Application of 2D & 3D Hydrodynamic Models to Kissimmee River Restoration Project

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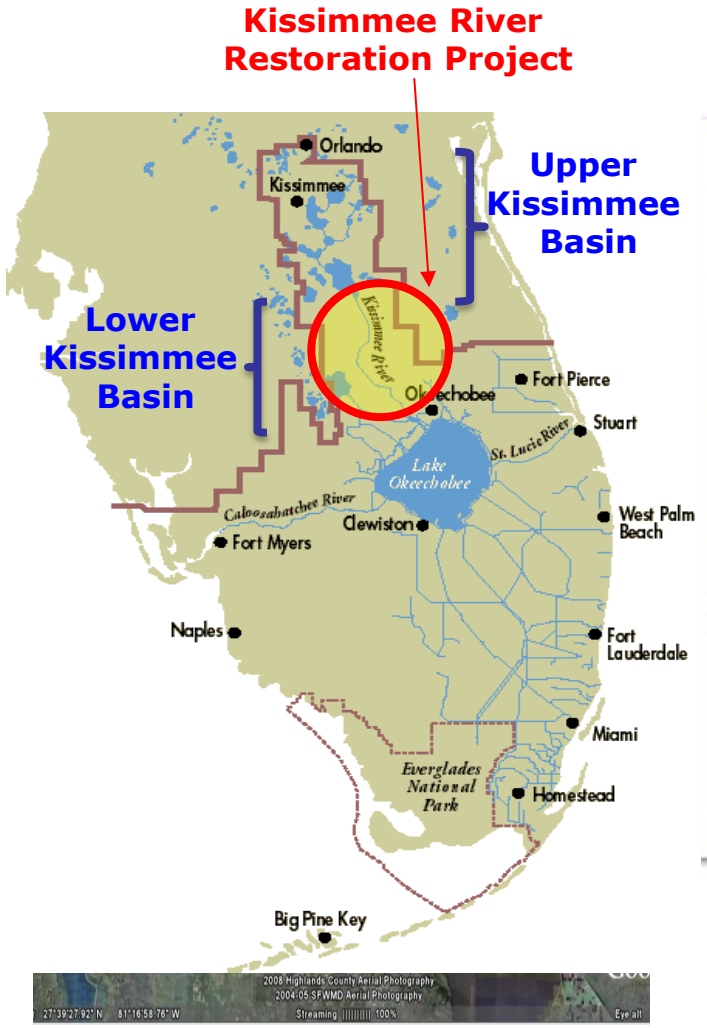
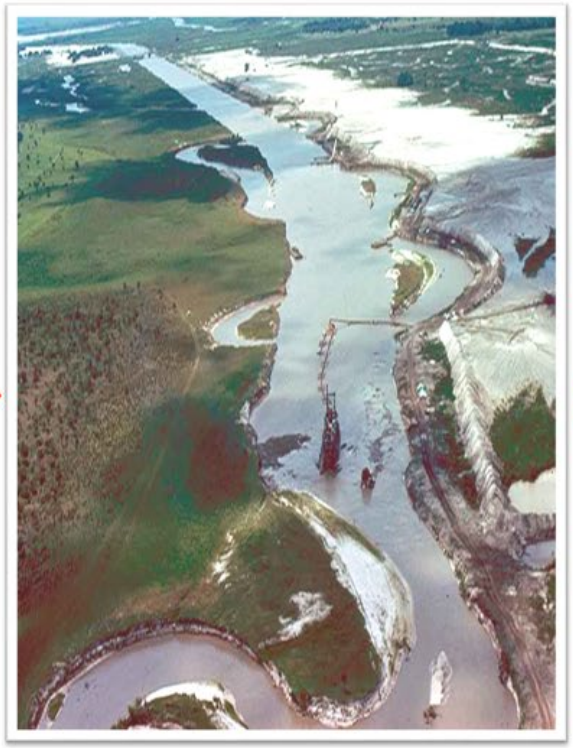
South Florida Water Management District

Kissimmee River Restoration Project Background



Flooding in Kissimmee Valley circa 1947



Channelization of Kissimmee River 1962-1971

Habitat degradation and decrease in fish and wildlife

KISSIMMEE RIVER RESTORATION PROJECT
SHORT TIMELINE

1976: Kissimmee River Restoration Act initiated planning studies

1992: Kissimmee River Restoration Project (KRRP) and Kissimmee River Headwaters Revitalization Project Authorized in 1992 Water Resource Development Act (WRDA)

1999: Construction on KRRP began

2001: Phase 1 Construction Complete

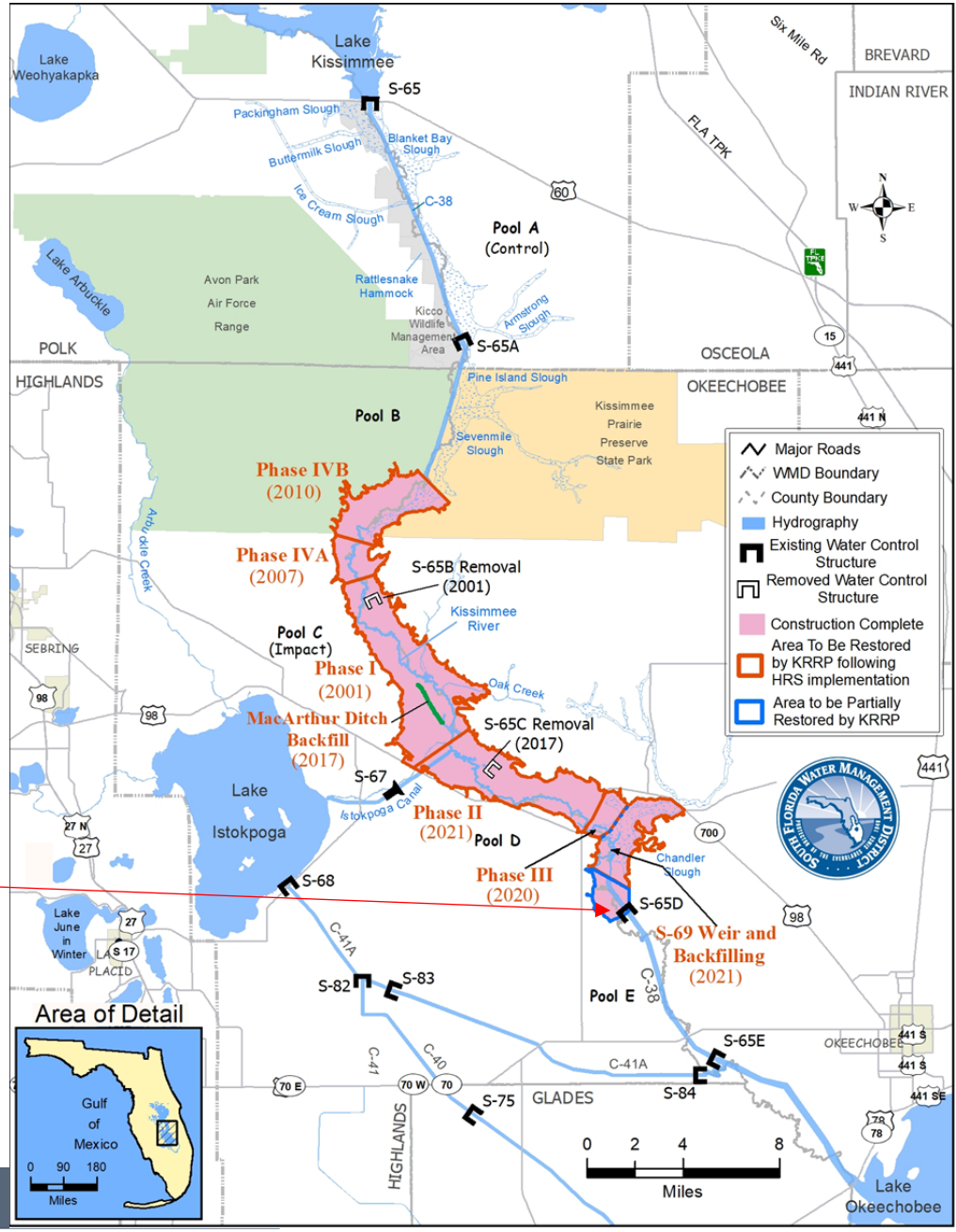
2010: Phase 4 Construction Complete

2011: no name storm illustrated some conveyance limitations at S65A

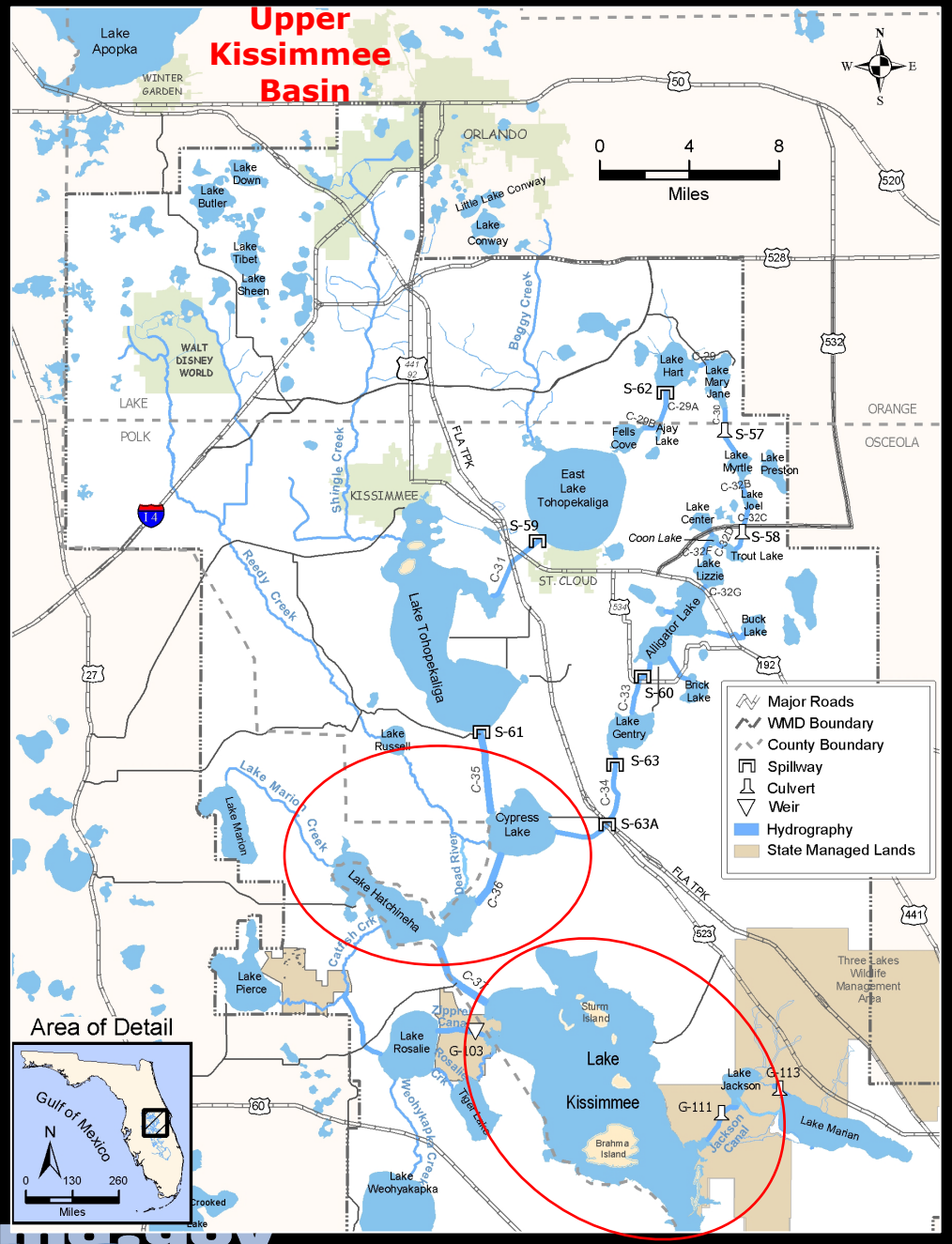
2021: Phases 2 and 3 Construction Complete including S69 weir

