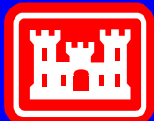


Sediment Impact Analysis Methods (SIAM): Overview and Application

Charles D. Little, Jr.
ERDC Coastal & Hydraulics Laboratory
Vicksburg, MS

NWK Sediment Webinar
December 2, 2010



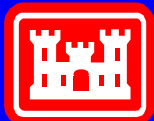
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Question: Why SIAM?

Answer: Emphasis on regional sediment management and need to assess channel rehabilitation measures



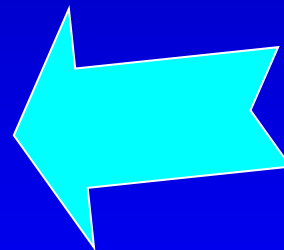
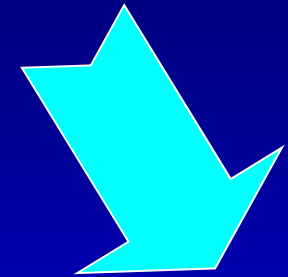
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Regional Sediment Management

- From Sources
- Through Pathways
- To Sinks



Regional Sediment Management

Sediment can impact a variety of projects:

- Flood control
- Navigation
- Reservoirs & impoundments
- Stream bank stabilization
- Stream rehabilitation
- Environmental/habitat restoration
- Irrigation and drainage

Challenges of regional sediment management:

- Wide range of stakeholders – land owners, infrastructure owners, municipalities, industry
- Budget & time constraints – sediment management on a system-wide scale can be \$\$\$!
- Assessing impacts to other projects – flood damage reduction, water supply



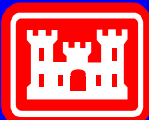
Assess Channel Rehabilitation Measures



How many structures are needed?



What are the impacts on sediment continuity?

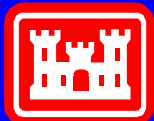


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SIAM was developed as a tool for sediment managers to assess the impacts of sediment management alternatives and rehabilitation measures on sediment continuity of a stream network.



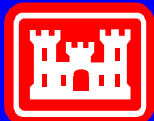
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Question: What is SIAM?

**Answer: A reach average
sediment continuity assessment
tool.**

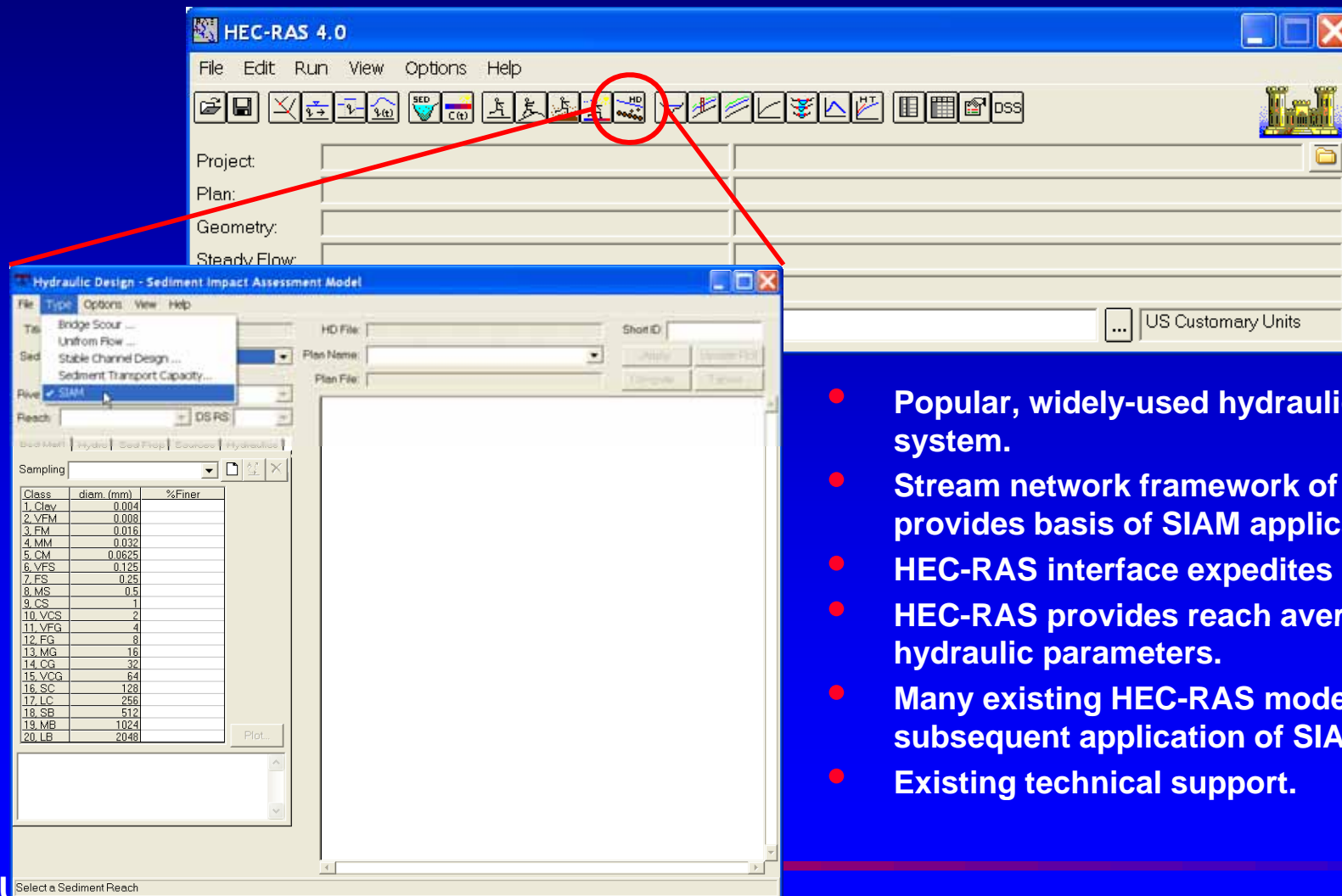


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SIAM is incorporated in HEC-RAS Hydraulic Design Module

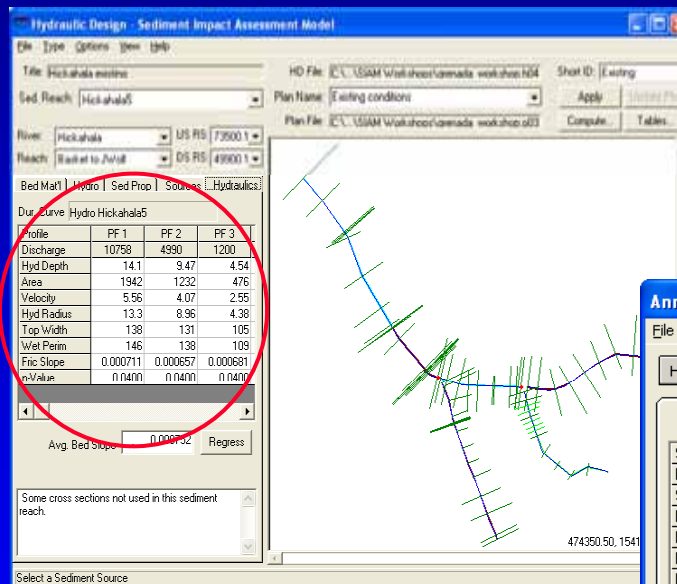


- Popular, widely-used hydraulic modeling system.
- Stream network framework of HEC-RAS provides basis of SIAM application.
- HEC-RAS interface expedites data entry.
- HEC-RAS provides reach averaged hydraulic parameters.
- Many existing HEC-RAS models permit subsequent application of SIAM.
- Existing technical support.

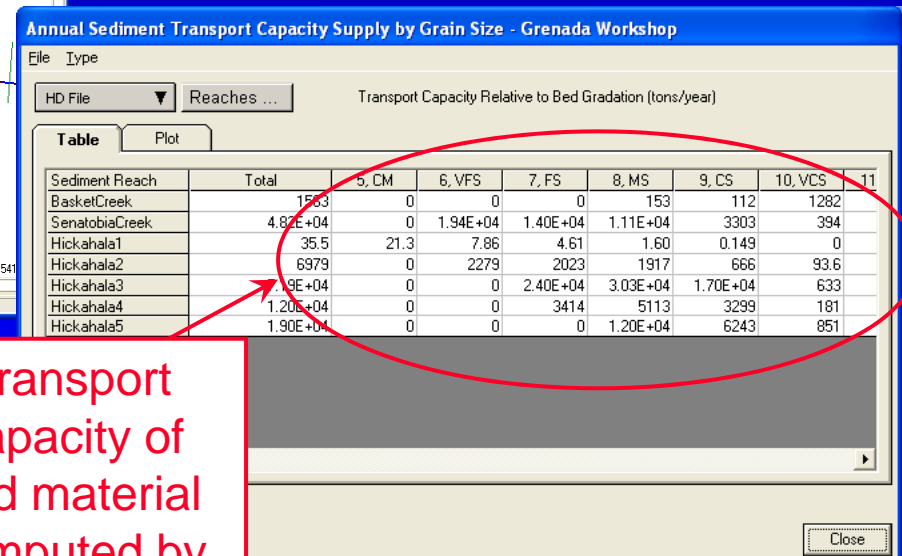


Capabilities: SIAM is

A reach-based sediment continuity model. Uses reach averaged hydraulic parameters for sediment transport computations by grain size class.



