Floodplain Map Revisions and Hydraulic Modeling: Common Mistakes and Steps to Avoid

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AECOM

AGENDA

- Floodplain Map Revisions
- Hydraulic Model Requirements
- Best Practices: 1D Hydraulic Modeling & Floodplain Mapping
- Key Takeaways
- Guidance & Resources

ACRONYMS

CLOMR	Conditional Letter of Map Revision
BFE	Base Flood Elevation
FDT	Floodway Data Table
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
LOMC	Letter of Map Change
LOMR	Letter of Map Revision
NFHL	National Flood Hazard Layer
SFHA	Special Flood Hazard Area
SOD	Summary of Discharge
WSEL	Water Surface Elevation

Floodplain Map Revision

Floodplain Map Revision

Communities rely on FEMA floodplain maps for flood insurance, zoning, and development decisions.

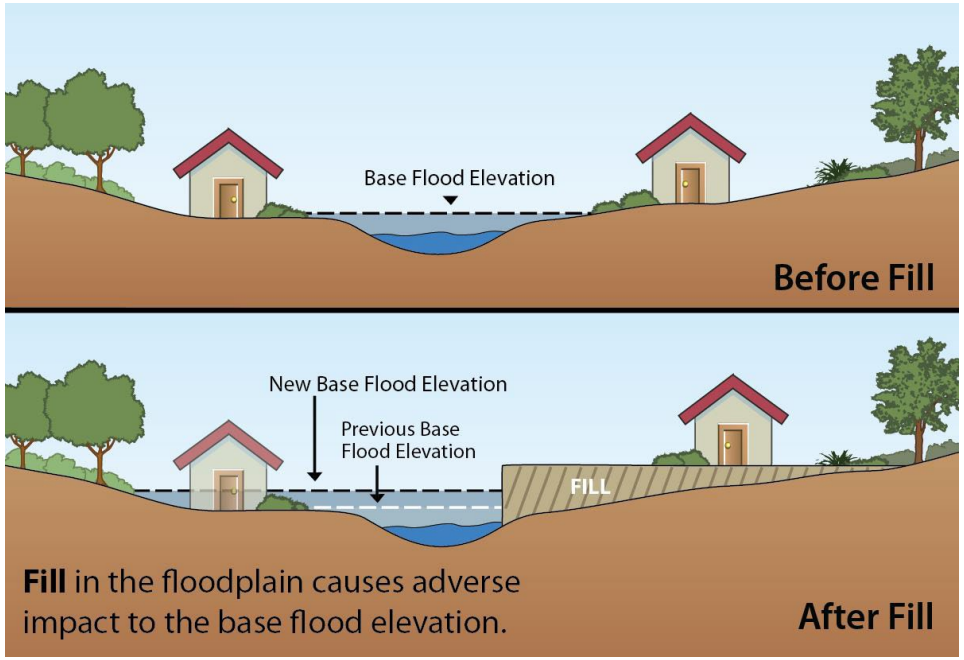
Many floodplain maps are based on old data and outdated methodologies

Flood maps must be revised to incorporate physical changes, updated topography, new data and improved modeling techniques

Updated flood maps help communities make safer, smarter decisions by reflecting current flood risks

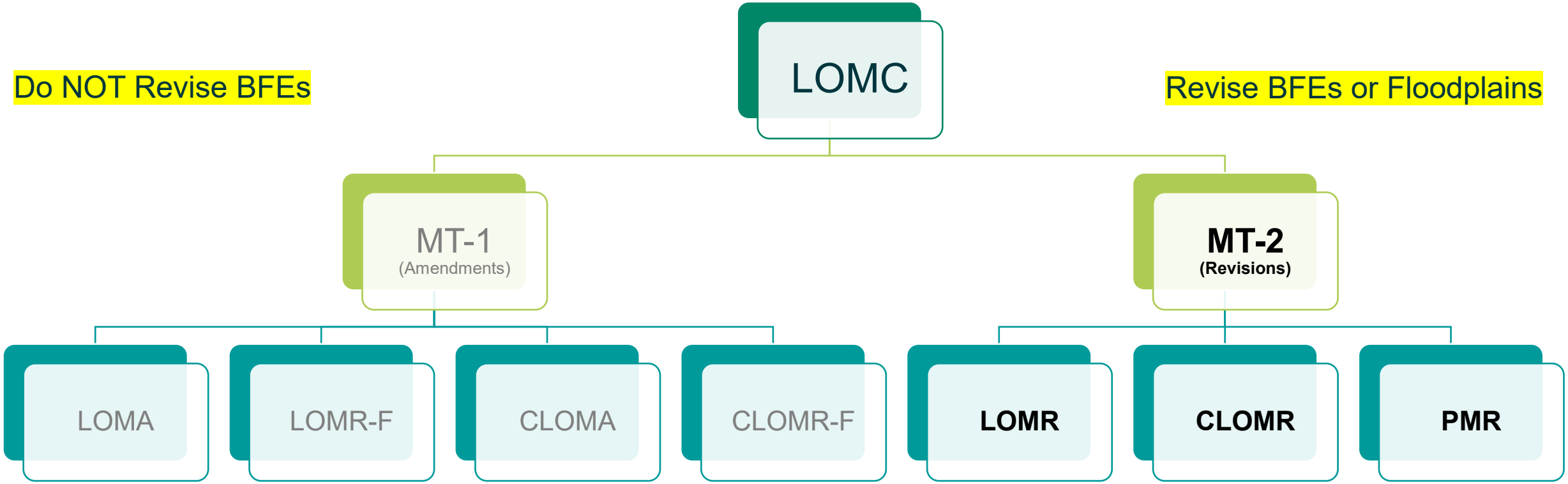
Underestimate risk → property loss and safety hazards.

Overestimate risk → unnecessary insurance and development restrictions.

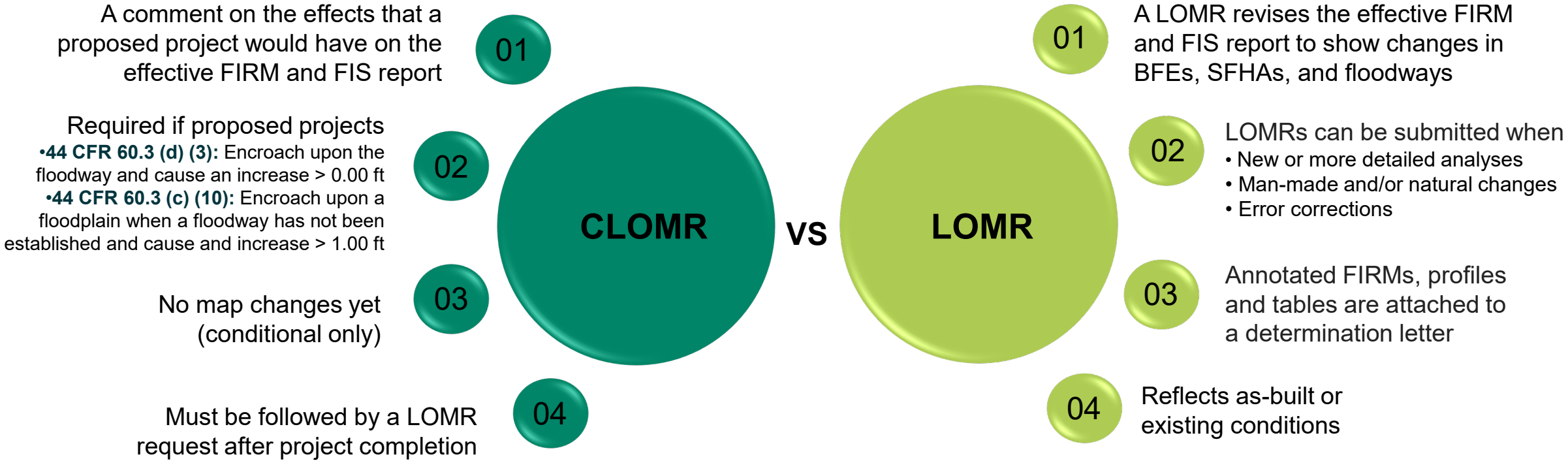


Source: piercecountywa.gov

Letter of Map Change (LOMC)



