# Broad River Lake Lure CFD

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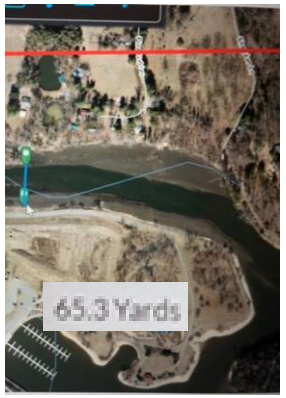
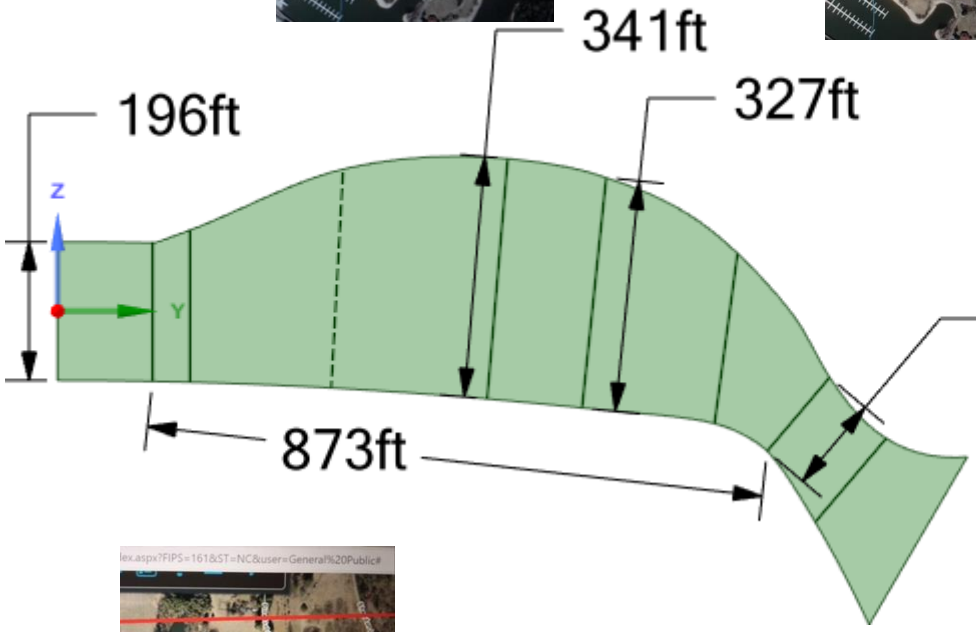
# Goals;

- Create a Model of the Broad River entering into Lake lure to evaluate velocity and flow profiles to determine gradients and geometries that might affect silt/ sand particulate buildup in river bed and lake bed.
- To help determine if the silt and sand deposits can be maintained in the river and after removal of the deposits in the lake…conduct maintenance removal in the river only.
- If the river is unable to become an area where the deposits can be maintained,..evaluate the lake area and what areas of the lake should be focused on for dredging.
- Desired outcome;
  - What areas should dredging be focused on to make the best use of dredging funds allocated and restore the lake to a better more sustainable condition.

# Model Buildout;

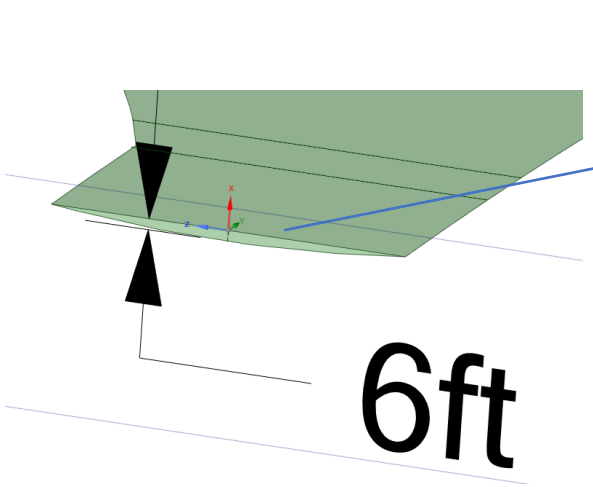


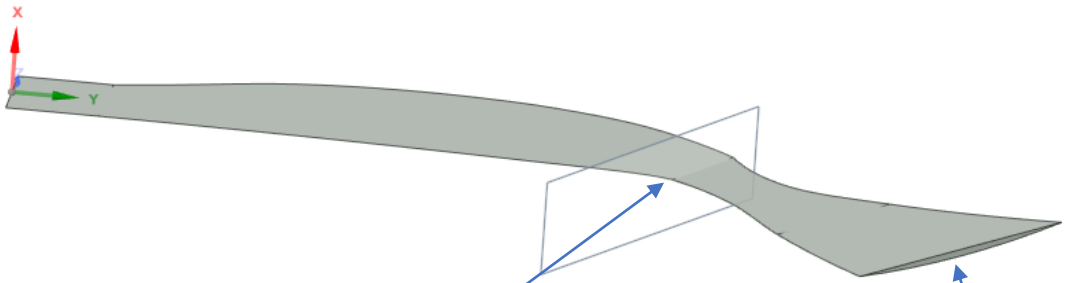


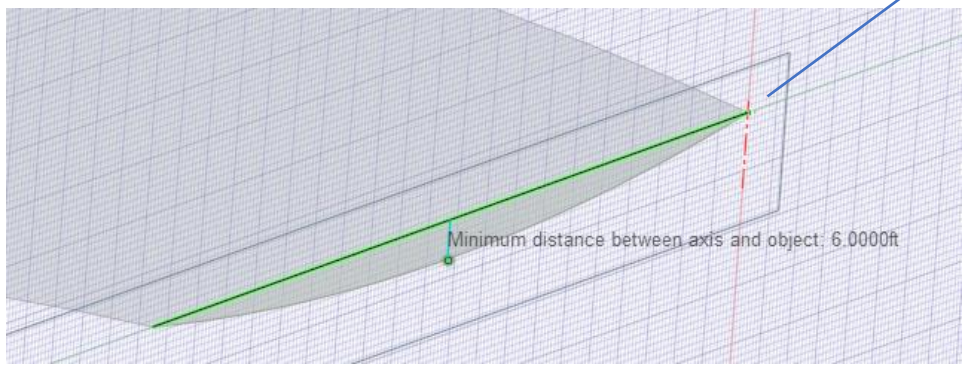



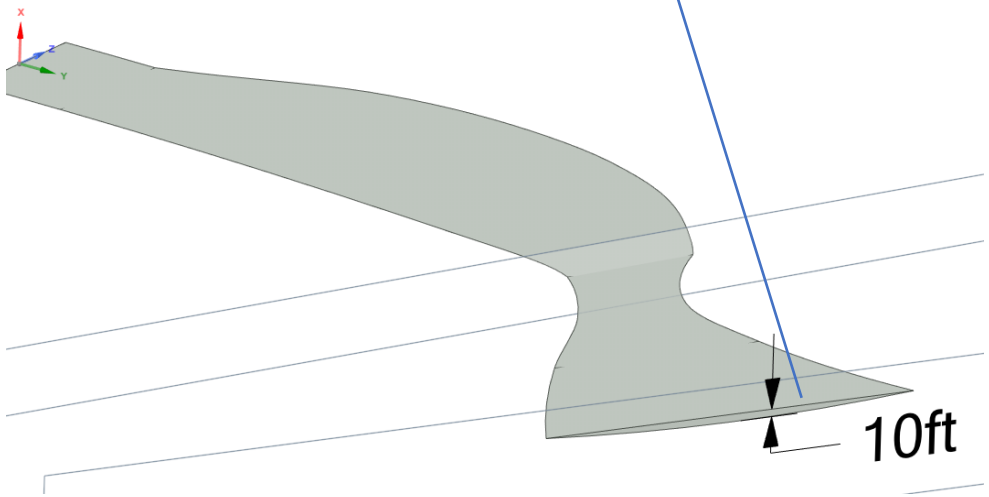



# Model Depths - Current



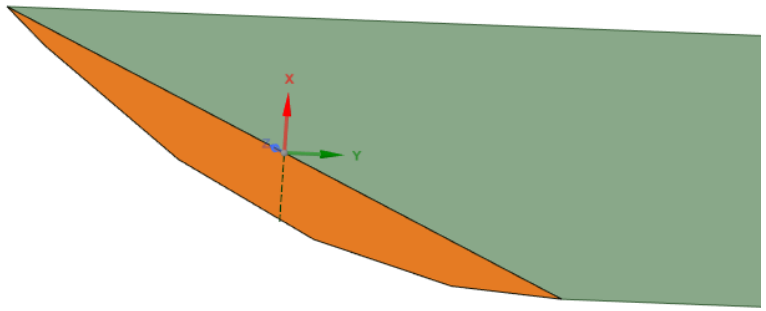





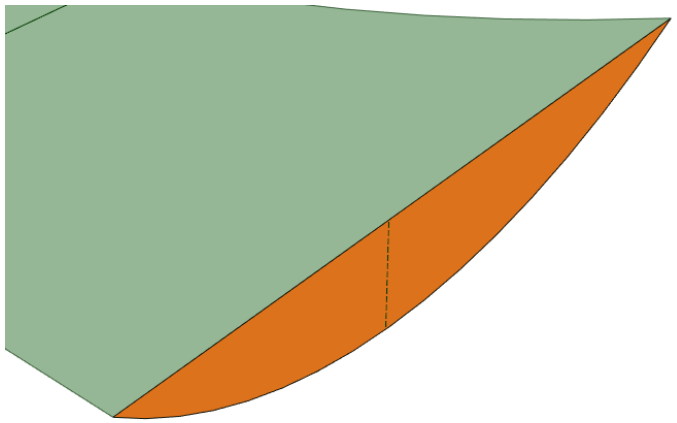
# Boundary Conditions

Inlet Area




| | |
|---|---|
| Area | 784.1877ft² |
| Perimeter | 392.2897ft |

Outlet Area



| | |
|---|---|
| Area | 4609.0598ft² |
| Perimeter | 555.4196ft |

# Rainfall vs. Flow Rate for Lake Lure

Rainfall intensity is classified according to the rate of precipitation:

- Light rain — when the precipitation rate is < 2.5 mm (0.098 in) per hour
- Moderate rain — when the precipitation rate is between 2.5 mm (0.098 in) - 7.6 mm (0.30 in) or 10 mm (0.39 in) per hour
- Heavy rain — when the precipitation rate is > 7.6 mm (0.30 in) per hour, or between 10 mm (0.39 in) and 50 mm (2.0 in) per hour

**Table 4: Summary of the Peak Flows and Rainfall Depths for Watershed Analysis of Lake Lure Dam**

| Storm Event | Rainfall Depth (in) | Lake Lure Inflow (cfs) |
|---|---|---|
| 10 year | 5.01 | 3,430 |
| 50 year | 6.70 | 7,390 |
| 100 year | 7.48 | 9,527 |
| 200 year | 8.29 | 11,963 |
| 500 year | 9.41 | 15,655 |
| 1000 year | 10.3 | 18,857 |
| 64% PMP | 18.99 | 59,750 |
| PMP | 29.67 | 108,379 |