Reach averaged hydraulics from HEC-RAS results



Transport capacity of bed material computed by grain size class



Capabilities: SIAM determines...

Local sediment balance by comparing computed annual transport capacity with bed material supply on a reach-by-reach basis.

Total Bed Material Budget - Grenada Workshop

File Type

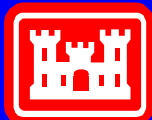
HD File ▼ Reaches ... Aggradation/Degradation (tons/year)

Table Plot

Sed Reach	Existing	Coarse	Coarse+Fine	CB+FB+LT
BasketCree	-1563	-1563	-1563	-1563
SenatobiaC	-1.22E+04	-1.22E+04	-1.22E+04	-4.82E+04
Hickahala1	6.29E+04	6.29E+04	4.29E+04	6943
Hickahala2	1.04E+05	1.04E+05	8.43E+04	8.43E+04
Hickahala3	-3.12E+04	-3.12E+04	-3.12E+04	-3.12E+04
Hickahala4	2.06E+04	8601	8601	8601
Hickahala5	-3045	-1.90E+04	-1.90E+04	-1.90E+04

Red values indicate bed degradation.
Blue values indicate bed aggradation.
Green values indicate bed equilibrium.

Close



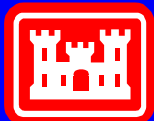
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SIAM Output for each Reach

- **Local balance (sediment continuity of bed material)**
- **Average annual transport capacity**
- **Bed material supply**
- **Wash material supply**
- **Local supply**
- **All results reported by grain size**



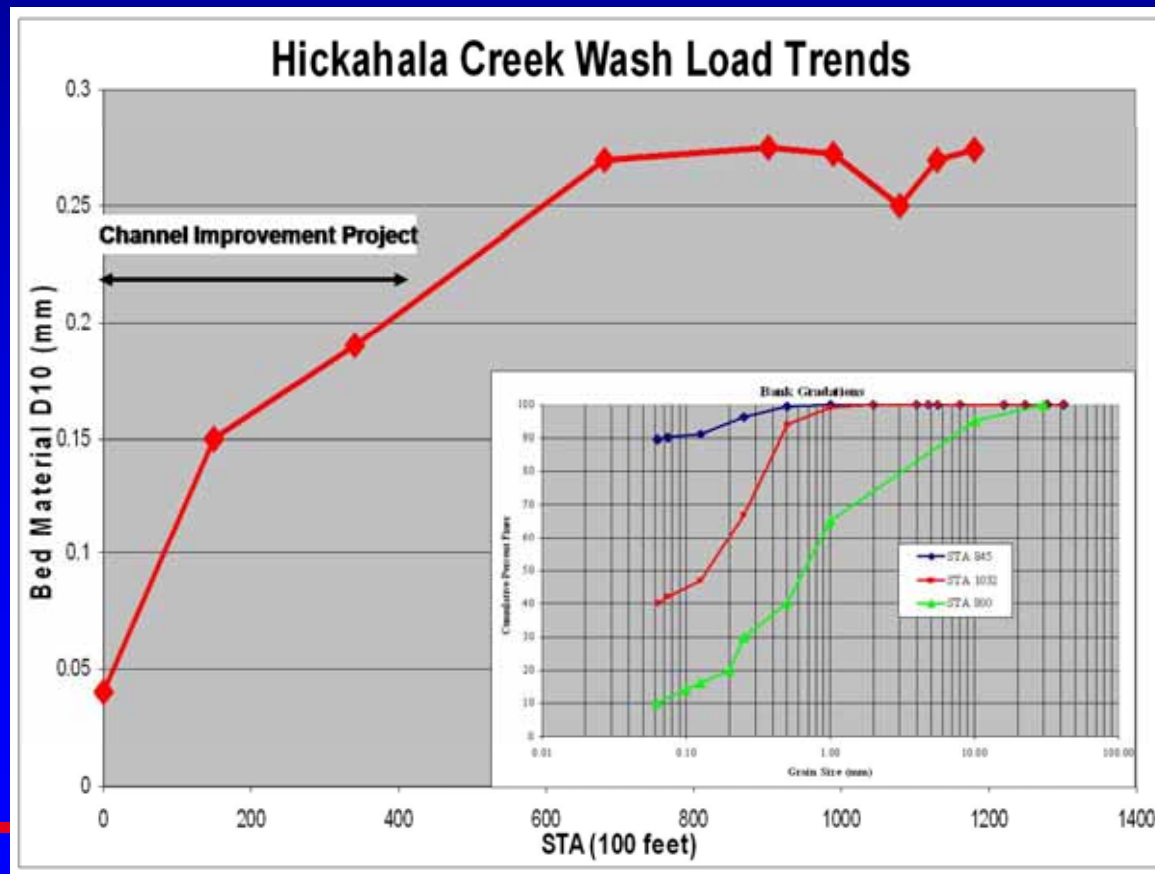
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Capabilities: SIAM distinguishes...

Between bed material load and wash material load based on user defined wash material threshold. Allows bed material and wash material to interchange from reach to reach..



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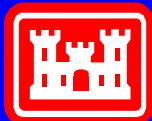


Bed Material/Wash Load Concepts



- Found in significant quantities in the bed
- Function of hydraulic regime
- Interacts with bed - more geomorphic effect (work) on channel development
- Long-term impacts, may take years/decades to see effects.

- Not found in significant quantities in the bed
- Function of supply
- No interaction with bed - more aesthetic or water quality effects
- Short-term impacts on a hydrograph timescale.

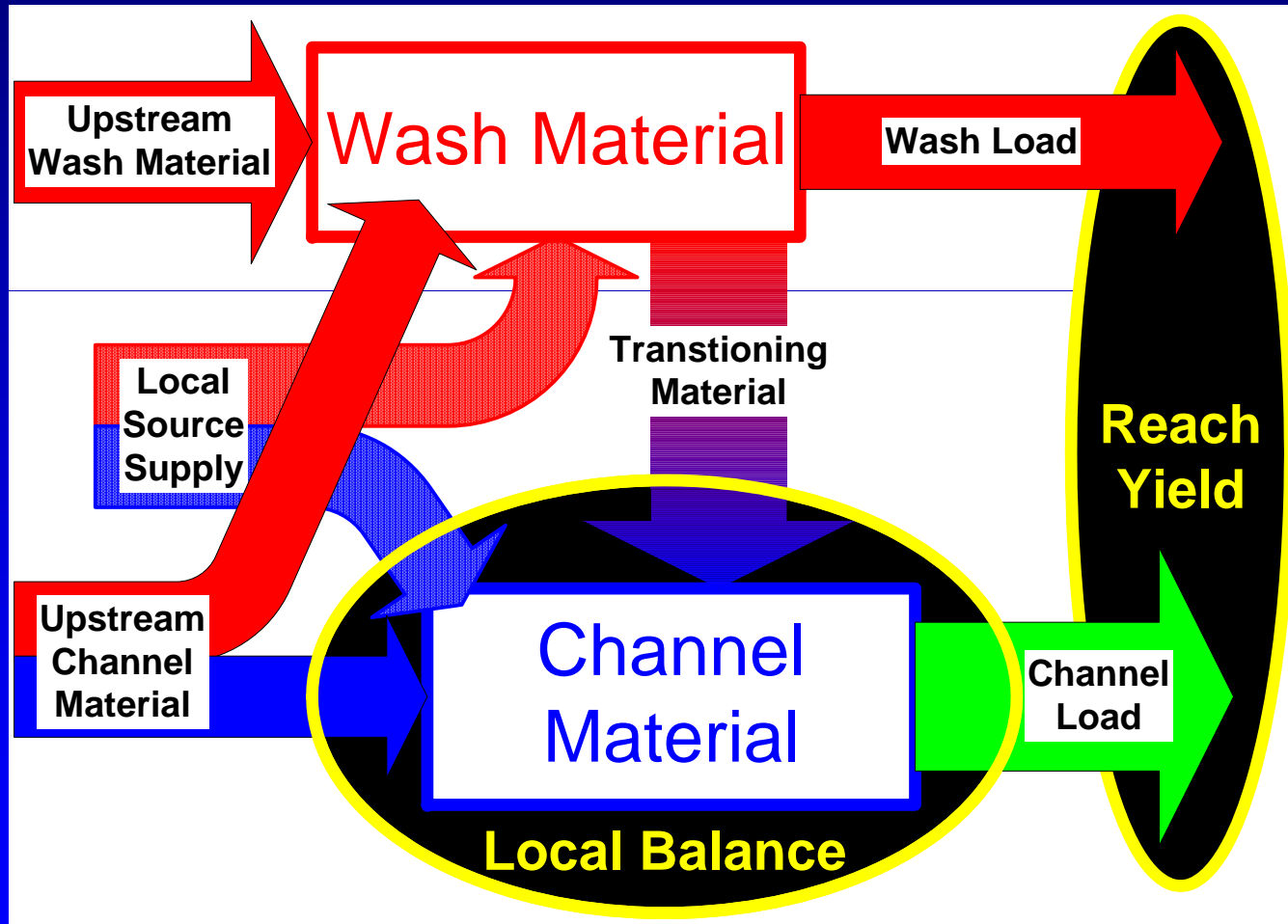


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How SIAM accounts for bed material and wash load.....



