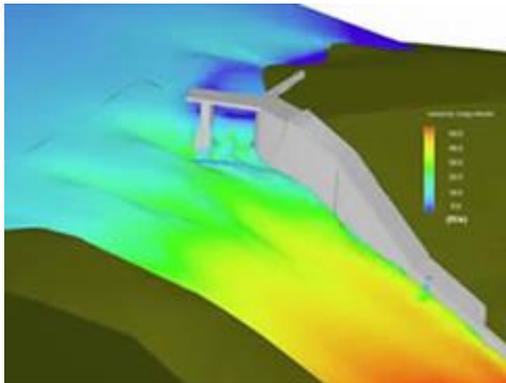
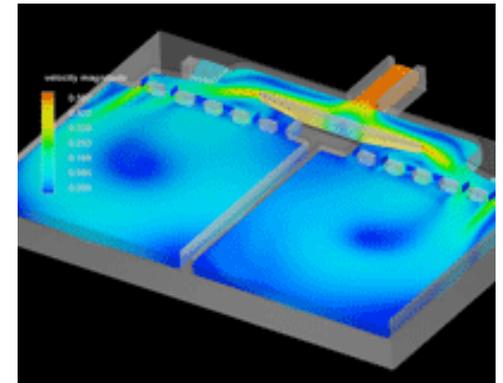


Computational Fluid Dynamics Modeling with *FLOW-3D*



Justin Boldt
6/10/2014



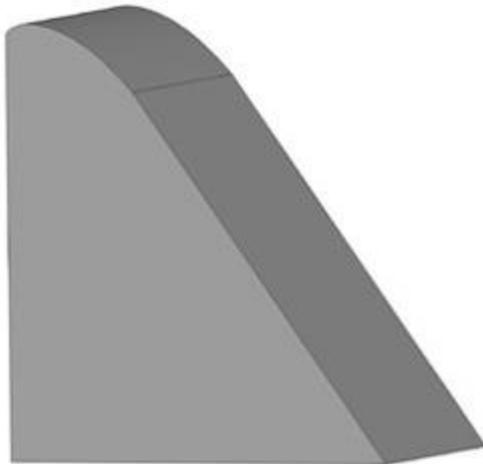
What is FLOW-3D?

- a powerful and highly-accurate CFD software package
- fluid dynamics modeling
- for industrial, engineering, and scientific applications
- for use in design phase or improving processes
- 30+ years experience
- proven

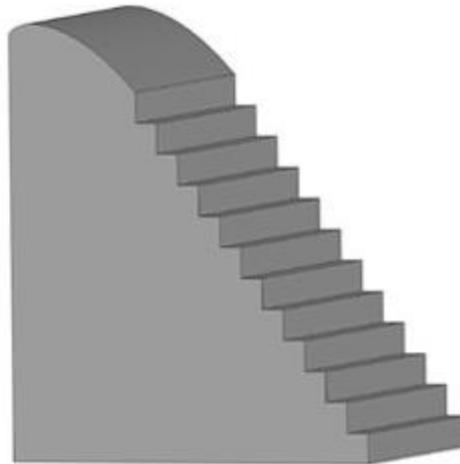


FLOW-3D examples

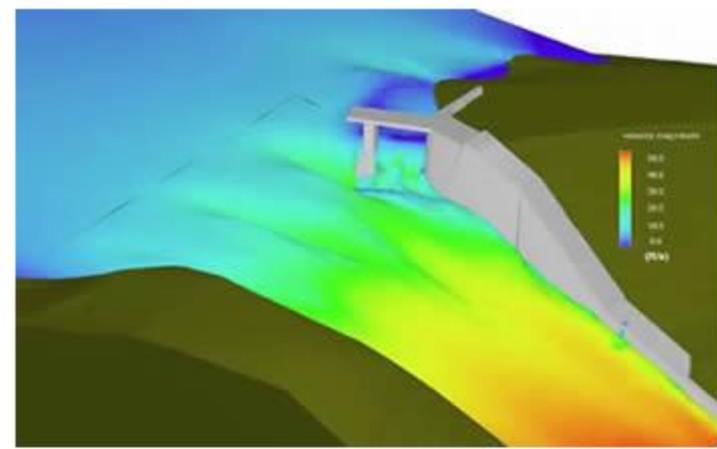
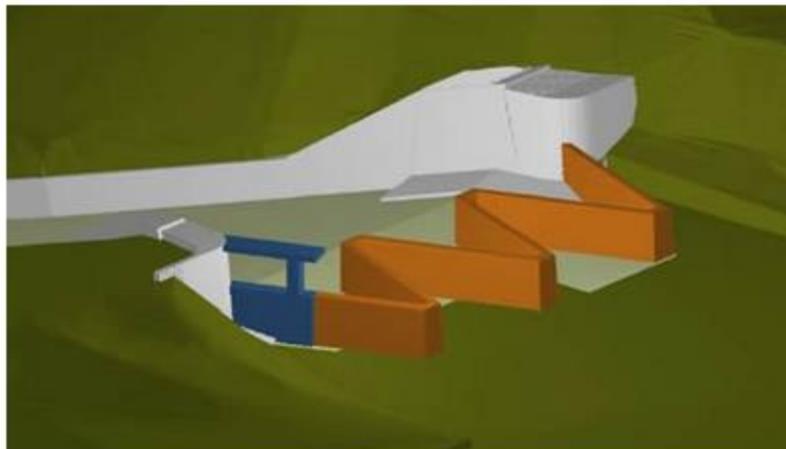
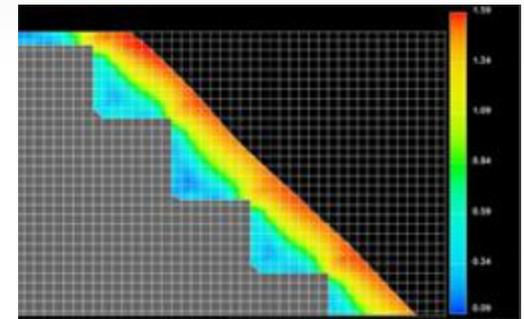
Simulating Flow Over Stepped Spillways
Assisted Spillway and Stilling Basin Design



Smooth Spillway

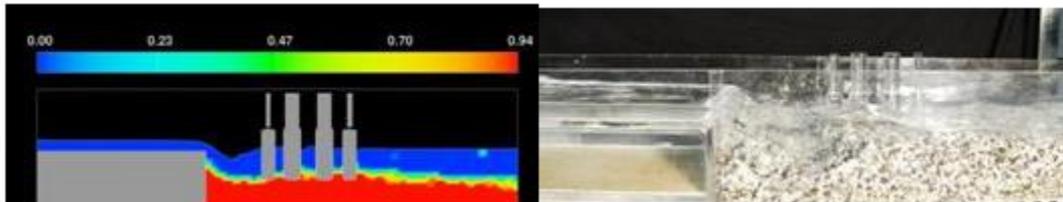
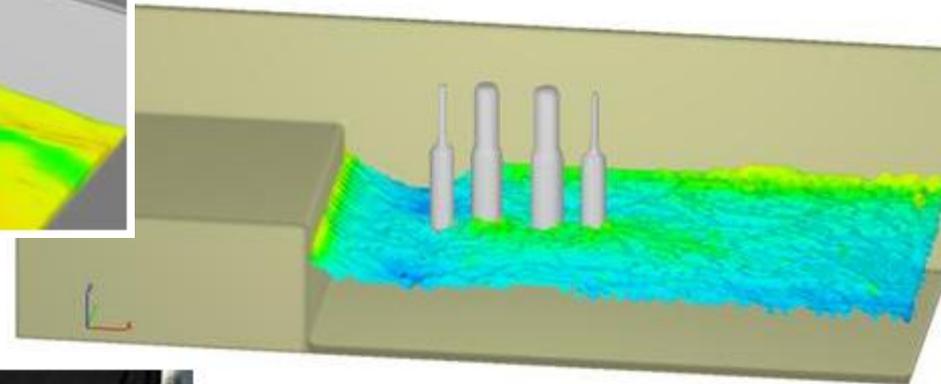
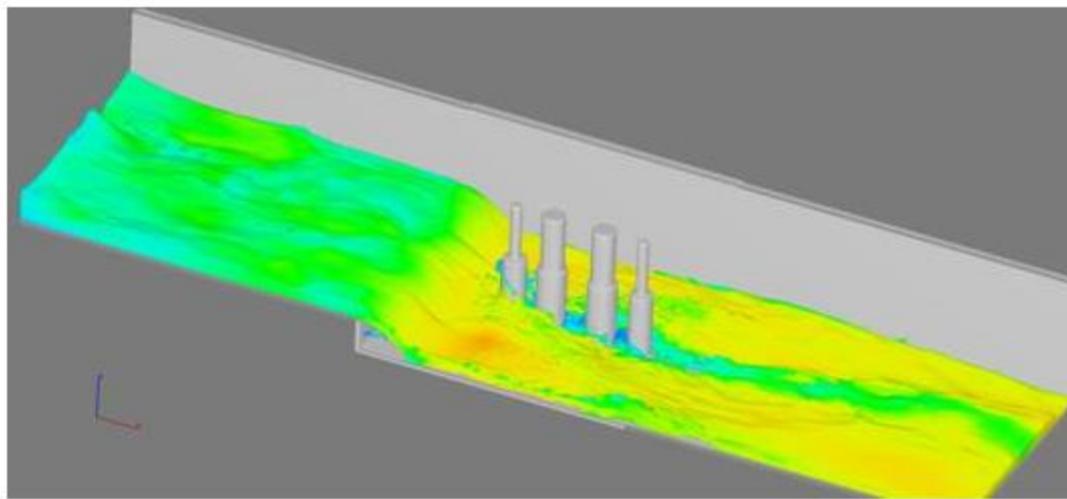


Stepped Spillway



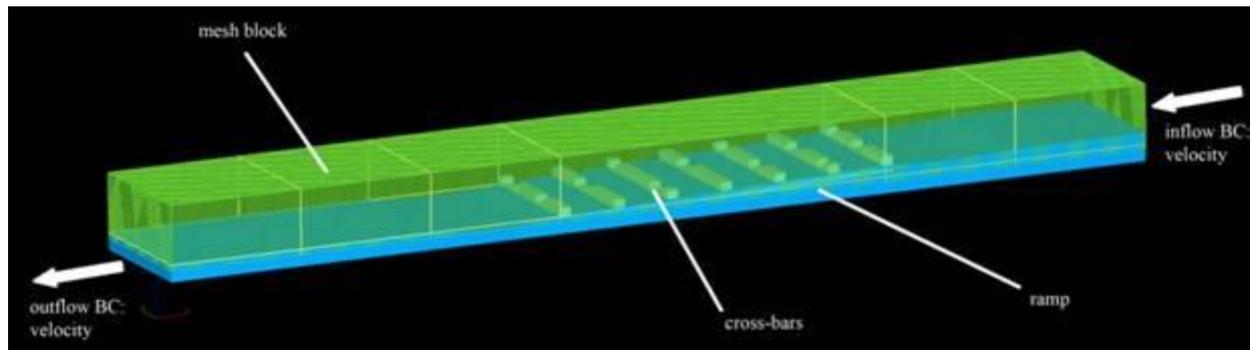
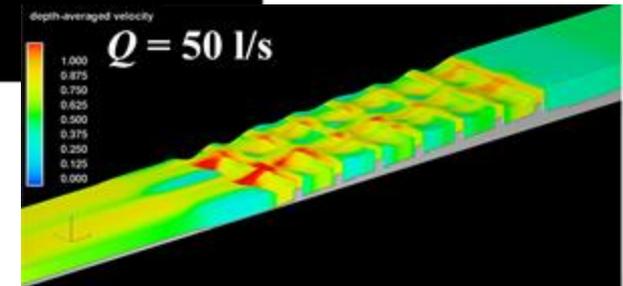
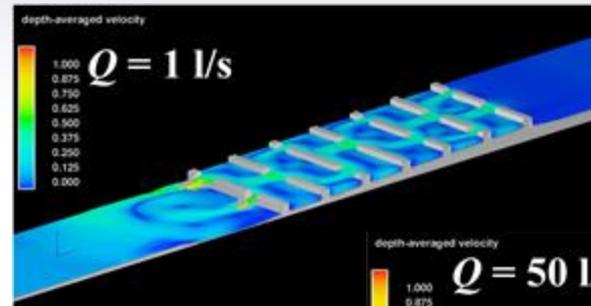
FLOW-3D examples