Heavy Rain (.3 in/hr)
2500 ft3/s

Light Rain (.1 in/hr)
800 ft3/s

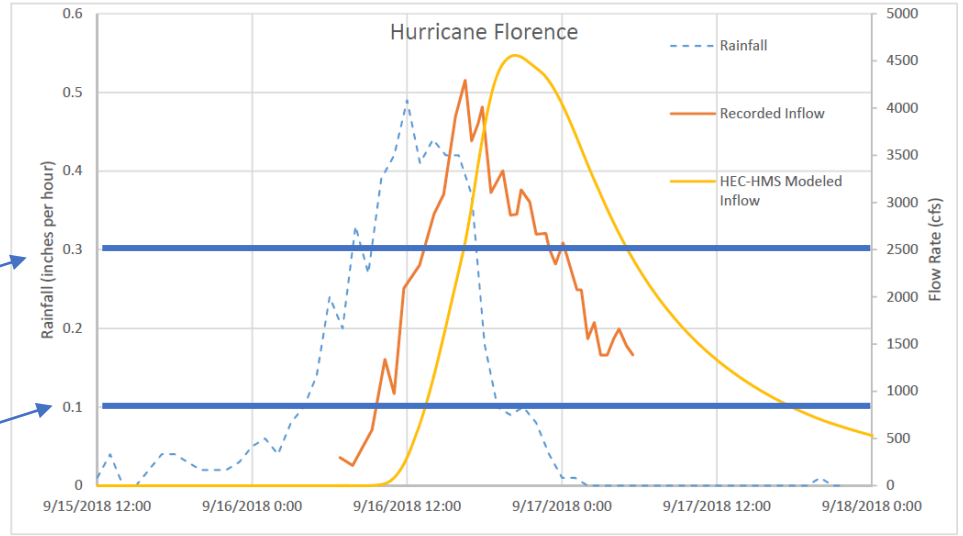
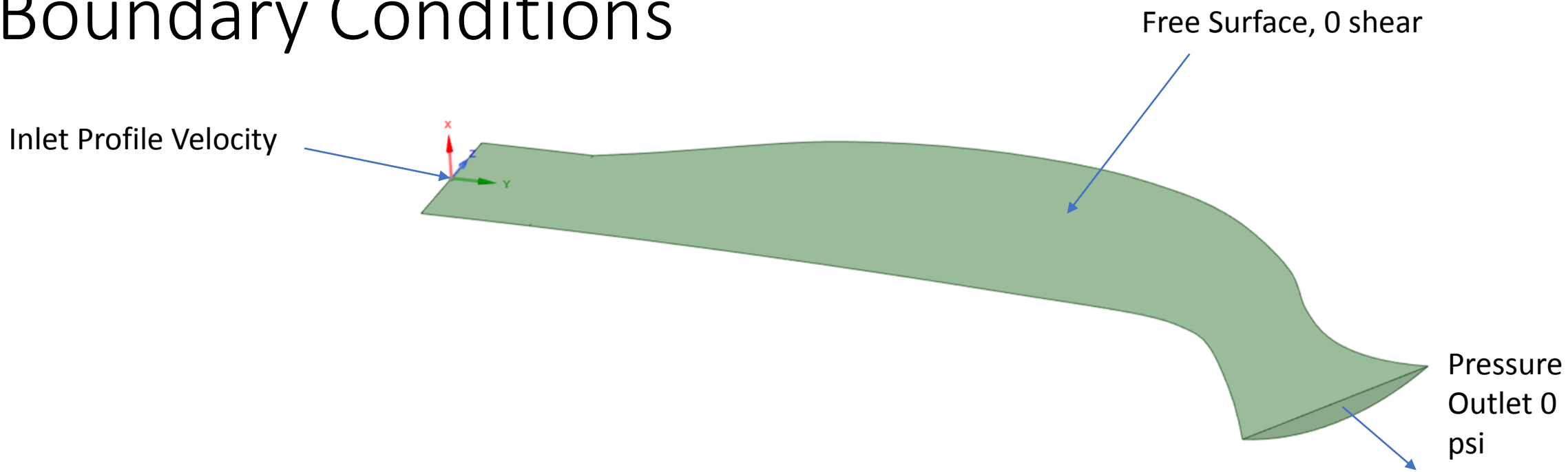



**Figure 3: Hurricane Florence Recorded Data and Modeled Inflow**

# Boundary Conditions




Flow Conditions 1: 10 yr Storm, 2: Heavy Rain
Inlet Volumetric Flow Rate – 1: 3430 ft3/sec, 2: 2500 ft3/s
Velocity inlet profile over area = 1: 4.374 ft/sec (1.333 m/s), 2: 3.188 ft/sec (0.9717 m/sec)

# Hjulstrom-Sundborg Diagram

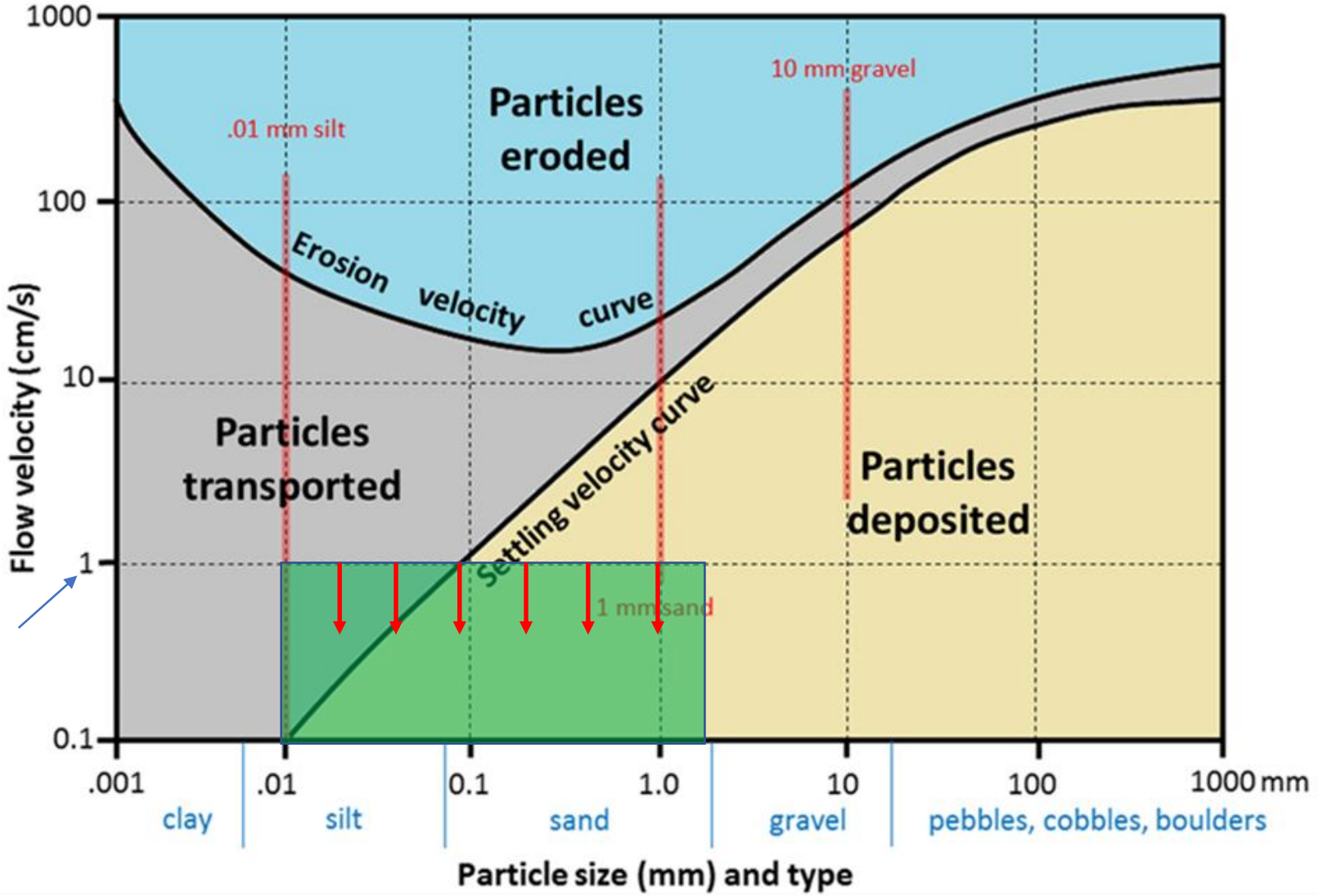



Diagram gives rule of thumb on water velocity and propensity to erode, transport, or settle particulates in water.

To prevent transport to lake bed, velocities in river areas should be reduced below 1 cm/s in order to allow settling of silt and sand to remain in river.

This would allow dredging in this location to be effective.

# Case 1: Base Model Case

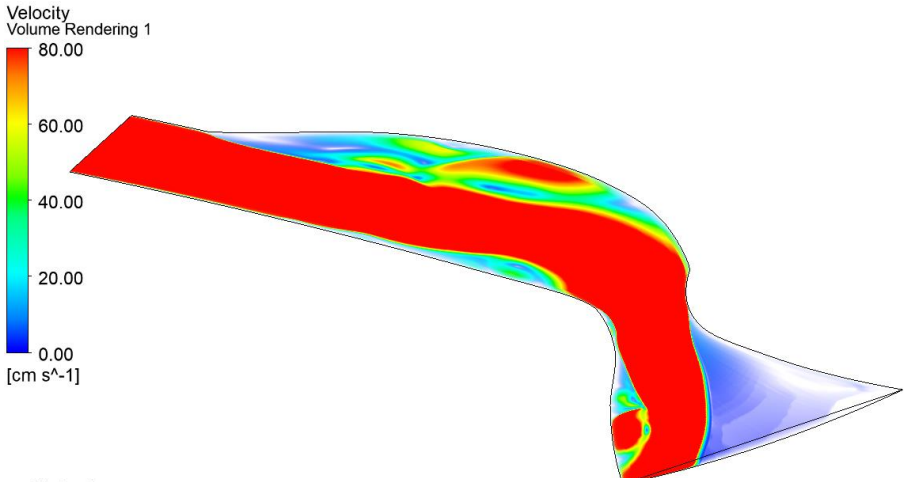
## 6 ft depth for river transition to 10 ft depth at lake