2022: Hurricane IAN flows lead to partial failure of S69 weir

2025: S69 weir repairs and Increment 1 Deviation – **WE ARE HERE**



SOUTH FLORIDA WATER MANAGEMENT DISTRICT



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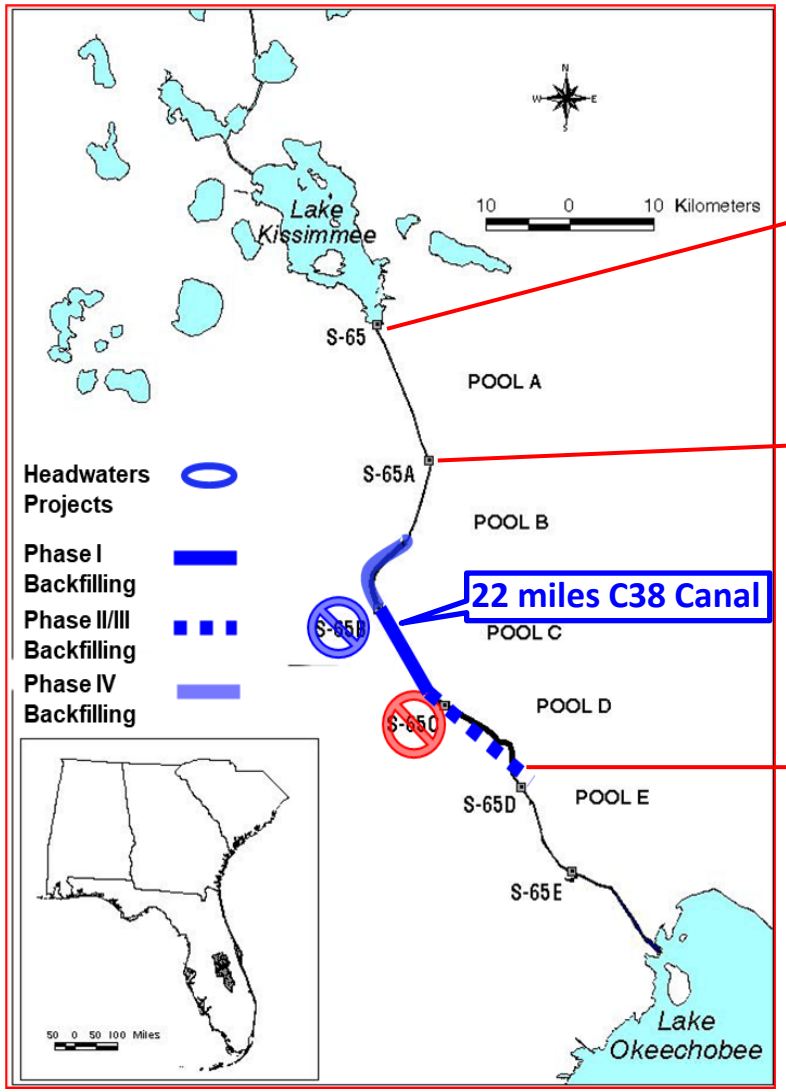
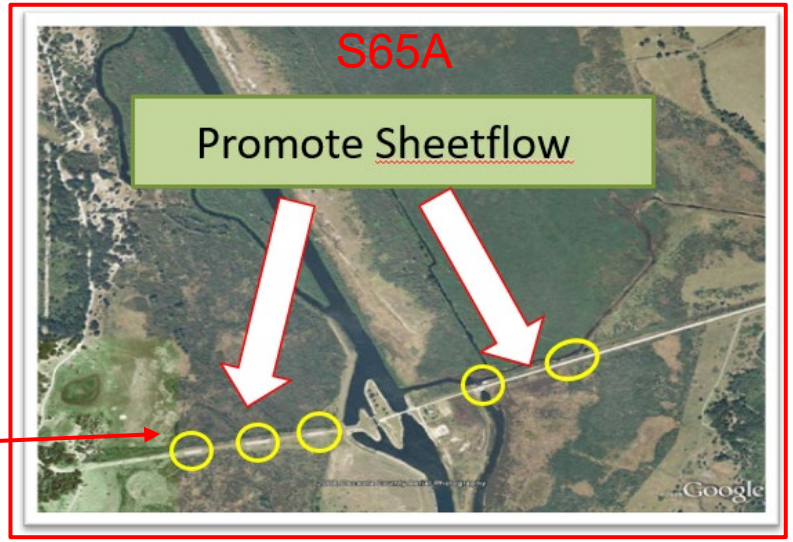
Kissimmee River Restoration Project





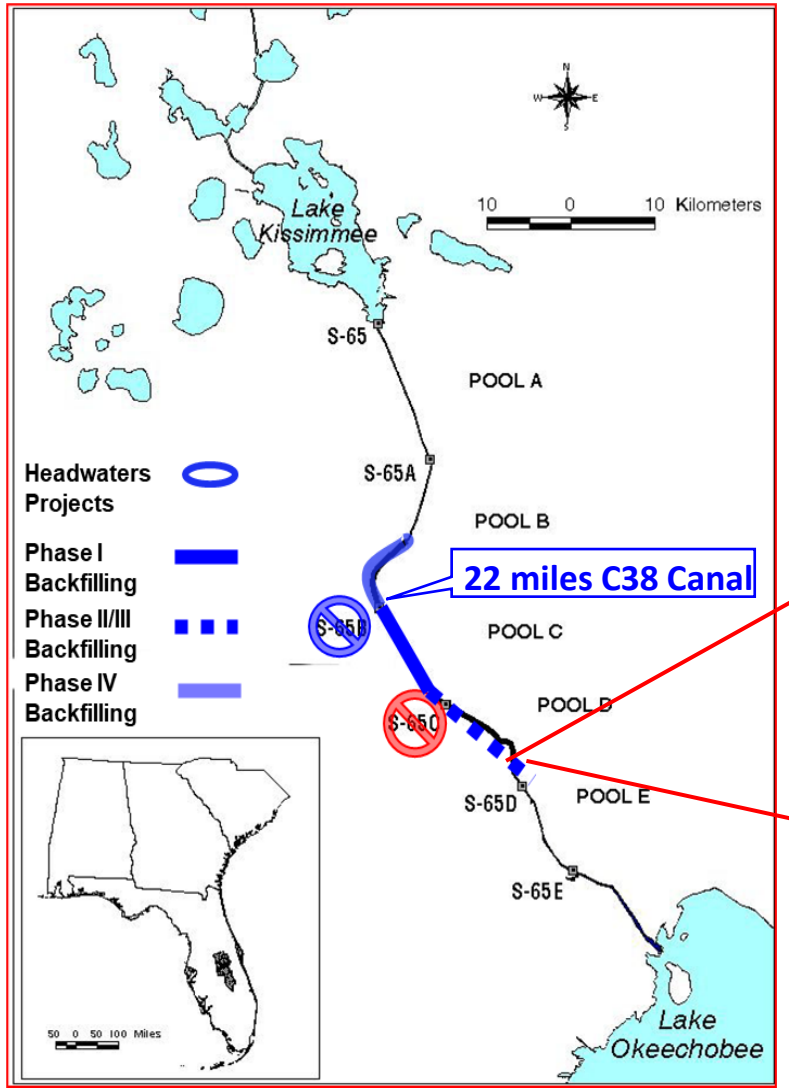
To achieve restoration of historic hydrology, 22 miles of the C-38 canal were backfilled and 2 water control structures were removed. To maintain the same flood protection level of service as the channelized system, 2 bays were added to the S-65 structure and modifications to the S-65A tieback levees were made, which included addition of three crested weirs on the west side and addition of culverts on the east side.

A U-shaped weir, named S69, was added at the end of the restoration reach to serve as the terminus structure and help inundate the floodplains in Pool B,C and D.

Kissimmee River Restoration

Looking north from the south end of the Phase IVB backfill which was completed in December 2009.

