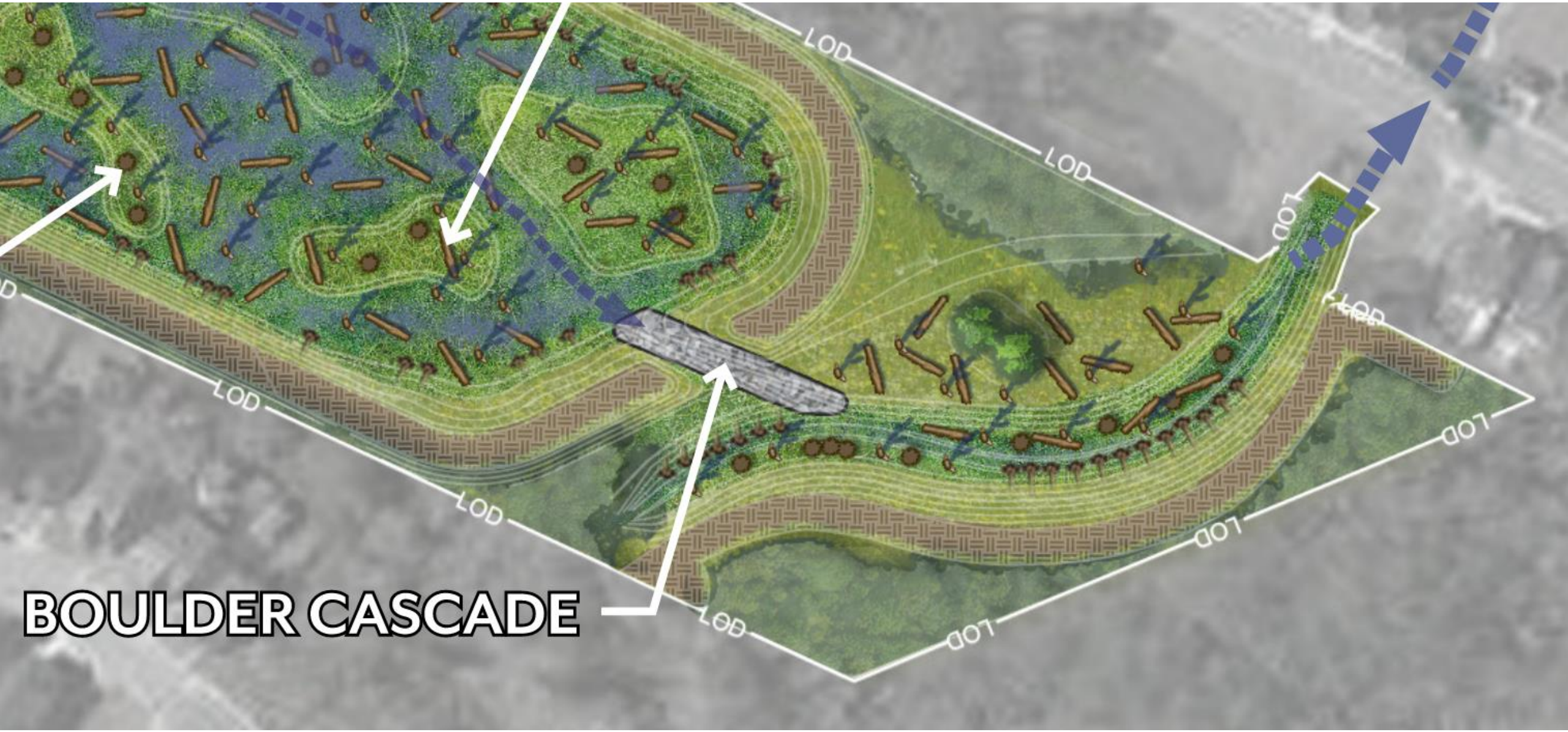
- Community Connectivity
- Environmental Education Signage

- Utilize on-site woody vegetation using:
  - Standing Snags
  - Inverted Rootwads in wetlands and outside bank.
  - Downed Logs in Wetlands and Floodplain Benches

Wetland Cell 1:
-footprint area-> 5.10 acres

2-yr storm flow depth-> 2.0 feet

Flow leaves via a boulder cascade into an enhanced stream with floodplain benching


LOD
LOD
LOD
LOD
LOD
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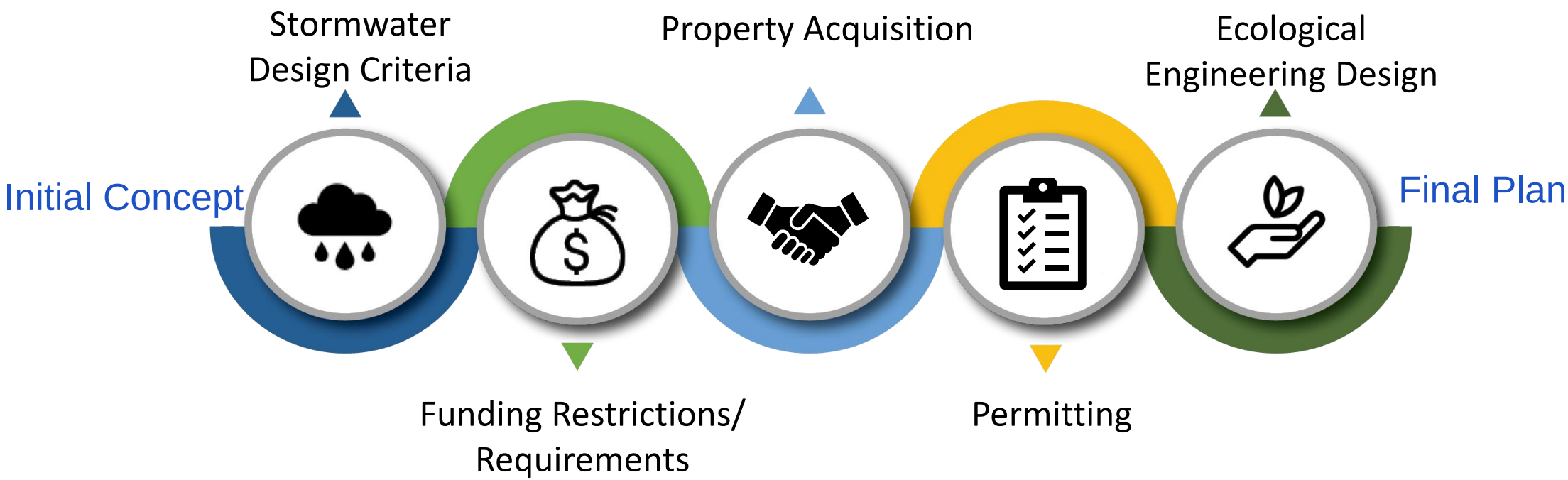
LOD
LOD
BOULDER CASCADE