Flow 1: 10 yr rain event 3450 cfs

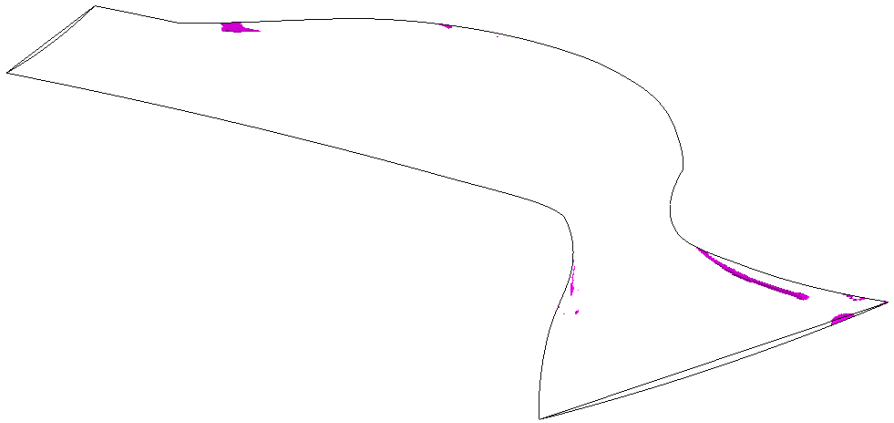
Flow 2: Heavy rain (.3 in/hr) 2500 cfs

# Velocity Profile- Base Model Configuration (6 ft)

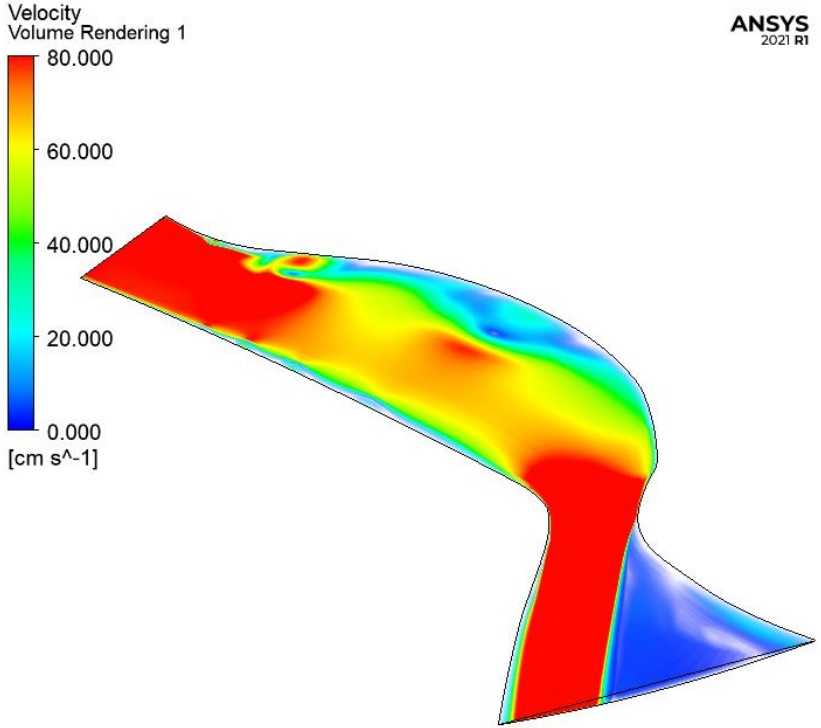
Flow 1
3450

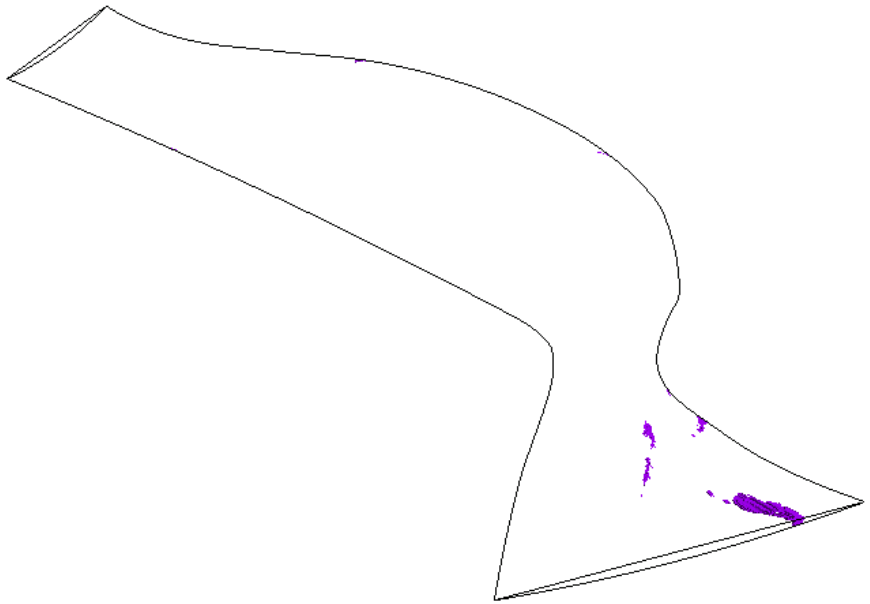



Purple Volume where
velocity is below 1 cm/s



Flow 2
2500



# Case 2:

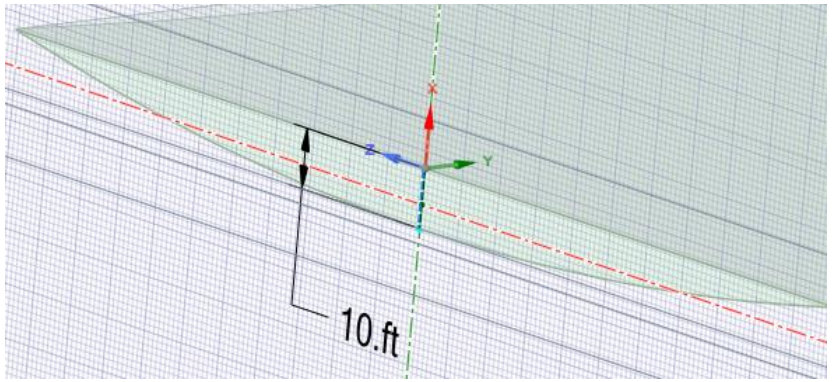
Dredge to 10 ft depth for river transition to 14 ft depth at lake

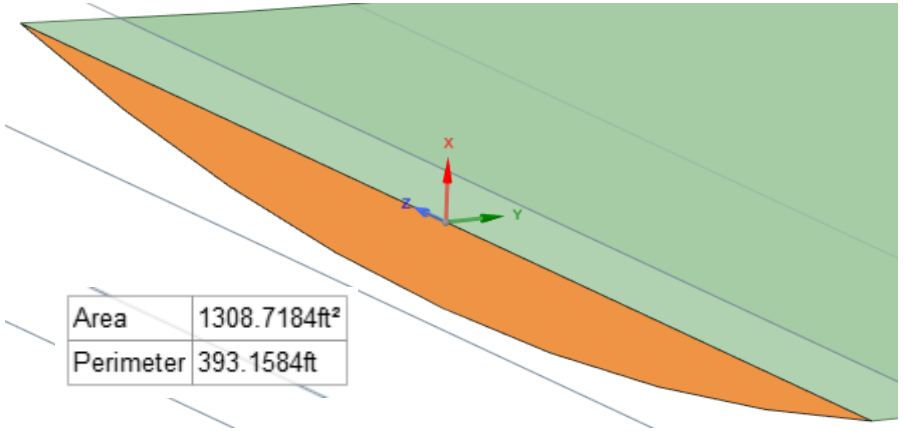
Flow 1: 10 yr rain event 3450 cfs

Flow 2: Heavy rain (.3 in/hr) 2500 cfs

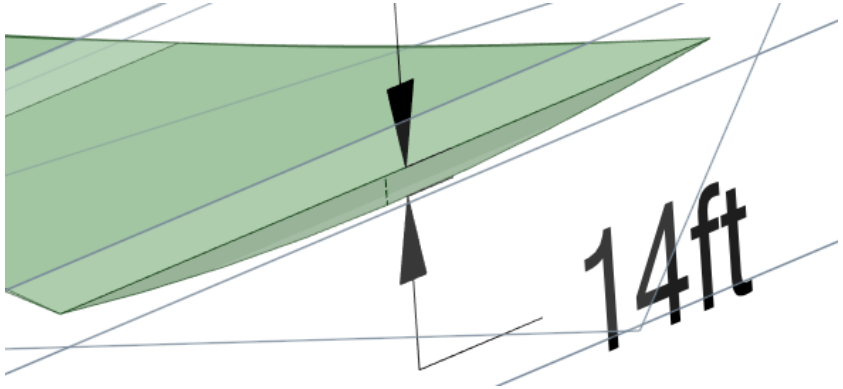
# River Depth 10 ft, lake mouth depth 14 ft