Letter of Map Revision (LOMR) & Conditional LOMR (CLOMR)

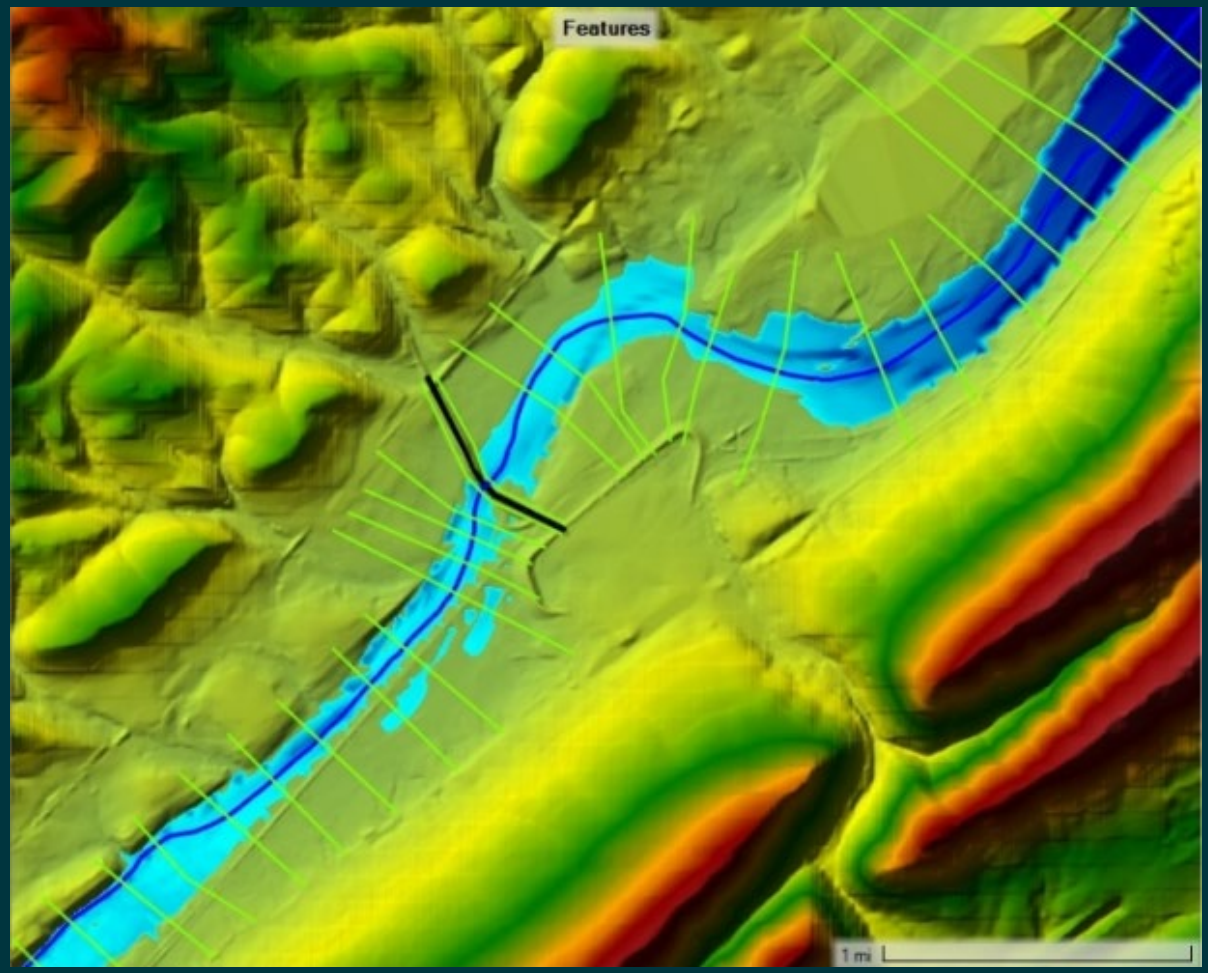


Study → CLOMR (conditional) → Build → LOMR (as-built or existing)

Hydraulic Model Requirements

Hydraulic Analysis

- Objectives
  - To determine the peak water surface elevations (WSELs)
  - To delineate the floodplain boundary
- Requirements to submit hydraulic analysis
  - Required for most LOMRs and CLOMRs
  - Based on hydraulic models identified in FEMA acceptable model lists



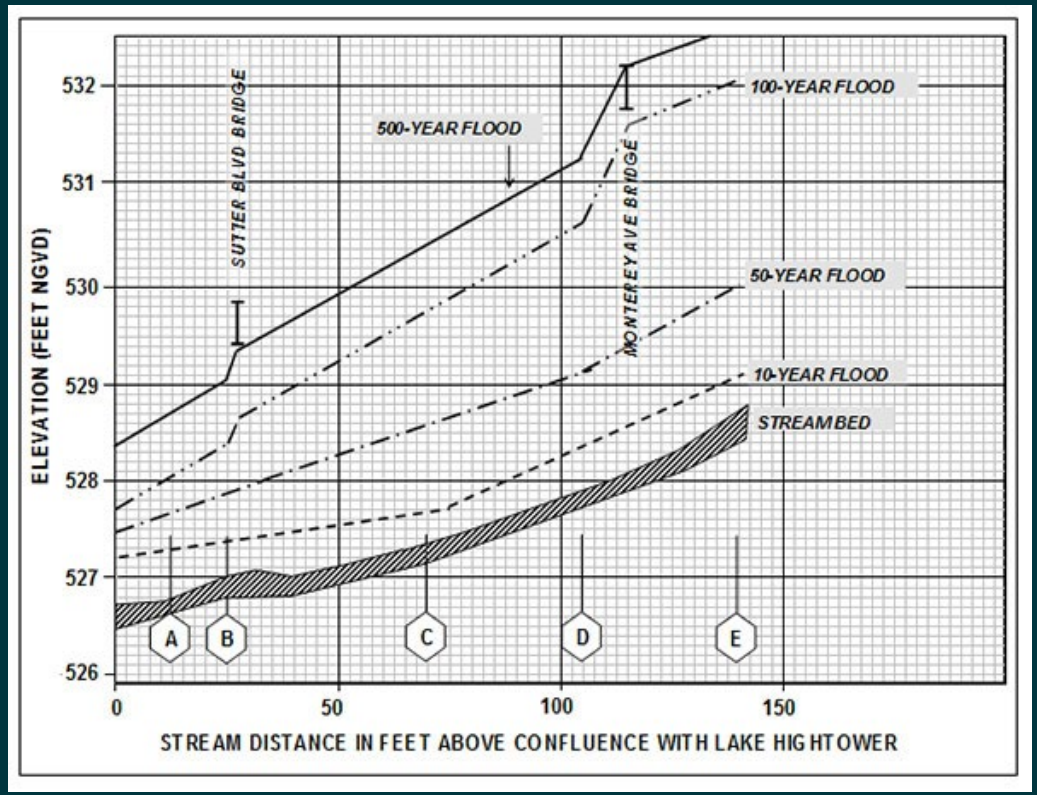
Source: HEC-RAS User's Manual

HYDRAULIC MODELS

Duplicate Effective	Identical to the effective model received from FEMA (https://www.fema.gov/sites/default/files/documents/fema_flood-insurance-study-data-request-form.pdf)
Corrected Effective	Correct errors in the duplicate effective model Must not include manmade changes post-publication of effective study
Pre-Project or Existing Conditions	Reflect any physical modification since the effective model, but prior to the construction of the project
Post-Project or Proposed Conditions	Reflect revised condition to include the new project