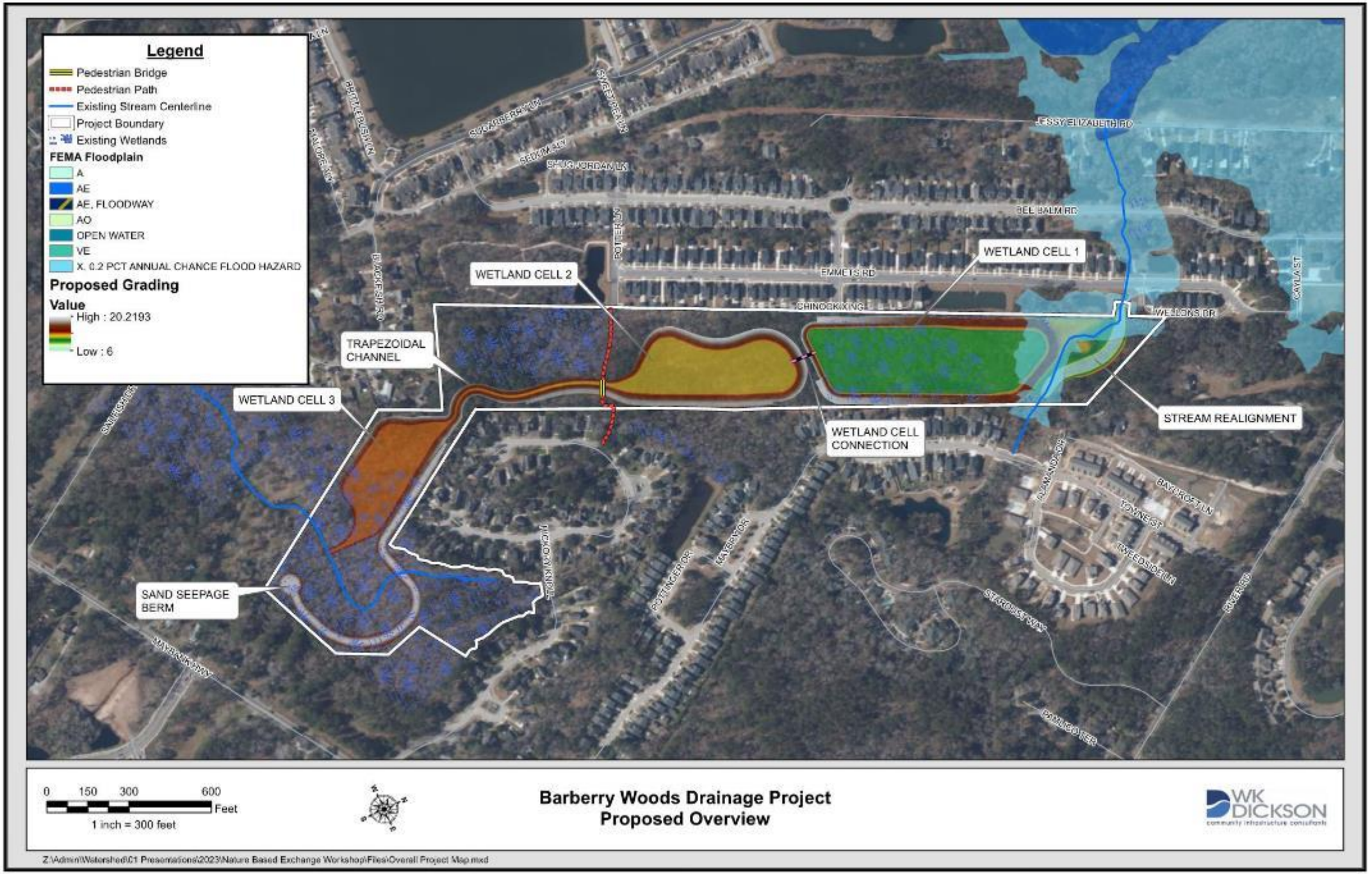
- Boulder Cascade utilized to manage the energy coming from Wetland 3 to revised channel

- Proposed Floodplain Bench will allow floodwaters to spread out and reduce shear stresses.

Project Development Curve



Final Design

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MULCH MAINTENANCE PATH
WOODY HABITAT FEATURES, TYP.
BOULDER CASCADE
MAYBANK HIGHWAY
HICKORY KNOLL WAY
TOWNE STREET
TOWNE STREET
0 60' 180'
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Questions?

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