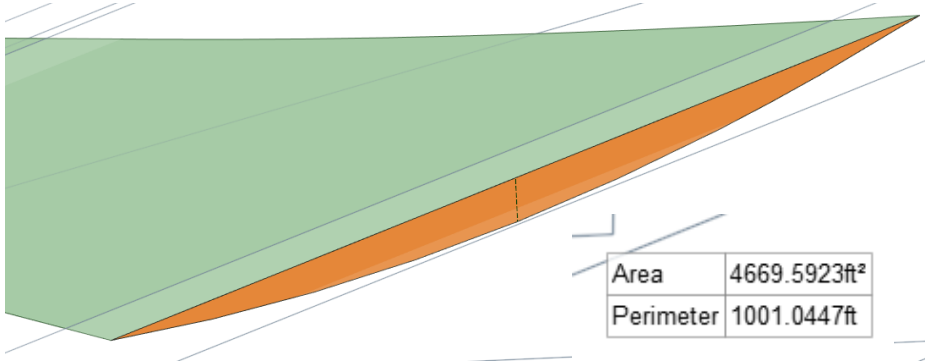
Inlet



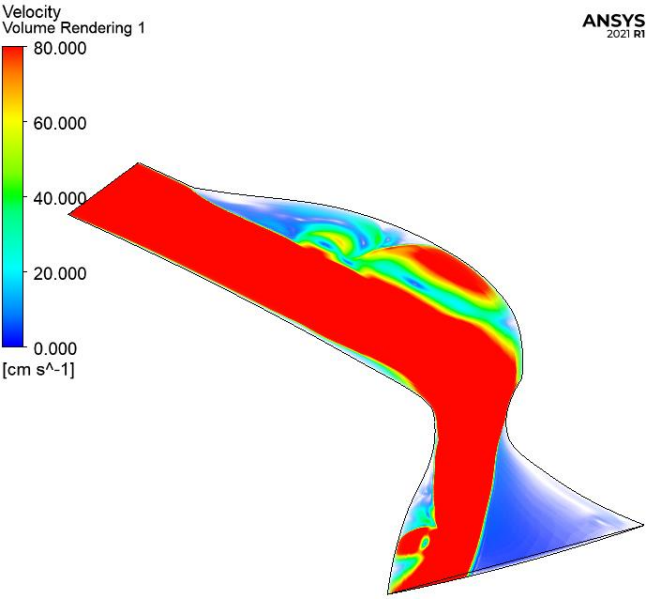

Outlet

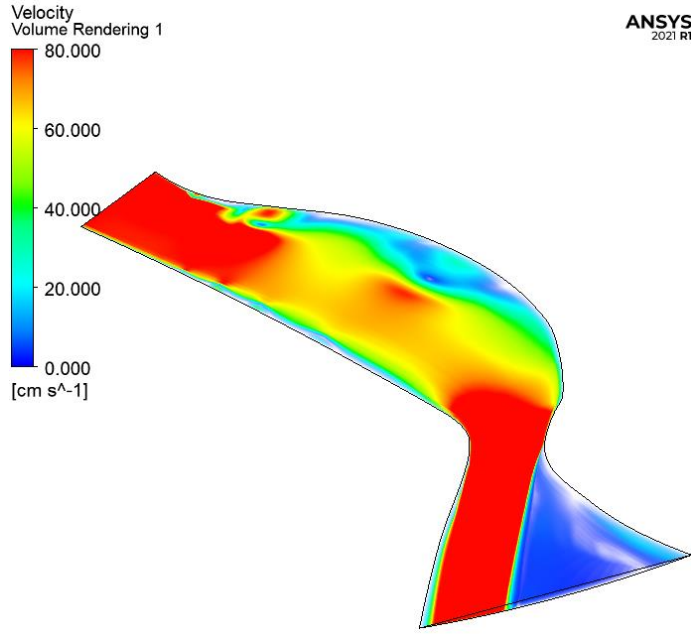


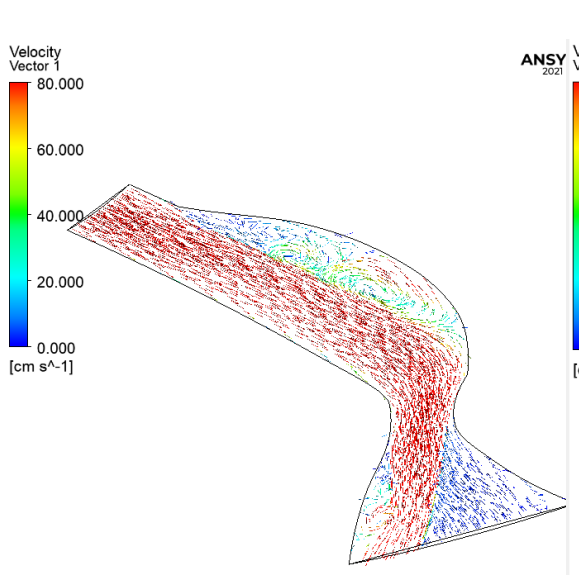




Flow 1: 10 yr storm – 80.3 cm/s
Flow 2: Heavy Rain – 58.2 cm/s

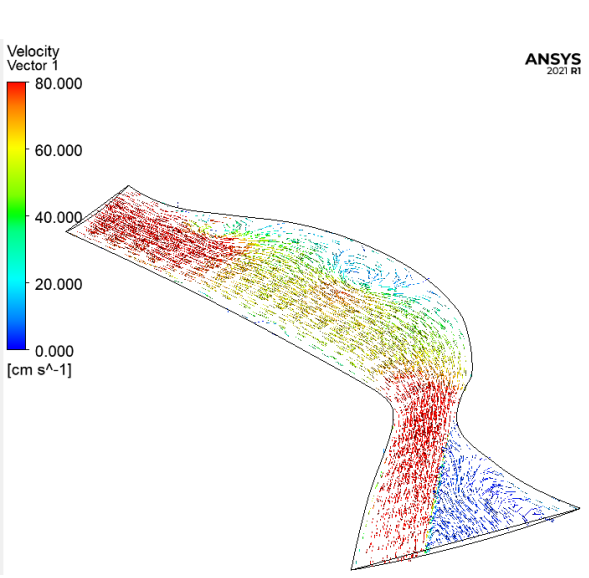
# Velocity Profile – 10 yr Storm Case 3450 cfs



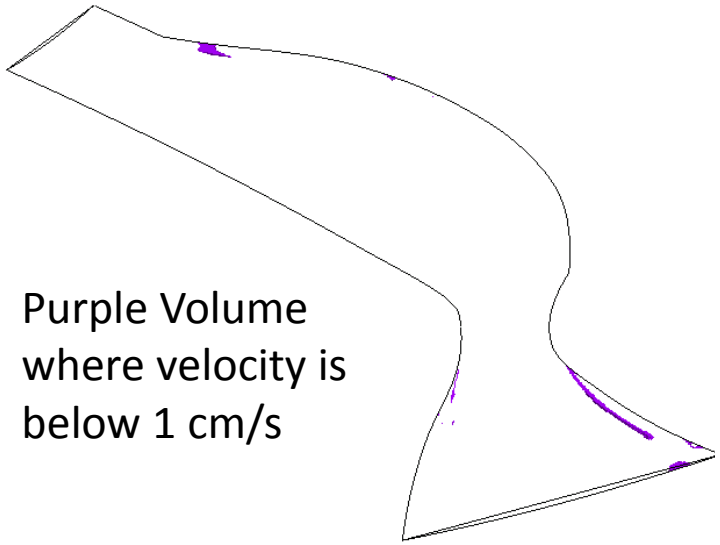




6ft River Depth (current)

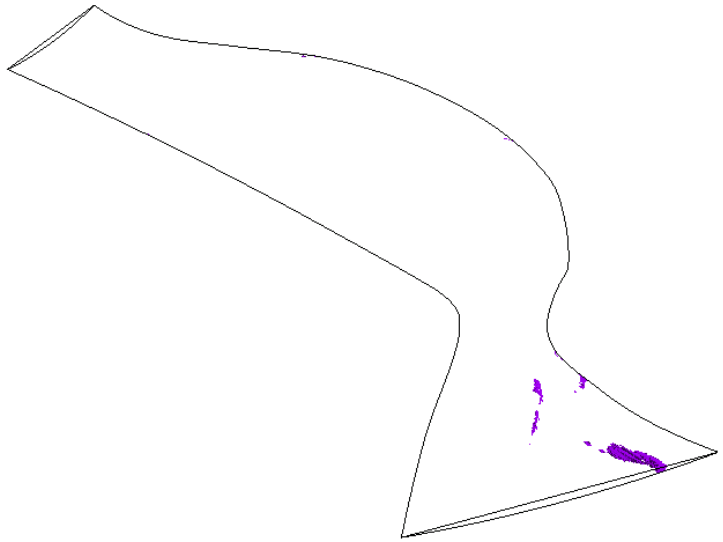



10ft River Depth



Purple Volume where velocity is below 1 cm/s

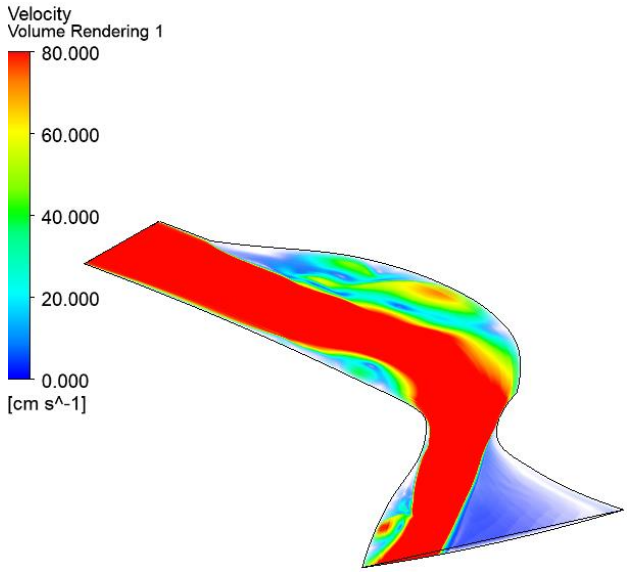
6ft River Depth (Current)

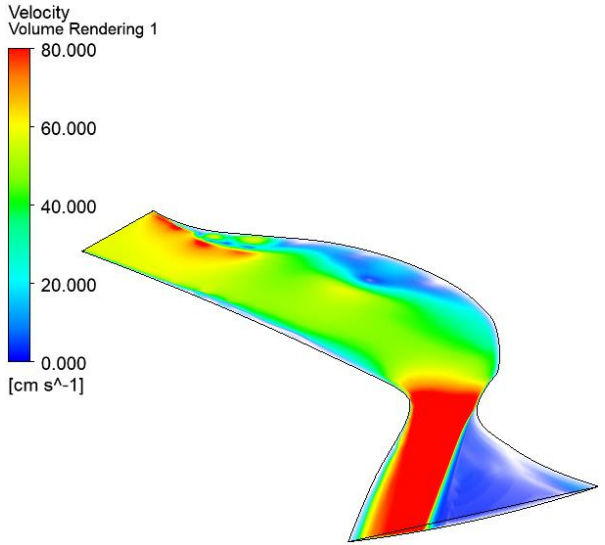


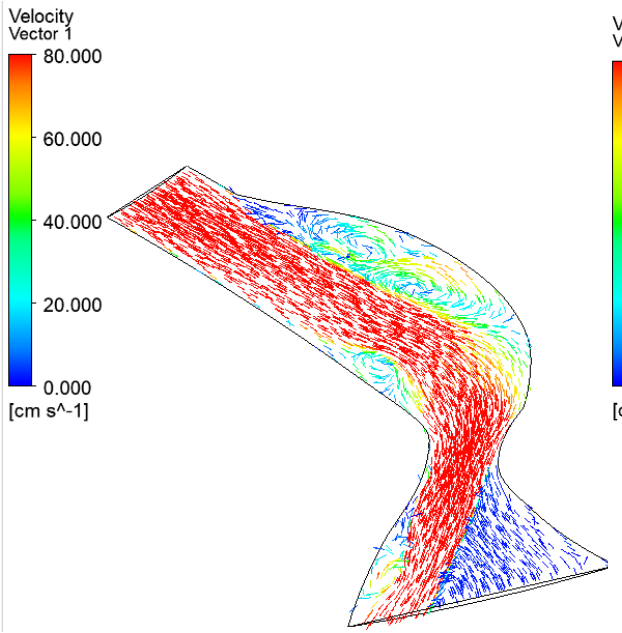
Dredge to 10ft River Depth

No significant change

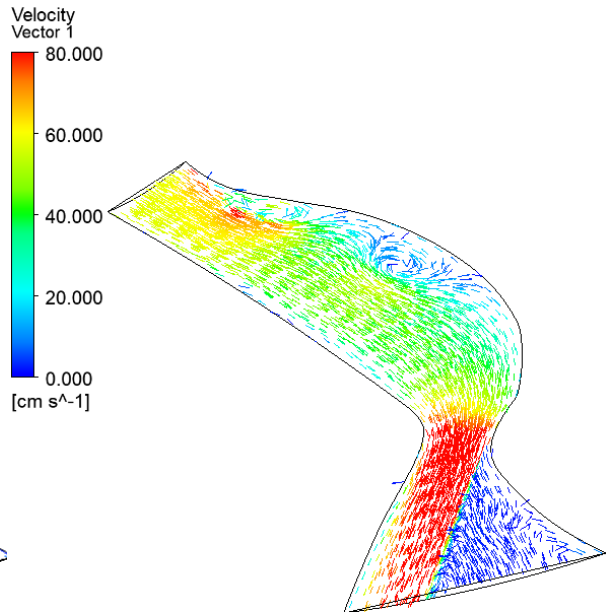
# Velocity Profile – Heavy Rain Case 2500 cfs



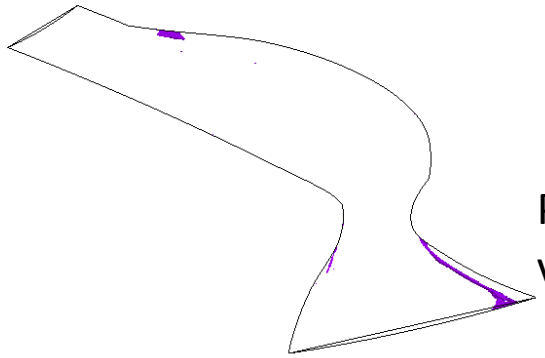




6ft River Depth
(Current)




10ft River Depth
(Current)



Purple Volume where
velocity is below 1 cm/s

**No significant change**

6ft River Depth
(Current)