Hydraulic Model Requirements

- Required Flood Frequencies (44 CFR 65.6 (a) (8)
  - Same recurrence interval(s) as in the effective (e.g., 10-, 50-, 100-, and 500- year, and floodway)
- Boundary Conditions
  - Slope area/normal depth (at a confluence or if known WSEL not available)
  - Junction (if tributary and main stream have coincident peaks)
  - Known WSEL (in the middle of a reach with effective BFEs or reliable source)
- BFE Tie-in (44 CFR 65.6 (a) (2)
  - Revised and unrevised BFEs must match within 0.5 foot at upstream and downstream ends
- Floodway Analysis
  - Baseline condition model and floodway model run
  - Surcharge should be between 0.0 and 1.0 feet



Source: Emergency Management Institute Learning Management System

1D Hydraulic Modeling : Best Practices

Identify, Diagnose, and Prevent Common Errors

1D MODELING IN CONTEXT

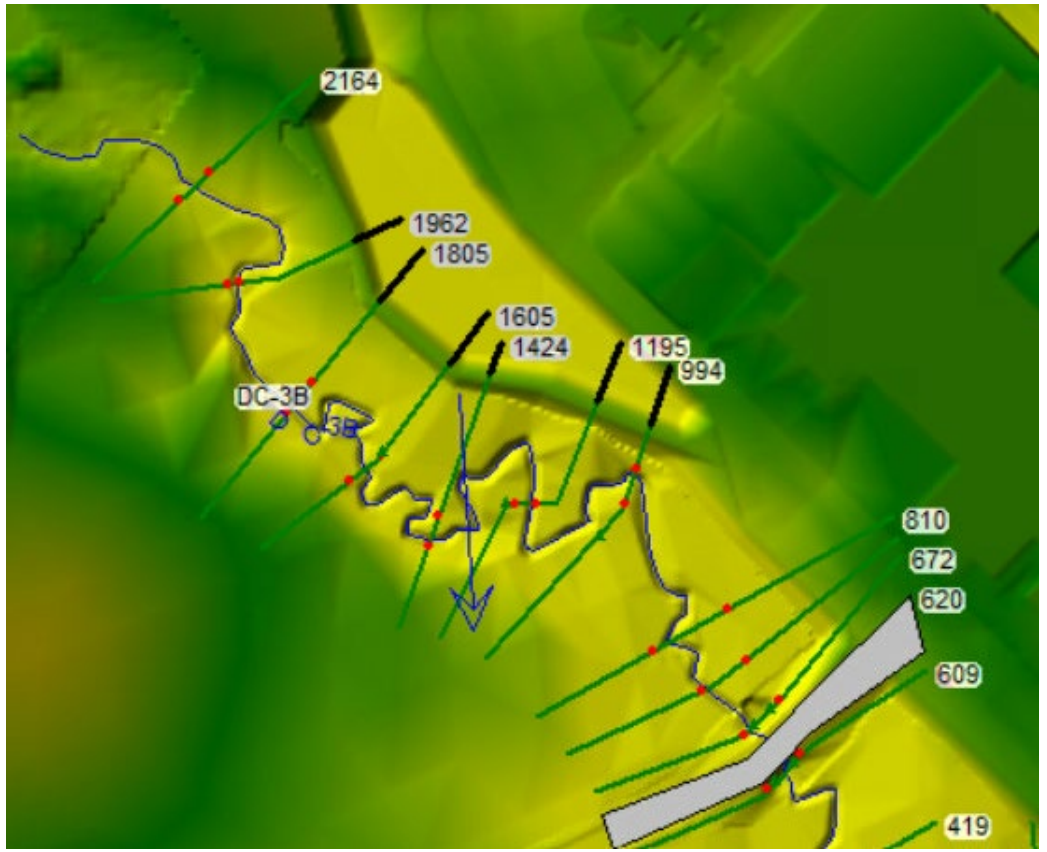
Cross-Section Based: Flow calculated along defined channel cuts

Assumption: Flow follows main channel alignment (limited lateral detail)

Efficiency: Faster to set up, computationally less intensive than 2D

FEMA-Approved Standard: Most accepted for LOMR/CLOMR submittals

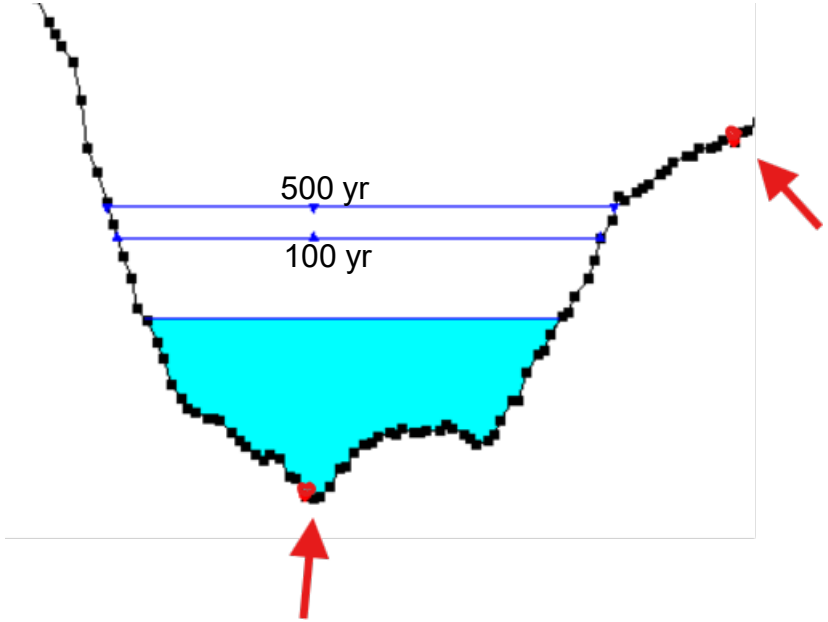
Limitations: Can miss complex overbank or split-flow hydraulics.



1D HYDRAULIC MODEL : BANK STATIONS

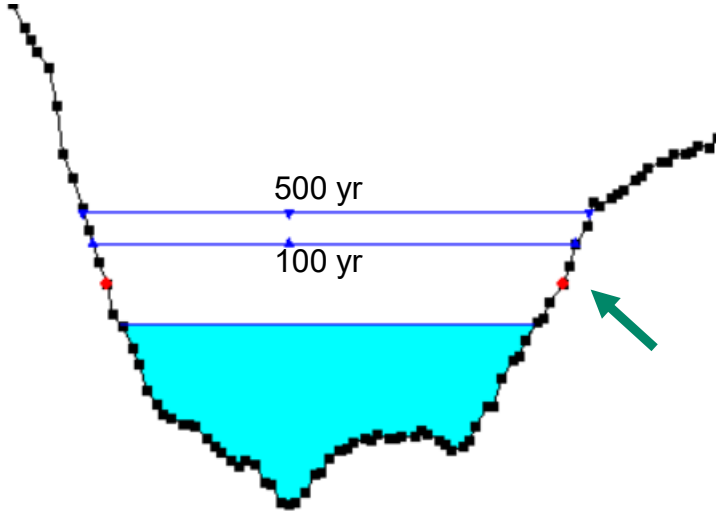
Don'ts

- Channel banks located at the bottom or at the edge of a cross-section



Do's

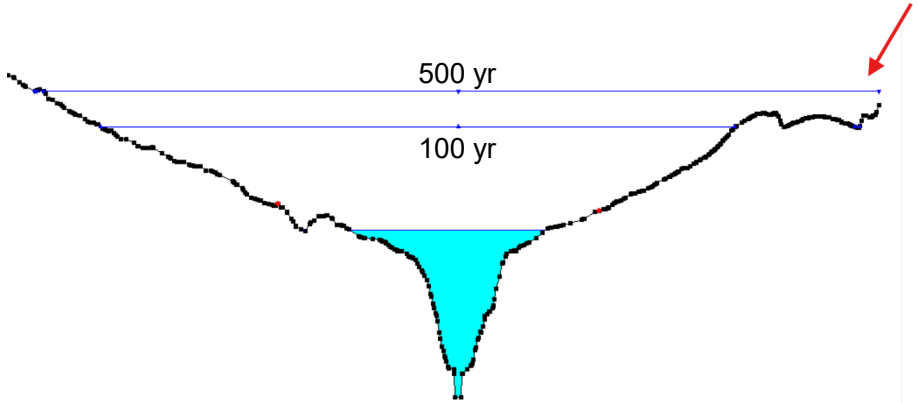
- Higher frequency storms commonly define channel banks and are usually below the BFE but above the bottom of the channel
- Maintain consistent channel width transitions to prevent crossing profiles