Question: What *isn't* SIAM?

**Answer: A sediment routing
model or a sediment
source/erosion predictor**



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SIAM is not a routing model....

- Cross section geometry is not adjusted, and sediment transport is not recomputed accordingly.
- Input geometry represents a “snapshot” that is assumed representative of average conditions for determination of sediment transport capacity.
- There is no temporal aspect (i.e., no time stepping through a hydrograph). Results are computed as average annual values.
- Cannot determine specific regions of scour or deposition.



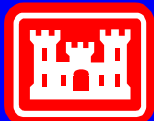
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SIAM is not a sediment source/erosion predictor....

- Does not compute bank erosion or channel bed incision.
- Sediment source input is user specified, both in quantity and grain size distribution.
- Sediment source loads are assumed uniform over the reach (no point source loading).



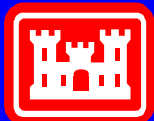
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Additional SIAM Limitations...

- Steady state, 1-dimensional hydraulics only.
- Assumes supply of bed material not limited within a reach. Application is limited to alluvial streams.
- Reach length selection can affect reach averaged values.



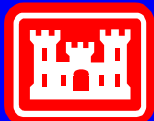
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Question: What is applicability of SIAM?

Answer: A screening tool for rapid assessment of the impacts of channel modification or stream rehabilitation measures on sediment continuity.



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SIAM Example Application

Hickahala Creek, MS

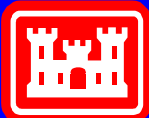
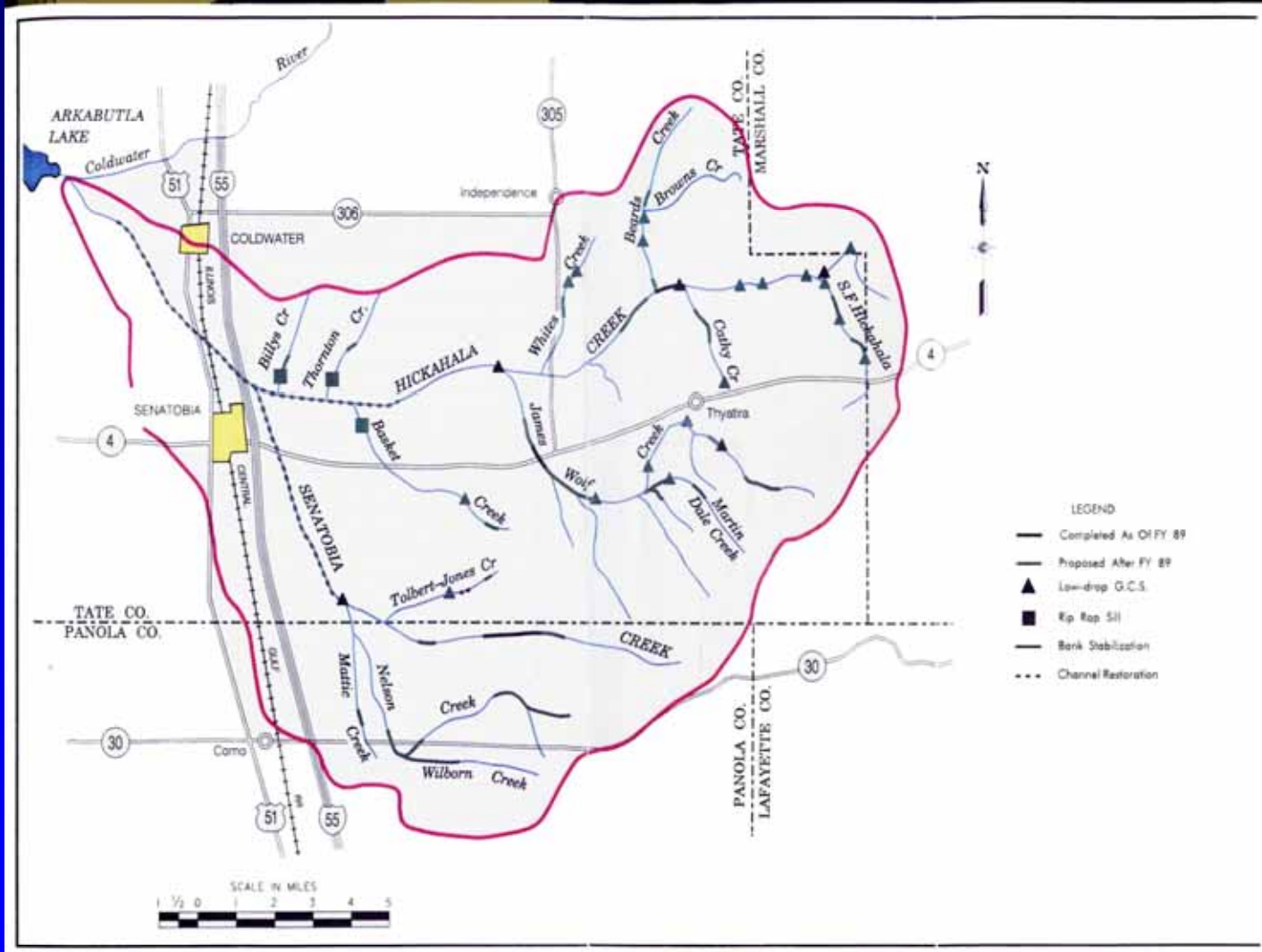


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Hickahala Creek Watershed



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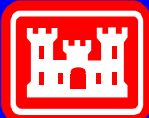
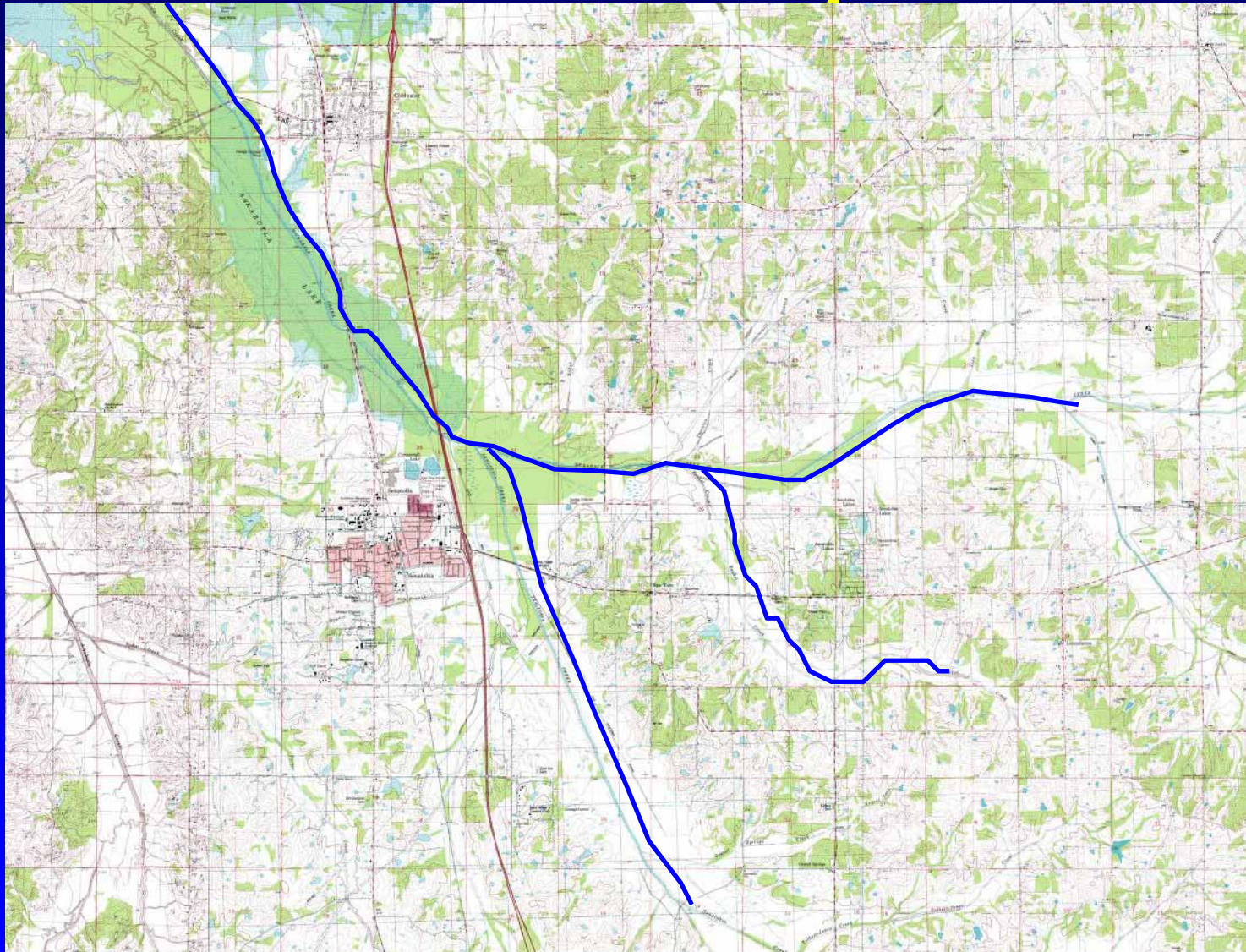