Modeling Local Bridge Scour during Flood Event: The Houfeng Bridge Failure in Taiwan



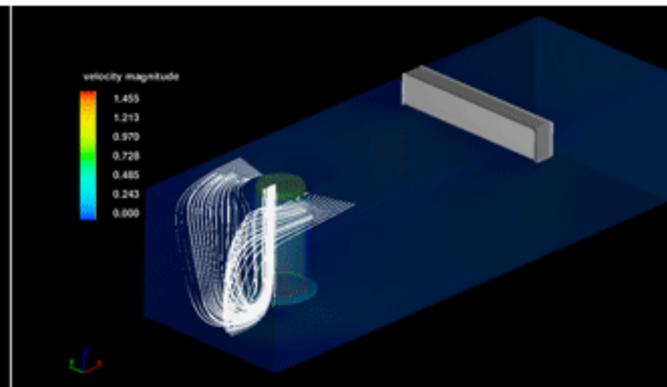
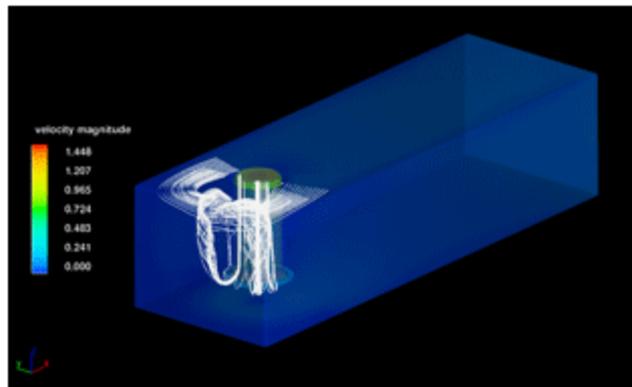
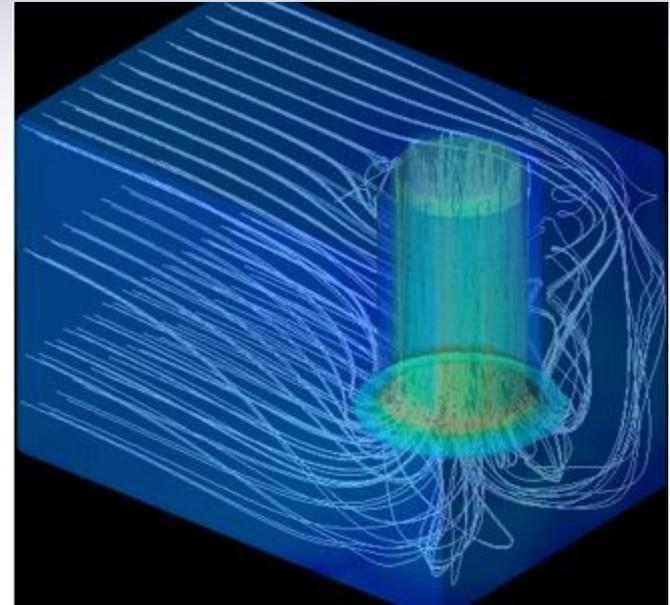
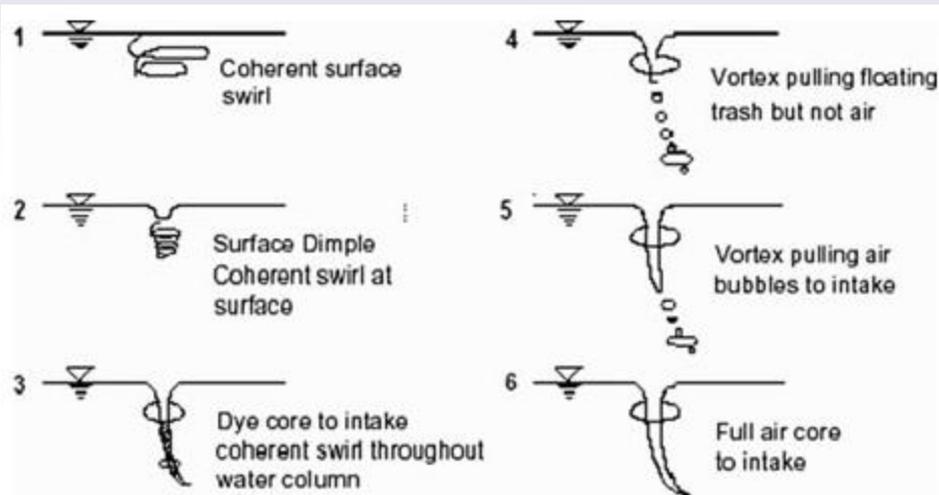
FLOW-3D examples

Simulating Cross-Bar Block Ramps with FLOW-3D



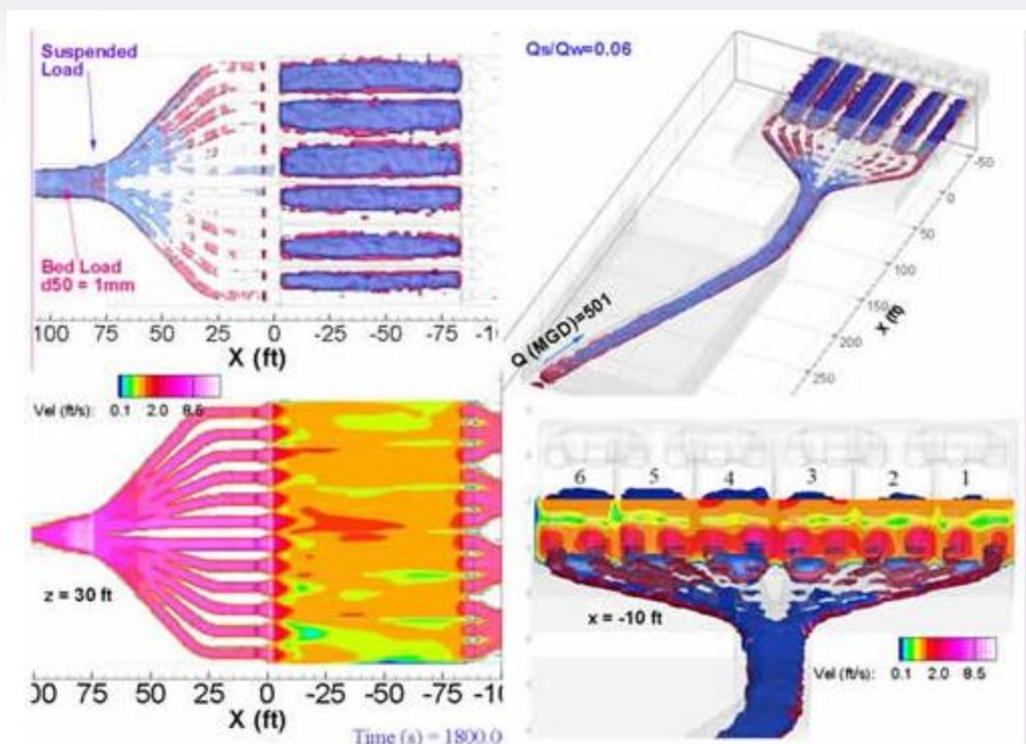
FLOW-3D examples

Pump Performance at Sump Intakes



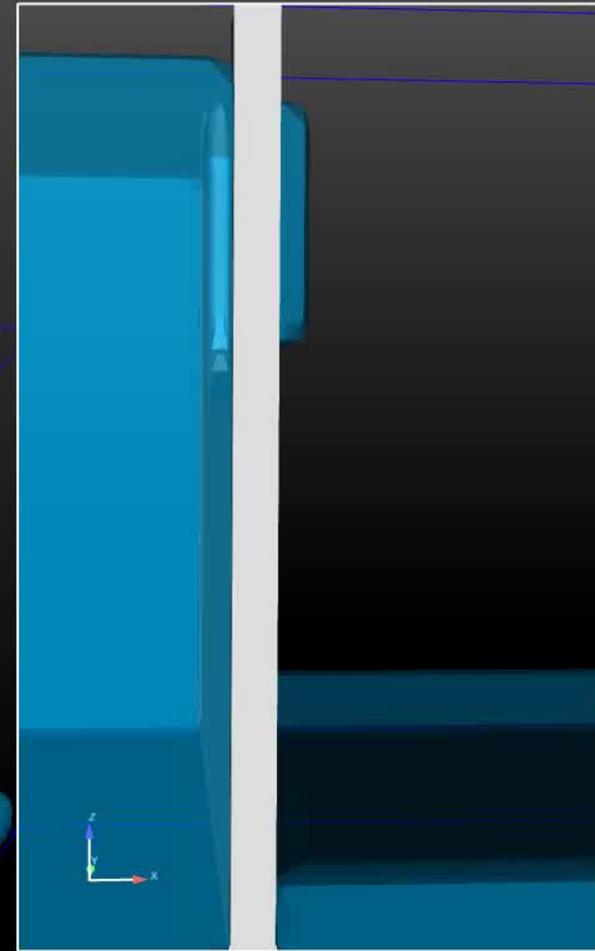
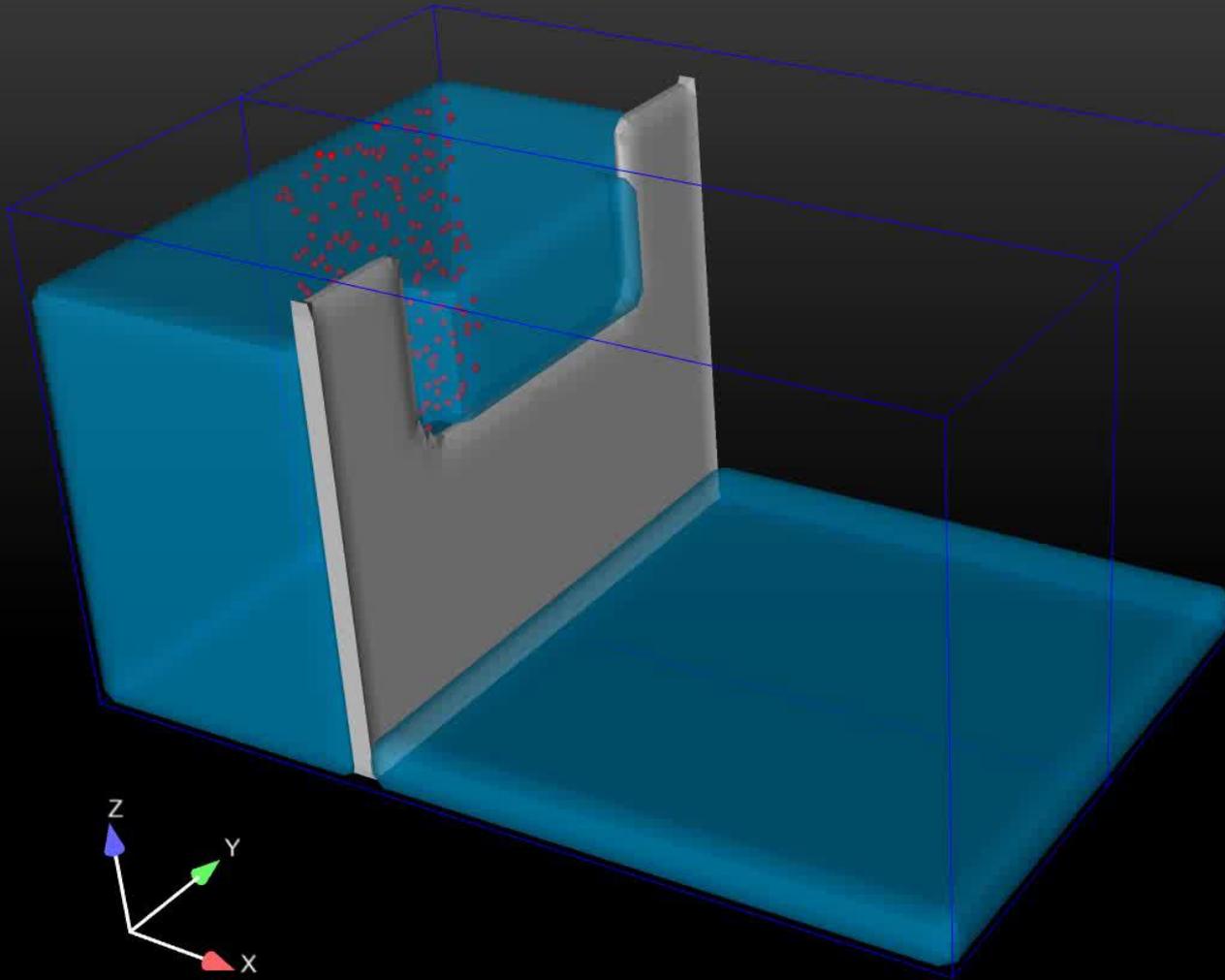
FLOW-3D examples