1D HYDRAULIC MODEL : VERTICALLY EXTENDED CROSS-SECTION

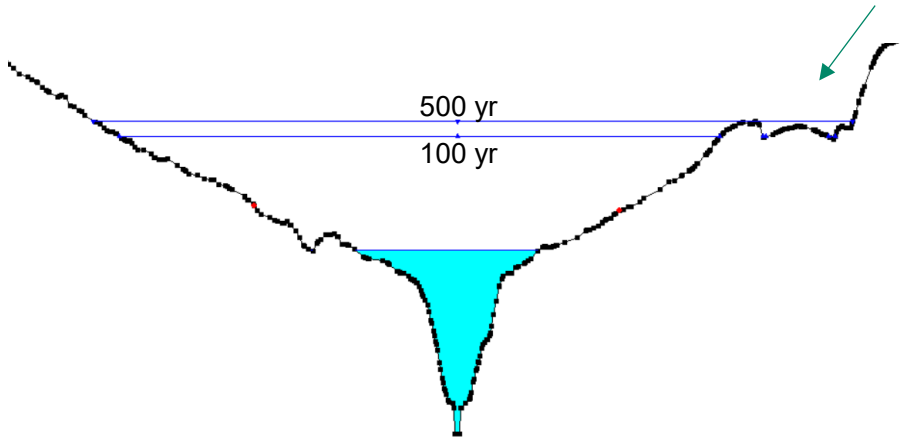
Don'ts

- Cross-section endpoint is below the BFE/WSELs
- The use of vertically extended cross sections might both overestimate the BFE/WSELs and underestimate the width of the base/0.2-percent-annual-chance floodplain



Do's

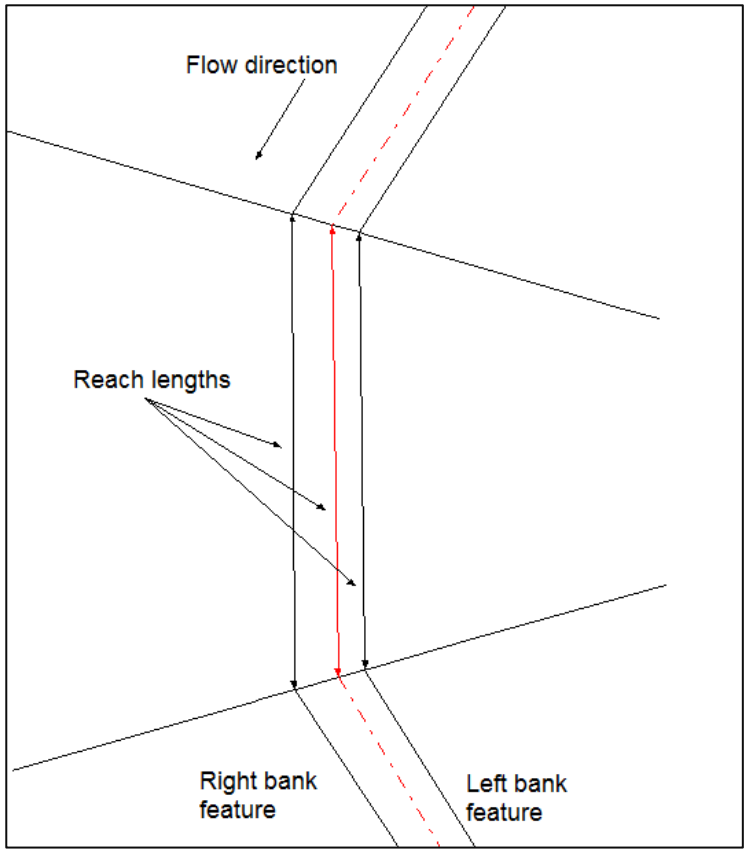
- End points of all cross sections should be equal or higher than the corresponding BFE/WSELs, otherwise quantify the amount of split flow



1D HYDRAULIC MODEL: CROSS-SECTION SPACING & ALIGNMENTS

Do's

- Excessive reach length distance between modeled cross sections should be avoided to more accurately analyze the Water Surface Elevations (WSELs) at densely populated areas
- Layout of cross sections should extend across the entire floodplain and be perpendicular to the anticipated flow lines
- In case of relatively large skew angle (>30 degrees), include the skew angle in the cross-section editor of HEC-RAS



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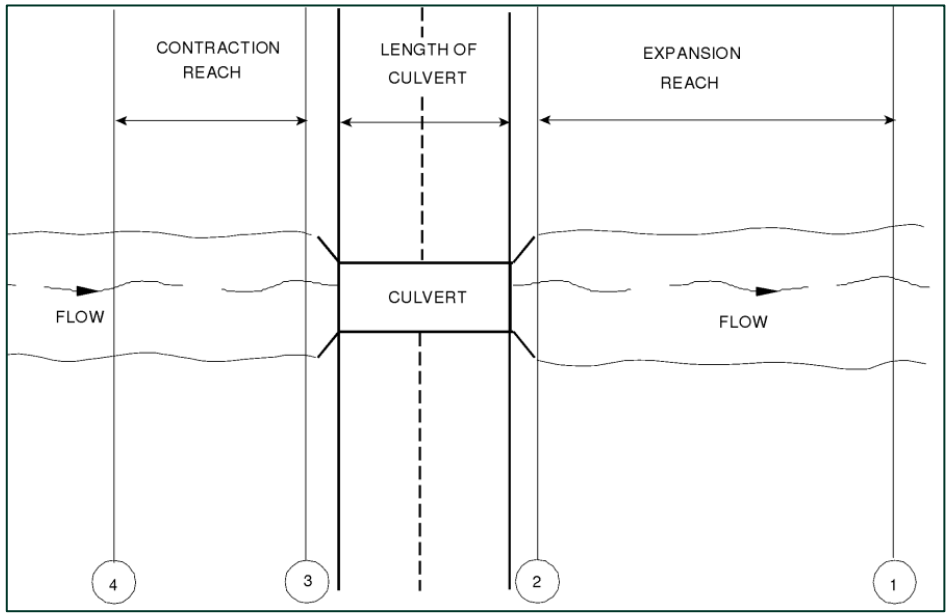
1D HYDRAULIC MODEL : STRUCTURES

- Consistent flow value through the structure
- At least two cross sections upstream and downstream of a structure
- Locate Sections 2 and 3 beyond pier footings (Bridges), wingwalls (Culverts) and road embankments
- Locate Sections 1 and 4 sufficiently upstream and downstream from the structure where fully expanded flow occurs
- Contraction and Expansion loss coefficients equal to **0.3 and 0.5** at Sections 2, 3, and 4 and **0.1 and 0.3** at Sections 1 and 5