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Hickahala Creek Example Network



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HEC-RAS/SIAM Interface

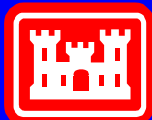
The screenshot displays the 'Hydraulic Design - Sediment Impact Assessment Model' window. The interface includes a menu bar (File, Type, Options, View, Help) and a title bar. The main configuration area contains the following fields:

- Title: Hickahala existing
- HD File: C:\...SIAM Workshops\arenada workshop.h04
- Short ID: Existing
- Sed. Reach: Hickahala5
- Plan Name: Existing conditions
- Plan File: C:\...SIAM Workshops\arenada workshop.p03
- River: Hickahala
- US RS: 73500.1
- Reach: Basket to JWolf
- DS RS: 49900.1

Buttons for 'Apply', 'Update Plot', 'Compute...', and 'Tables...' are visible. Below the configuration fields are tabs for 'Bed.Mat()', 'Hydro', 'Sed Prop', 'Sources', and 'Hydraulics'. The 'Sed Prop' tab is active, showing a 'Sampling' dropdown set to 'Hick5Bed' and a table of sediment classes.

Class	diam. (mm)	%Finer
1. Clay	0.004	
2. VFM	0.008	
3. FM	0.016	
4. MM	0.032	
5. CM	0.0625	2
6. VFS	0.125	5
7. FS	0.25	8
8. MS	0.5	60
9. CS	1	95
10. VCS	2	100
11. VFG	4	
12. FG	8	
13. MG	16	
14. CG	32	
15. VCG	64	
16. SC	128	
17. LC	256	
18. SB	512	
19. MB	1024	
20. LB	2048	

The right side of the window shows a reach diagram with a blue line representing the river channel and green lines representing cross-sections. The status bar at the bottom indicates coordinates: 473932.80, 1540263.00.

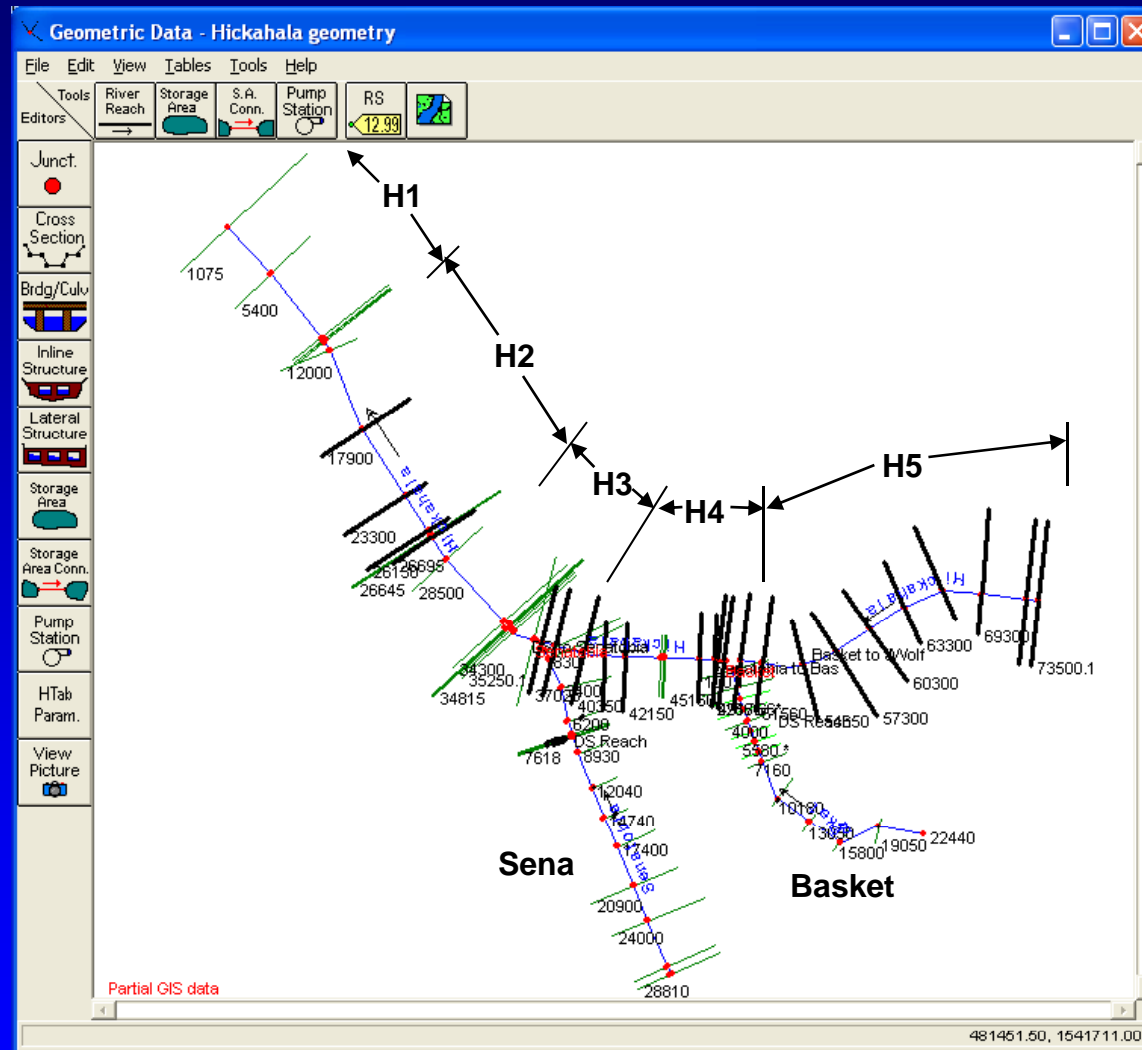


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Hickahala Creek HEC-RAS Model



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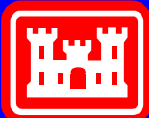


HEC-RAS/SIAM Interface

The screenshot displays the 'Hydraulic Design - Sediment Impact Assessment Model' window. The 'Title' field is 'Hickahala existing' and the 'Sed. Reach' is 'Hickahala5', both highlighted with a red oval. The 'HD File' is 'C:\...SIAM Workshoo\varenada workshop.h04' and the 'Short ID' is 'Existing'. The 'Plan Name' is 'Existing conditions' and the 'Plan File' is 'C:\...SIAM Workshoo\varenada workshop.p03'. The 'River' is 'Hickahala' (US RS: 73500.1) and the 'Reach' is 'Basket to JWolf' (DS RS: 49900.1). The 'Sed. Prop' tab is active, showing a table of sediment classes and their properties.

Class	diam. (mm)	%Finer
1. Clay	0.004	
2. VFM	0.008	
3. FM	0.016	
4. MM	0.032	
5. CM	0.0625	2
6. VFS	0.125	5
7. FS	0.25	8
8. MS	0.5	60
9. CS	1	95
10. VCS	2	100
11. VFG	4	
12. FG	8	
13. MG	16	
14. CG	32	
15. VCG	64	
16. SC	128	
17. LC	256	
18. SB	512	
19. MB	1024	
20. LB	2048	

The diagram on the right shows a reach of the Hickahala River with a red box labeled 'SIAM Reach' pointing to a specific section. The coordinates at the bottom right are 473932.80, 1540263.00.



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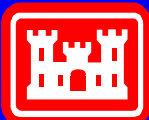
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HEC-RAS/SIAM Interface

The screenshot displays the 'Hydraulic Design - Sediment Impact Assessment Model' window. The 'River' dropdown is set to 'Hickahala' and the 'Reach' dropdown is set to 'Basket to JWolf'. A red circle highlights these two dropdowns, with a red arrow pointing to a red-bordered box containing the text 'HEC-RAS River and Reach'. The 'US RS' is 73500.1 and the 'DS RS' is 49900.1. The 'Plan Name' is 'Existing conditions'. The 'Plan File' is 'C:\...SIAM Workshops\arenada workshop.p03'. The 'Title' is 'Hickahala existing' and the 'HD File' is 'C:\...SIAM Workshops\arenada workshop.h04'. The 'Short ID' is 'Existing'. The 'Apply', 'Update Plot', 'Compute...', and 'Tables...' buttons are visible. The 'Sed. Reach' dropdown is set to 'Hickahala5'. The 'Sampling' dropdown is set to 'Hick5Bed'. The 'Class' dropdown is set to 'Hick5Bed'. The 'Plot...' button is visible. The 'Select a Sediment Source' dropdown is empty.