CFD Modeling of Flow into the Aerated Grit Chamber of a Water Reclamation Plant

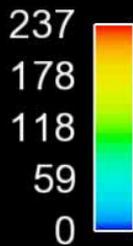


Flow Over A Weir

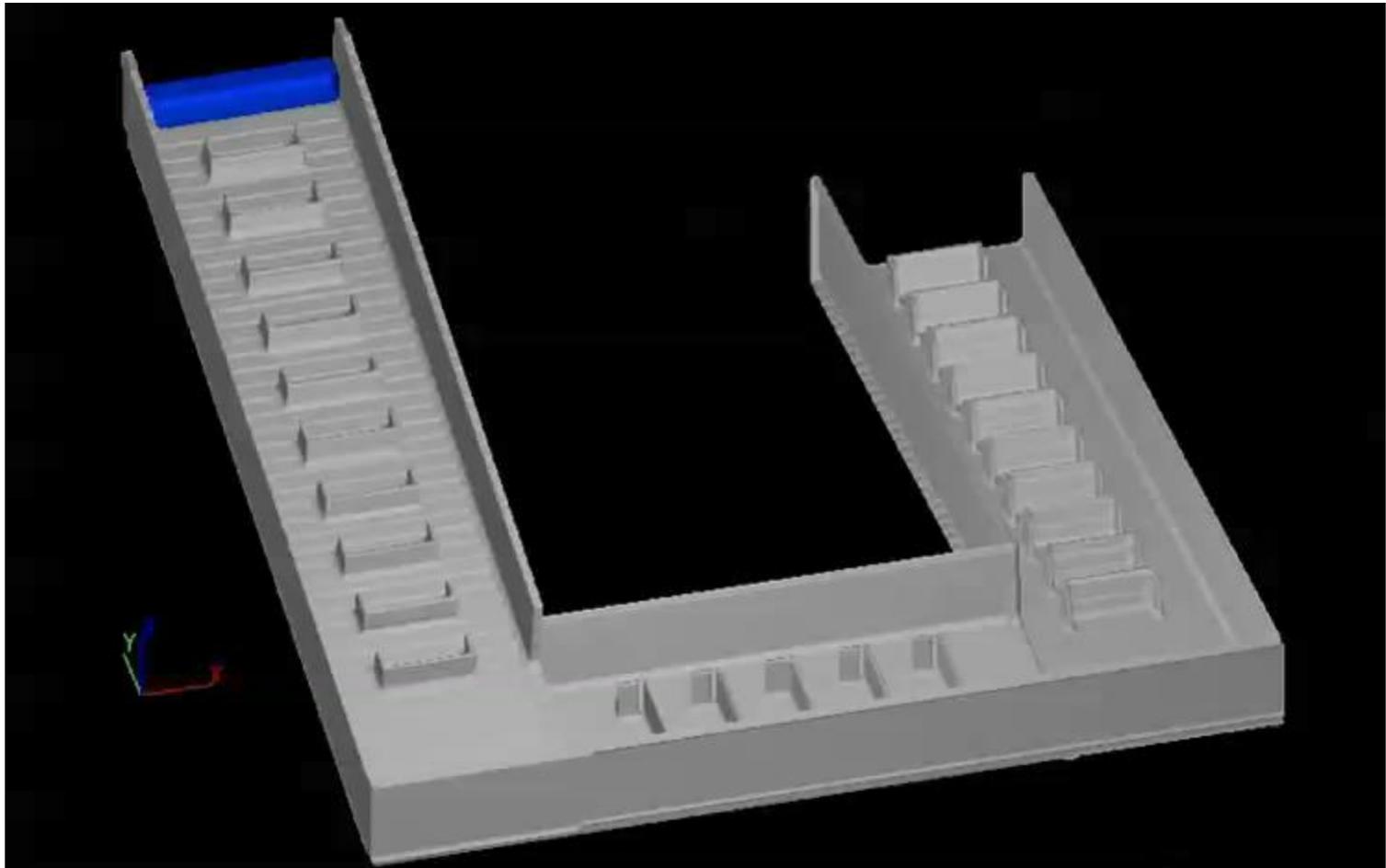
Time = 0.000 sec



Velocity (cm/s)