Kissimmee River Restoration Project – S69 Weir

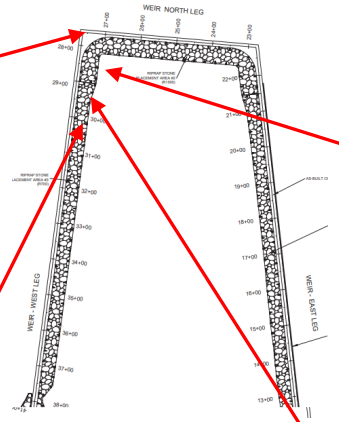


2021: S-69 weir under construction

S-69 weir post 2022 Hurricane Ian – Jan 2023

S-69 weir post 2022 Hurricane Ian – Sept 2022

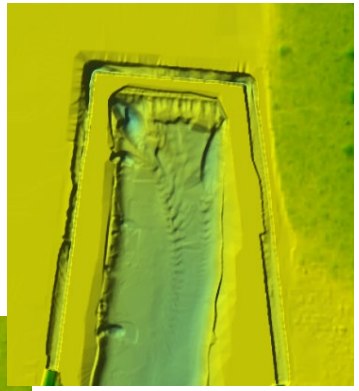
S69 Weir Damage



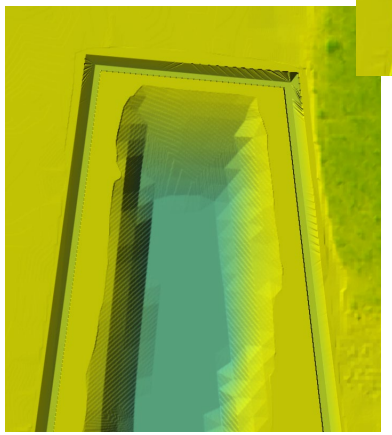
Model Assessment

Different Phases HEC-RAS 2D & 3D CFD model studies

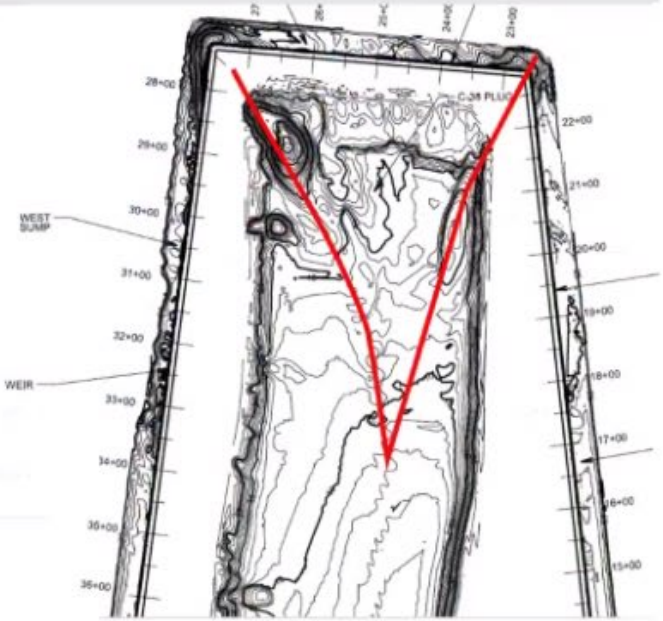
Refurbishment



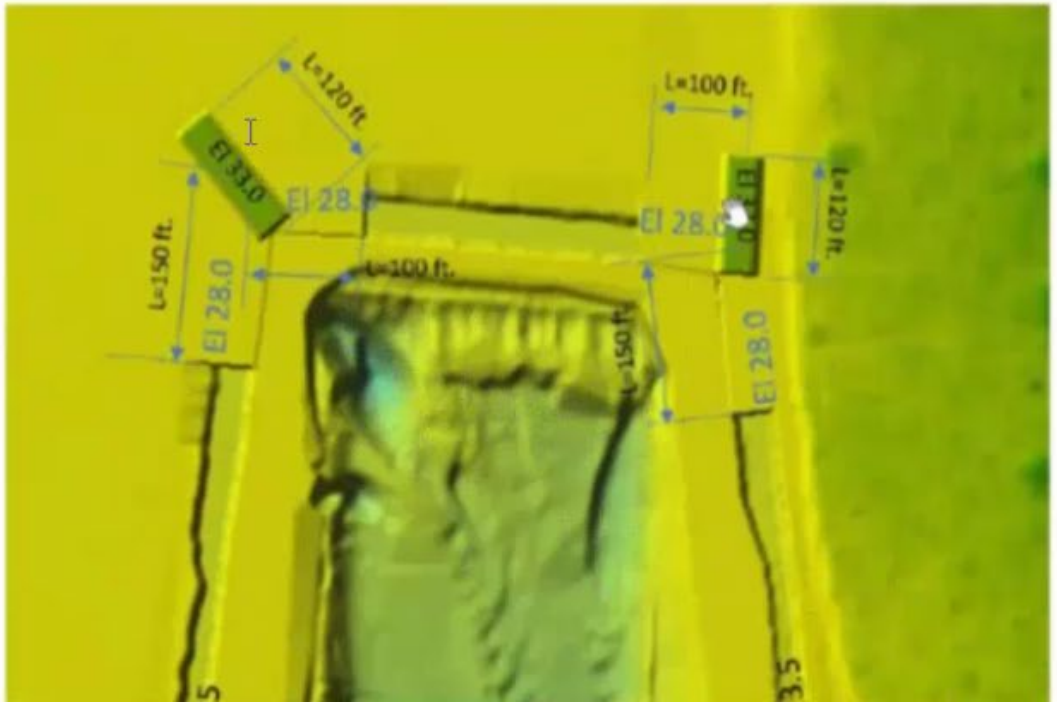
Post-Storm

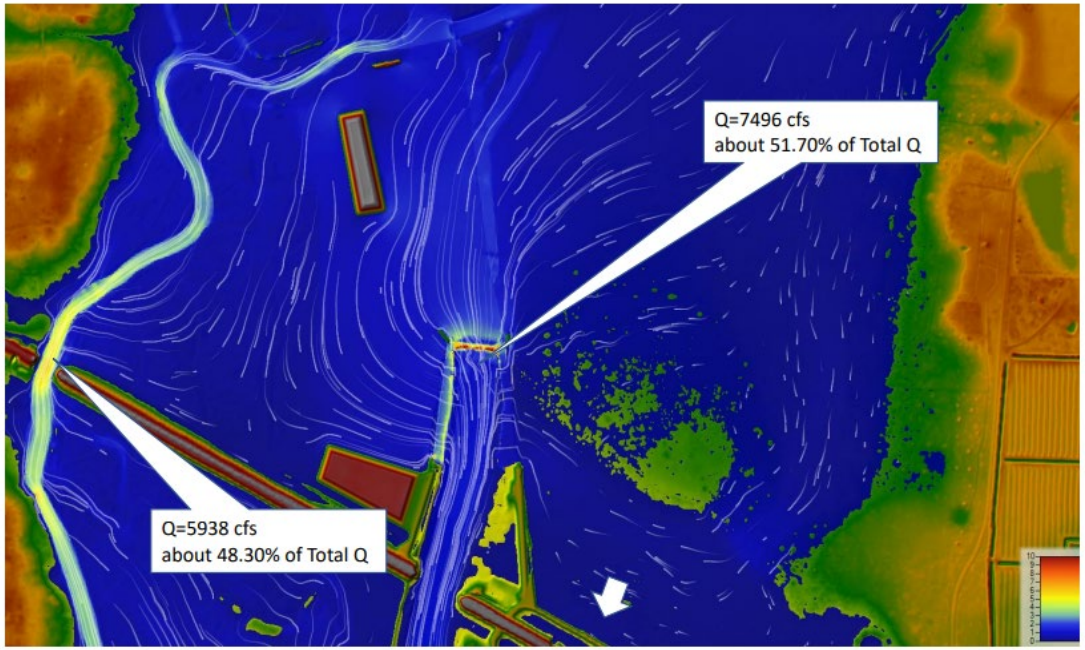


Pre-Storm



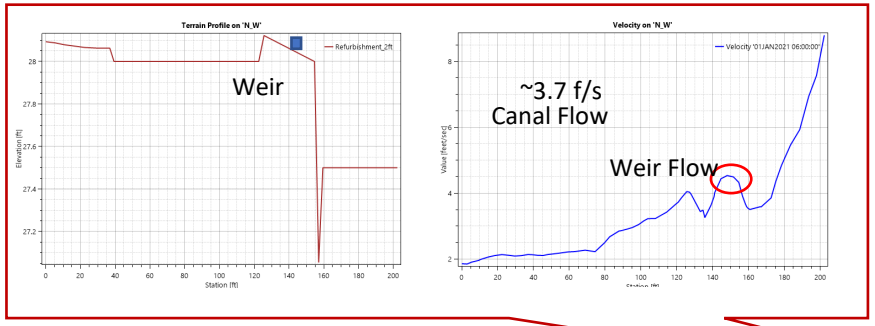
Vortex shedding between 2 merging jets

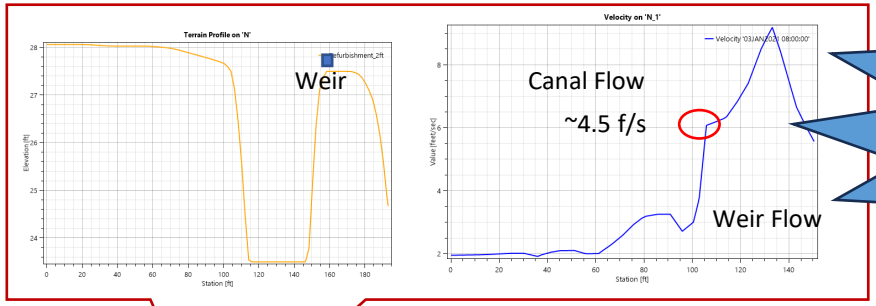




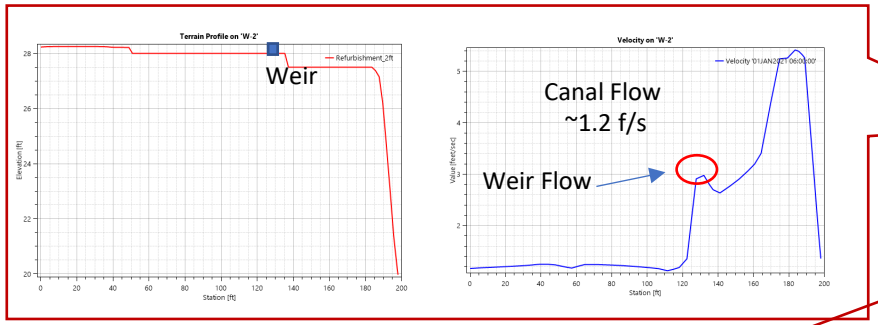
Post-Storm Assessment

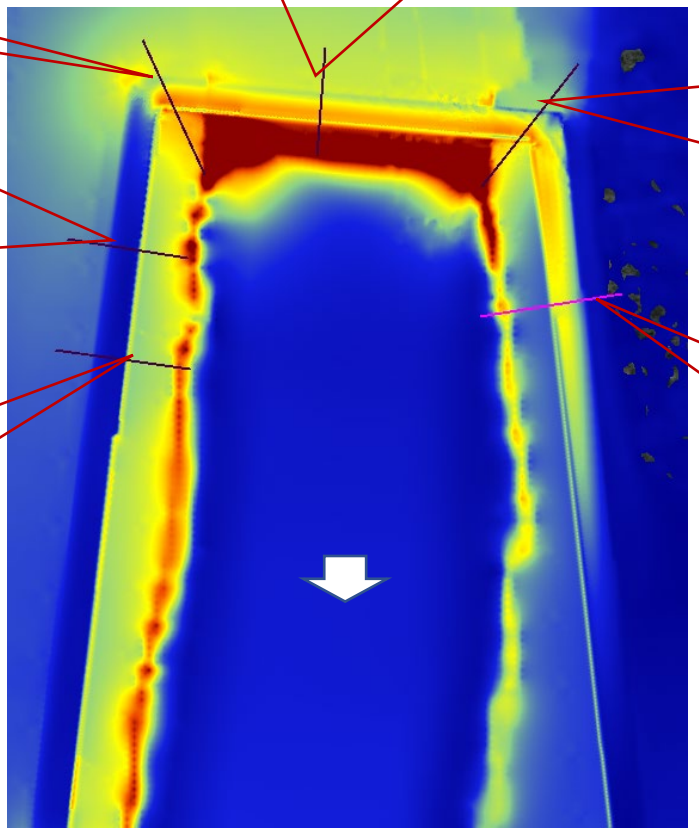
(Q=14500 cfs, TW=28.30 ft. NGVD)