Do's

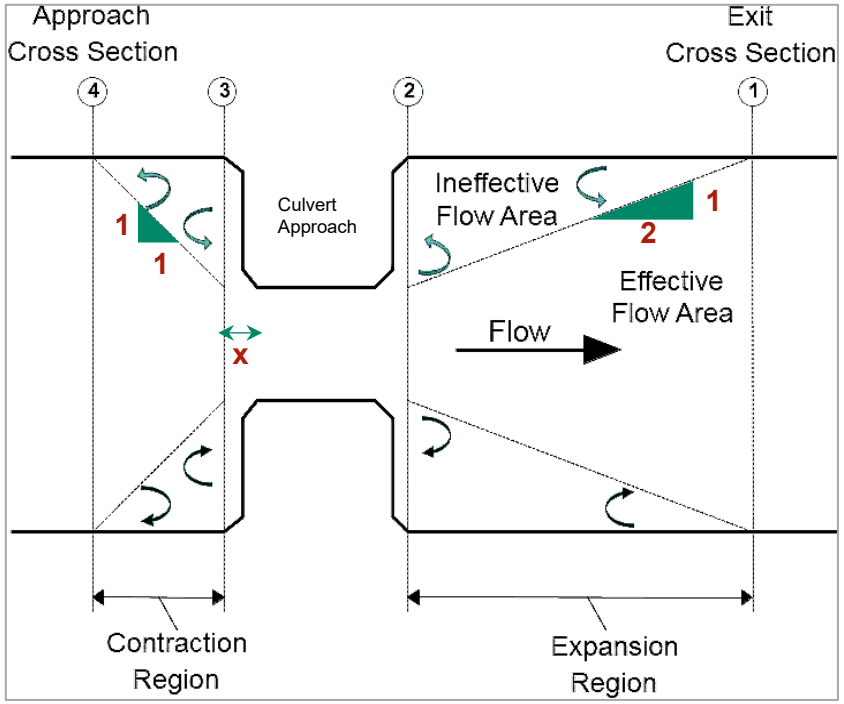


	River Station		Contraction	Expansion
28	6782	Section 5	0.1	0.3
29	6736	Section 4	0.3	0.5
30	6674	Section 3	0.3	0.5
31	6580		Culvert	
32	6487	Section 2	0.3	0.5
33	6393	Section 1	0.1	0.3

1D HYDRAULIC MODEL : STRUCTURES

Do's

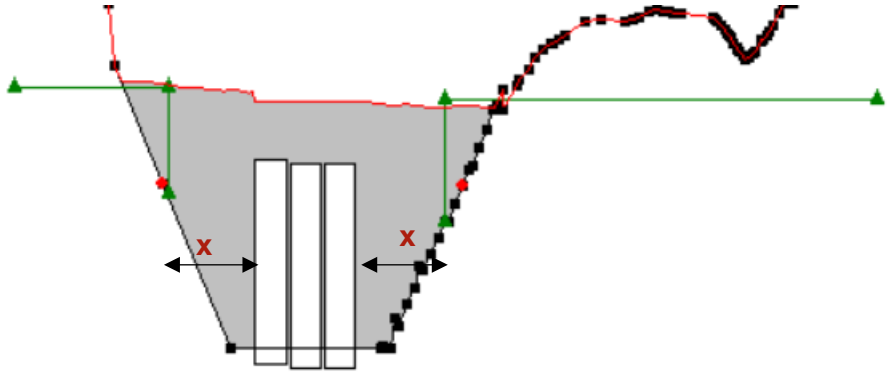
- Place ineffective flow (IF) upstream and downstream of a structure
  (HEC-RAS Hydraulic Reference Manual)



knowledge.civilgeo.com

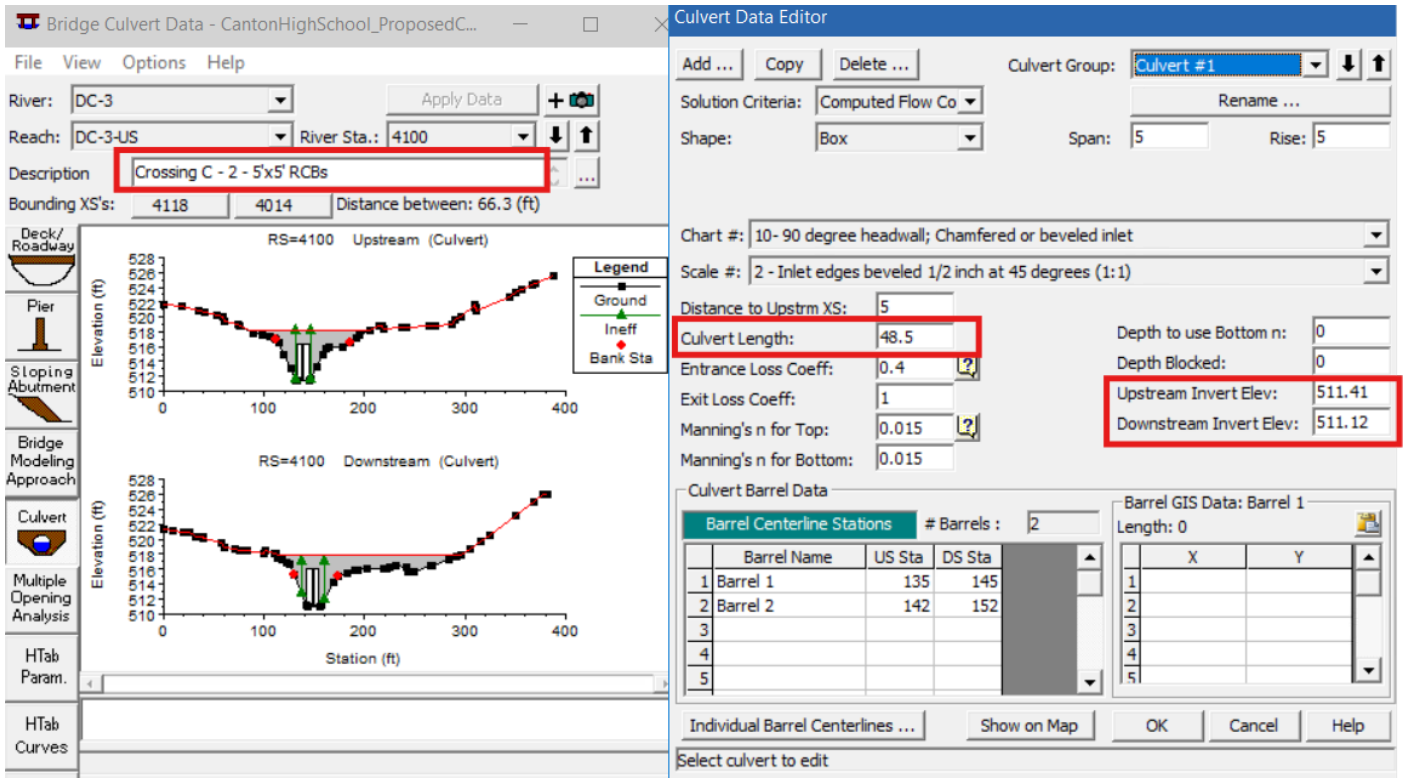
Do's

- Use 1:1 contraction and 1:2 expansion ratios to model flow transitions
- Set the ineffective height to be at the lowest elevation of the road