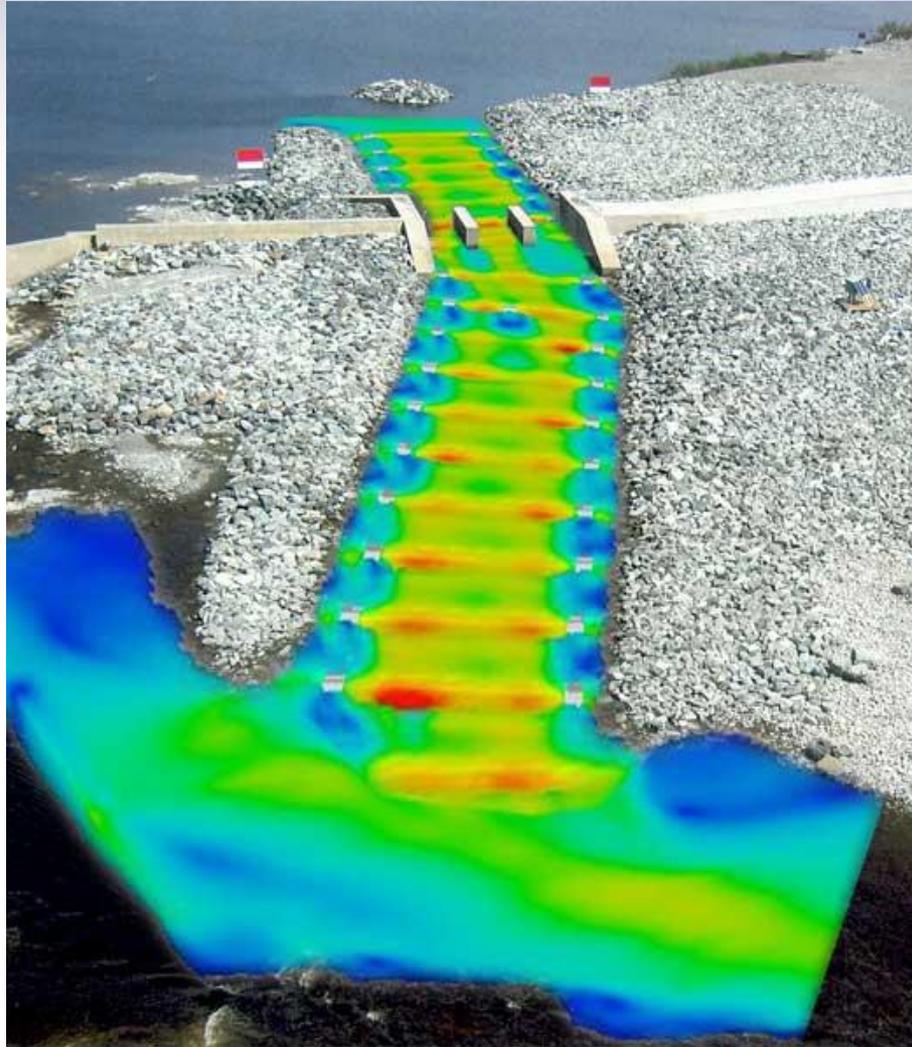


Fish Passage Design

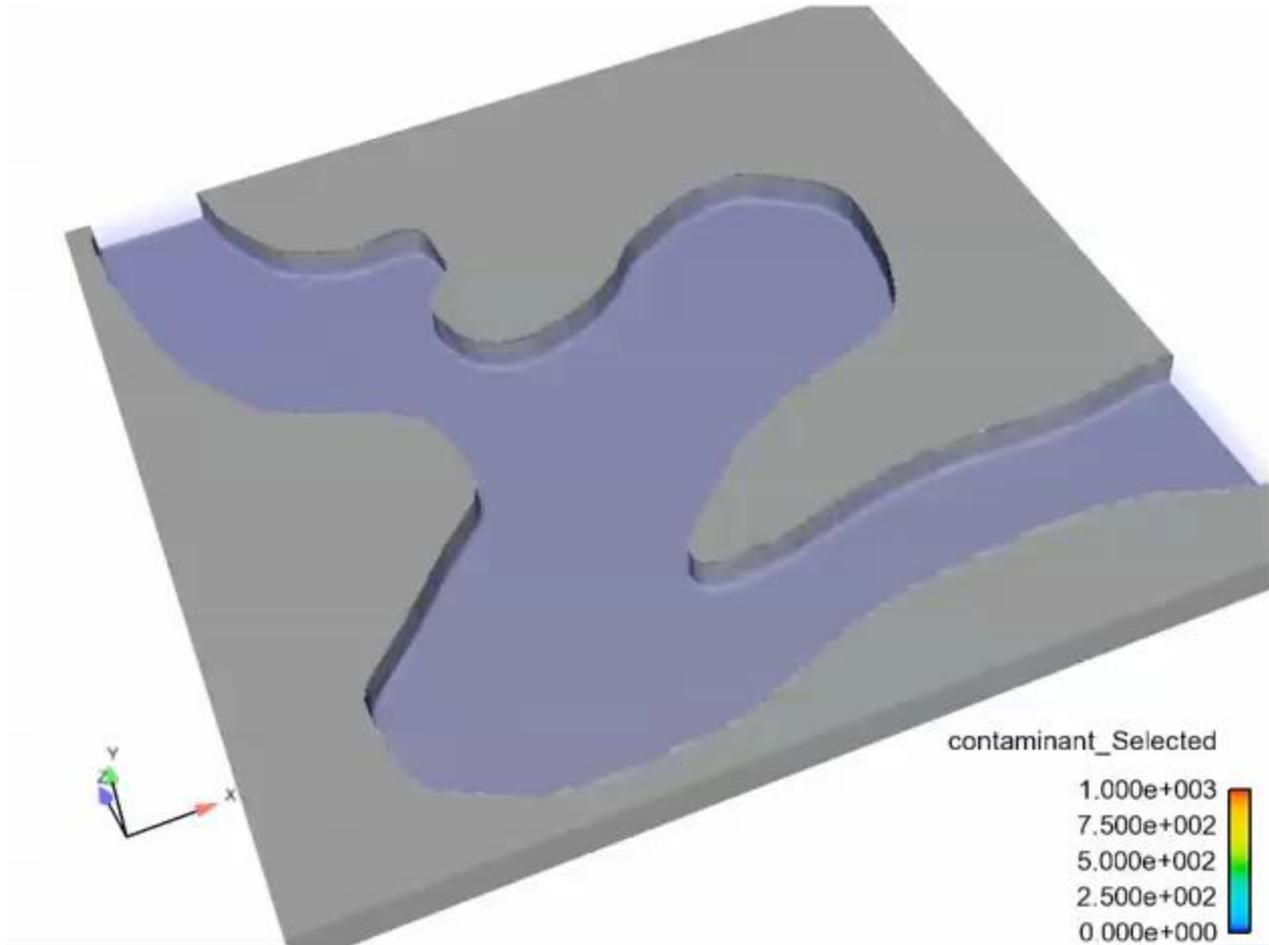


FLOW-3D examples

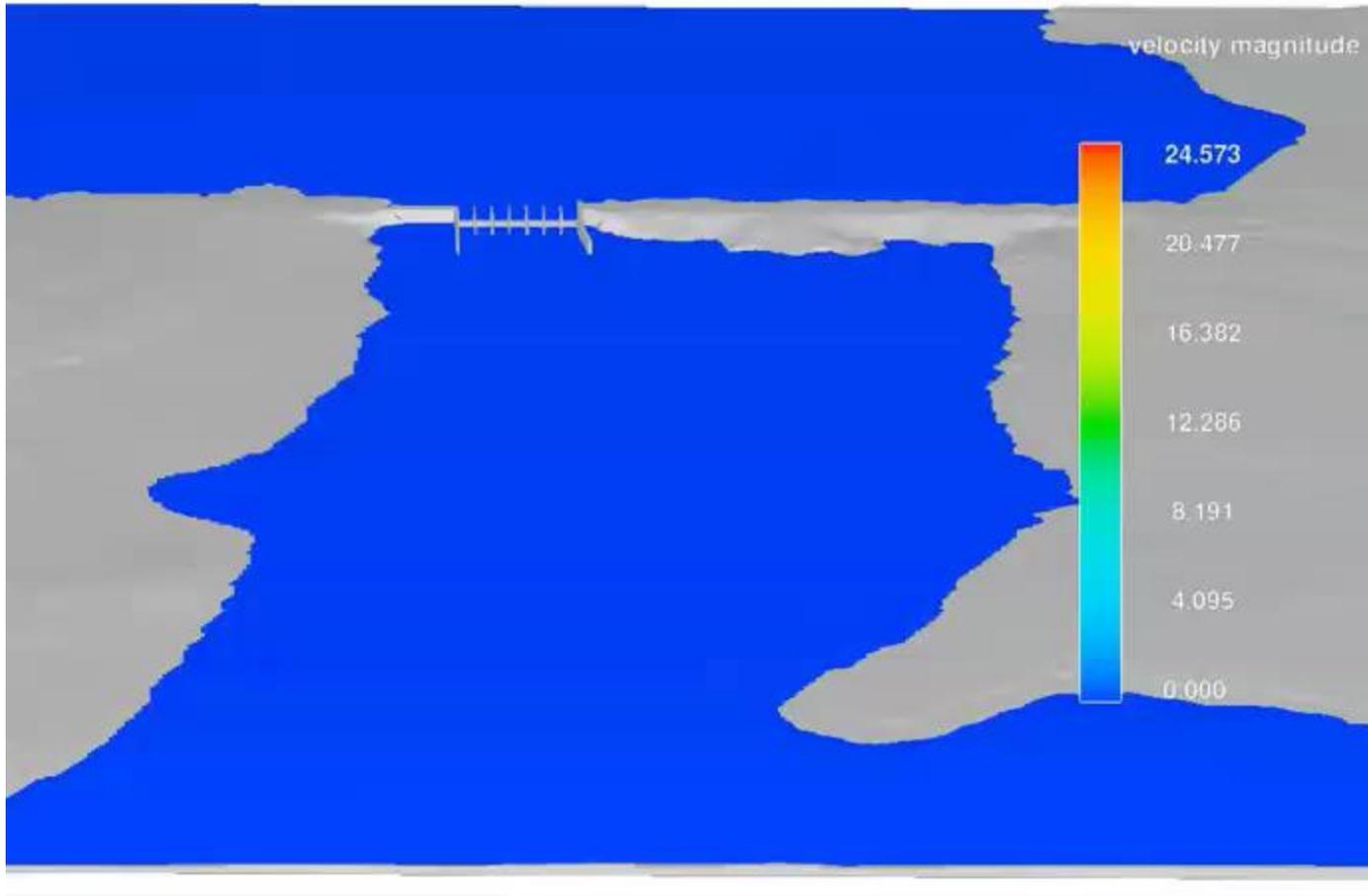
Fish Passage Design



Contaminant Dispersion



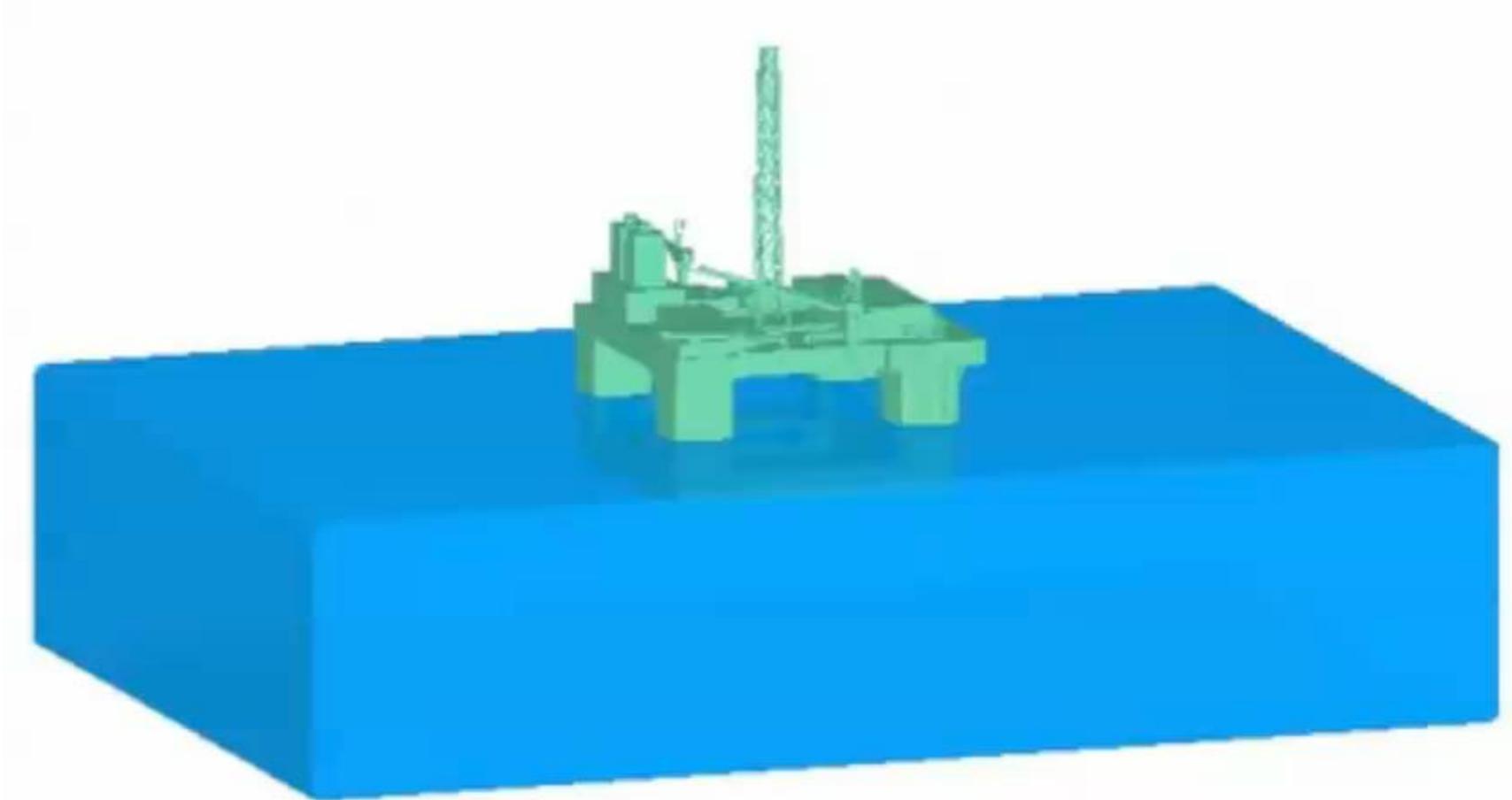
Spillway Modeling



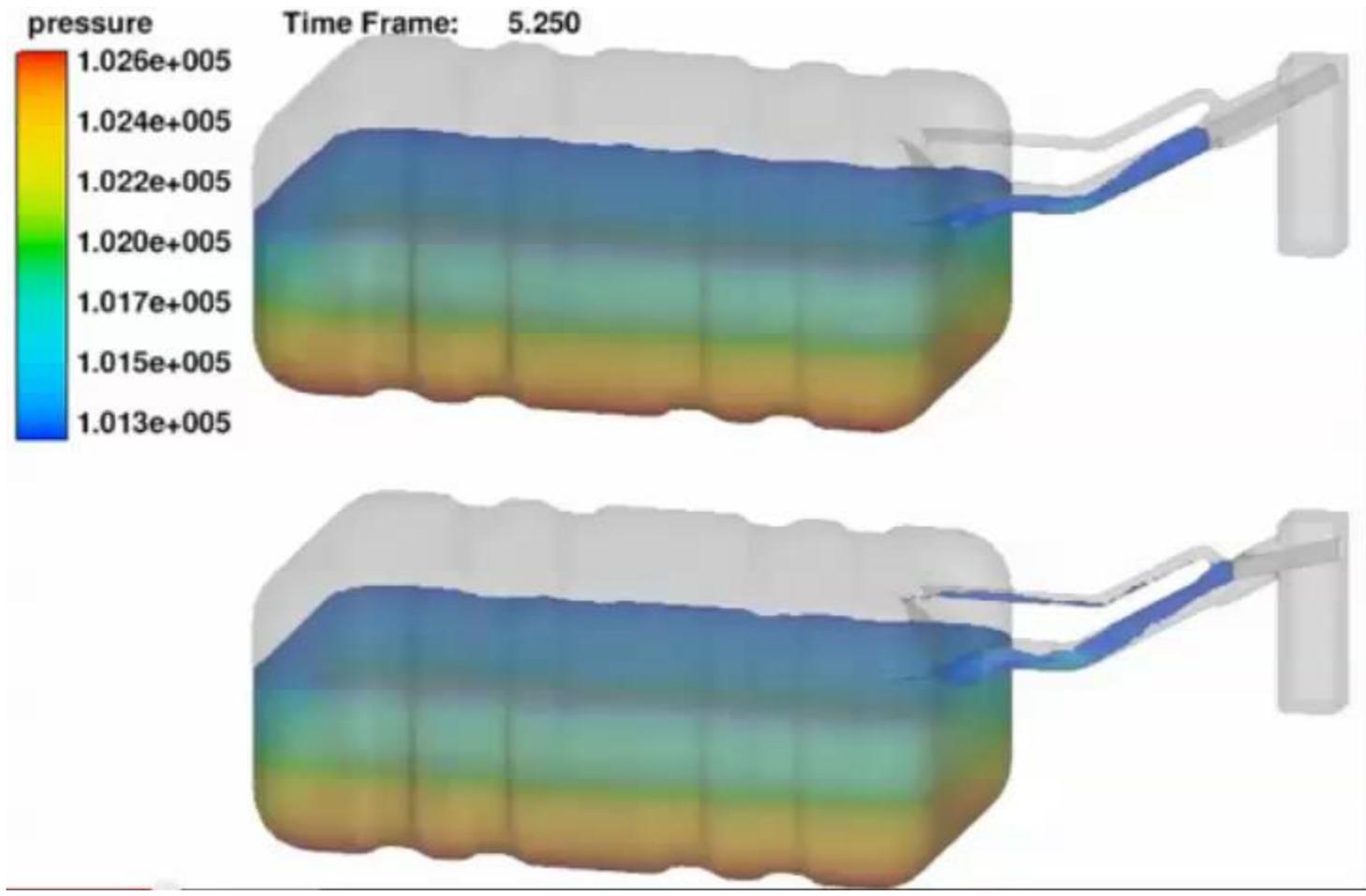
Landslide Analysis



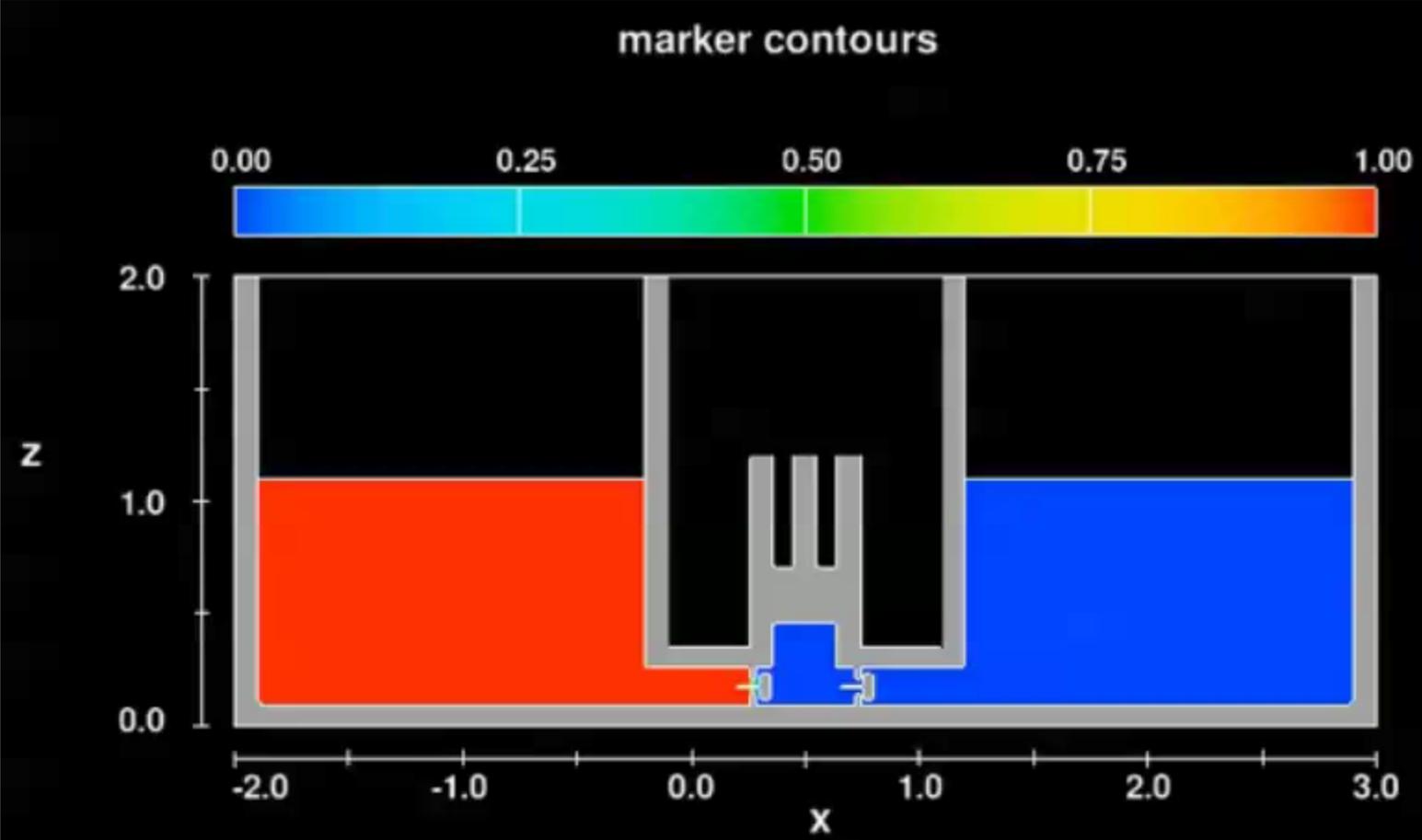
Floating Offshore Platform