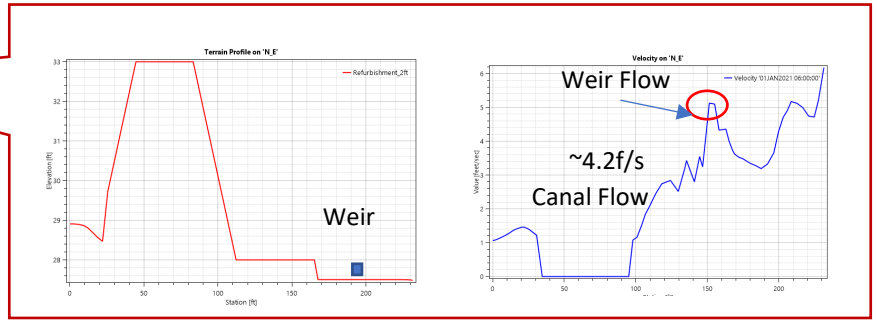


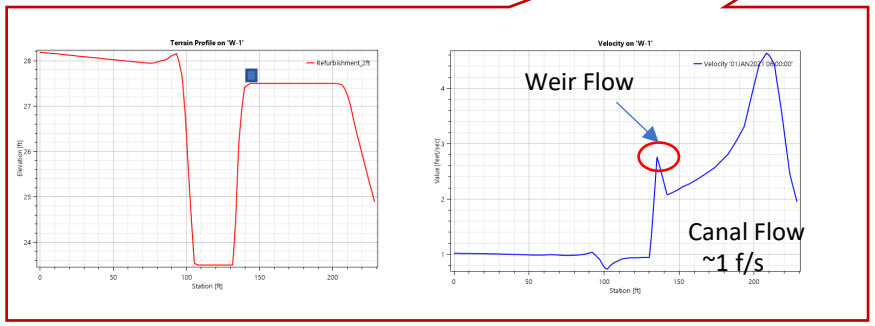


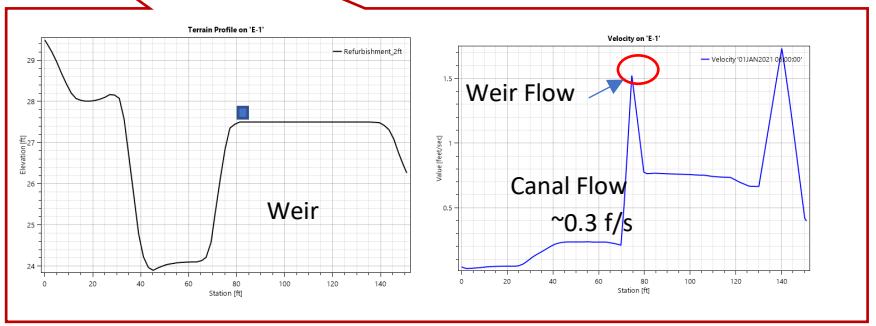
Post-storm Assessment





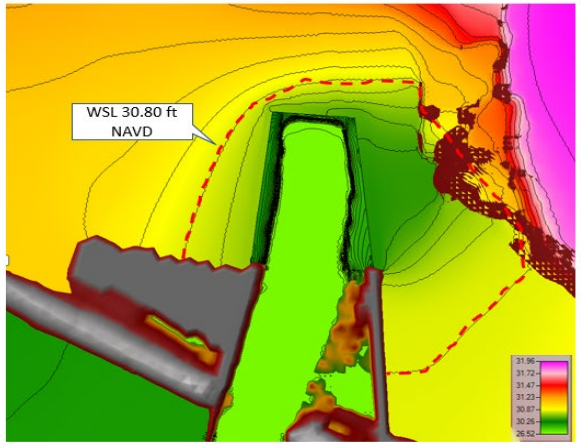




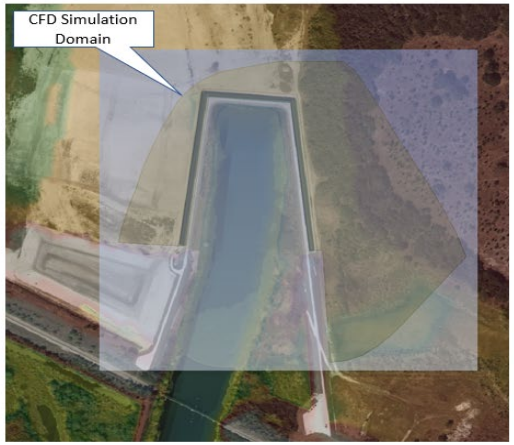


Post storm assessment reveals erosive velocities in the canal sump

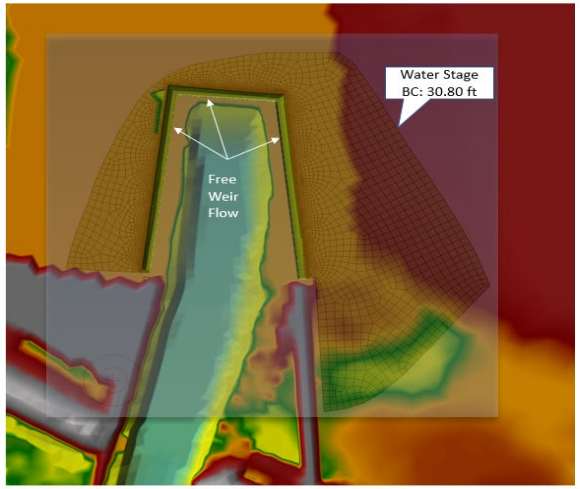
CFD Model Setup



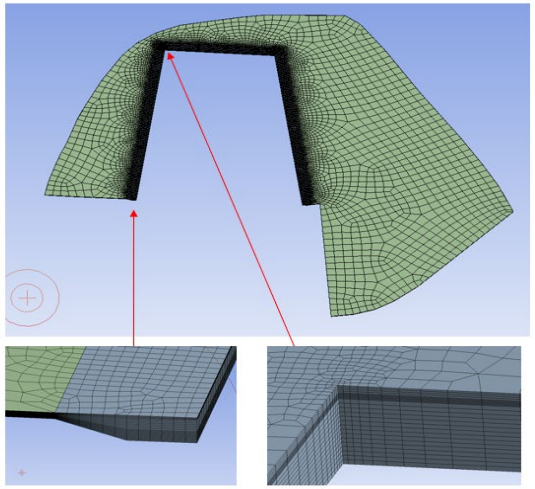
Hec-Ras 2D model Results
-- WSL Contour Lines



Extract Bathymetry for CFD
model Study



3D CFD Model Setup (with Rigid-lid Assumption)



Mesh Details

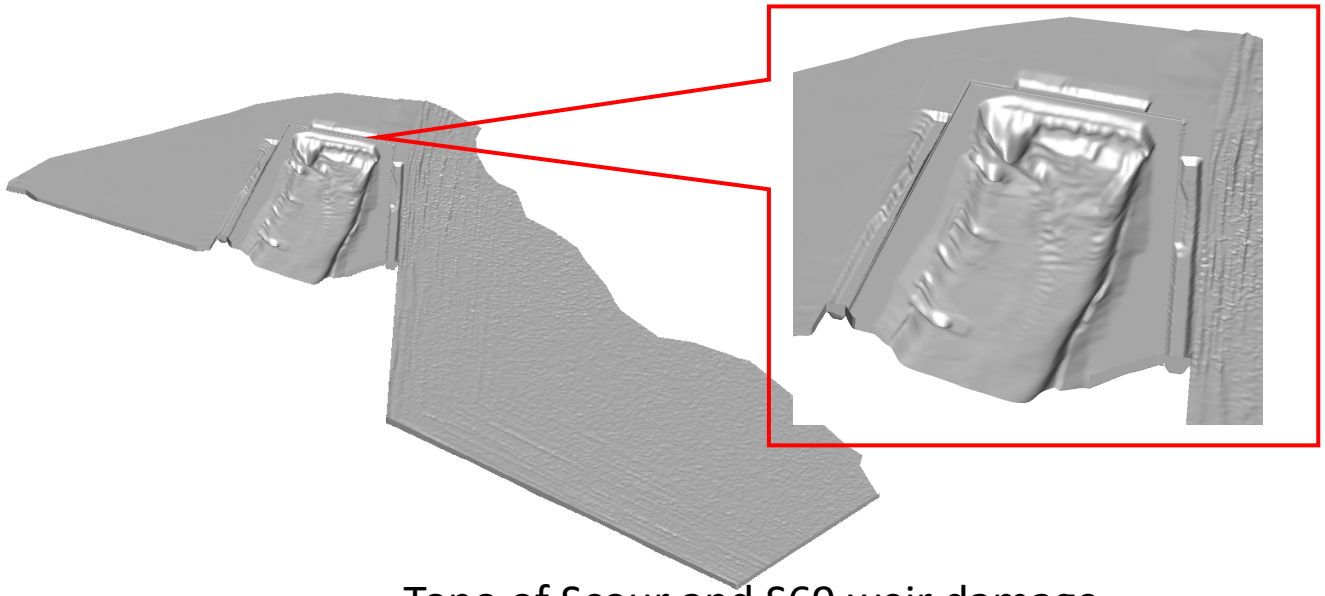
From Hec-Ras 2D result to 3D CFD Study

Boundary Conditions

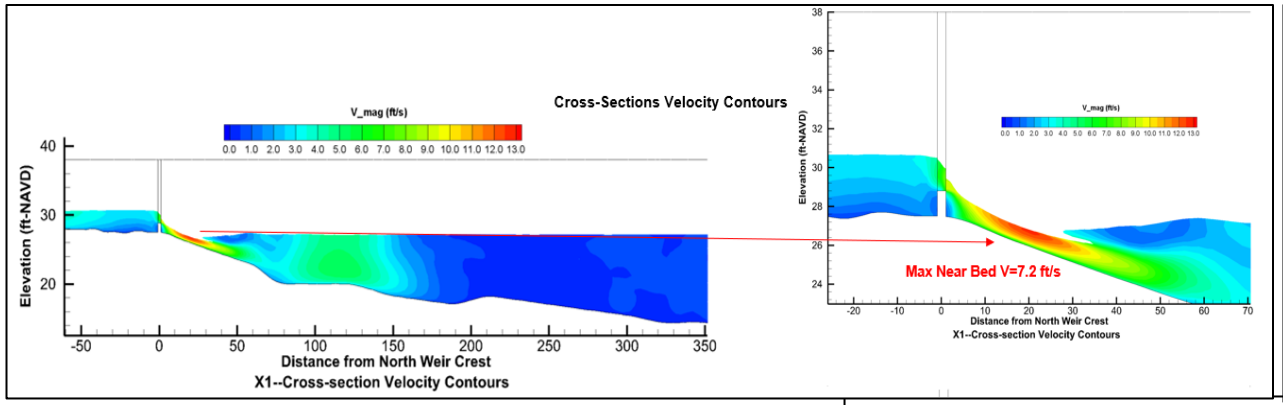
Storm	Northern Pool Inflow (cfs)	Chandler Inflow (cfs)	Outlet Stage (ft-NAVD88)
5-Year	11,668	547	25.6
10 Year (Hurricane Ian)	13775	725	27.09
100-Year	24,426	2,376	27.6
SPF	27,234	3,493	27.6

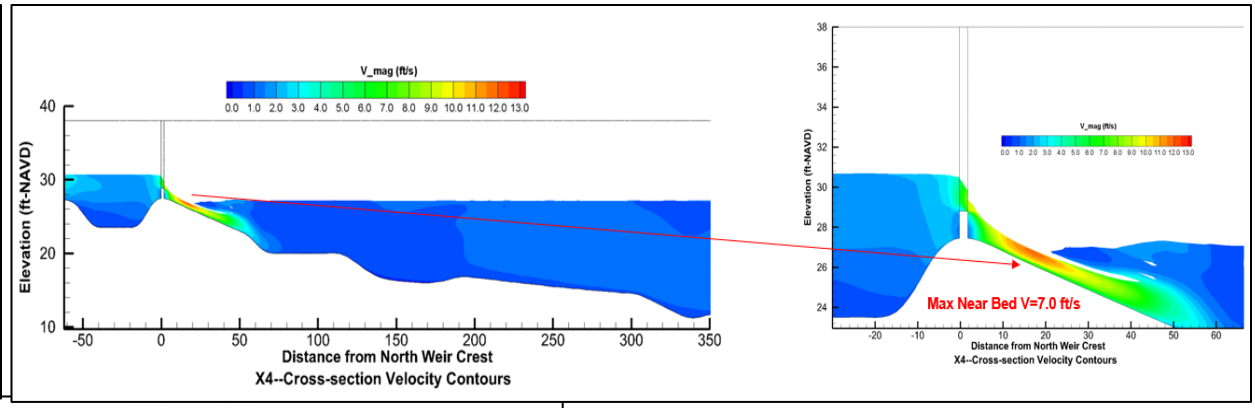
Model Scenarios

Storm	Before Scour	After Scour	Refurbishment
5-Year	x	x	
10 Year (Hurricane Ian)	x	x	x
100-Year	x	x	x
SPF	x	x	x