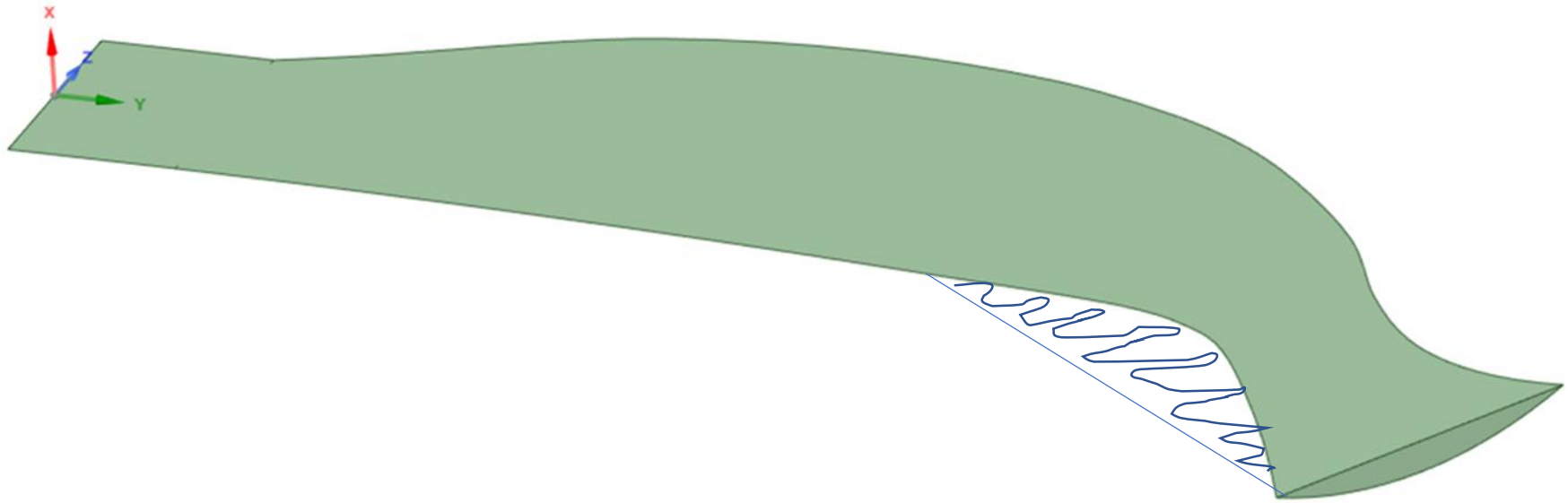
10ft River Depth
(Current)

# Case 3:

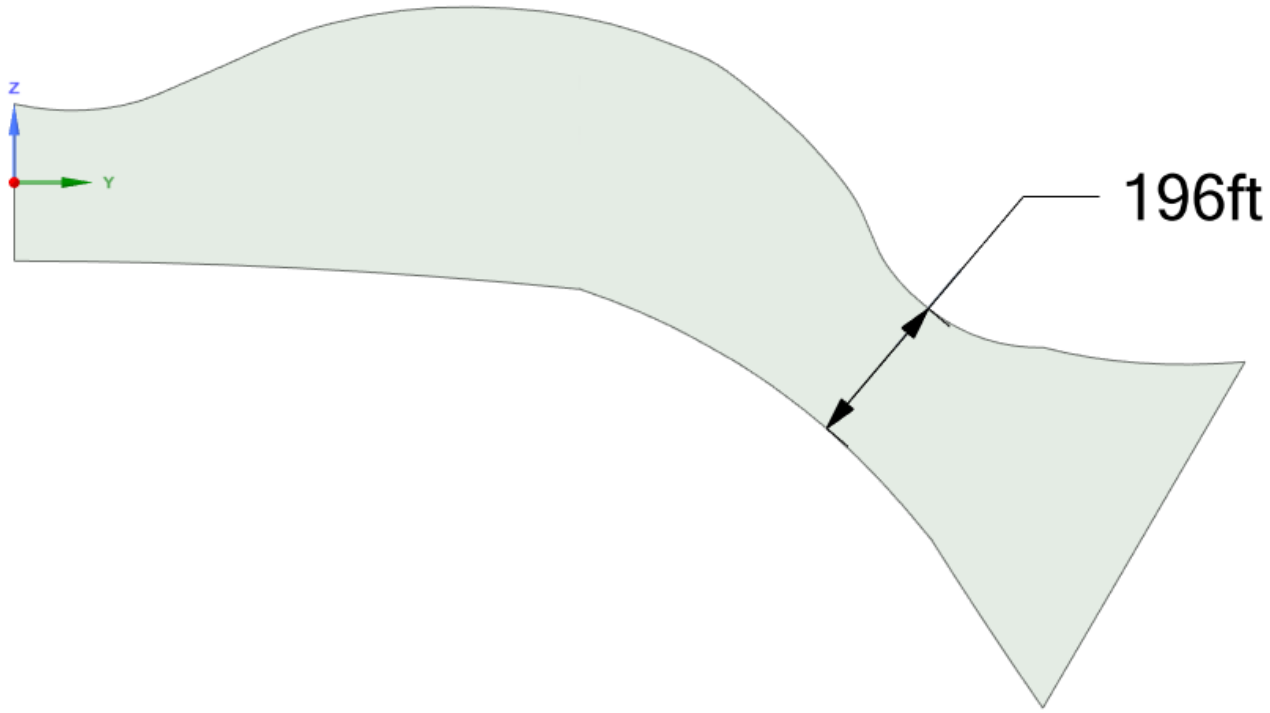
## Widen Bend at river to reduce mouth speed / velocity