Class	diam. (mm)	%Finer
1. Clay	0.004	
2. VFM	0.008	
3. FM	0.016	
4. MM	0.032	
5. CM	0.0625	2
6. VFS	0.125	5
7. FS	0.25	8
8. MS	0.5	60
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12. FG	8	
13. MG	16	
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17. LC	256	
18. SB	512	
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20. LB	2048	

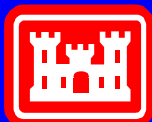
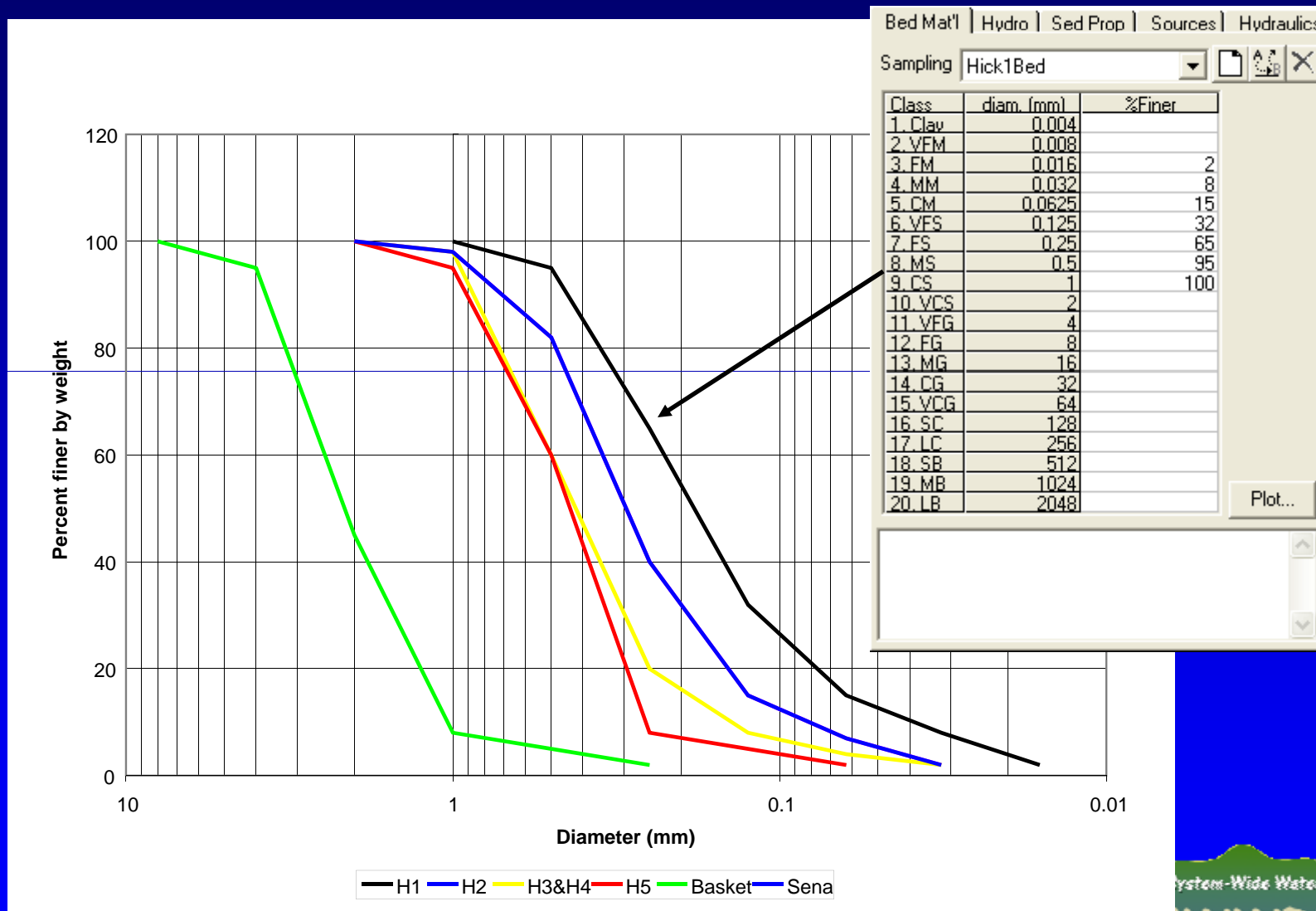