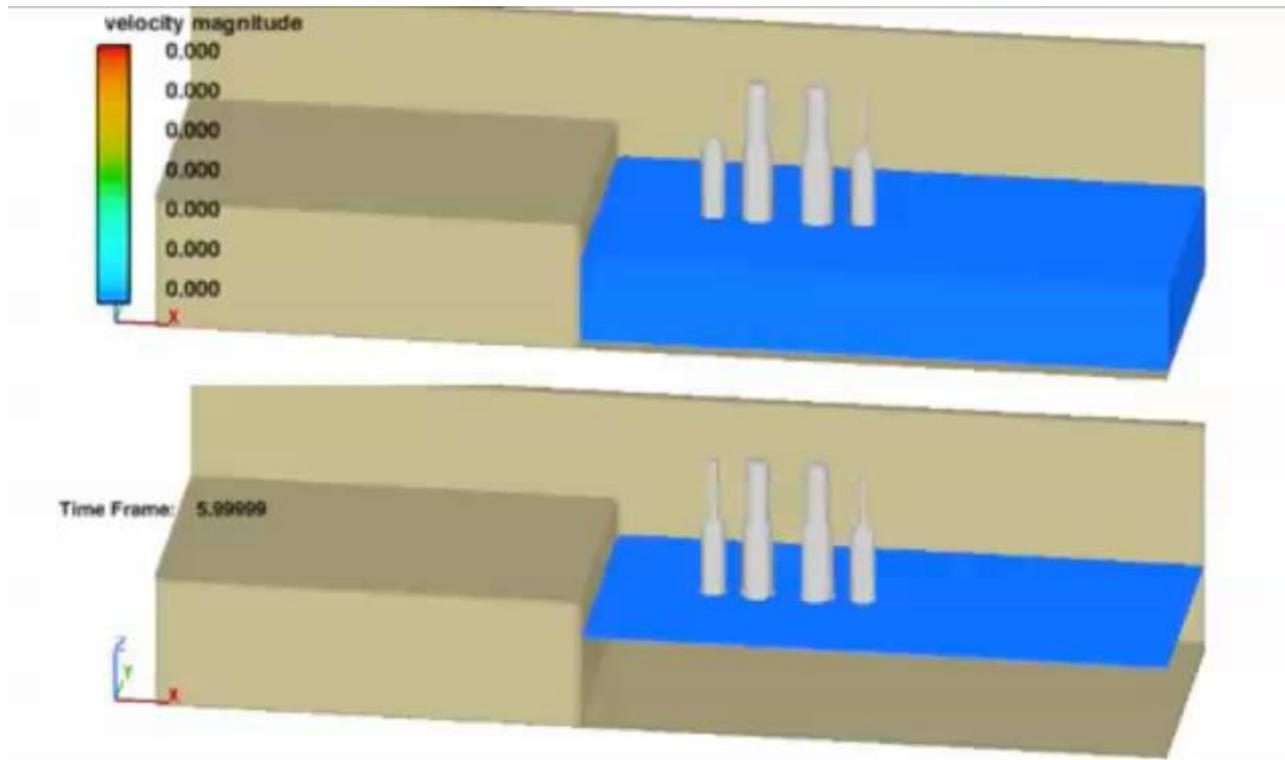
Fuel Tank Filling



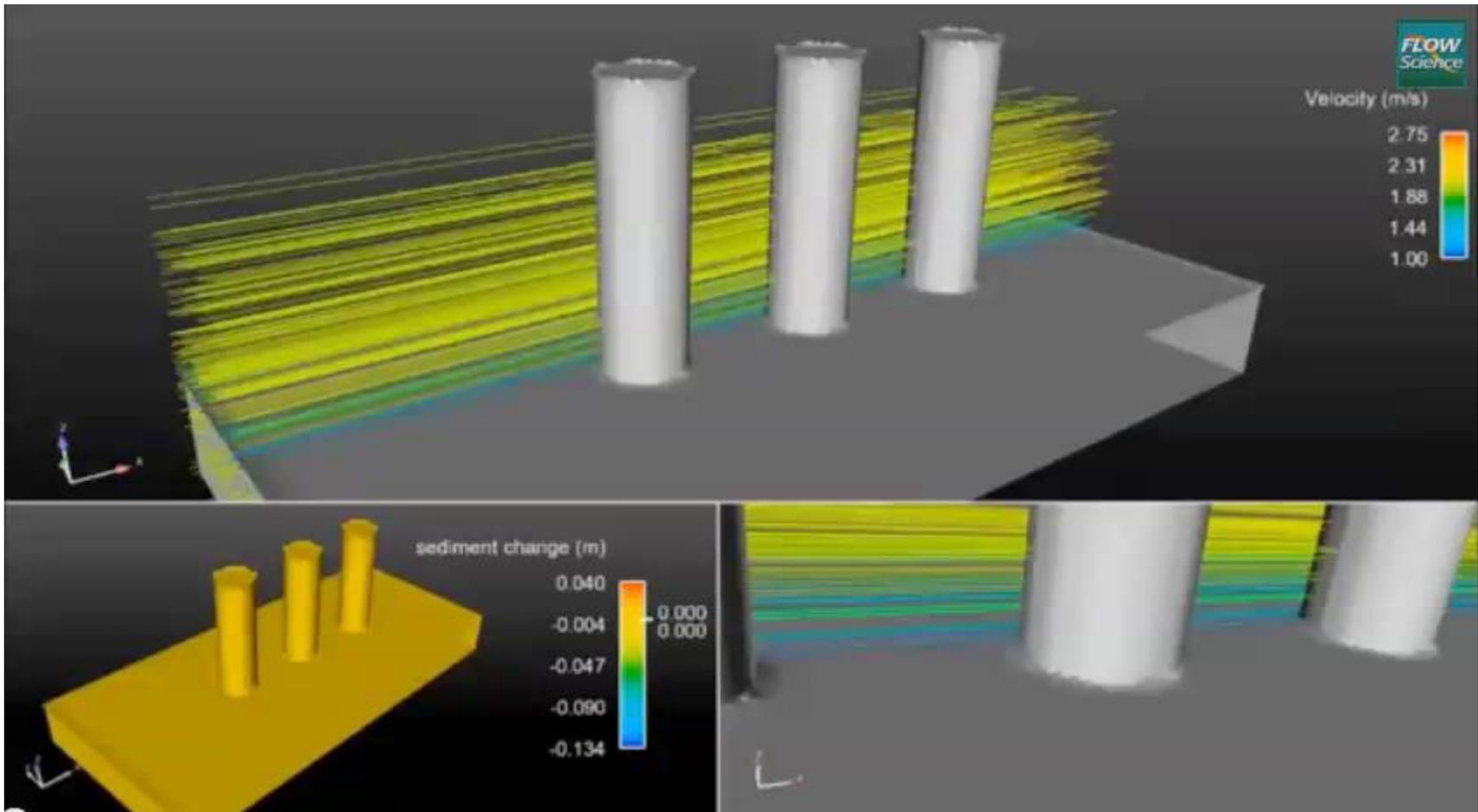
Piston Pump



Sediment Scour – Bridge Piers



Scour Development – Bridge Piers



Case Study

Computational Fluid Dynamics Analysis of
Suspended Sediment Sampler Efficiency

Objectives

Research objective:

The evaluation and verification of accuracy of FISP physical sediment samplers.