Flow 1: 10 yr rain event 3450 cfs

Flow 2: Heavy rain (.3 in/hr) 2500 cfs



# Modified Turn




**Increased narrow opening to mouth of river from 136 ft by 20 yds to 196 ft.**

**10 ft dredged depth**

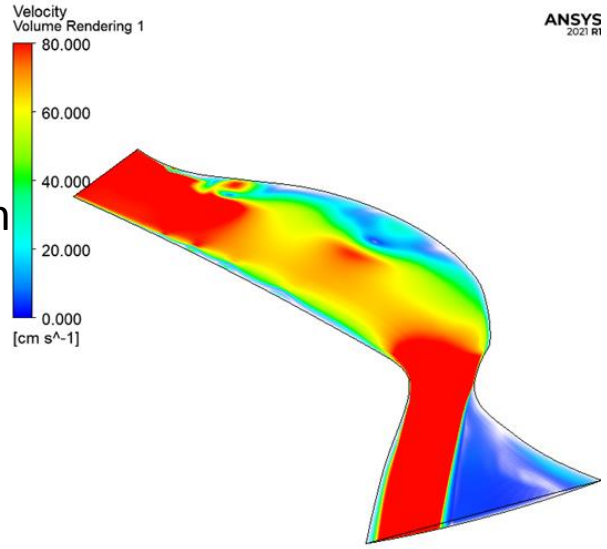
# Velocity Contours

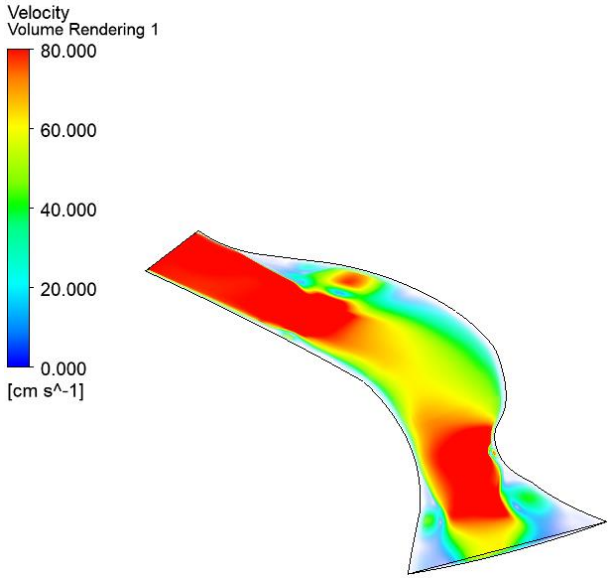
Original

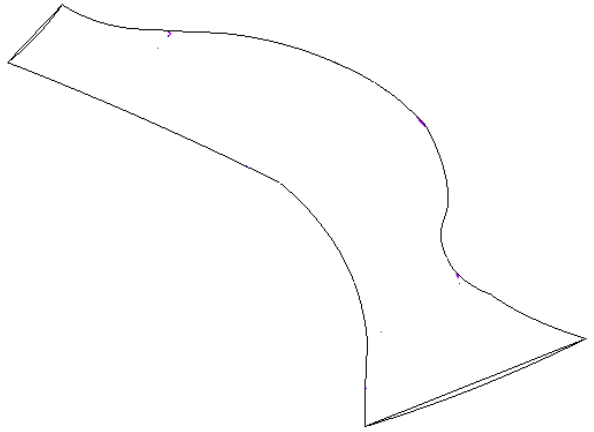
Widen Bend

Purple volume where velocity is below 1 cm/s

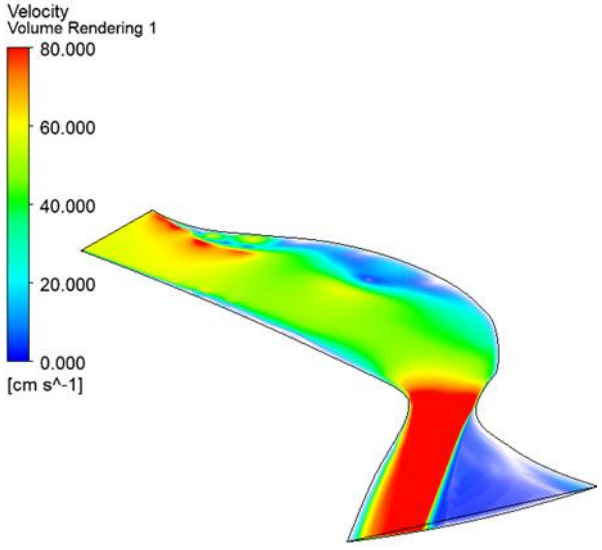
Flow 1: 10yr Storm 3450

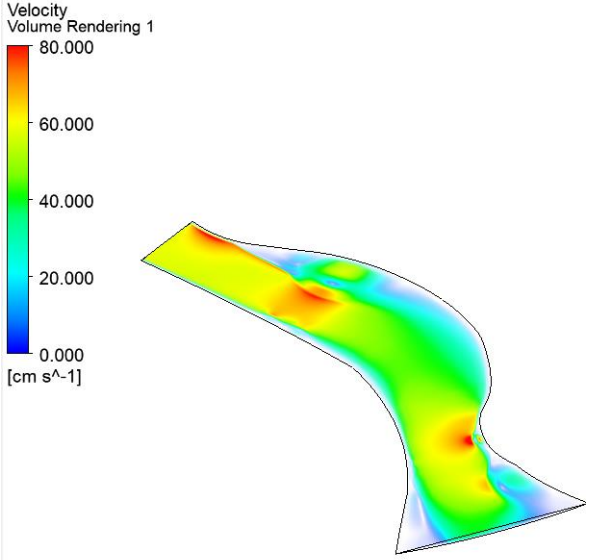


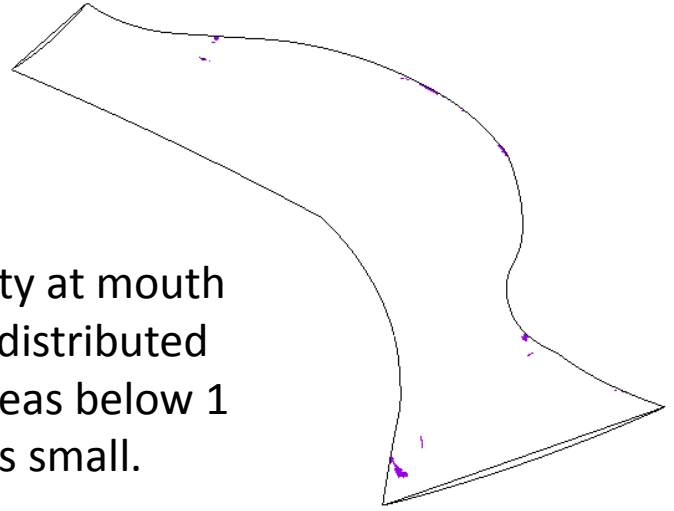



Flow 2: Heavy rain 2500



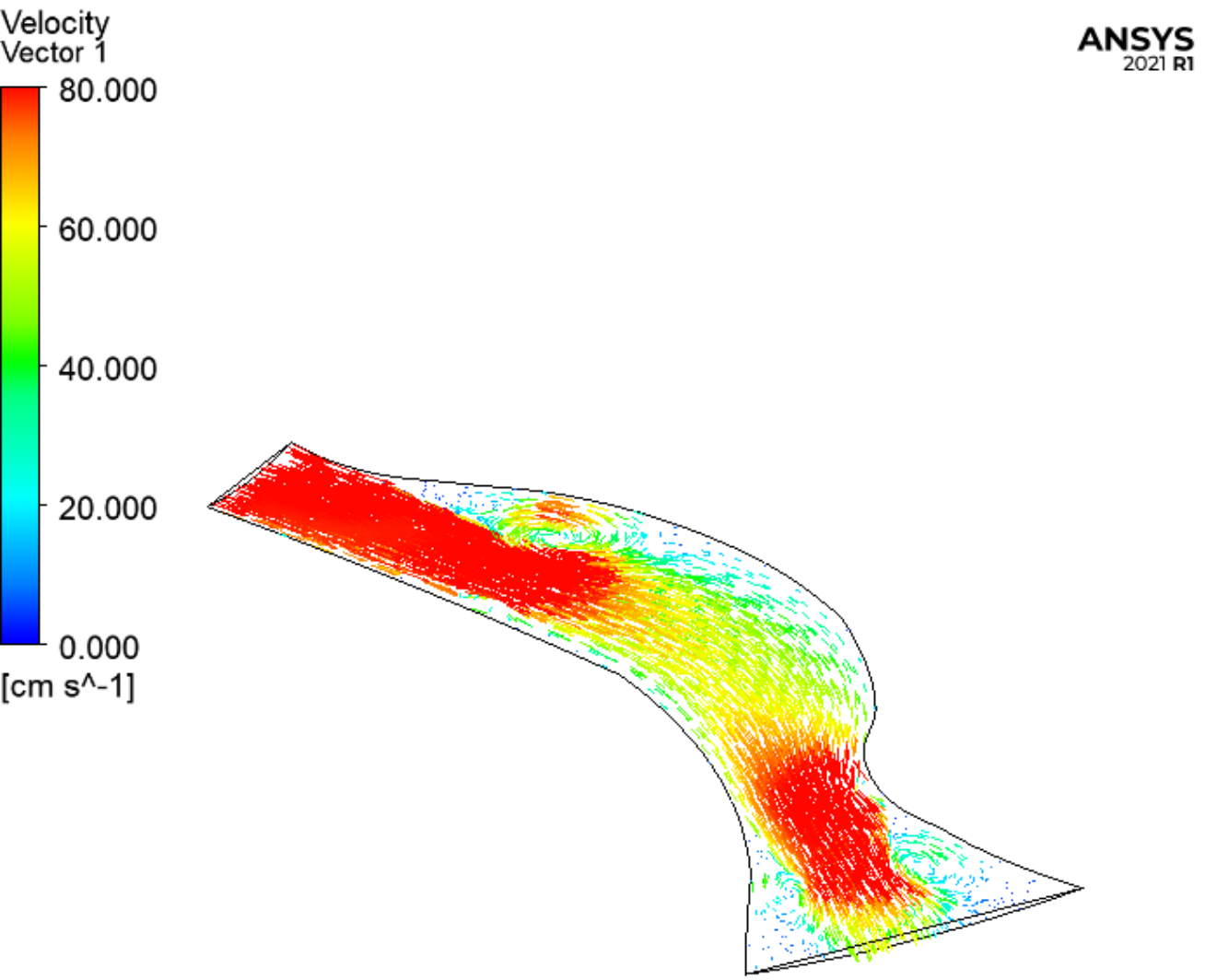



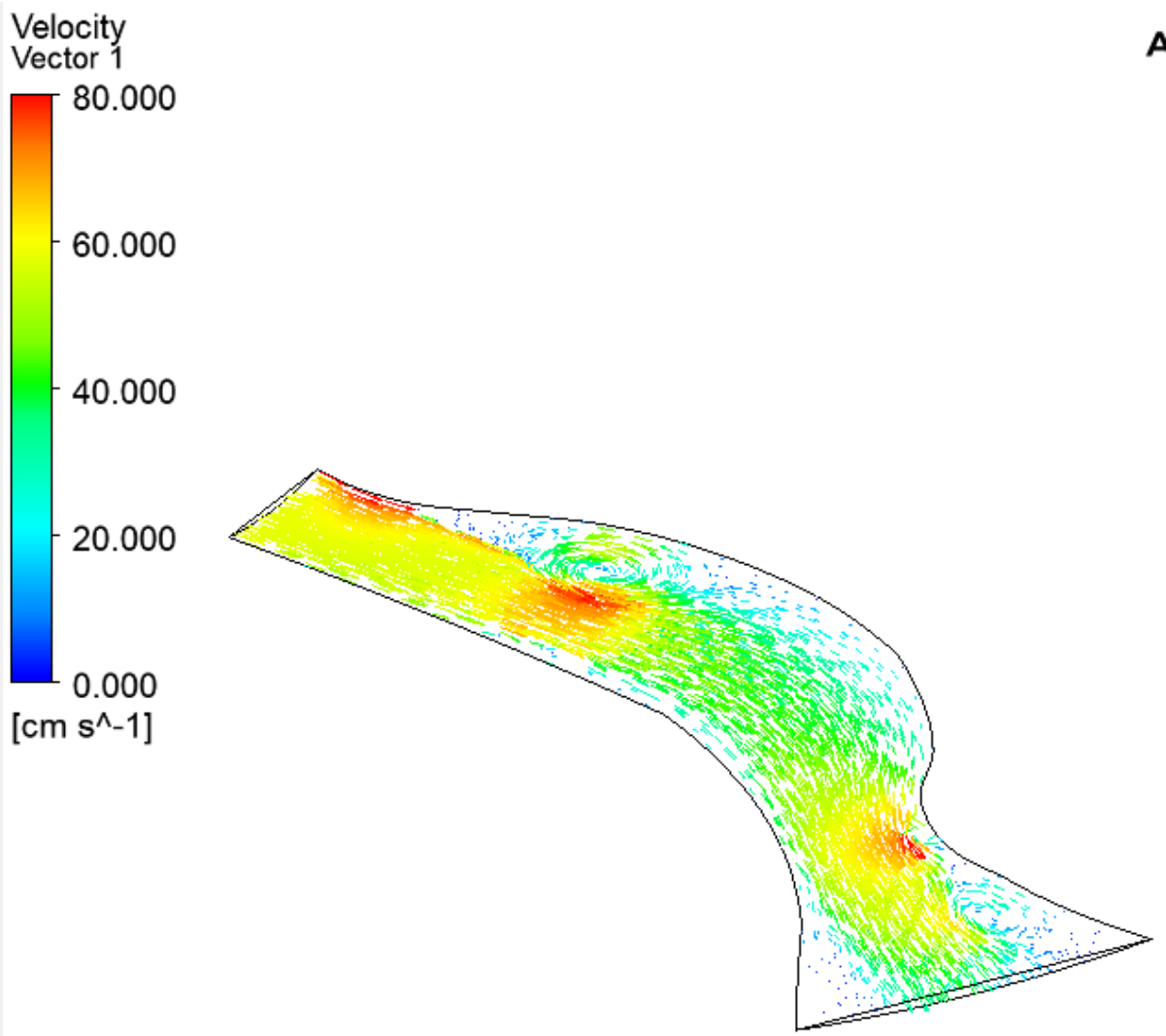
Velocity at mouth more distributed but areas below 1 cm/s is small.

# Velocity Vectors

Flow 1: 10yr Storm
3450




Flow 2: Heavy rain
2500

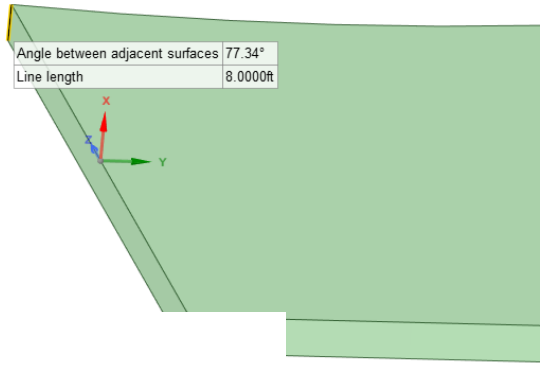


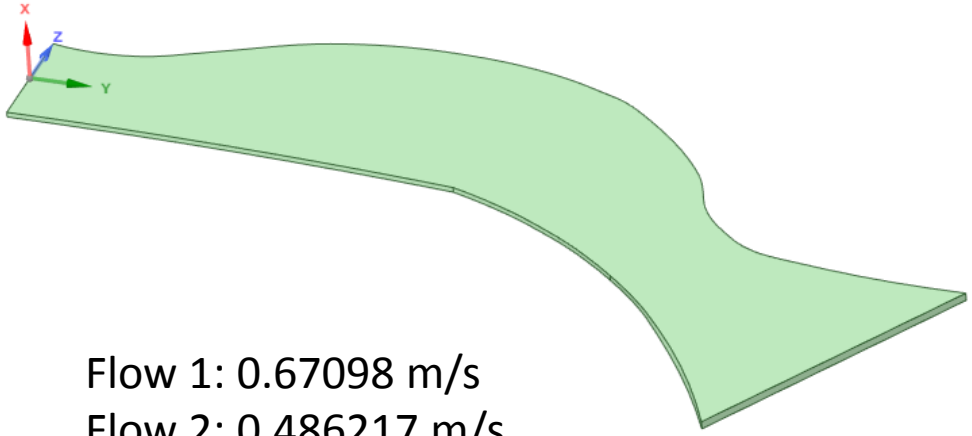
# Case 4:

Widened Bend at river to slow down mouth speed 8ft dredge depth, shore to shore, 14 foot slope to lake after mouth.