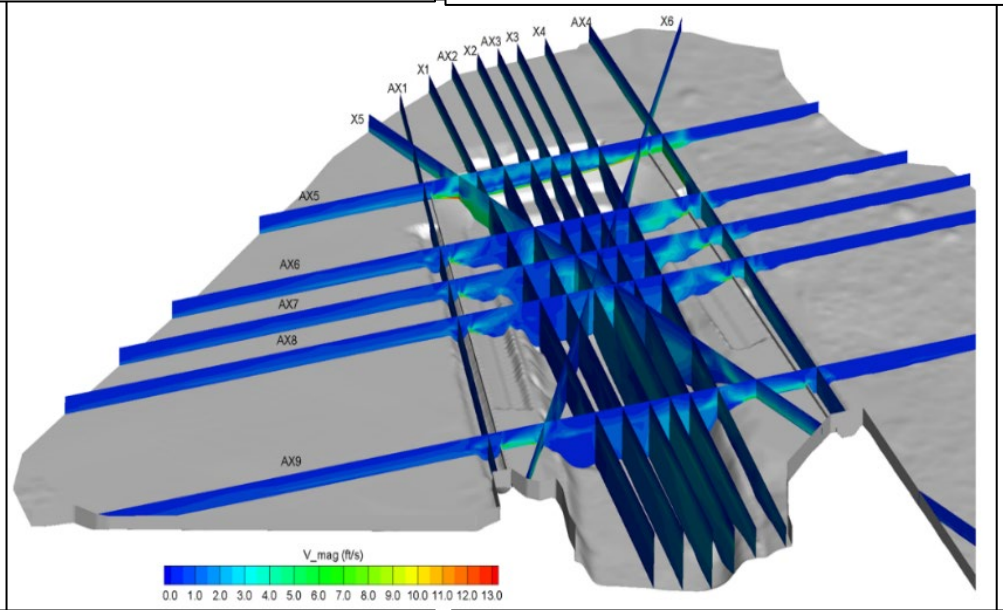


Topo of Scour and S69 weir damage

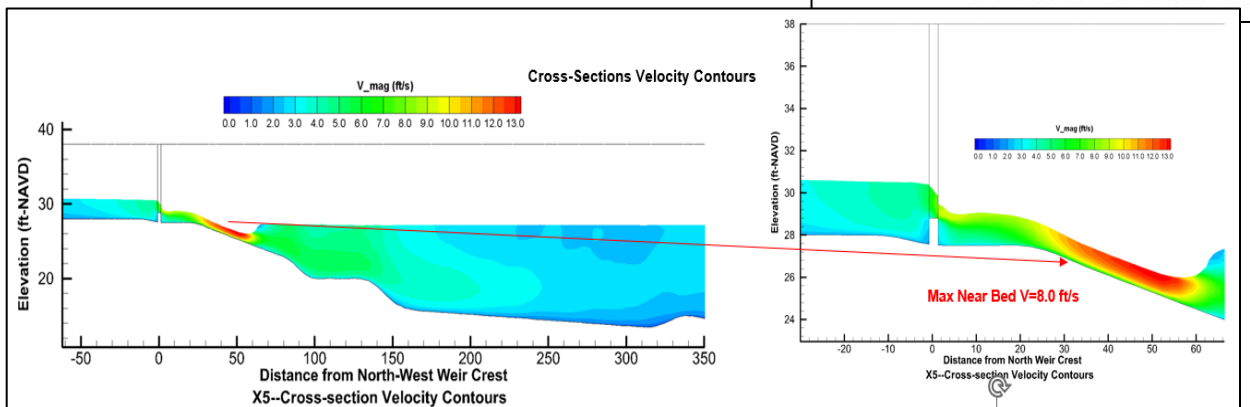


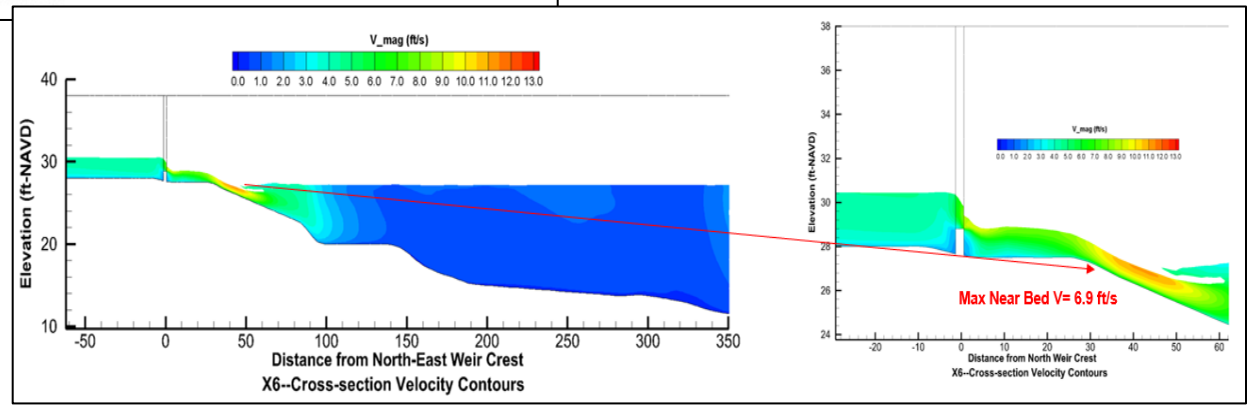


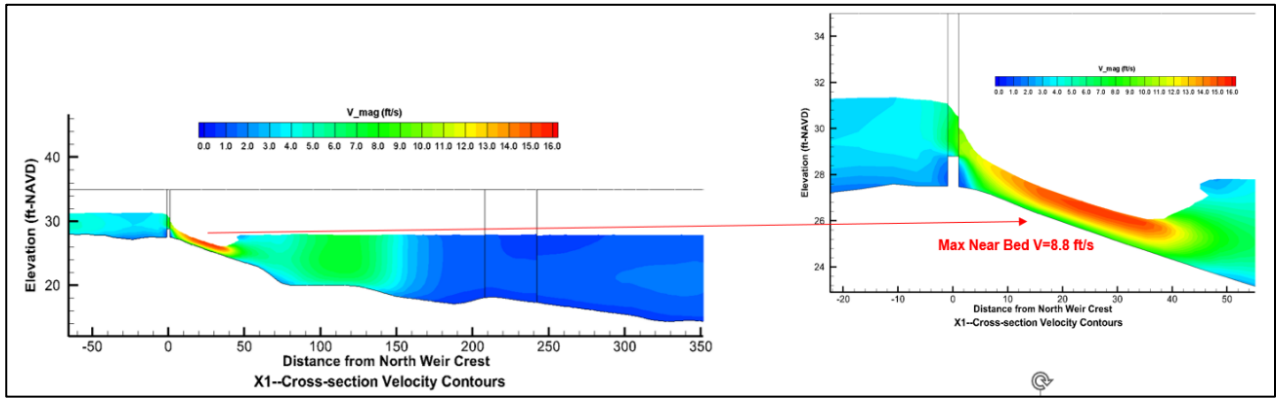
Fully Refurbished Weir 1-10

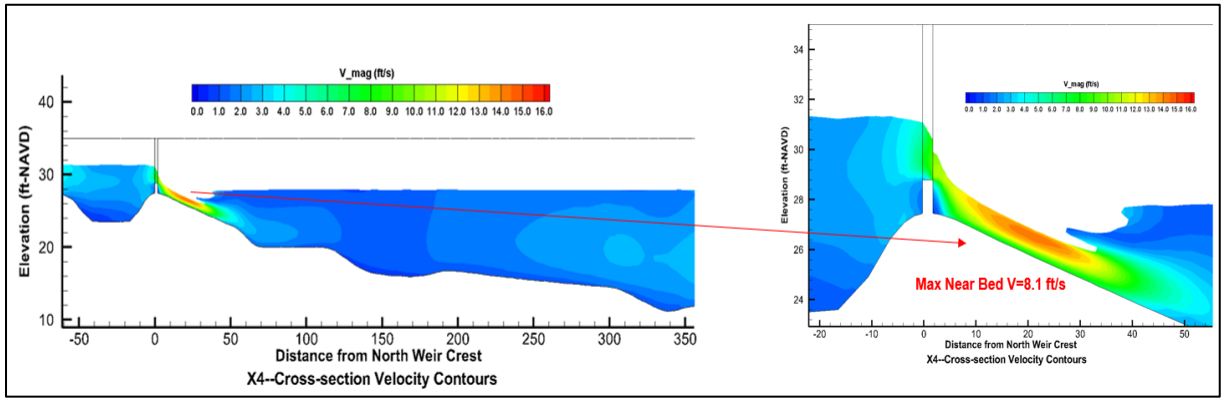


Max Velocities ranged between 6.9 and 8 ft/s
Target: < 10 ft/s

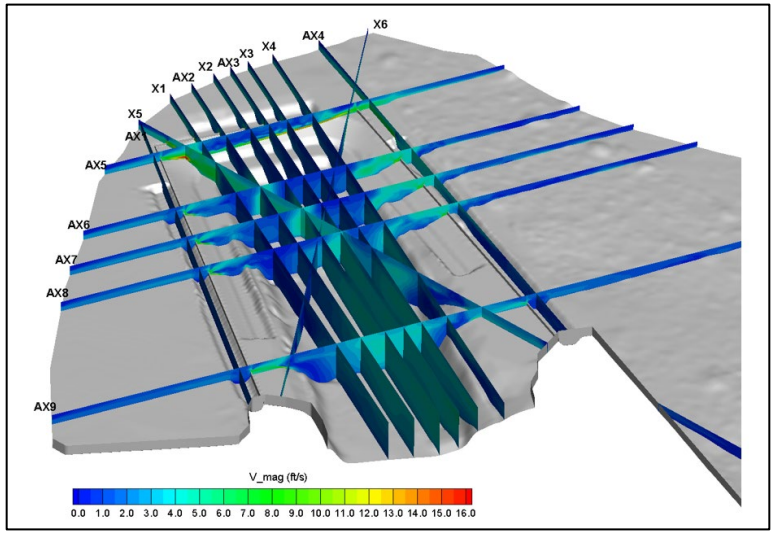




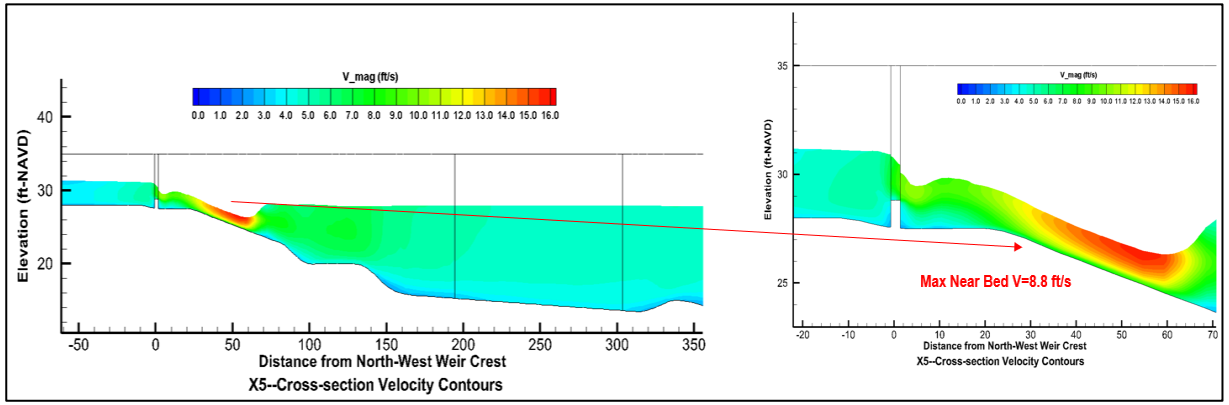


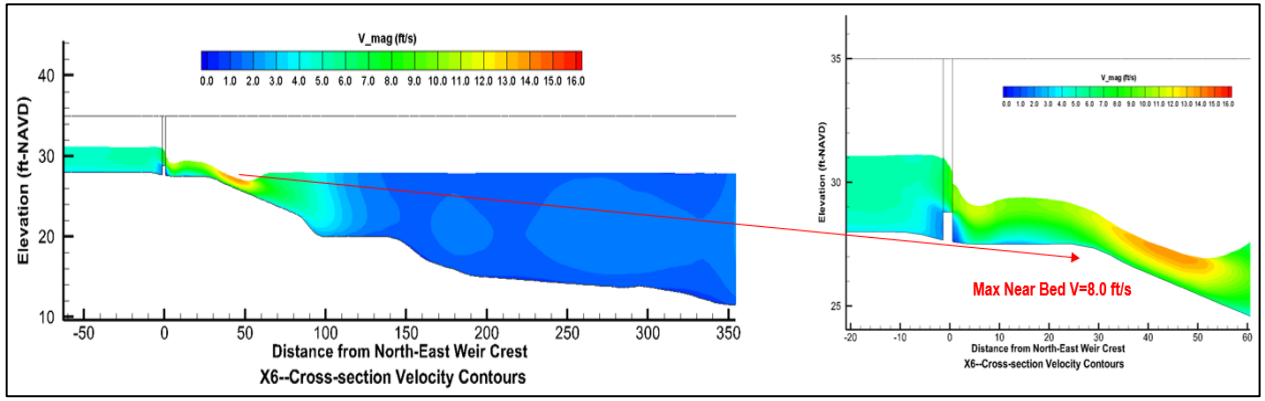


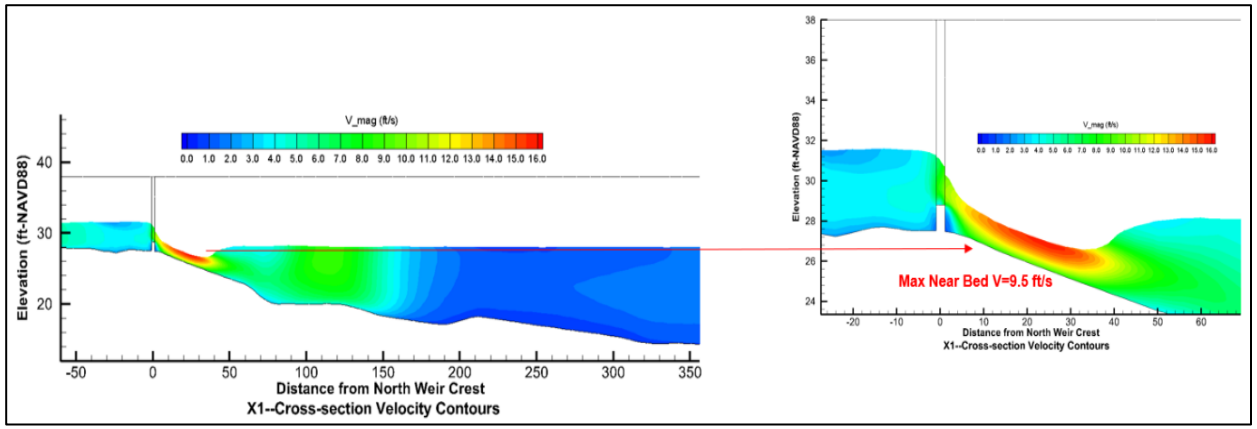
Fully Refurbished Weir 1-100

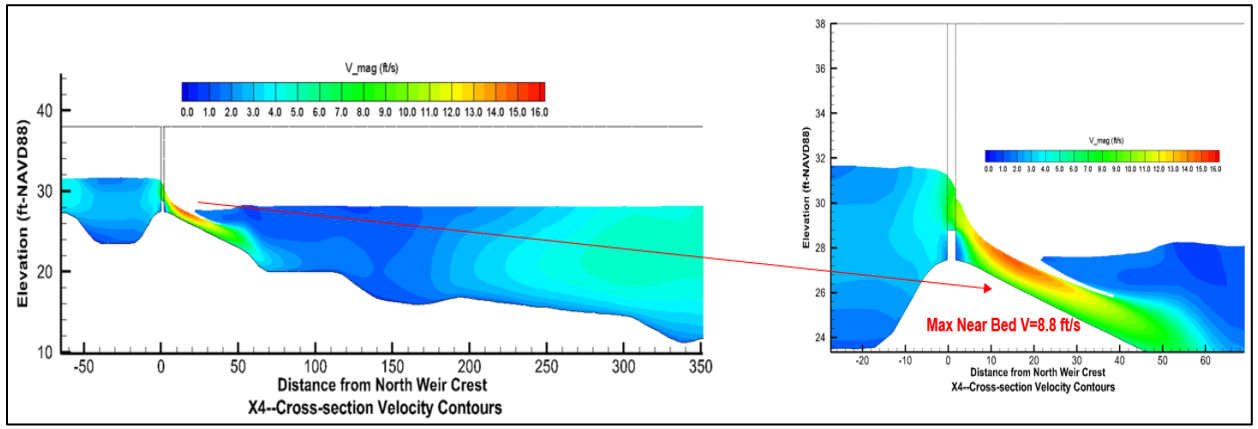


Max Velocities ranged between 8.0 and 8.8 ft/s
Target: < 10 ft/s

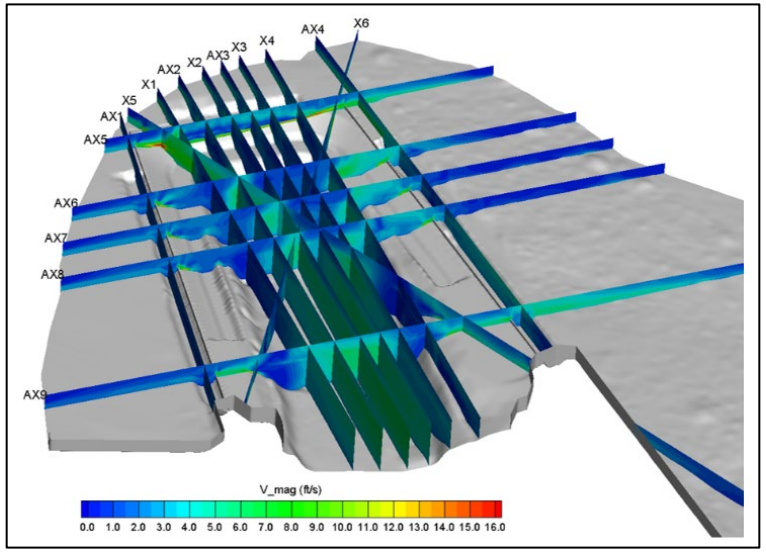








Fully Refurbished Weir SPF



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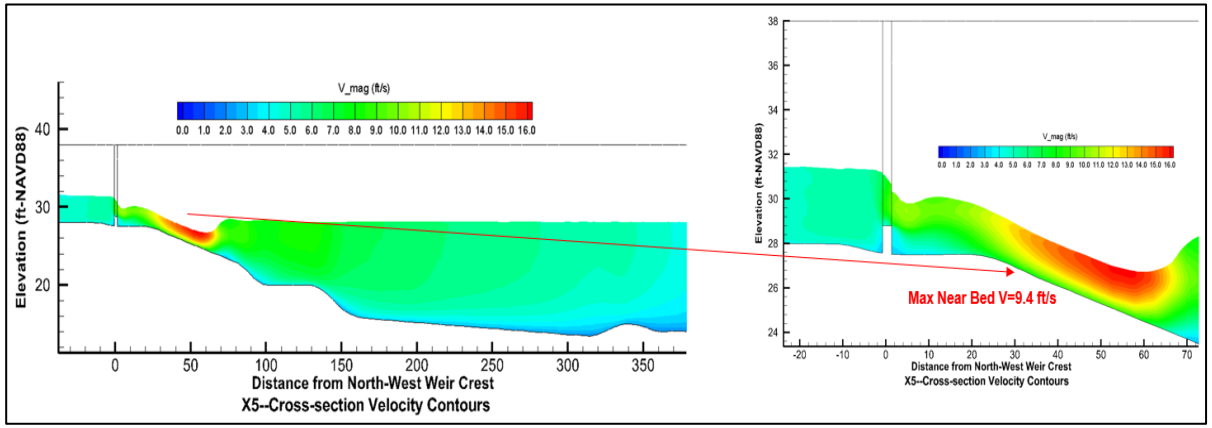
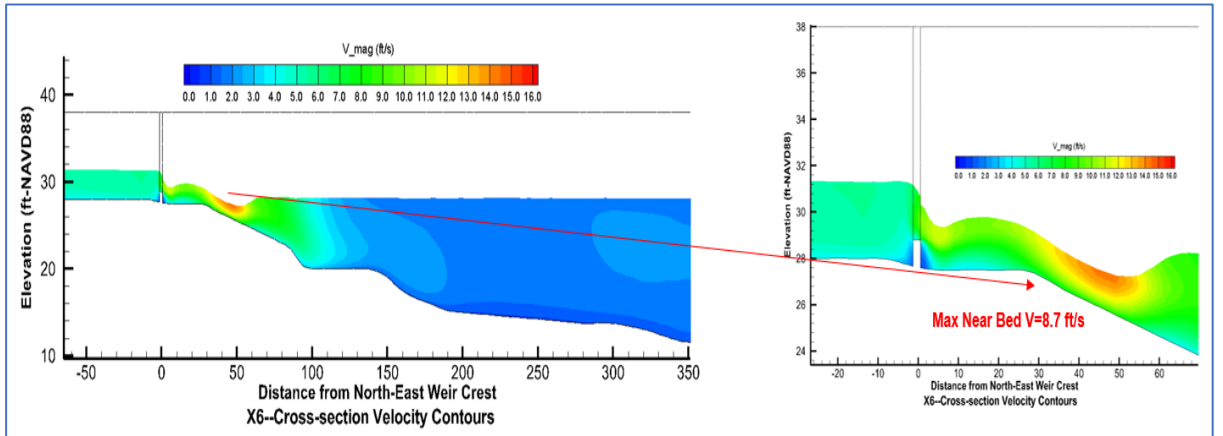




Sept 30, 2022

Oct 07, 2022

Kissimmee River Restoration S-69 Weir

- January 3, 2023, aerial photo

location of the damage

April 3, 2023 – S69 weir repairs underway

Summary

- A 2D (HECRAS2D) and 3D (Ansys Fluent) Models were developed in support of S69 weir repairs and rehabilitation
- S69 weir is the terminus structure of the restored reach of the river and is a key structure in achieving restoration target of Kissimmee River Restoration.

- Upcoming challenges:
  - Gradual implementation of the Headwaters Revitalization Schedule, which should help improve water management for floodplain recovery
  - Complete S69 weir repairs
  - Operate the infrastructure to meet the ecological flows need of the river while preserving the authorized level of flood control for both the Lower and Upper Kissimmee Basins

Questions?

Thanks for your interest!

