UNDERSTANDING BASE LEVEL ENGINEERING (BLE)

BLE Modeling Approaches: 1D vs. 2D

Base Level Engineering (BLE) is the method in which accurate flood risk information is developed using ground elevation data and modeling software. BLE focuses on unknown, unmodernized, and unmapped areas. It can support a community's current (effective) flood map or provide flood risk information for areas without maps. BLE shows flood extents, flow velocities, flood depths, and water surface elevations on a large scale, such as a watershed, community, or county.

BLE studies can use one-dimensional modeling (1D) or two-dimensional modeling (2D), depending on the needs and traits of the watershed. This provides floodplain administrators and other local officials access to quality data that meets their needs.

One-Dimensional Modeling Approach to BLE Development

Studies with 1D BLE modeling can use HEC-RAS or other hydraulic models with a step-backwater approach. This model assumes that floodwaters are mostly moving in one direction along a well-defined path and is most suited for watersheds where stream reaches have a more confined flow with minimal split or lateral flows.

PROS	• Accurately models hydraulic structures (e.g., bridges and culverts). • Provides great scalability. Small, localized changes to a reach can be implemented and assessed without affecting the entire watershed. • Simple to modify for engineers, developers, and regulators assessing project impacts. • Easier to map and manage floodways. • Historically, studies have been performed in the 1D environment, more compatible with existing floodplain regulation language.
CONS	• Limited capability compared to 2D. • Poor approximation of wide floodplains with undefined flowpaths. • More challenging to map stream attenuation and interconnectivity. • Requires much more model development effort. • Flooding sources decentralized (e.g., each stream contained in separate model). • Flooding extents are stream-focused, and may miss flooding along smaller contributing tributaries.

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Two-Dimensional Modeling Approach to BLE Development

Studies with 2D BLE modeling can use HEC-RAS 2D or other two-dimensional modeling platforms like SRH-2D and FLO-2D. These programs apply a computational mesh or grid network to account for water moving horizontally in more than one direction.

PROS	• Great at modeling large areas such as watershed, community, or county. • Efficiently simulate all flooding sources within a watershed within a single model, including flooding along minor contributing tributaries. • Accurately models shallow overbank flows, wide floodplains, and braided stream conditions. • More accurate project impact assessments. • Allows for dynamic hydrologic inputs, including rainfall and hydrographs. • Detailed water surface elevation and velocity grid outputs. • Incredibly useful visual outputs of flooding extents. • Output water surface elevation grids reduce inaccuracies with flood profiles. • More robust equation sets and control over computational parameters.
CONS	• Requires more technical expertise. • More difficult for engineers and developers to modify. • Requires detailed terrain data. • More difficult to modify small sections of the model. • The larger datasets can be more difficult to share/access. • Long model run times for large areas. • Difficult to model floodways. • Requires more manual “cleanup” to create floodplain maps. • Difficult to simulate hydraulic effects of bridges in current model version.

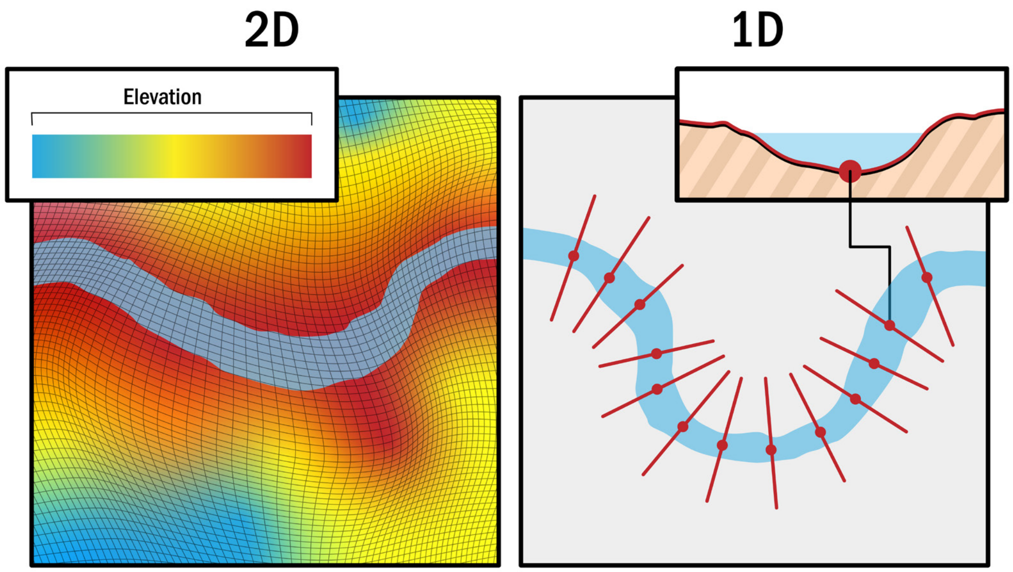
BLE Modeling Approaches: 1D vs. 2D

When to Use 1D vs. 2D

	1D BLE Approach	2D BLE Approach
Best for:	Confined flow, hydraulic structures	Unconfined flow, lateral flows, large and/or interconnected watersheds
Typical Model:	HEC-RAS	HEC-RAS 2D; SRH-2D; FLO-2D
Model Approach:	Step-backwater	Computational Mesh
Inputs:	Cross-sections, roughness coefficients, boundary conditions, discharge values, other model parameters	Terrain dataset, mesh cell size and orientation, roughness coefficients, hydrologic inputs, boundary conditions
Outputs:	Floodplain boundaries, water surface profiles, tabulated hydraulic parameters	Floodplain boundaries, depth and velocity grids, water surface contours, water surface elevation grids
Scalability:	Excellent	Good
Maintenance:	Easy to update and re-run	More difficult to update and re-run

1D and 2D Modeling and Flood Maps

Communities can work with their state and FEMA to find priority reaches from a BLE study to include on flood maps, based on development trends or changes in flood risk. Both 1D and 2D BLE studies can be added to flood maps as new or updated approximate study (Zone A) areas. No BFEs would be published, but the community would have access to cross-sections with water surface elevations (for 1D studies) and water surface elevation grids (for 2D studies) for local use in GIS. By adding improvements to the BLE model, such as survey data, refinements to the cross sections (1D) or mesh size/alignment (2D), updated hydrologic inputs, and more, BLE models can relatively easily produce detailed study (Zone AE) floodplain boundaries ready to be mapped on a Flood Insurance Rate Map (FIRM).



Regulating in 1D vs. 2D Floodplain Areas

Both 1D and 2D approaches to BLE will result in the same BLE datasets, such as Flood Depth Grids and Floodplain Extents. Both approaches also allow for accurate demonstration of project or development impacts, though with different levels of effort.

IN 1D AREAS	1D HEC-RAS models can serve as a base model for showing localized project impacts, such as those related to a bridge repair/replacement, watercourse alteration, or floodplain encroachment. Updated cross-section geometries and model inputs can be adjusted based on proposed project design. In most cases, No Rise certifications are more straightforward using a 1D model.
IN 2D AREAS	Maintenance and revision of a 2D model can require more technical expertise. Project impacts are largely assessed by updating the terrain and computational mesh rather than cross-section geometry and other inputs of a 1D model. No Rise certifications are possible with 2D models but impacts to water surface elevations can reach far outside of a project area due to the interaction of the grid cells to one another. Water surface elevation grids generated by 2D models can be used to easily and accurately support a Letter of Map Amendment (LOMA) request.

Additional Resources

- A full library of BLE materials is available at FEMA.gov, including fact sheets and user guides.
- Review additional Flood Map Products and Tools.

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