1:1 Ratio to Place IF in Contraction Zone

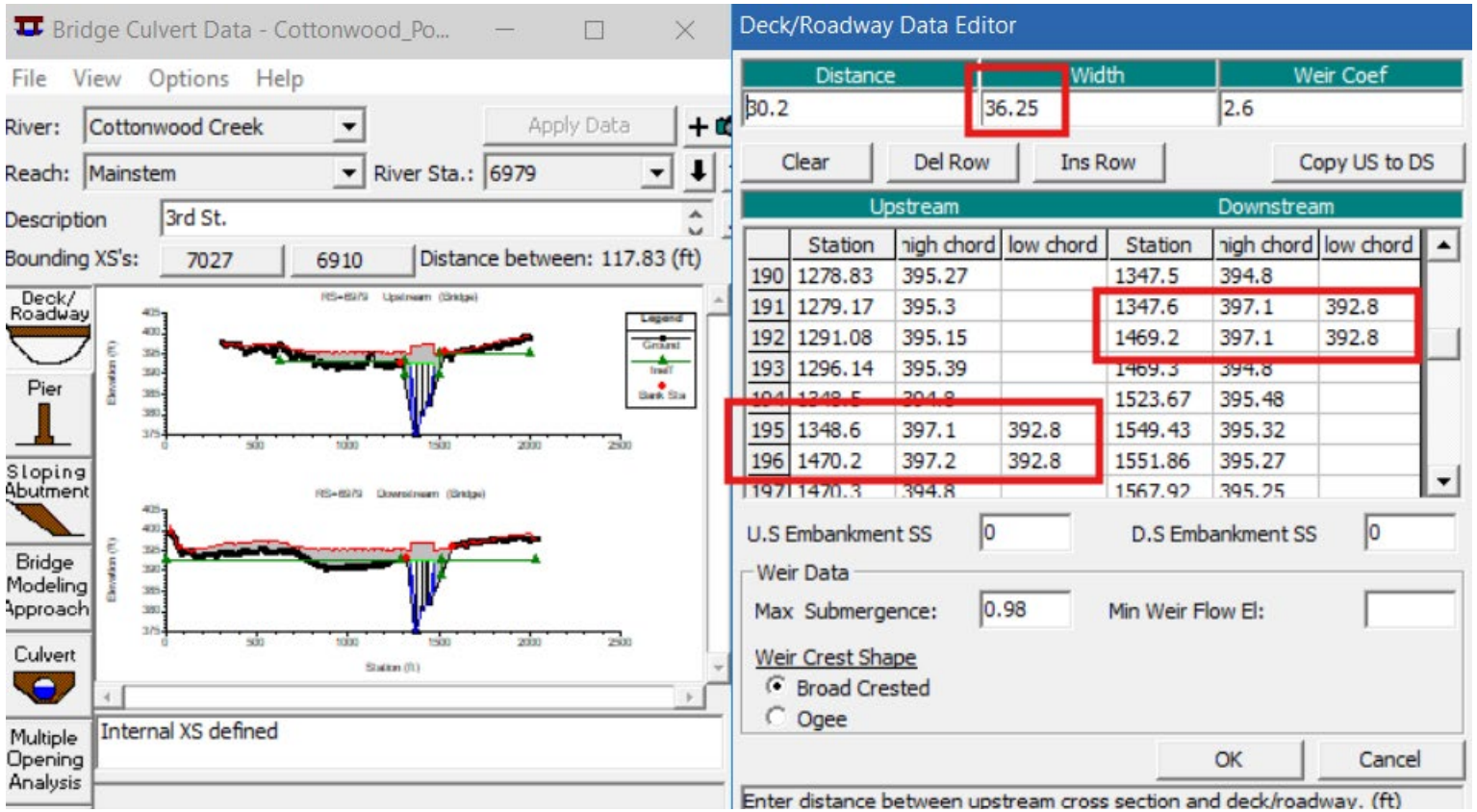
1D HYDRAULIC MODEL : CULVERTS



Do's

- Plans should include the size and length of the culvert along with all invert elevations
- Different barrel entries each with their own invert elevations and lengths to increase accuracy
- Recommended Manning's "n" range is between 0.011 and 0.017
  (HEC-RAS Hydraulic Reference Manual)
- For LOMRs, plans need to be "as-built" and certified
- Vertical datum (NAVD/NGVD) of tha plan should be consistent with the hydraulic model

1D HYDRAULIC MODEL : BRIDGES

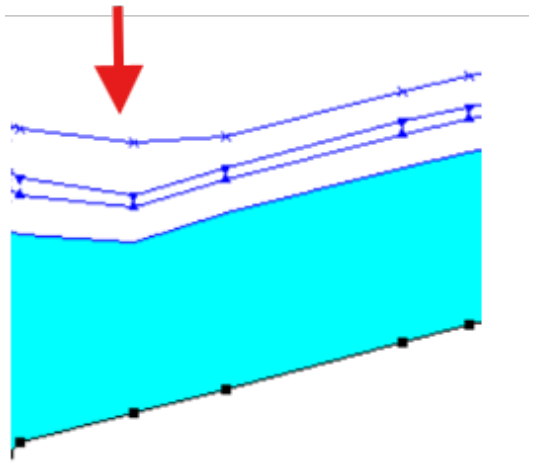


Do's

- Plans should include the dimensions of the bridge as well as low chord and high chord elevations
- Bridges with piers should be modeled using the highest energy answer between “Energy” and “Momentum” methods
  (HEC-RAS Hydraulic Reference Manual)

1D HYDRAULIC MODEL : DRAWDOWNS

- Drawdown refers to sudden decrease in water surface elevation at a cross-section compared to its immediate downstream cross-section
- Occurs in the downstream of a structure, in areas with abrupt changes in terrain or channel geometry, etc

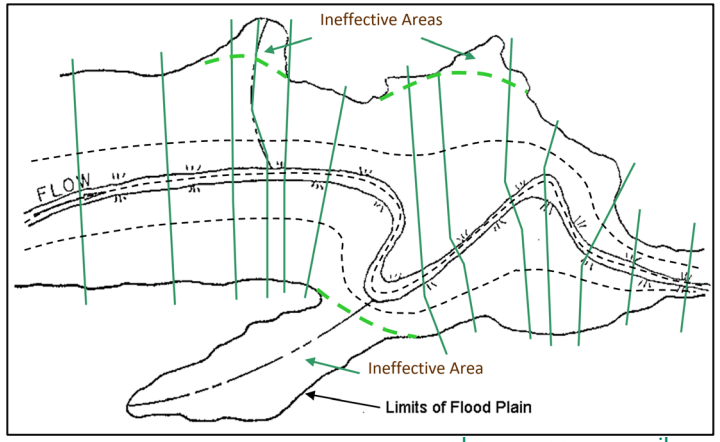


Do's

- Eliminate or reduce drawdowns to less than 0.1 foot or provide justification
- If drawdowns are an accurate hydraulic condition, must ensure that the floodplain mapping at these locations is based on the higher water surface elevation calculated downstream of the drawdown

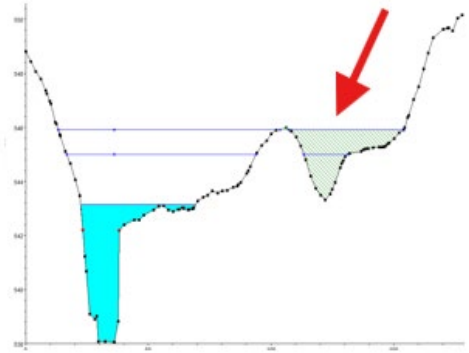
1D HYDRAULIC MODEL : INEFFECTIVE AREAS & BLOCKED OBSTRUCTION

