

EEMS Demonstration Model Description

DM_HS_Low_Chord_Trap_Bridge

1 Objective

This demonstration model uses EFDC+ Explorer (EE) and EFDC+ to simulate hydrodynamics and dye transport in a trapezoidal channel domain, demonstrating the hydraulic influence of a low-chord bridge boundary condition in EFDC+. The model was developed by DSI for testing the low-chord hydraulic structure module in EFDC+.

The simulation captures how a tidally influenced flow field interacts with a bridge structure configured as a low-chord pressure boundary condition, illustrating the backwater effect upstream of the structure during high-flow conditions and the modulation of water levels by the downstream tidal forcing.

2 Model Description

The model configuration is summarized in Table 1 and the model domain is shown in Figure 1. The domain represents a trapezoidal channel with bottom elevations ranging from -4 m to 10 m. The simulation covers a 5-day period with a fixed time step of 2 seconds.

Table 1 Model configuration summary

Run Period (Julian time)	Horizontal Cells	Vertical Layers	Activated Modules
0–5	707 active cells	• 1 layer	• Hydrodynamics

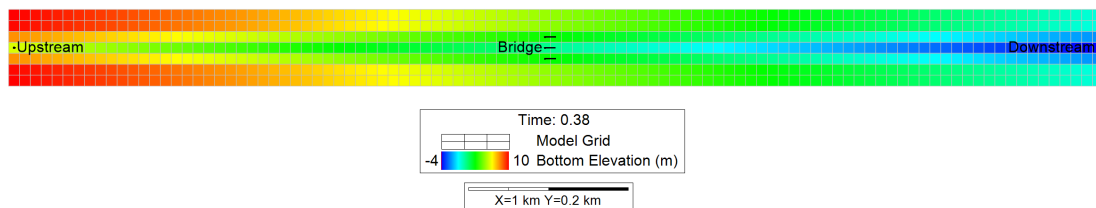


Figure 1 Model domain showing the trapezoidal channel grid with the bridge structure location ($I = 152$)

2.1 Hydrodynamic Configuration

The hydrodynamic configuration uses a two-time-level integration scheme on a single-layer grid with 707 active cells. Wetting and drying is activated using the variable depth cell-face masking approach with a nominal dry depth of 0.05 m and a wet threshold of 0.07 m.

Boundary conditions consist of a time-series inflow at the upstream end ($I = 103$, $J = 6$) and a tidal water surface elevation boundary at seven cells along the downstream (east) face ($I = 203$,

$J = 3-9$). The tidal forcing is an M_2 harmonic with an amplitude of 3.0 m and a phase of 8,750 s relative to the simulation start.

2.2 Low-Chord Bridge Configuration

The bridge structure is configured as three adjacent pressure-controlled hydraulic structures spanning cells $I = 152, J = 5$ to $I = 152, J = 7$, with the downstream side at $I = 153$. All three cells use water surface elevation from bottom for both upstream and downstream reference heads option with a low-chord elevation of 4.9 m and uncontrolled operation. The key low-chord structure parameters are summarized in Table 2.

Table 2 Low-chord bridge structure parameters

Parameter	Value
Bridge cell columns (I index)	152 (upstream) – 153 (downstream)
Bridge cell rows (J index)	5, 6, 7
Control type	4 (absolute water surface elevation)
Low-chord elevation	4.9 m
Structure operation type	Uncontrolled
Rating table IDs	1, 2, 3

3 Model Results

Figure 2 shows the 2D spatial distribution of water surface elevation and depth-averaged velocity vectors across the channel at $t = 0.38$ days, corresponding to increasing limb of the upstream inflow. Figure 3 shows water surface elevation time series at an upstream cell (Cell 340, $I = 138, J = 6$) and a downstream cell (Cell 365, $I = 163, J = 6$) over the full 5-day simulation.

At $t = 0.38$ days, the upstream reach exhibits water surface elevations approaching 10 m (red), with velocity vectors directed strongly eastward toward the bridge. A sharp hydraulic gradient is visible at the bridge location ($I = 152$), where the water surface drops abruptly from the elevated upstream pool to lower elevations on the downstream side. Downstream of the bridge, velocities are lower and water levels reflect the tidal boundary condition, with the downstream end showing near-zero or negative elevations at this phase of the tidal cycle. The inset hydrograph panels confirm the peaked upstream inflow pulse (left) and the oscillatory tidal signal at the downstream boundary (right).