Flow 1: 10 yr rain event 3450 cfs

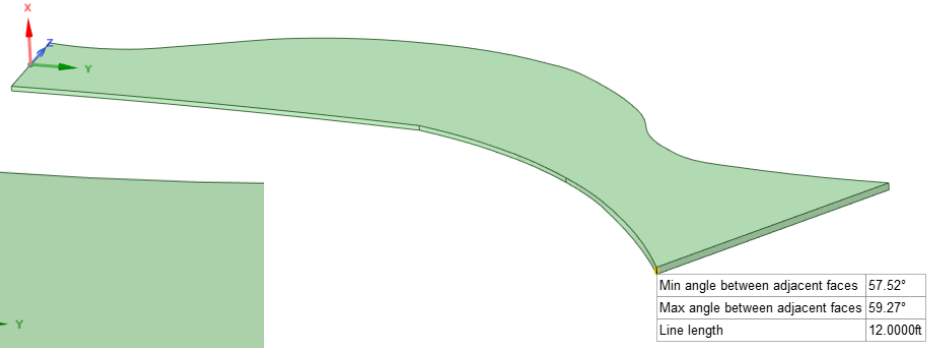
Flow 2: Heavy rain (.3 in/hr) 2500 cfs

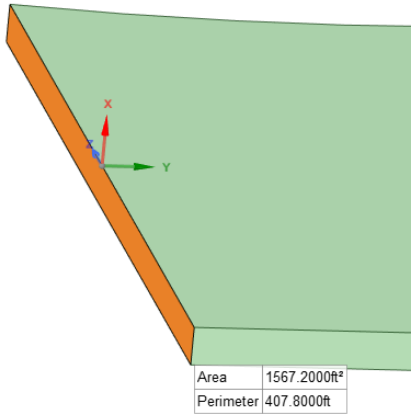


Flow 1: 0.67098 m/s

Flow 2: 0.486217 m/s



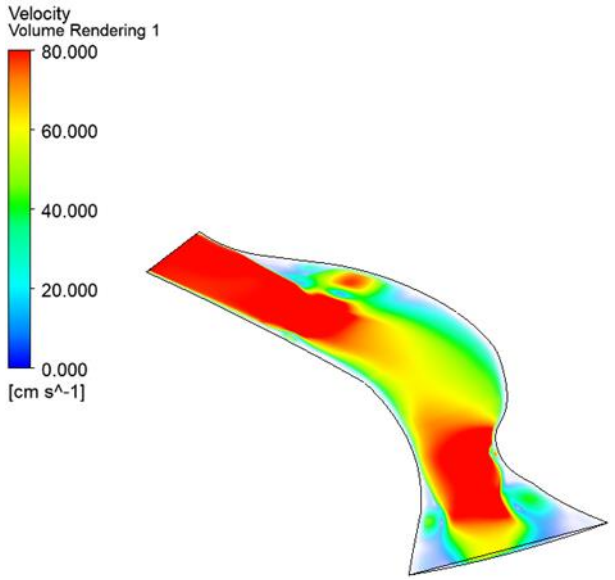
# Velocity Contours-Widened Bend

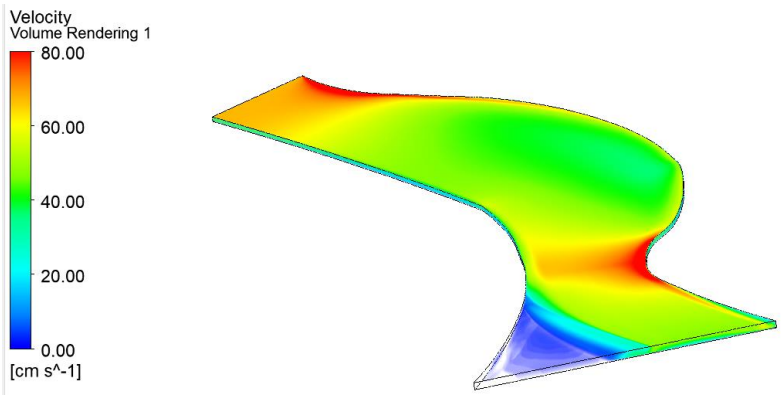
10 ft Dredge Arc Bottom

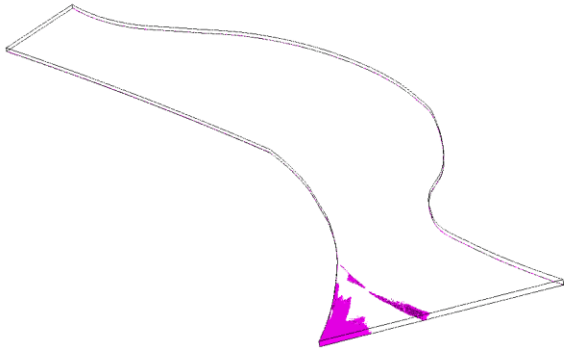
8 ft Dredge Shore to Shore

Purple volume where velocity is below 1 cm/s

Flow 1: 10yr Storm 3450



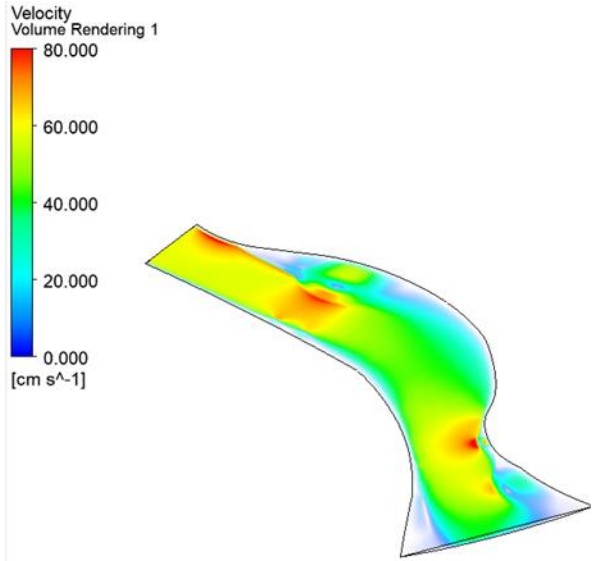



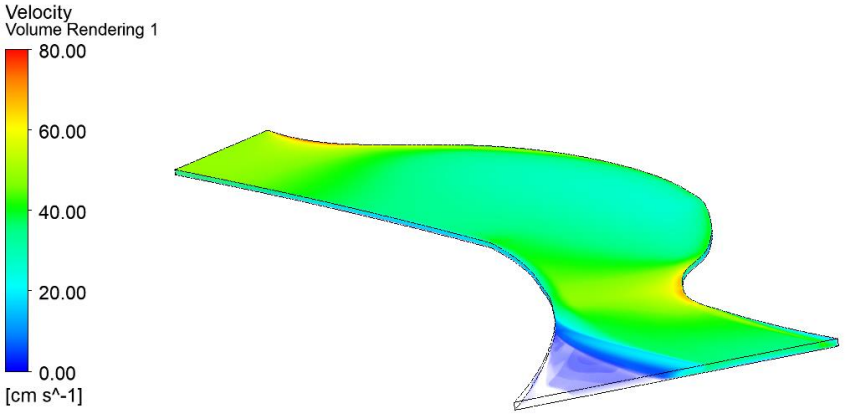



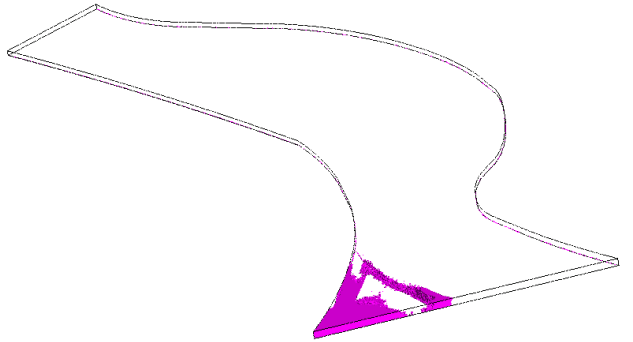
Shore to shore dredging evens out velocity profile.

Velocity below 1 cm/s is small.