Do's



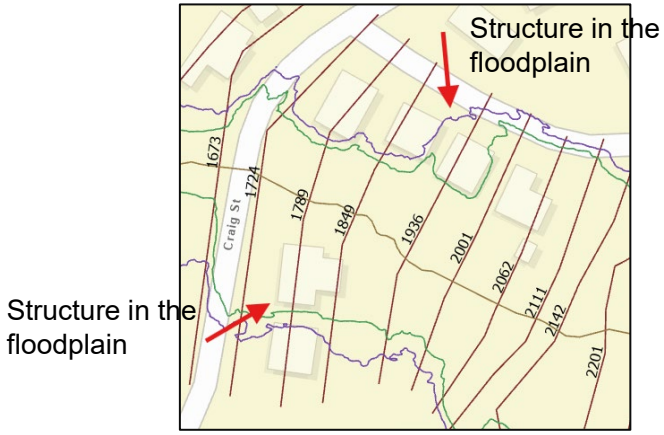
hec.usace.army.mil

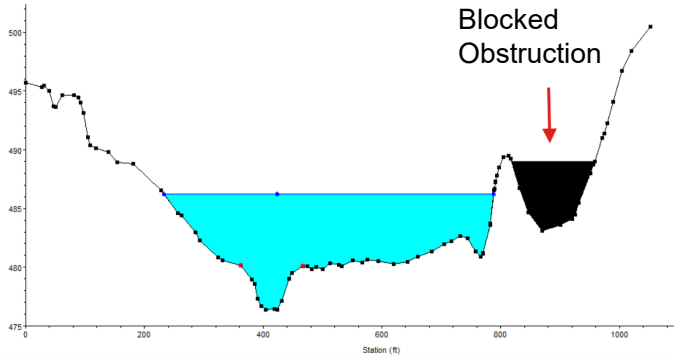
Ineffective Flow Areas



Placing ineffective flow areas where flow will not be actively conveyed

Do's



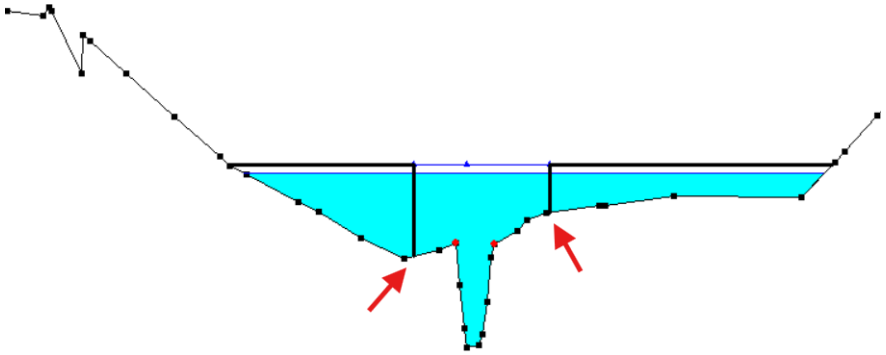


Placing blocked obstruction to represent structures/ponds in the floodplain

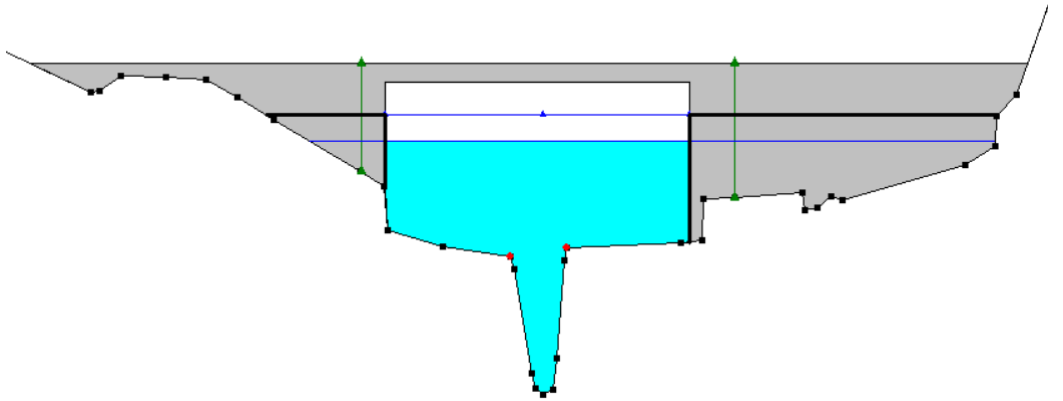
1D HYDRAULIC MODEL : FLOODWAY ENCROACHMENTS

- The floodway encroachment stations should be located in the flood fringe (the area between the channel banks and the boundary of the base floodplain)
- No encroachment stations within the opening of the bridges
- Floodway should be hydraulically smooth and free of sudden expansion, contraction, and backwater areas

Do's



Placing encroachment stations in the flood fringe



Placing encroachment stations outside of the bridge opening

Floodplain Mapping : Best Practices

Identify, Diagnose, and Prevent Common Errors

TOPOGRAPHIC WORKMAP

Show

- Topographic contours
- Revised/Proposed delineations
- Effective delineations
- Cross sections
- Streamlines
- Graphical tie-ins
- Certification (signed, sealed & dated)
- North arrow and scale
- Vertical datum
- Associated GIS/CAD data

PROPOSED BASE FLOOD ELEVATION
PROPOSED CROSS SECTION
PROPOSED 0.2 PCT ANNUAL CHANCE FLOOD HAZARD
PROPOSED 1 PCT ANNUAL CHANCE FLOOD HAZARD
PROPOSED FLOODWAY
PROPOSED LIMIT OF DETAILED STUDY
EFFECTIVE 1 PCT ANNUAL CHANCE FLOOD HAZARD
CORPORATE LIMITS
MINOR CONTOURS
MAJOR CONTOURS
EFFECTIVE ZONE A
EFFECTIVE ZONE X
PROPOSED AREA OF REVISION

N
W E
S

Figure 5.1
Topographic Map
Map Created - December 18, 2012
Scale: 1"=100'
Vertical DATUM: NAVD88

Seal and sign the workmap here.

FLOODPLAIN MAPPING : STREAM CENTERLINE

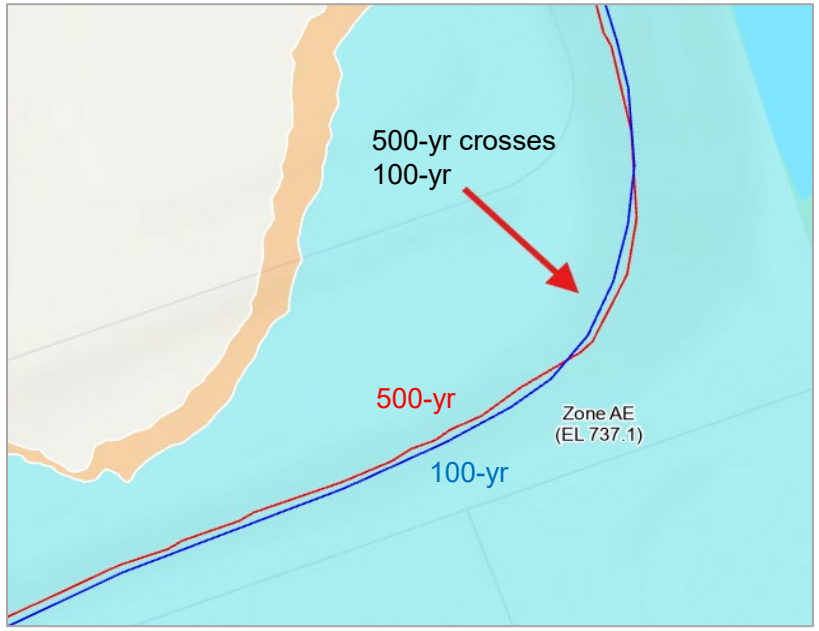
- Revised stream centerline must tie in to the effective centerline at both the upstream and downstream ends of the revised reach

- Streamline to remain within the regulatory floodway following the lowest points of the topography

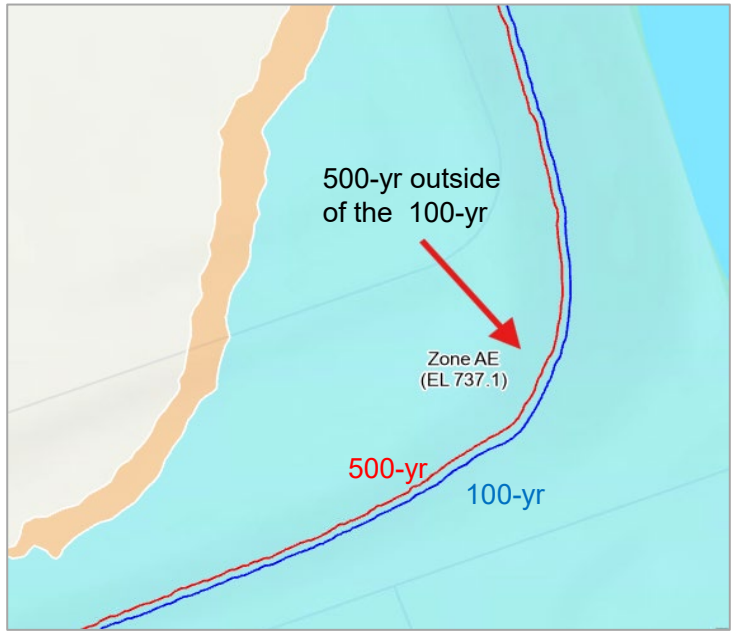
FLOODPLAIN MAPPING : ACCURATE DELINEATION