Over the full simulation, the upstream water surface elevation rises sharply to approximately 7.2 m during the initial high-flow event (days 0.5–1.5), substantially exceeding the low-chord elevation of 4.9 m. The downstream cell shows a markedly lower water surface of approximately 4.5 m over the same period, reflecting the backwater impoundment imposed by the bridge. After day 2.0, the upstream level stabilizes near the tidal equilibrium at approximately 4 m, while the downstream boundary continues to oscillate tidally between approximately 0.5 m and 3 m. These results confirm that the low-chord boundary condition in EFDC+ correctly represents the hydraulic control imposed by the bridge at high-flow conditions and its interaction with a tidal downstream boundary.

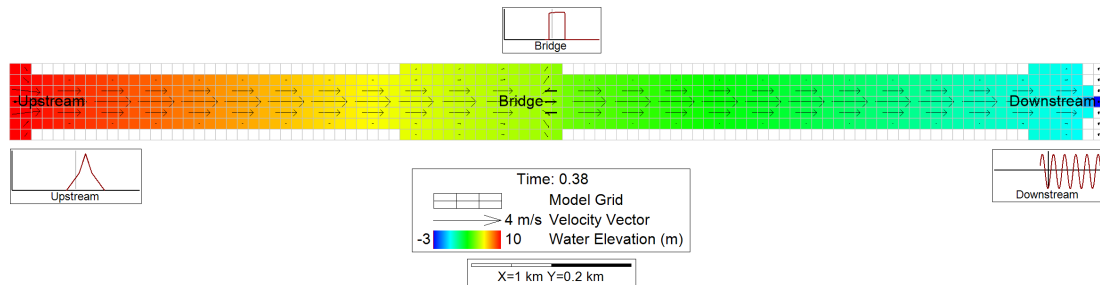


Figure 2 Depth-averaged water surface elevation and velocity vectors at $t = 0.38$ days

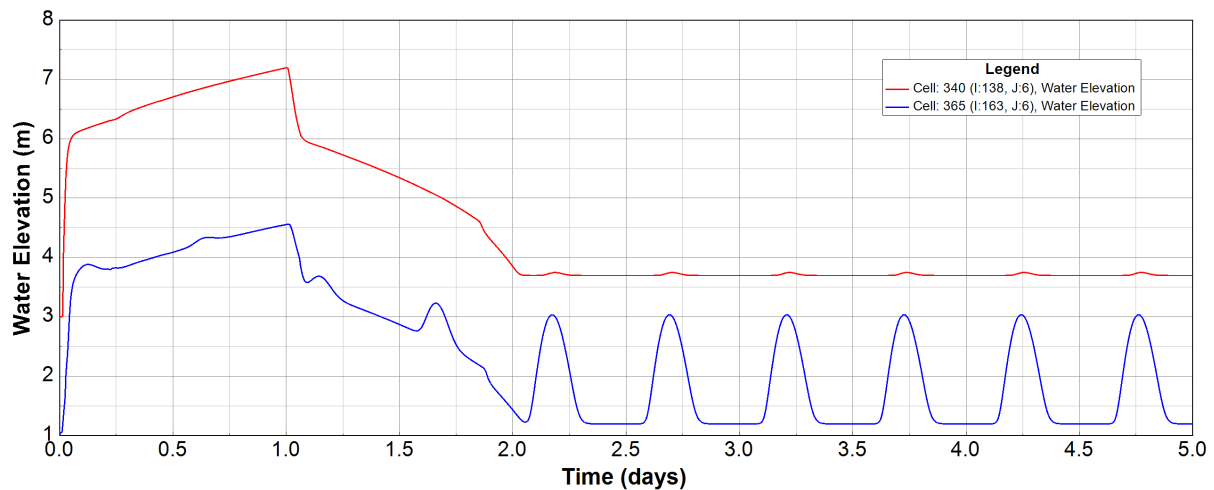


Figure 3 Water surface elevation time series at Cell 340 ($I = 138$, $J = 6$, upstream of bridge) and Cell 365 ($I = 163$, $J = 6$, downstream of bridge), days 0–5.

4 Notes

4.1 Disclaimer

This model is provided to demonstrate that EFDC+ Explorer and EFDC+ can be used to build and analyze this type of models. The simulation results are consistent with expected behavior; however, the model should not be considered a final or validated product. Users are encouraged to review, modify, and refine model parameters to obtain results appropriate for their specific application.

4.2 EEMS Demo Mode

In Demo mode, the model is validated against a set of predefined signatures, including grid size, domain area, center coordinates, transport count, and module configuration. While certain parameter values may be adjusted, the grid cannot be modified, transports cannot be added, and the prescribed module setup cannot be altered. Any deviation from these conditions results in the model no longer being considered a valid demo model.

4.3 Support

For technical support, additional documentation, or to obtain the latest version of EFDC+ Explorer, please visit: www.eemodelingsystem.com