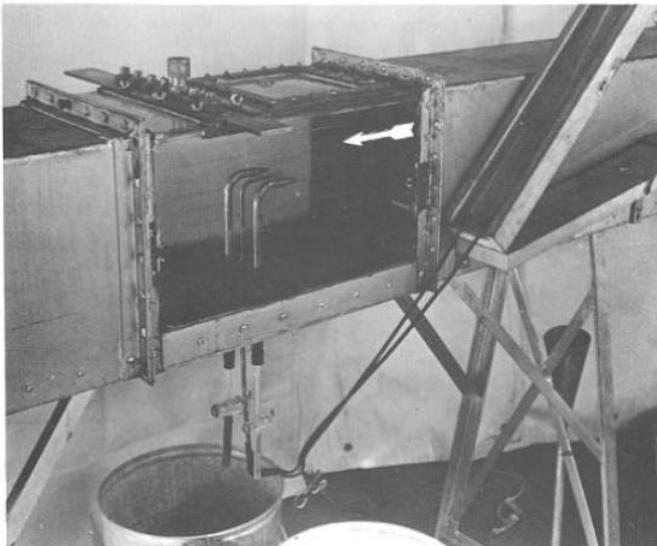
US DH-81

ISOKINETIC: water velocity at intake nozzle = ambient stream velocity

Background



a. Duplicate sampler nozzles and pitot tube.



b. Sampling station in conduit.

Fig. 2 - Sampling apparatus.

Figures from FISP Report No. 5 (1941), "Laboratory Investigation of Suspended Sediment Samplers"

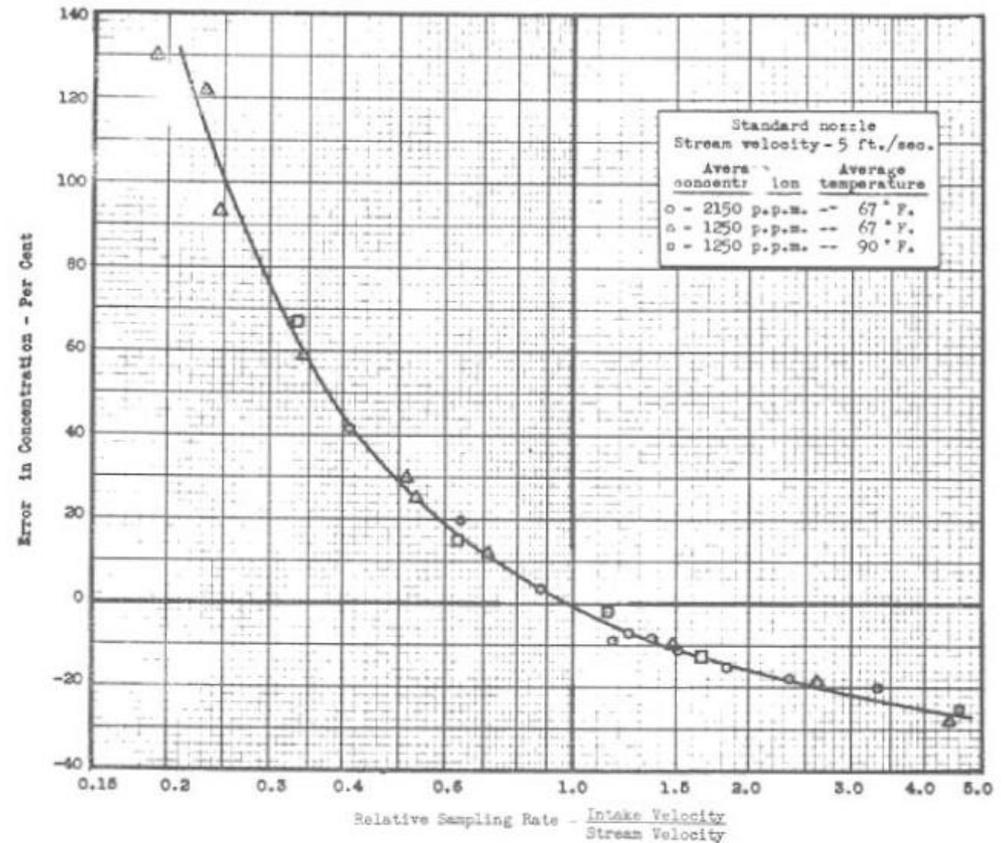


Fig. 10 - Effect of sampling rate on sediment concentration -- 0.45 mm. sediment.

Methods



Disclaimer: The use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Advantages of CFD:

- lower cost
- control of flow conditions
- control of particle characteristics
- know “true” values
- flow field visualization
- improve designs

Technical Drawing of Nozzle

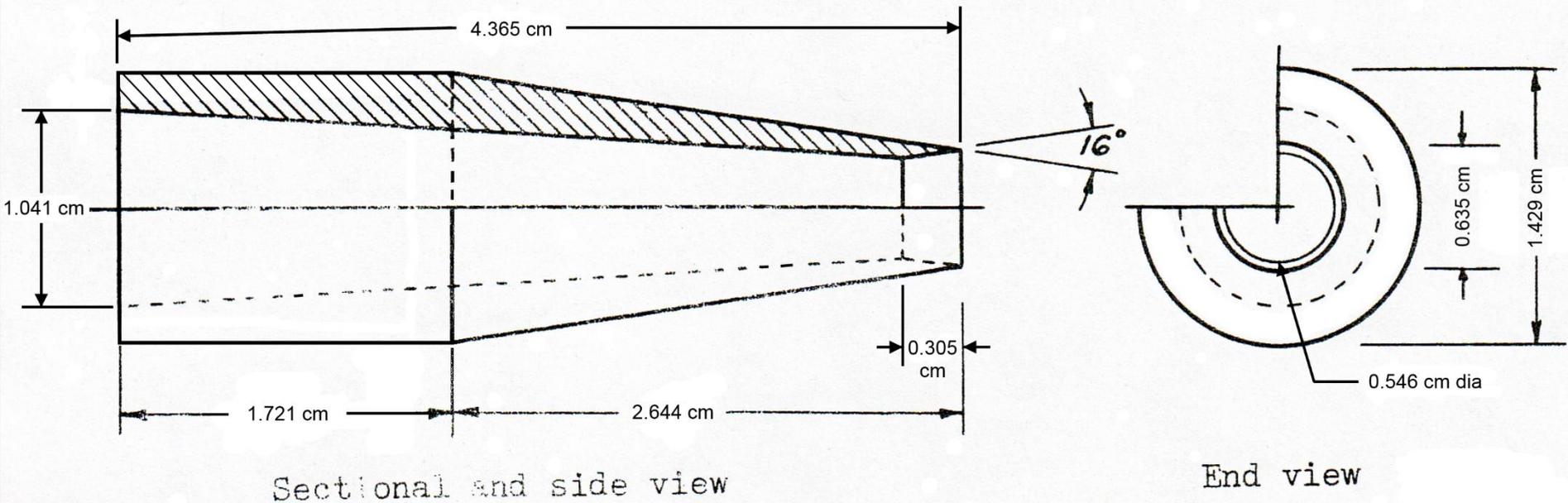
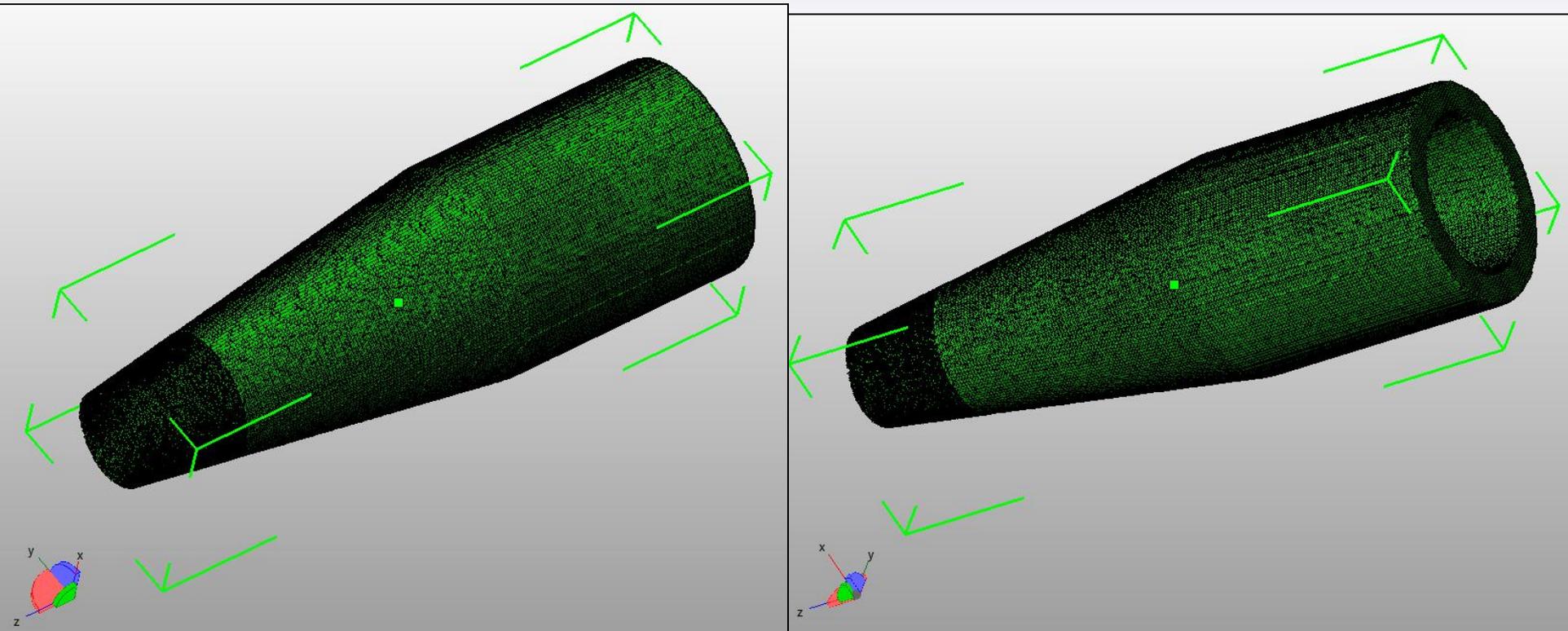


Fig. 9 - Standard nozzle intake diameter 0.25 in.