- Floodway remains within the 1-percent-annual-chance (Base) floodplain
- Base Floodplain remains within the 0.2-percent-annual-chance floodplain

Don'ts

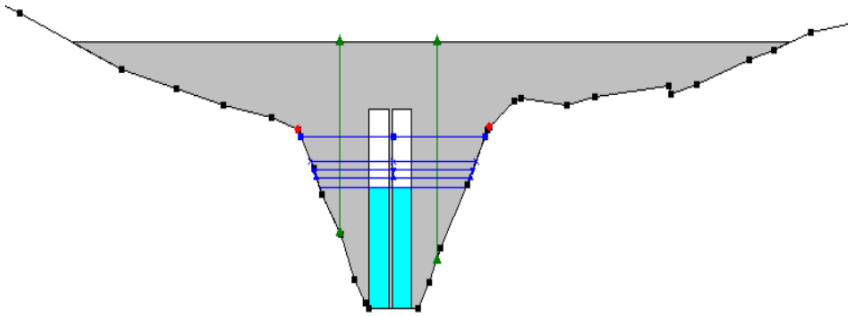


Do's

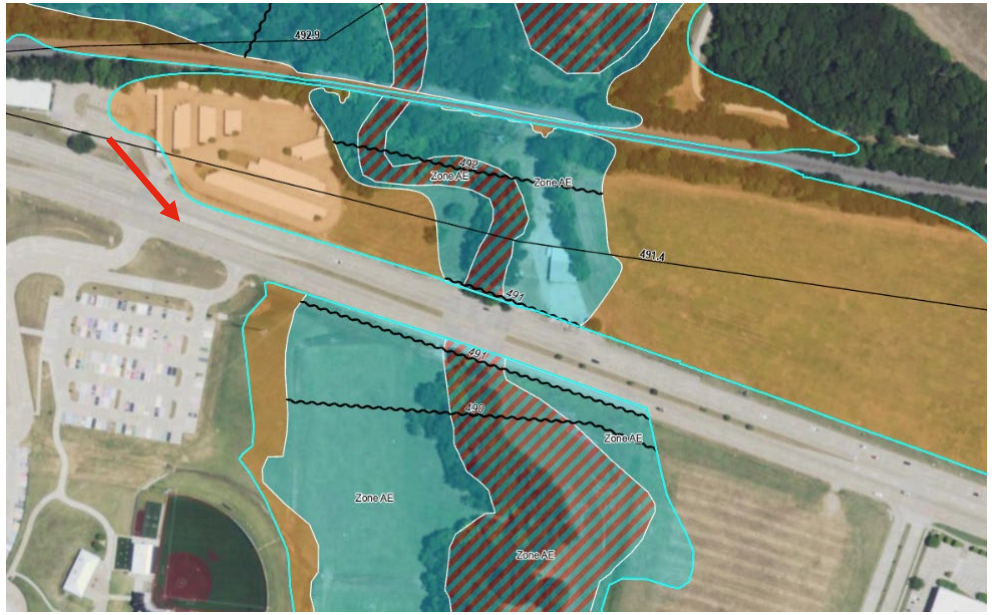


FLOODPLAIN MAPPING : STRUCTURE

- Flood hazard delineations should be truncated at the upstream and downstream ends of a culvert when the hydraulic analysis shows that the culvert contains flow
- Same rule is not applicable for bridges



Do's



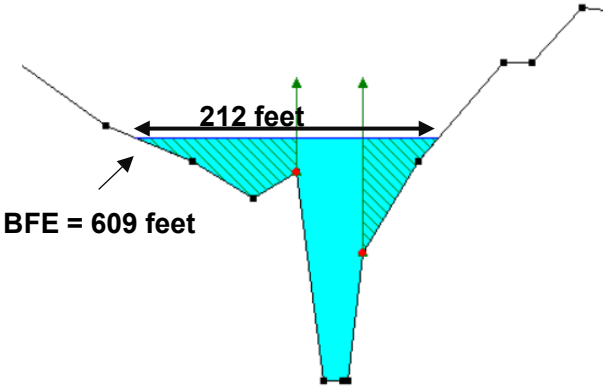
Delineations truncated when culvert contains flow

FLOODPLAIN MAPPING : MAP-MODEL DISCREPENCY

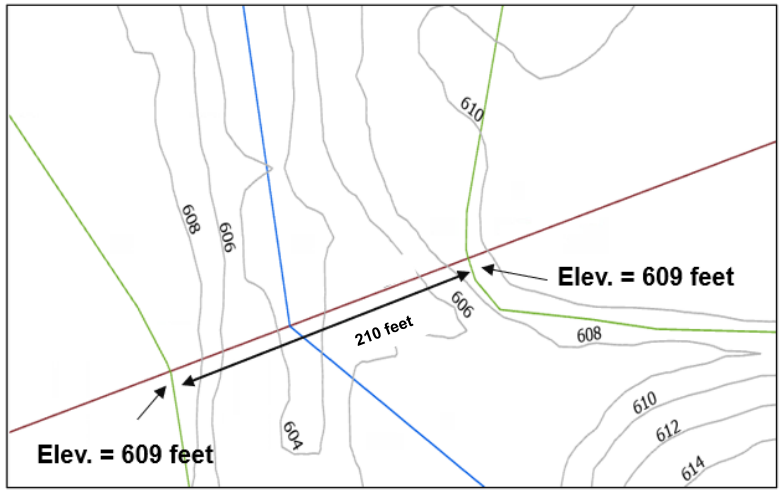
- Ensure consistency between the information presented in the topographic work map and the hydraulic model
- Map-model discrepancies are where the difference between map and model is more than **5%** of FIRM map scale or where the percent difference is more than **20%**
- Cross section geometry used in the hydraulic model should match the topography shown on the work map.

Do's

Modeled base floodplain top width = 212 feet



Mapped base floodplain top width = 210 feet



FLOODPLAIN MAPPING : GRAPHICAL TIE-IN

- Correctly delineate the floodplains at the upstream and downstream revision limits according to updated topography and then graphically tie in a short distance upstream and downstream of these cross-sections

- Ensure smooth graphical tie-ins between the revised/proposed and effective flood hazard boundary delineations at the upstream and downstream ends of the revised reach

- Ensure the digital file (i.e., GIS/CAD) is consistent with the work map

Do's

KEY TAKEWAYS

- Floodplain maps must be regularly updated.
- Hydraulic analysis is essential for floodplain map revisions
- Common errors in hydraulic modeling and floodplain mapping can be prevented
- Inaccurate floodplain mapping can either underestimate or overestimate risk
- Reliable floodplain mapping builds safer, more resilient communities

GUIDANCE & RESOURCES

- MT-2 Guidance
  https://www.fema.gov/sites/default/files/documents/fema_guidance-flood-risk-analysis-mapping_112022.pdf
- Map Service Center
  https://msc.fema.gov/portal
- National Flood Hazard Layer (NFHL) Viewer
  https://msc.fema.gov/nfhl
- Flood Insurance Study (FIS) Data Requests
  https://www.fema.gov/sites/default/files/documents/fema_flood-insurance-study-data-request-form.pdf
- FEMA Accepted Hydraulic Models
  https://www.fema.gov/flood-maps/products-tools/numerical-models/hydraulic
- FEMA Guidance Document 52
  General Hydraulics Considerations
  https://www.fema.gov/sites/default/files/documents/fema_general-hydraulics-guidance.pdf
- FEMA Guidance Document 80
  Hydraulics: One-Dimensional Analysis
  https://www.fema.gov/sites/default/files/2020-02/Hydraulics_OneDimensionalAnalyses_Nov_2016.pdf

Thank You

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