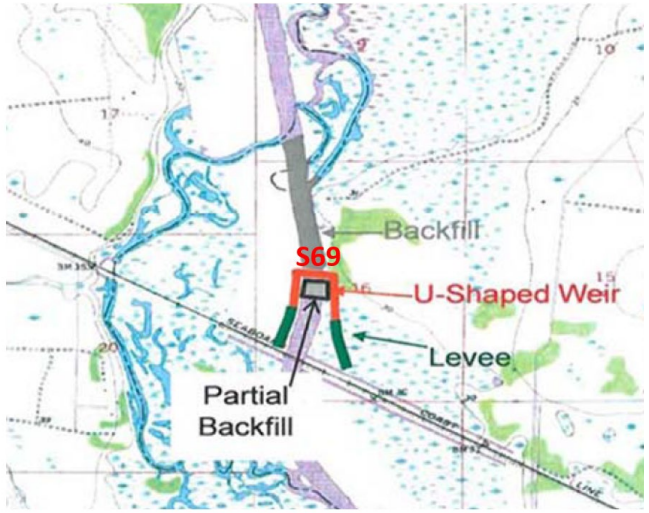
Matahel Ansar

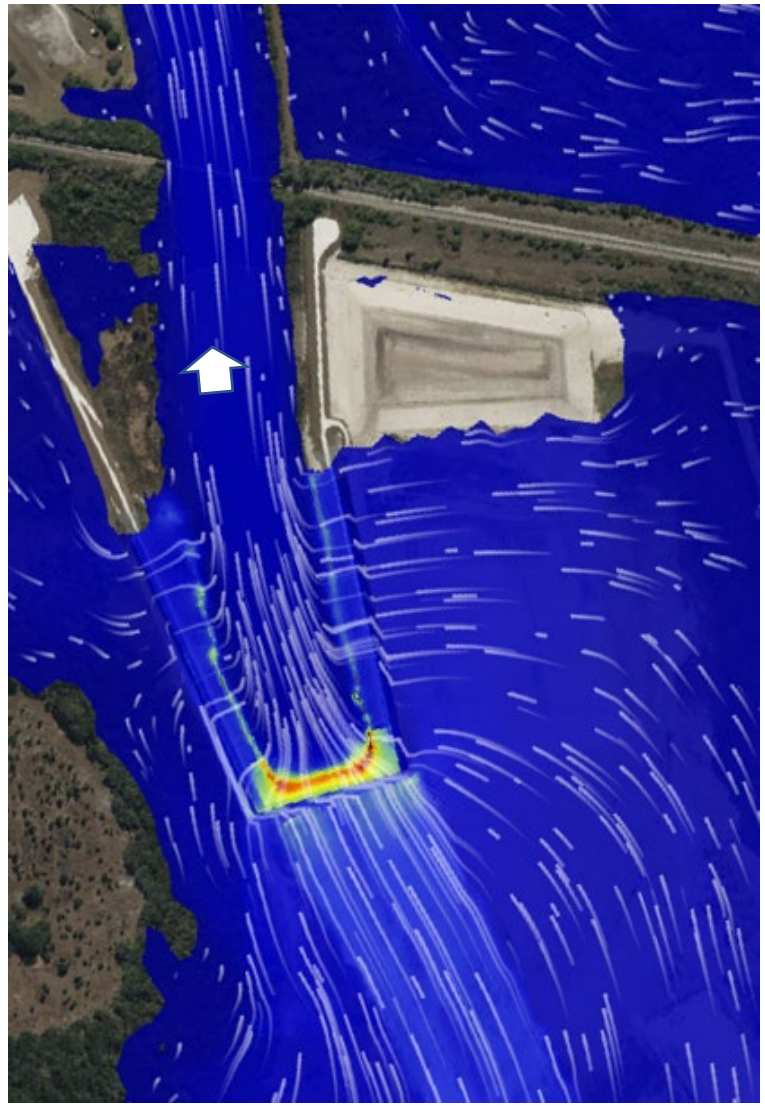
mansar@sfwmd.gov

S69 Weir Pre-, Post-Storm and Refurbishment Scenarios HEC-RAS 2D & 3D CFD Model Assessment

Background S69 Weir and KRR Project

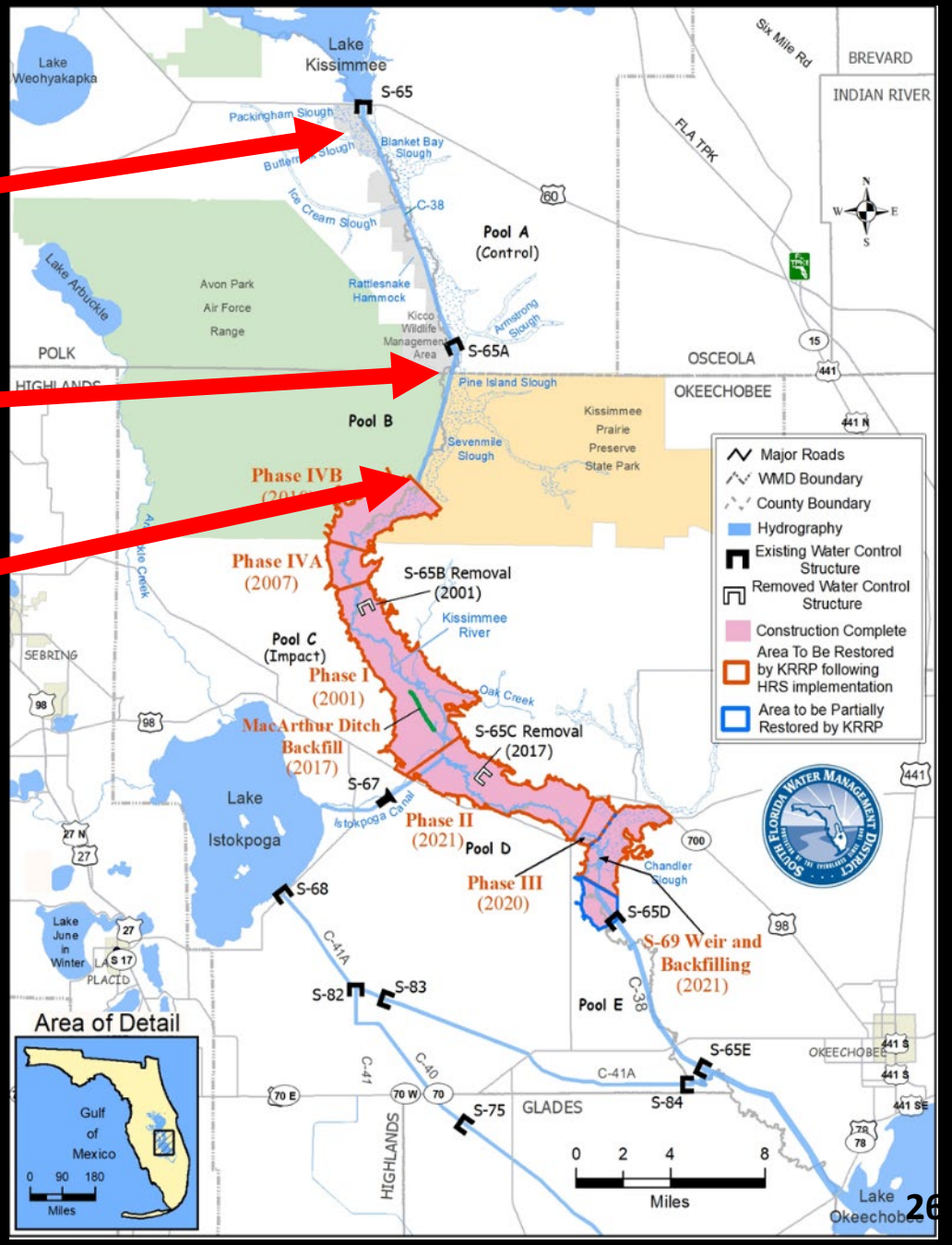
- S69 weir is key flood diverting hydraulic structure of the Kissimmee River Restoration project, it is located between S65C and S65D spillway, near the downstream terminus of the C-38 Canal.
- Hurricane Ian caused some damage of this "U" shape of the weir, per USACE request, HEC-RAS 2D and 3D CFD was used to pre-, post storm and refurbishment scenarios assessment



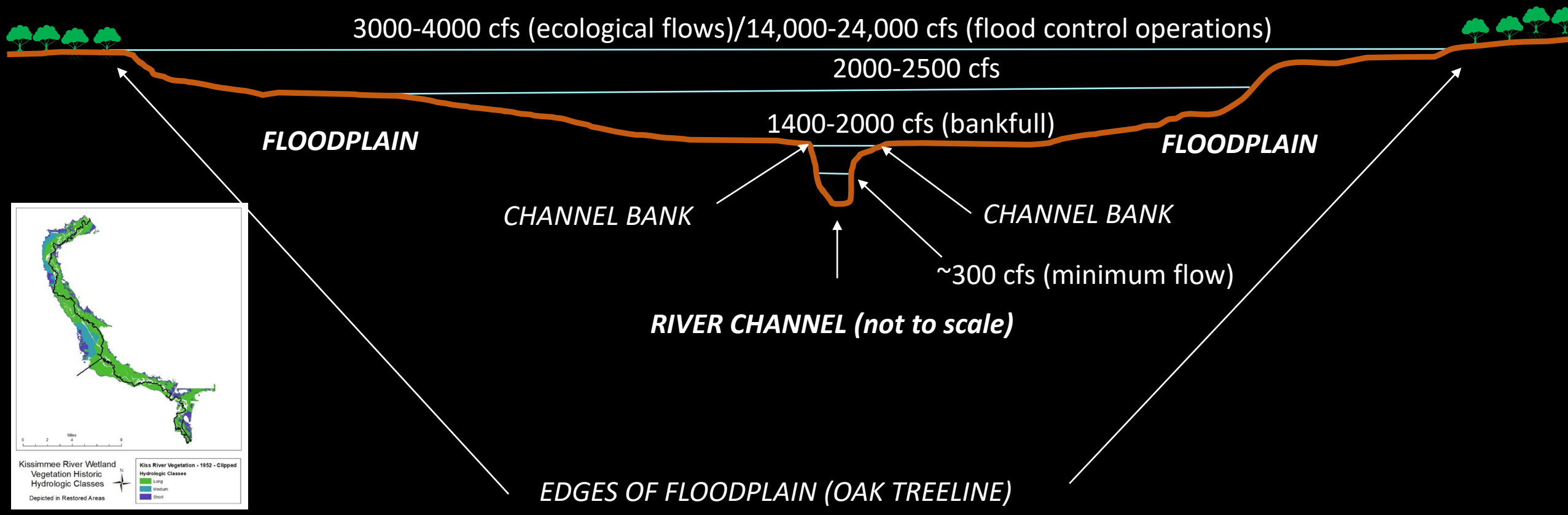


How KRR Hydrology Works

1. Water is released from Lake Kissimmee through S-65
2. Water flows through the C-38 canal in Pool A and is released through the S-65A water control structure toward the KRR project area
3. About 5 miles south of S-65A, water reaches the KRR project area where the canal has been backfilled
4. Water entering the project area flows into the reconstructed river channel
    1. At low flows, water flows within the river channel
    2. At flows greater than about 1400 cfs, the floodplain begins to be inundated
5. At high flows (> 3000 cfs) the S69 weir helps raise the stages and inundate the floodplains