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Bed Material Gradations

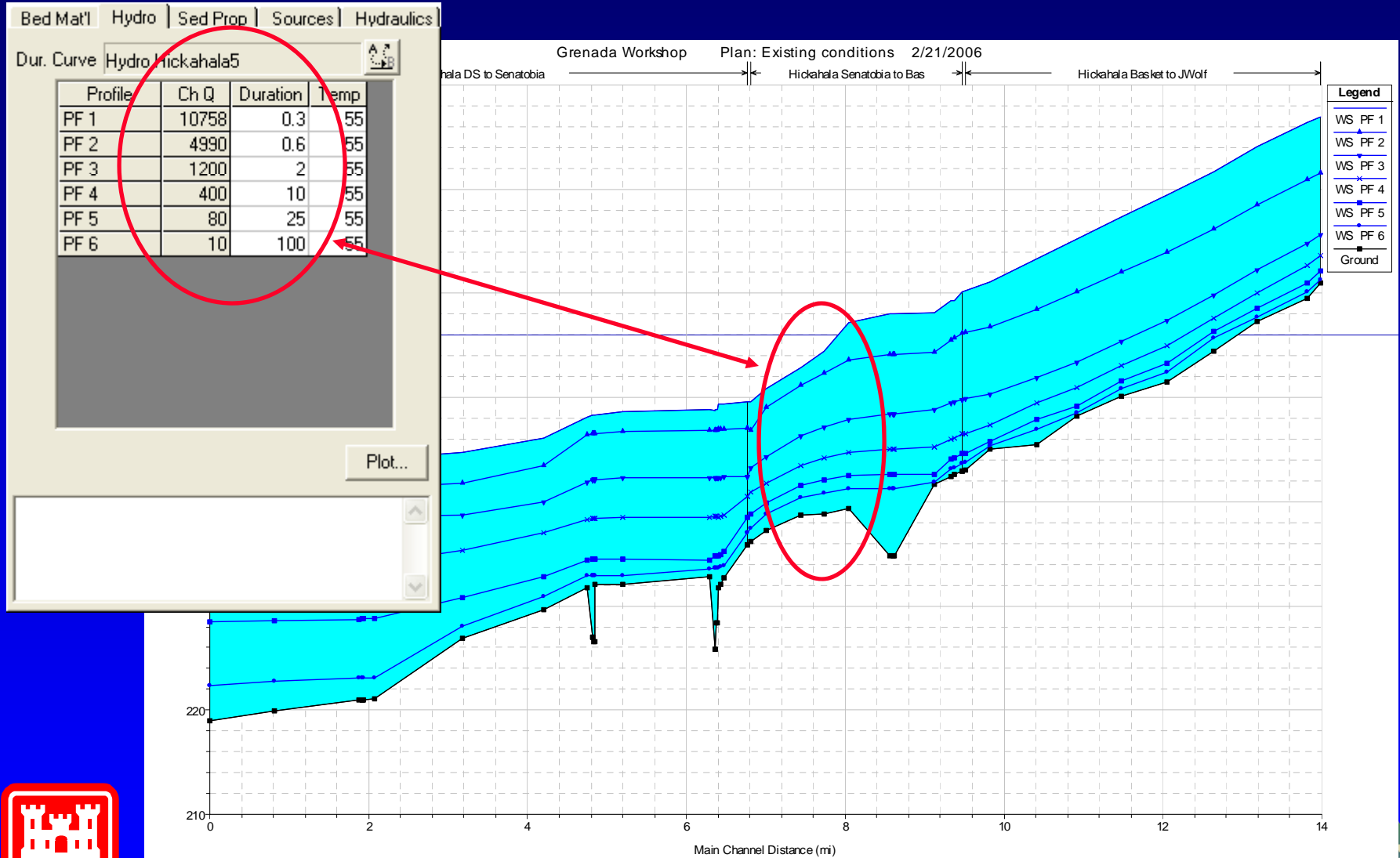


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Flow Duration Input

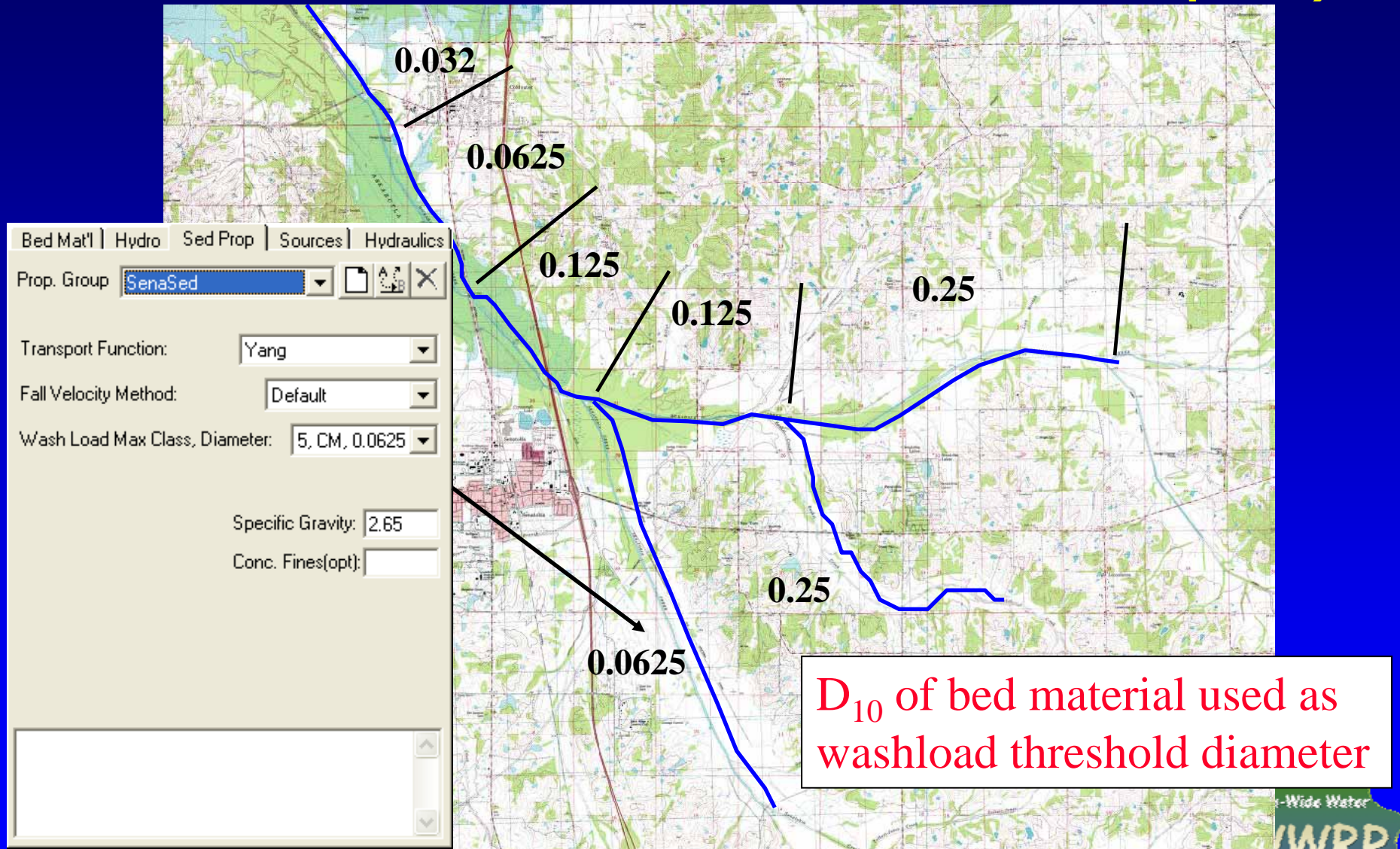


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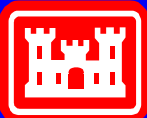
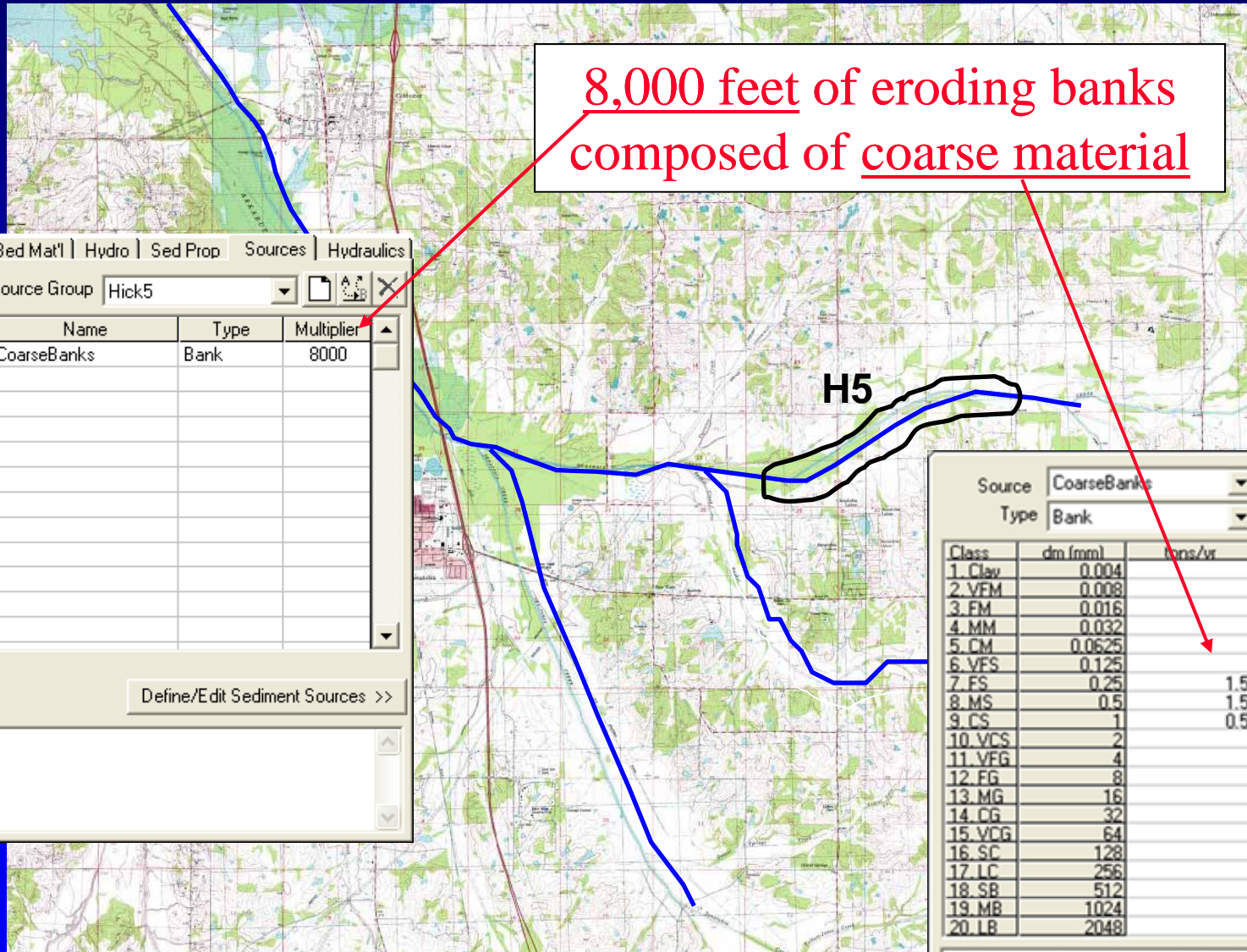
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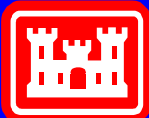
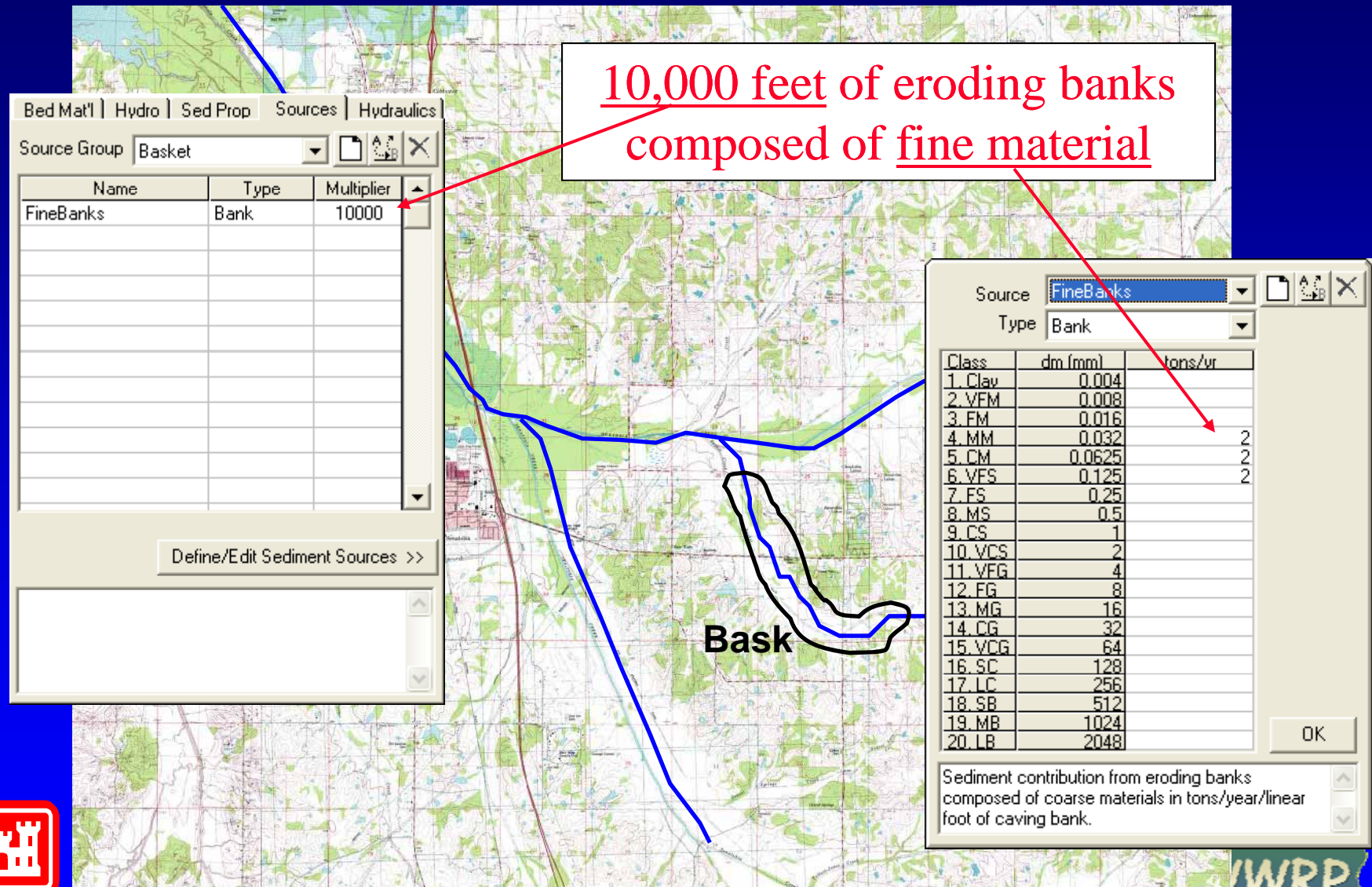
Wash Material Threshold Diameters (mm)