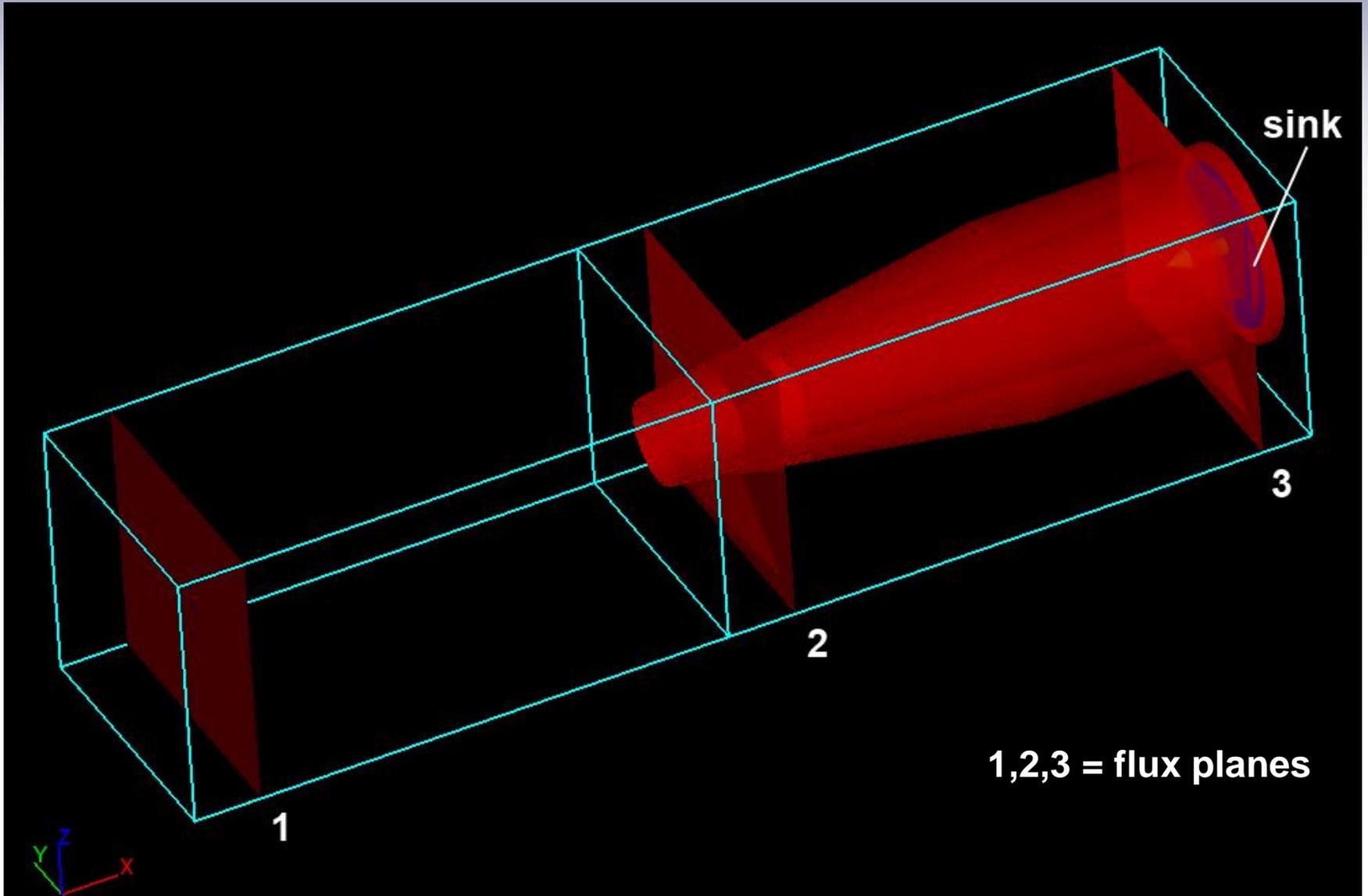
modified from FISP Report No. 5 (1941), "Laboratory Investigation of Suspended Sediment Samplers"

3-D Rendering of Nozzle



.stl file (**ST**ereo**L**ithography)

FLOW-3D: Geometry



FLOW-3D: Flux Planes

pressure contours

0.000E+00

0.000E+00

Z

1.0

-1.0

-4.000

-2.327

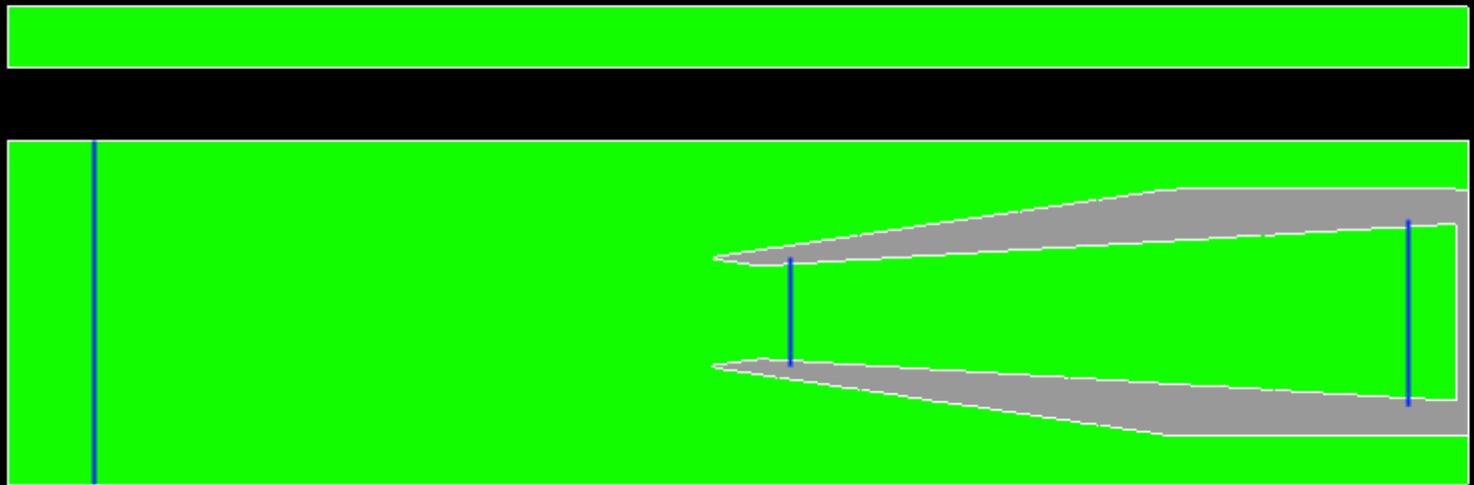
-0.654

1.019

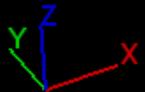
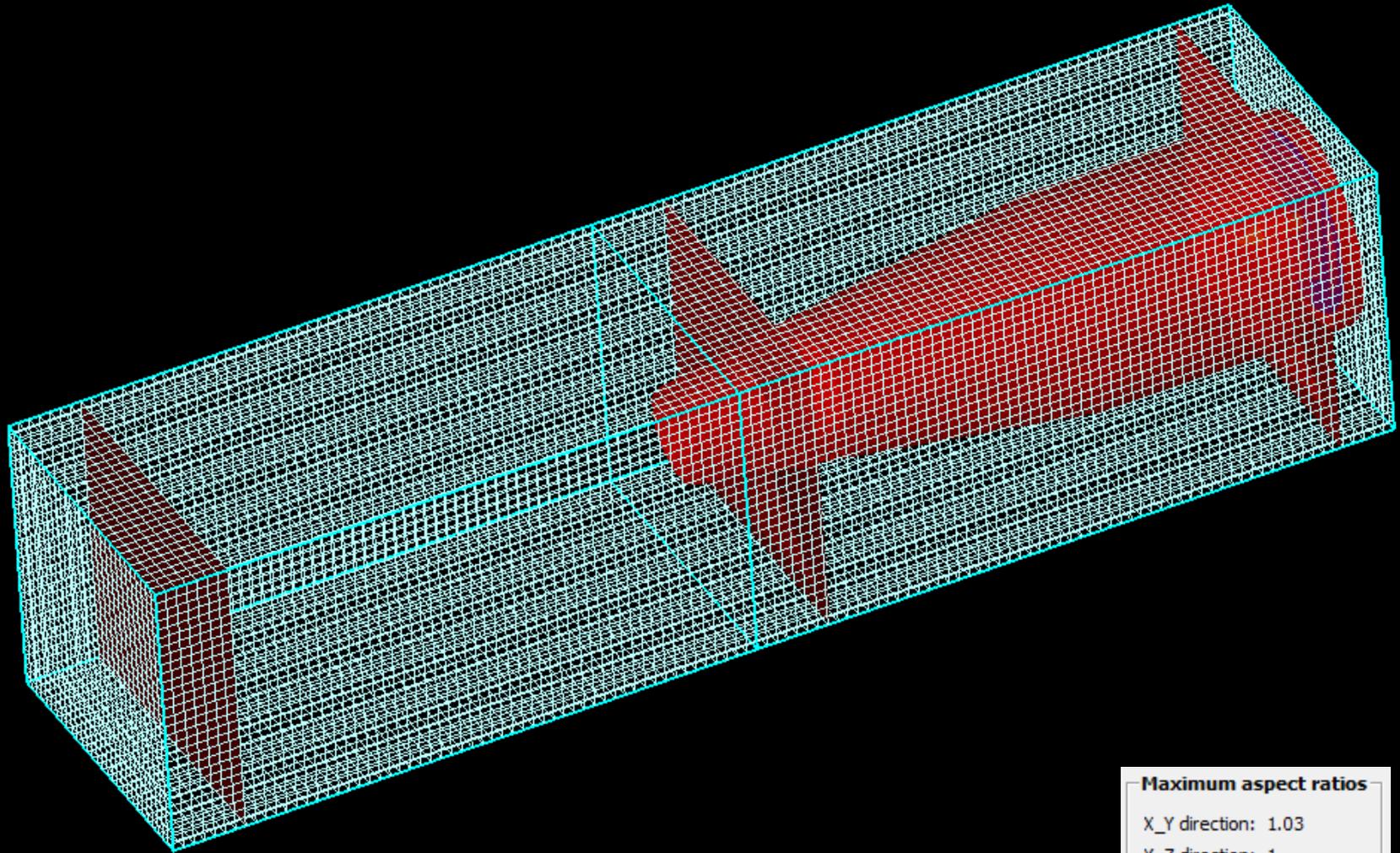
2.692

4.365

X



FLOW-3D: Mesh



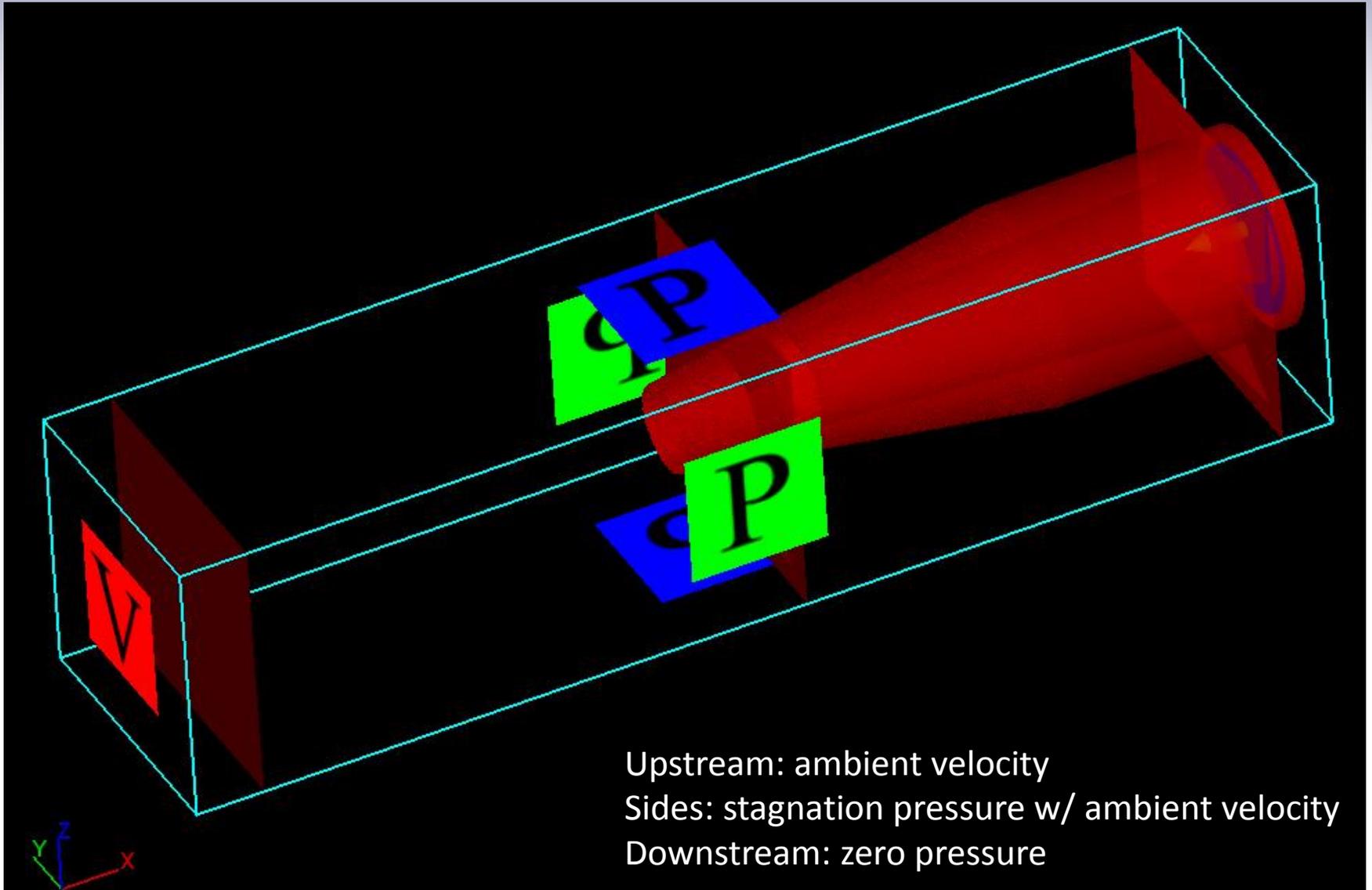
Maximum aspect ratios

X_Y direction: 1.03

Y_Z direction: 1

Z_X direction: 1.03

FLOW-3D: Boundary Conditions



Upstream: ambient velocity

Sides: stagnation pressure w/ ambient velocity

Downstream: zero pressure

FLOW-3D: Simulation Variables

Variables:

- Intake efficiency (0.2–3.0)
- Ambient velocity (5 ft/s, 3 ft/s, 2 ft/s)
- Sediment size (0.45 mm and 0.15 mm)
 - spherical particles with SG = 2.65
- Turbulence (low, medium, high)

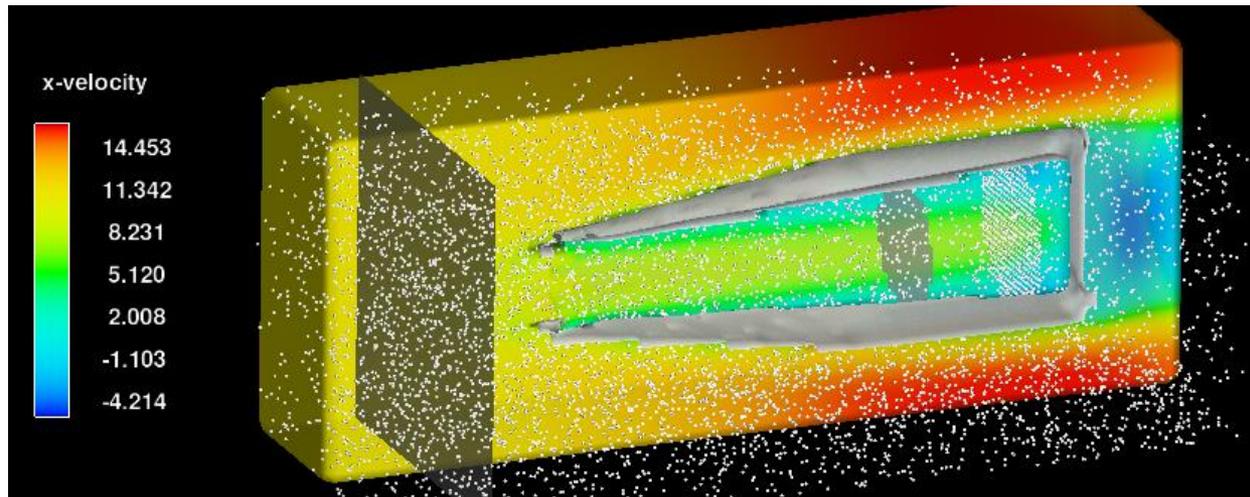
- Temperature (constant at 20°C)
- Design tolerances
- Particle-size distribution
- Other characteristics

Table 1. Summary of CFD simulations.

Simulation	Turbulence	Velocity (ft/s)	Intake efficiency	Sediment Size (mm)
1	Low	5	0.4	0.45
2	Low	5	0.6	0.45
3	Low	5	0.8	0.45
4	Low	5	1	0.45
5	Low	5	1.2	0.45
6	Low	5	1.4	0.45
7	Medium	5	0.4	0.45
8	Medium	5	0.6	0.45
9	Medium	5	0.8	0.45
10	Medium	5	1	0.45
11	Medium	5	1.2	0.45
12	Medium	5	1.4	0.45
13	High	5	0.4	0.45
14	High	5	0.6	0.45
15	High	5	0.8	0.45
16	High	5	1	0.45
17	High	5	1.2	0.45
18	High	5	1.4	0.45
19	Medium	5	0.4	0.15
20	Medium	5	0.6	0.15
21	Medium	5	0.8	0.15
22	Medium	5	1	0.15
23	Medium	5	1.2	0.15
24	Medium	5	1.4	0.15
25	Medium	3	0.4	0.15
26	Medium	3	0.6	0.15
27	Medium	3	0.8	0.15
28	Medium	3	1	0.15
29	Medium	3	1.2	0.15
30	Medium	3	1.4	0.15
31	Medium	2	0.4	0.15
32	Medium	2	0.6	0.15
33	Medium	2	0.8	0.15
34	Medium	2	1	0.15
35	Medium	2	1.2	0.15
36	Medium	2	1.4	0.15

Preliminary Results

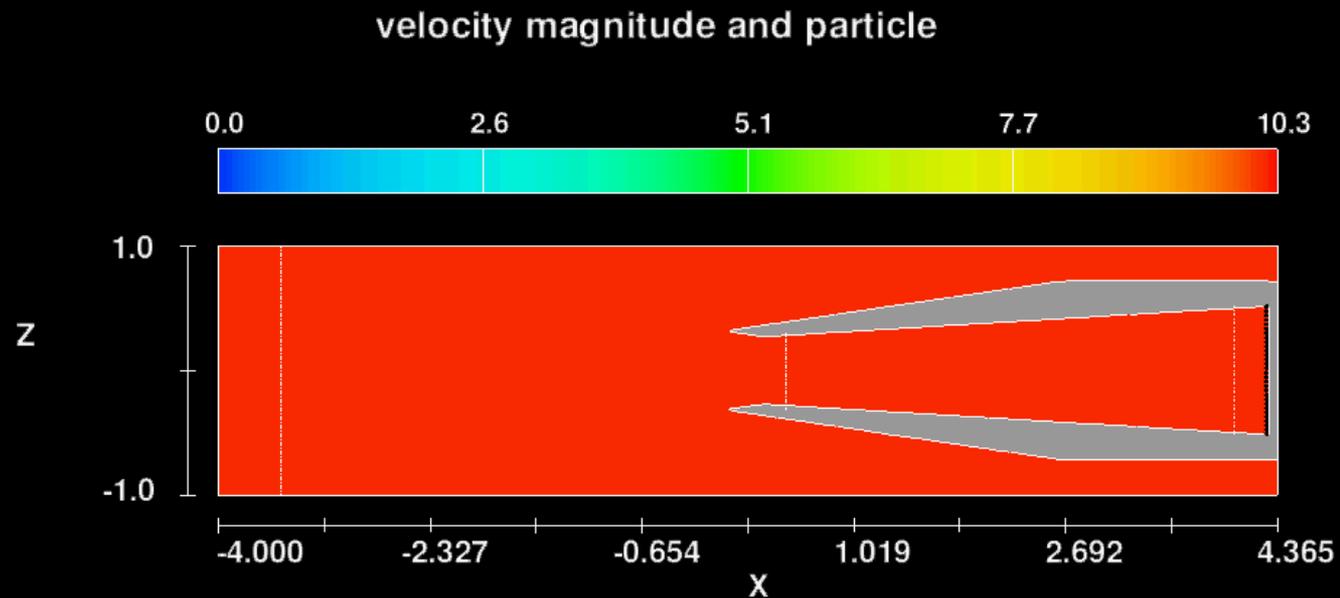
Data are provisional and subject to revision.



3-D simulation output (x-velocity) with particles.

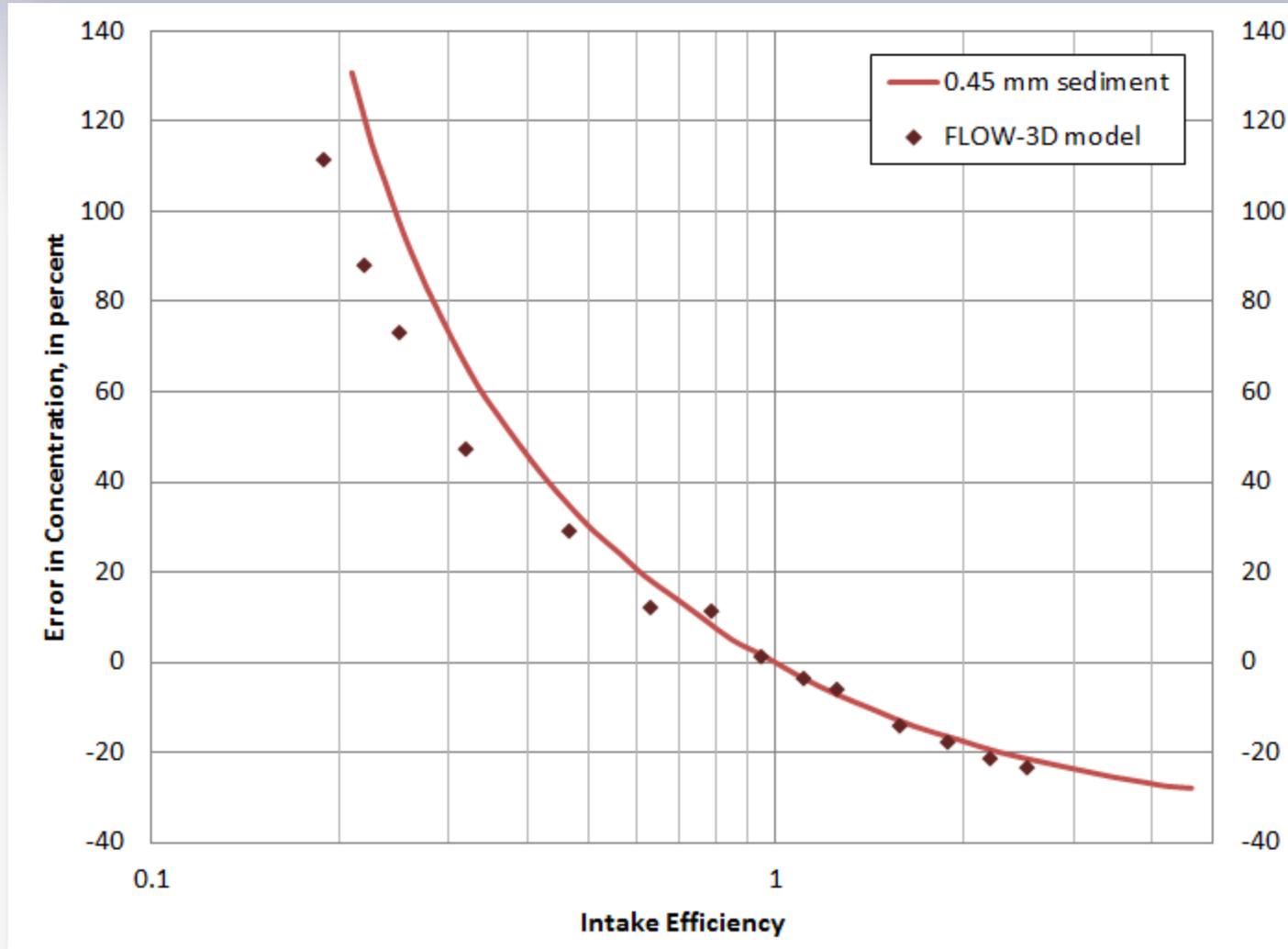
Preliminary Results

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Preliminary Results

Data are provisional and subject to revision.



Questions?

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