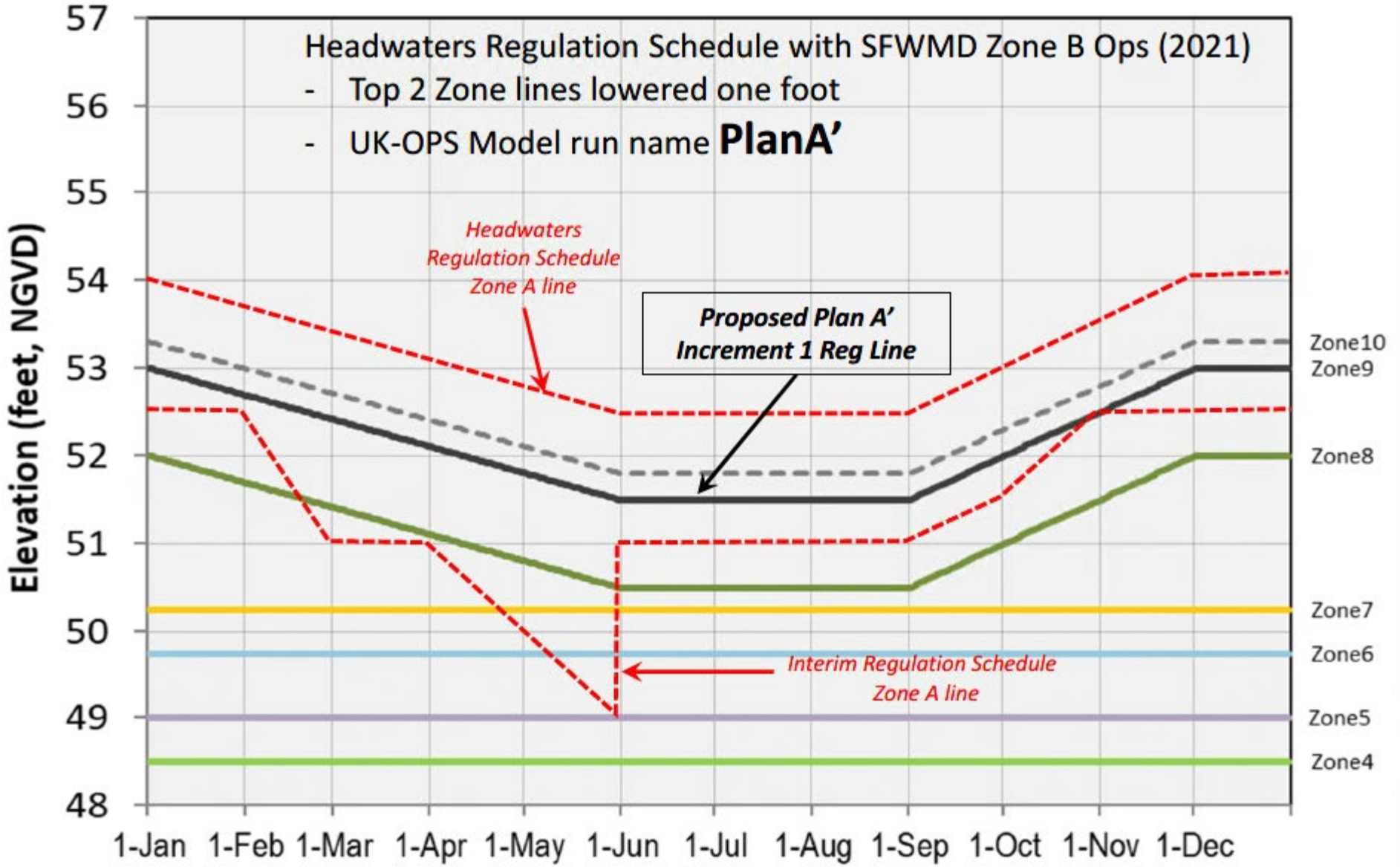


River Channel and Floodplain Stage Depend on Volume of Discharge Into the KRR Project Area

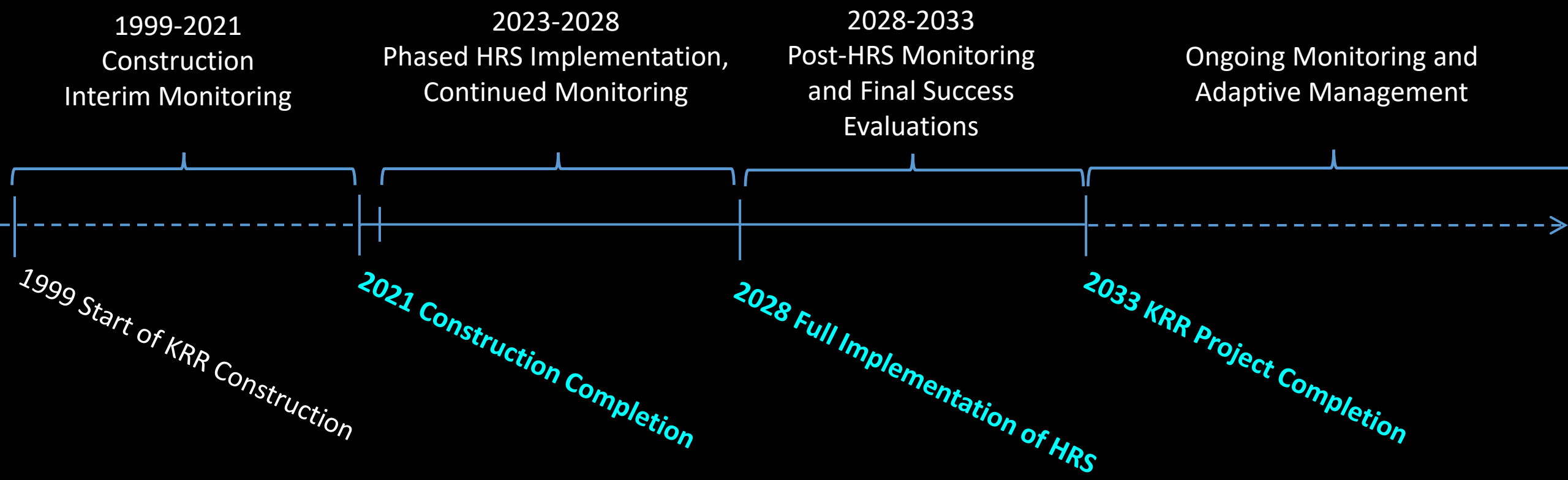


Operating Zones

Lakes Kissimmee, Cypress & Hatchineha

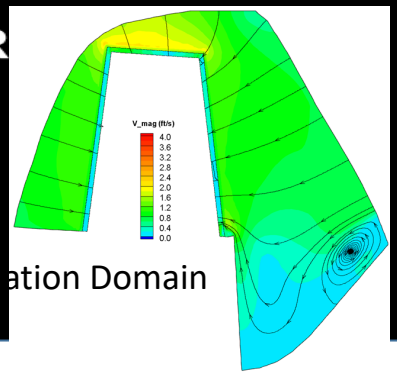


Remaining KRR Timeline (Estimated)



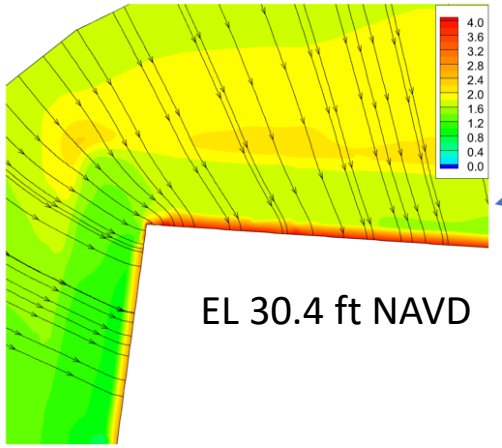
Pre-Storm CFD Assessment

(Q=14500 cfs, TW=27.80 ft. NGVD)

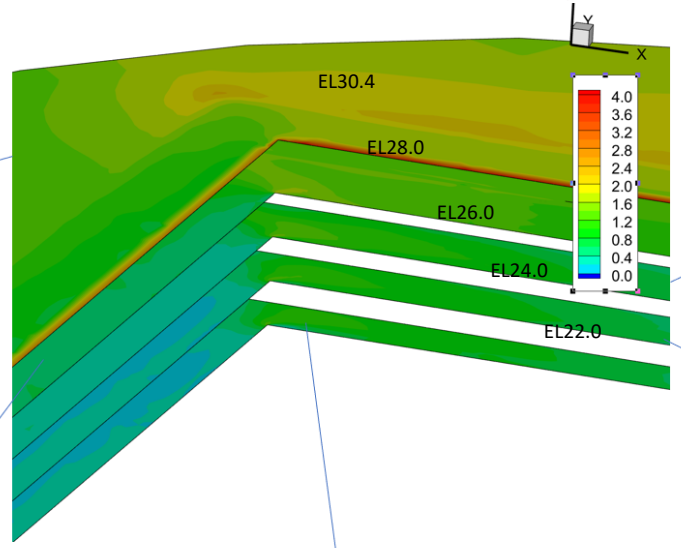


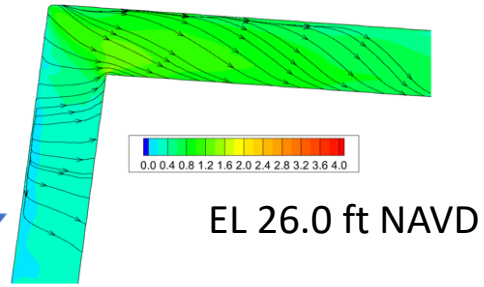
ation Domain

Pre-storm Assessment

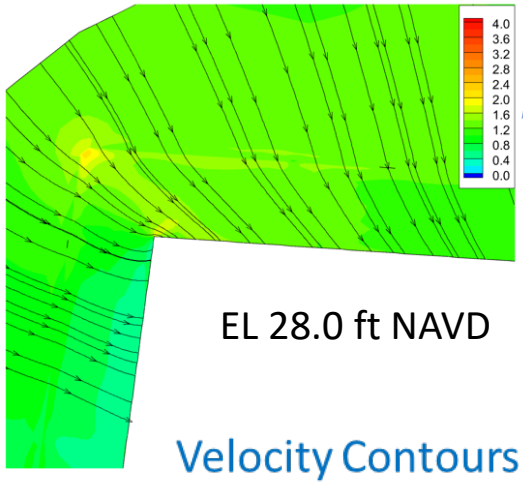


EL 30.4 ft NAVD

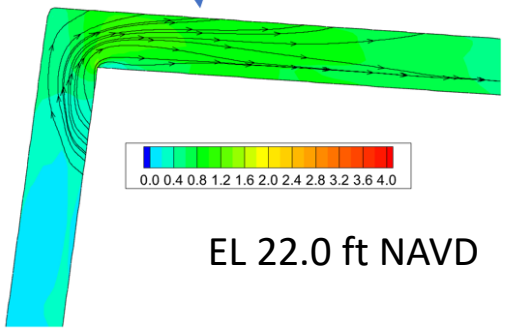




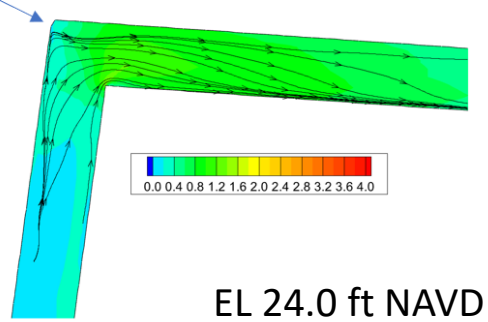
EL 26.0 ft NAVD



EL 28.0 ft NAVD



EL 22.0 ft NAVD



EL 24.0 ft NAVD

Velocity Contours (ft/s) in different water elevation in the north-west of Sump Canal