Coarse Bank Sediment Source – Reach “H5”

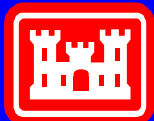


Fine Bank Sediment Source – Reach “Bask”

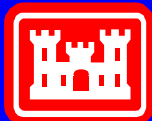
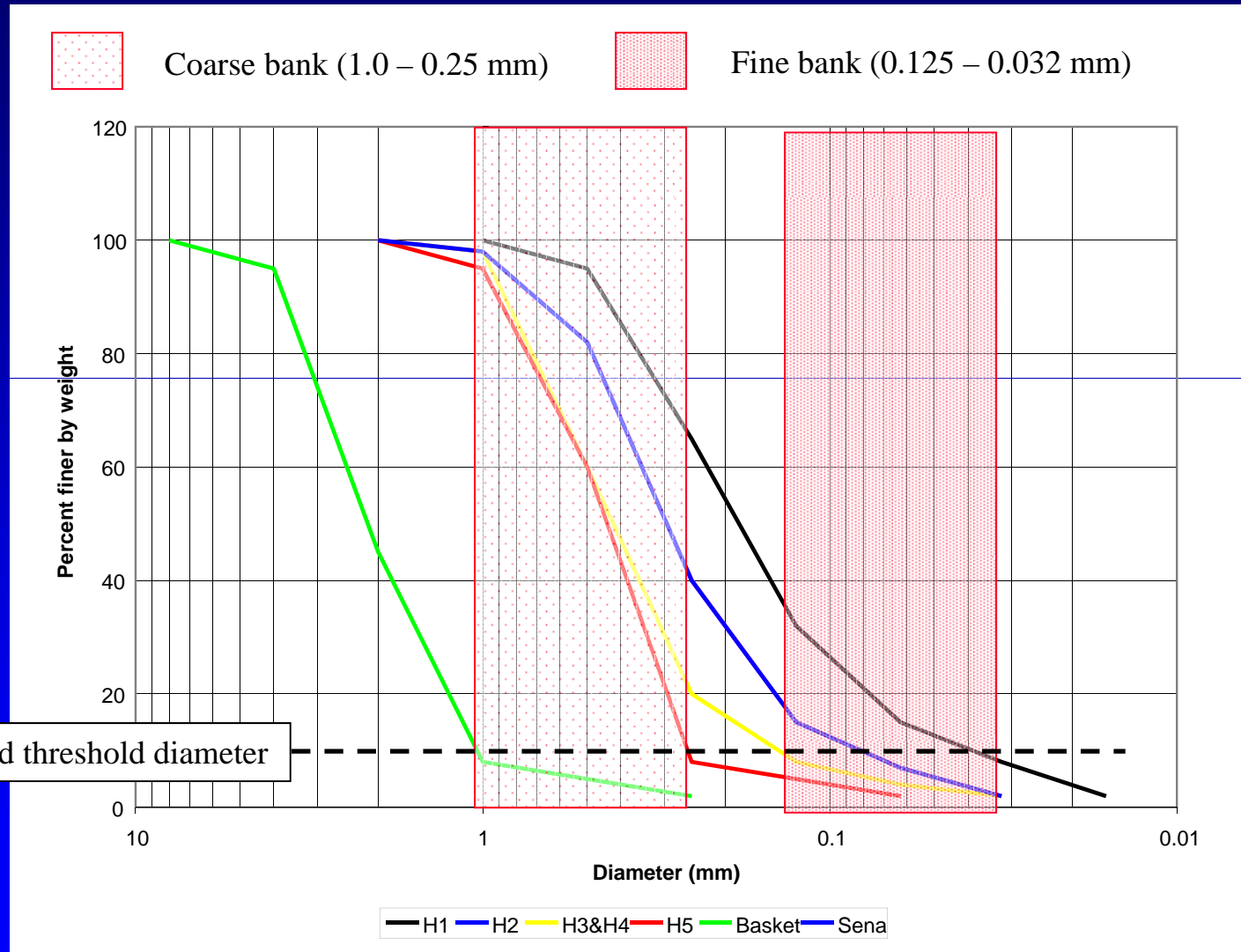


Example scenarios for Hickahala Creek SIAM application

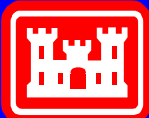
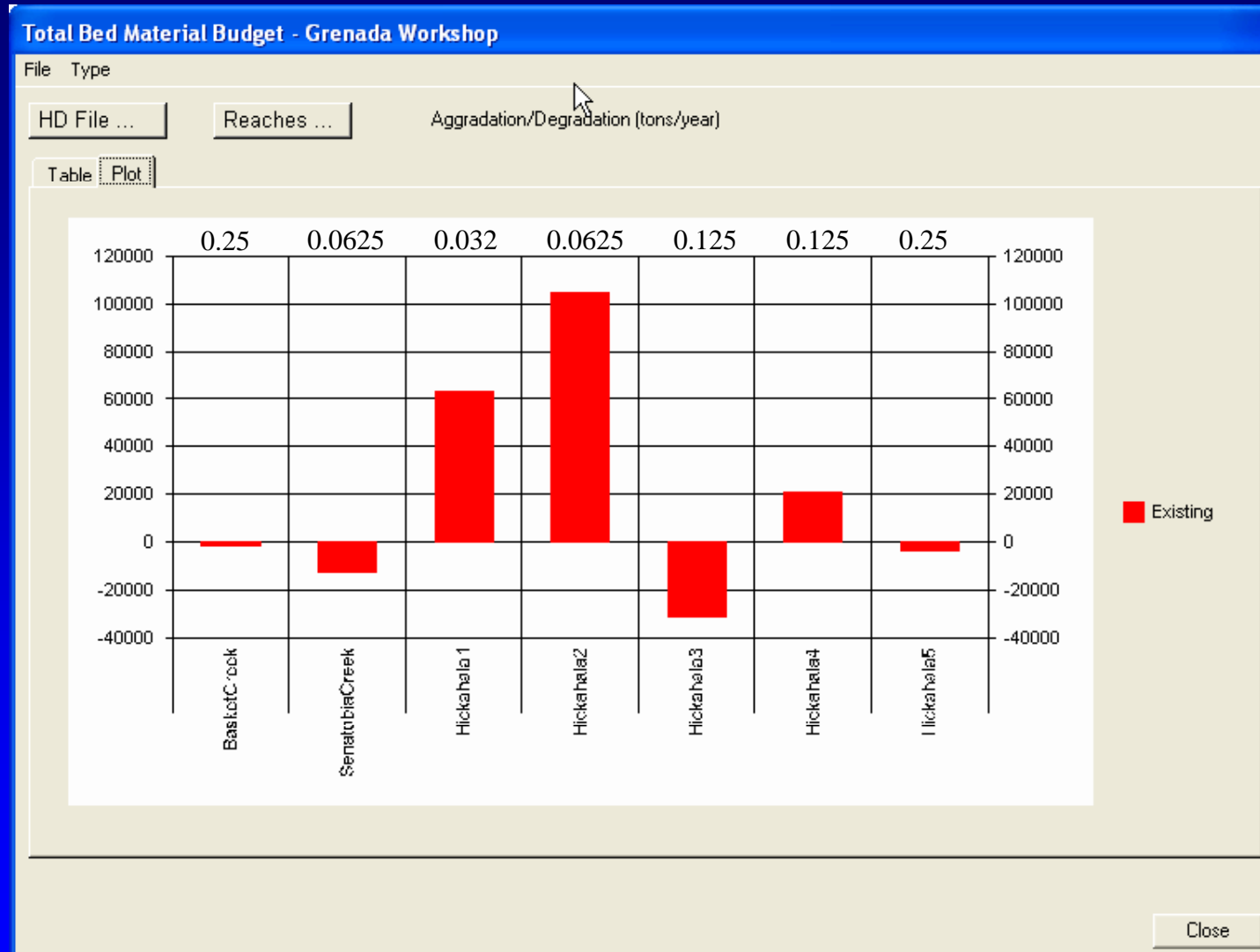
- 1. Existing conditions, with sediment sources from coarse material bank erosion and fine material bank erosion.**
- 2. Coarse material bank erosion source removed (bank stabilization).**
- 3. Coarse & fine material bank erosion source removed (bank stabilization).**
- 4. Grade control structures added in reach H5.**