Flow 2: Heavy rain 2500



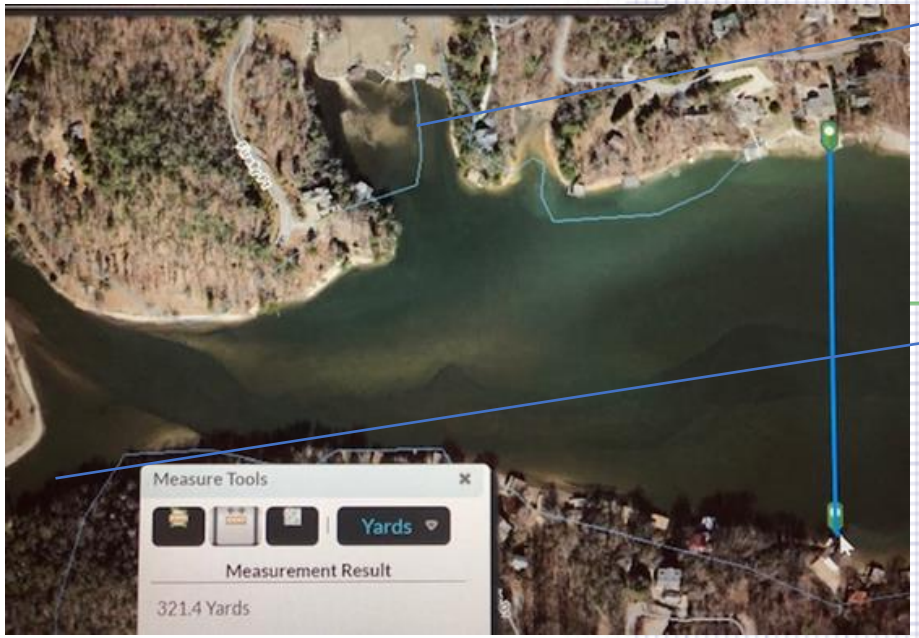



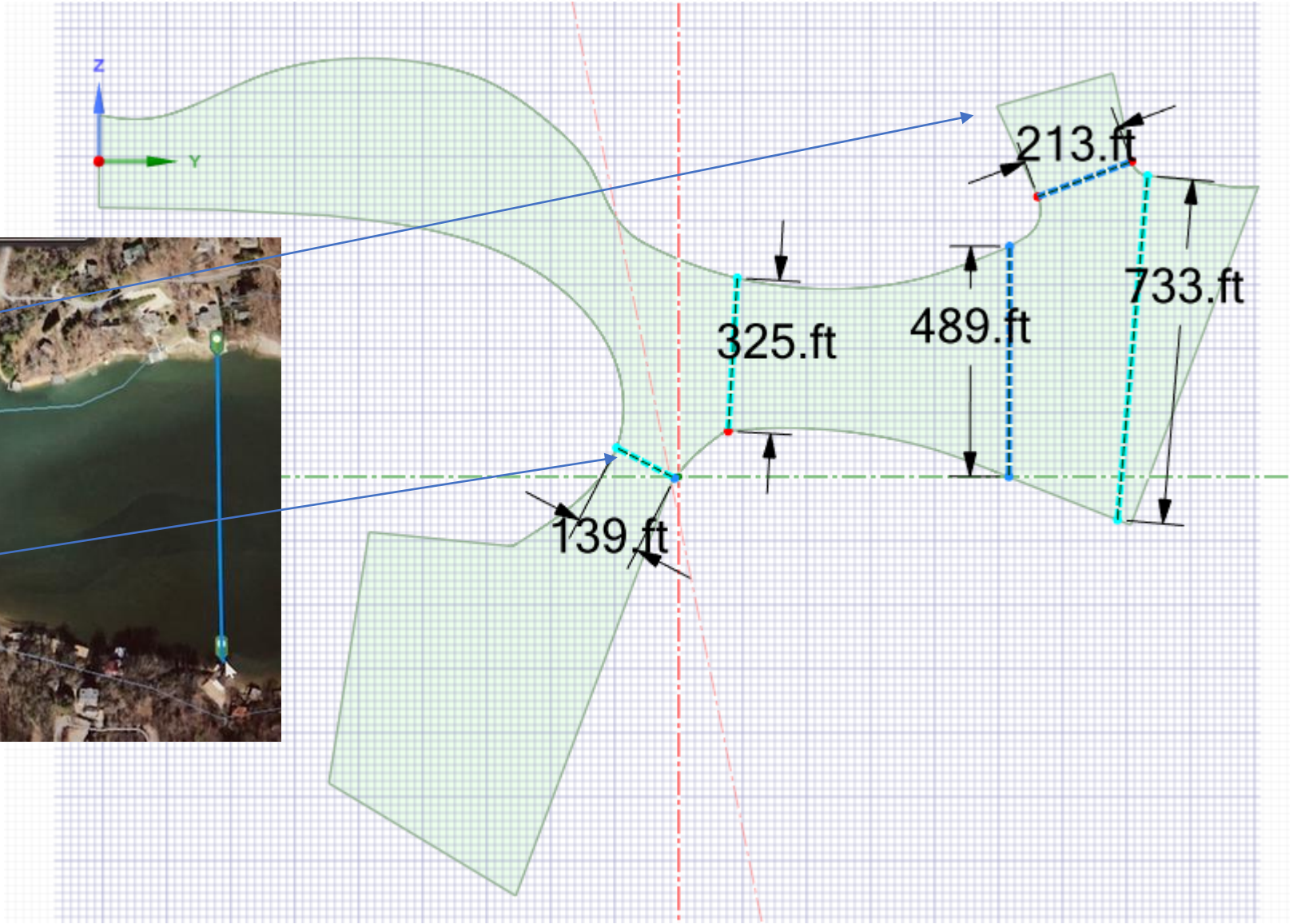



# Case 5:
# Enlarge the model to include the front end of the lake.

Flow Condition Light Rain (.1 in/hr) 800 cfs

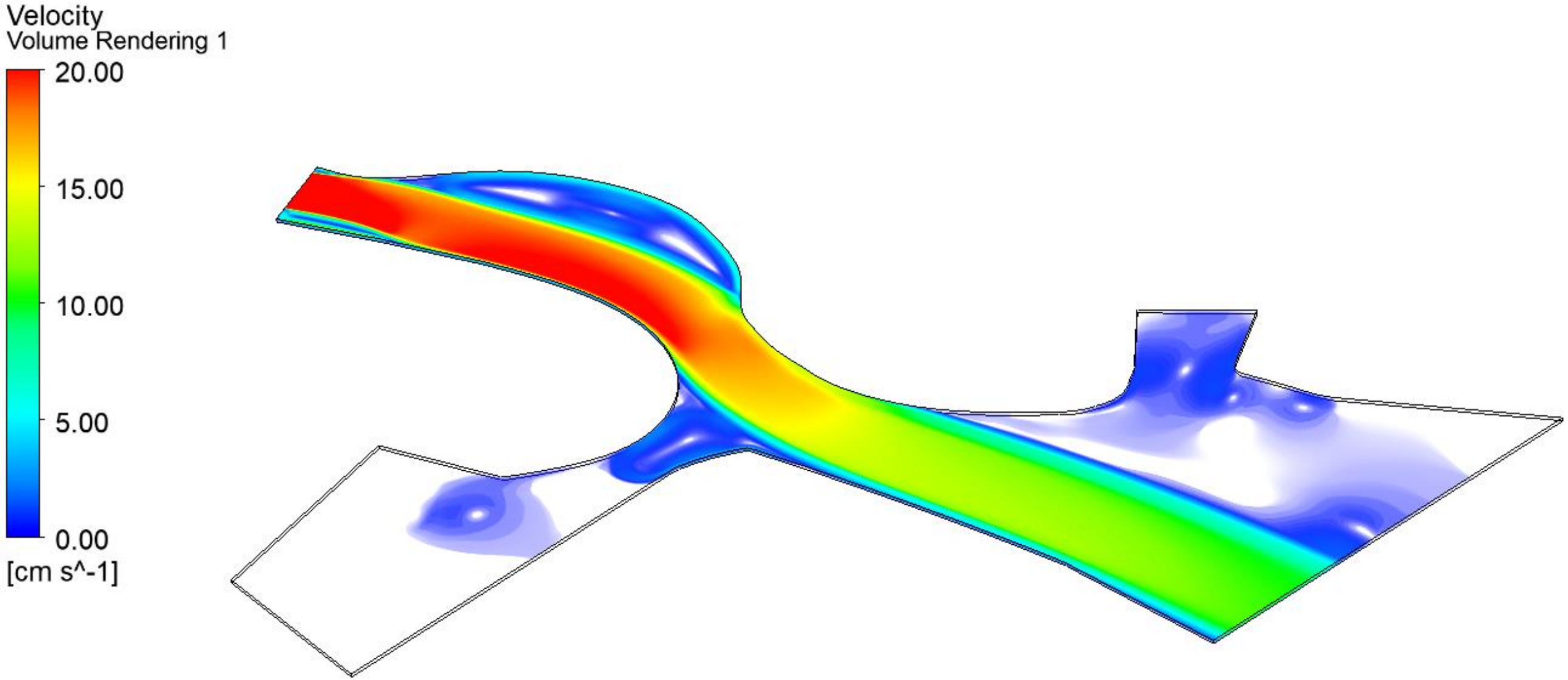
# Model Build out:



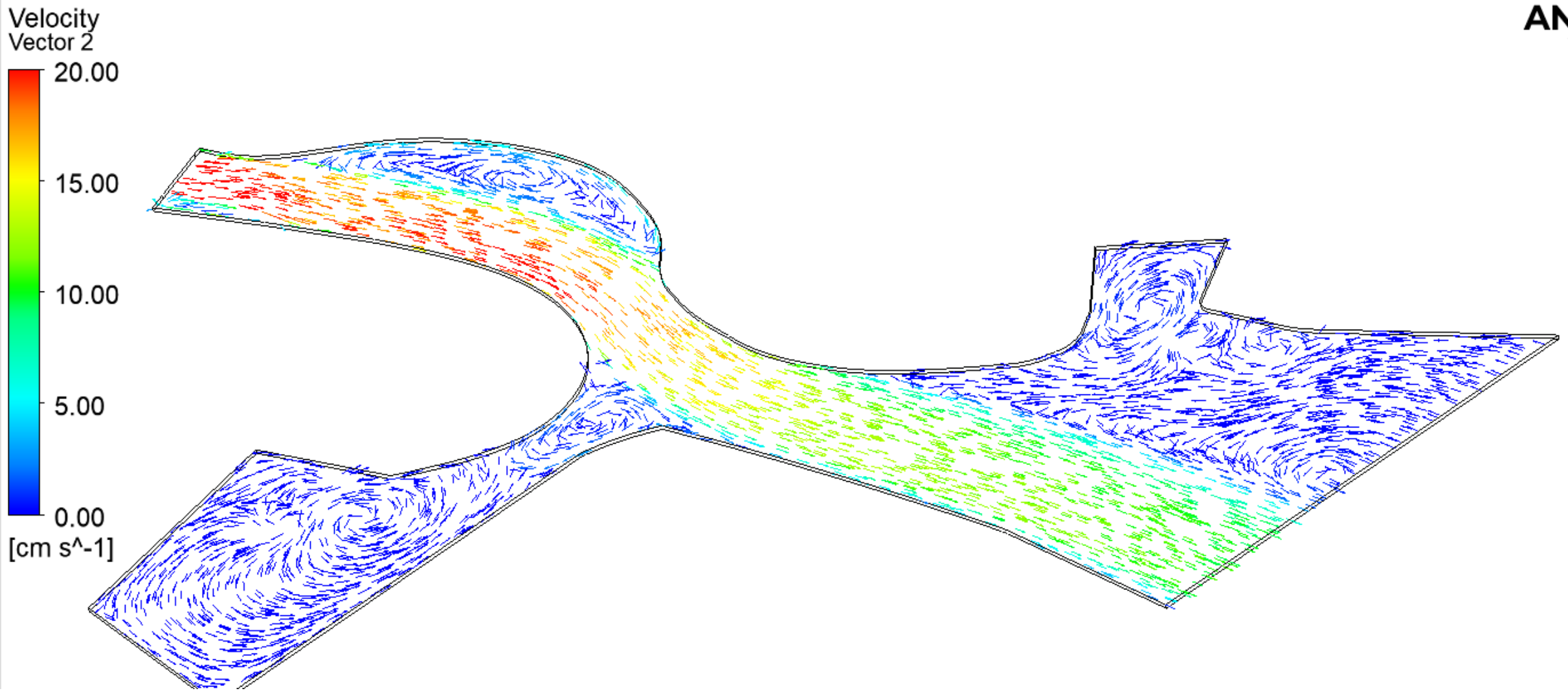



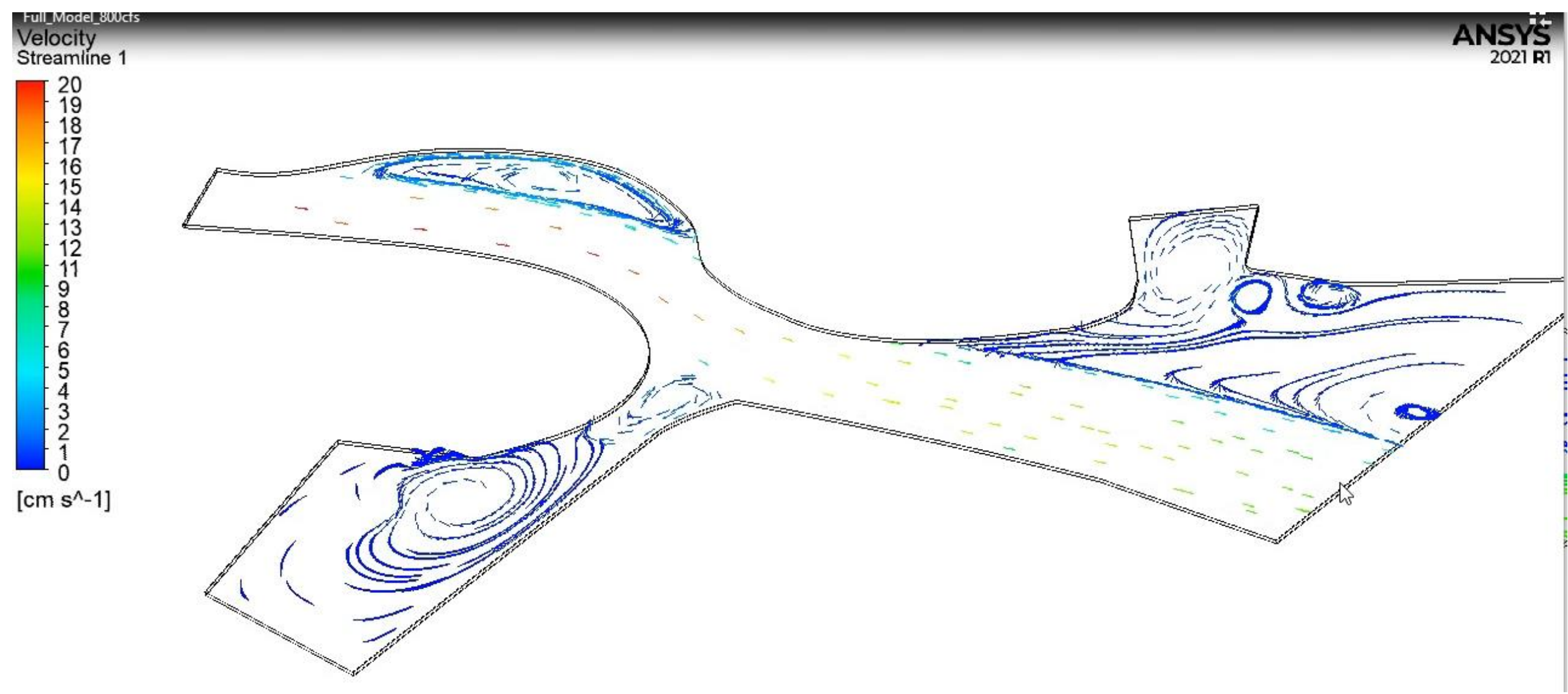

Note: Assumes Uniform 8 ft depth

# Inlet 800 cfs light rain condition



# Inlet 800 cfs Condition




Full_Model_800cfs
Velocity
Streamline 1
20
19
18
17
16
15
14
13
12
11
9
8
7
6
5
4
3
2
1
0
[cm s^-1]
ANSYS
2021 R1

# Conclusions

- Using the river as a location to contain and maintain the silt and sand deposits doesn’t appear to be a workable solution.
- Some localized areas in the river may need some dredging from time to time.
- Widening the river entrance into the lake area will help reduce the velocity of the river entering the lake so that the silt and sand are not carried as far downstream and help contain the sand and silt in a more confined area.
- Removal and continuous dredging should be focused in the lake area to make the best use of dredging funds.