Relation of bank sources to bed material



SIAM results: Existing Conditions

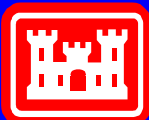
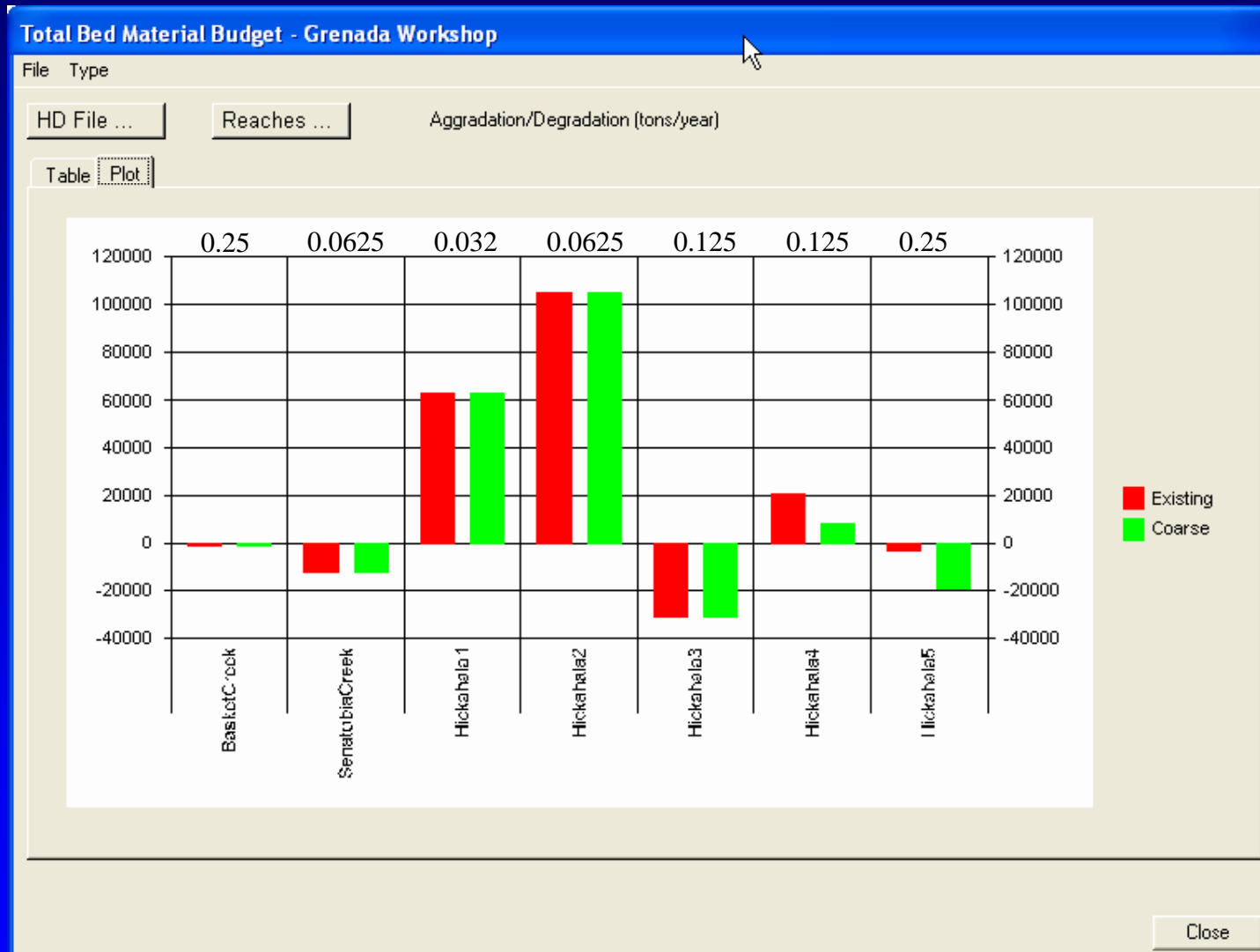


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SIAM results: Coarse banks stabilized

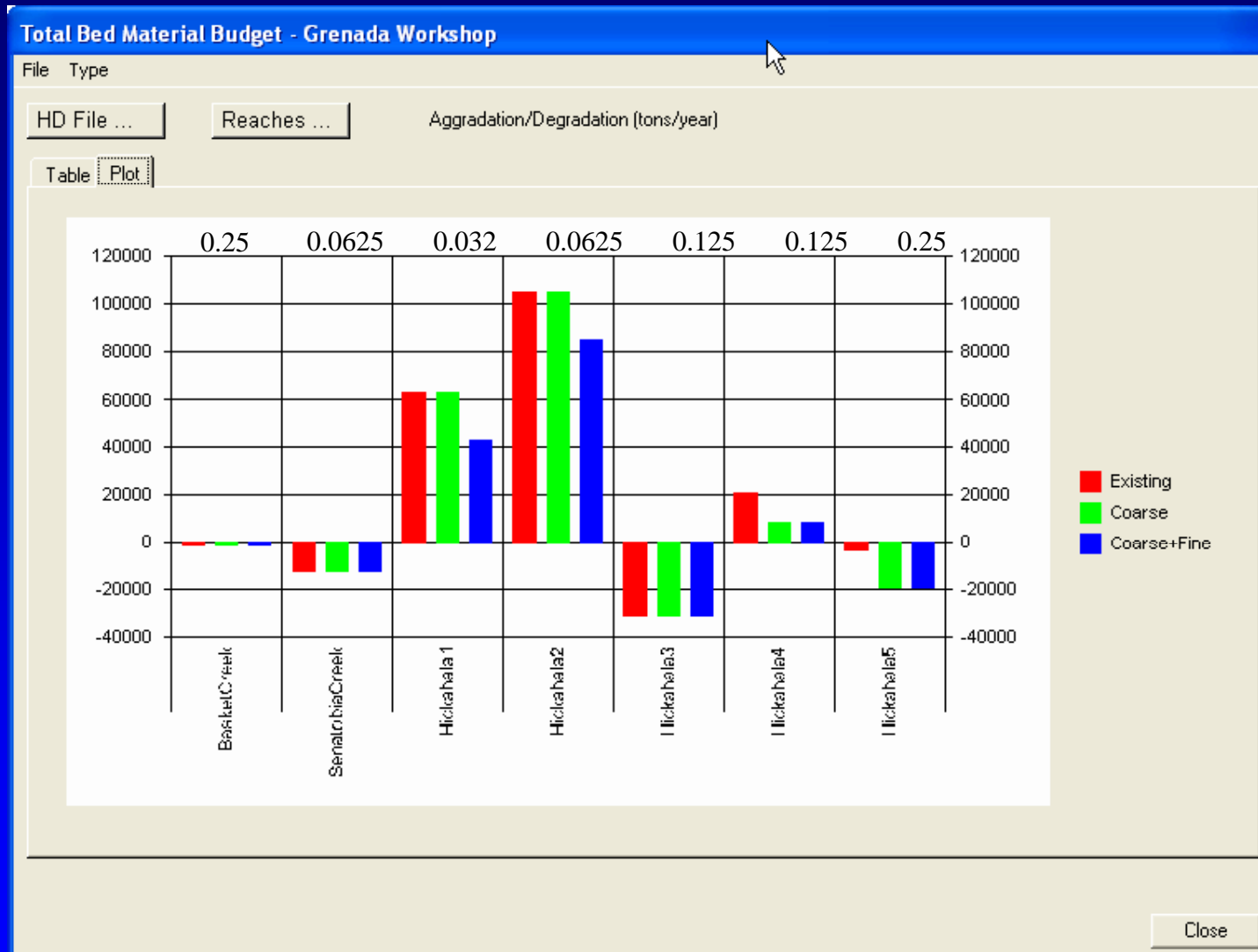


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SIAM results: Fine banks stabilized

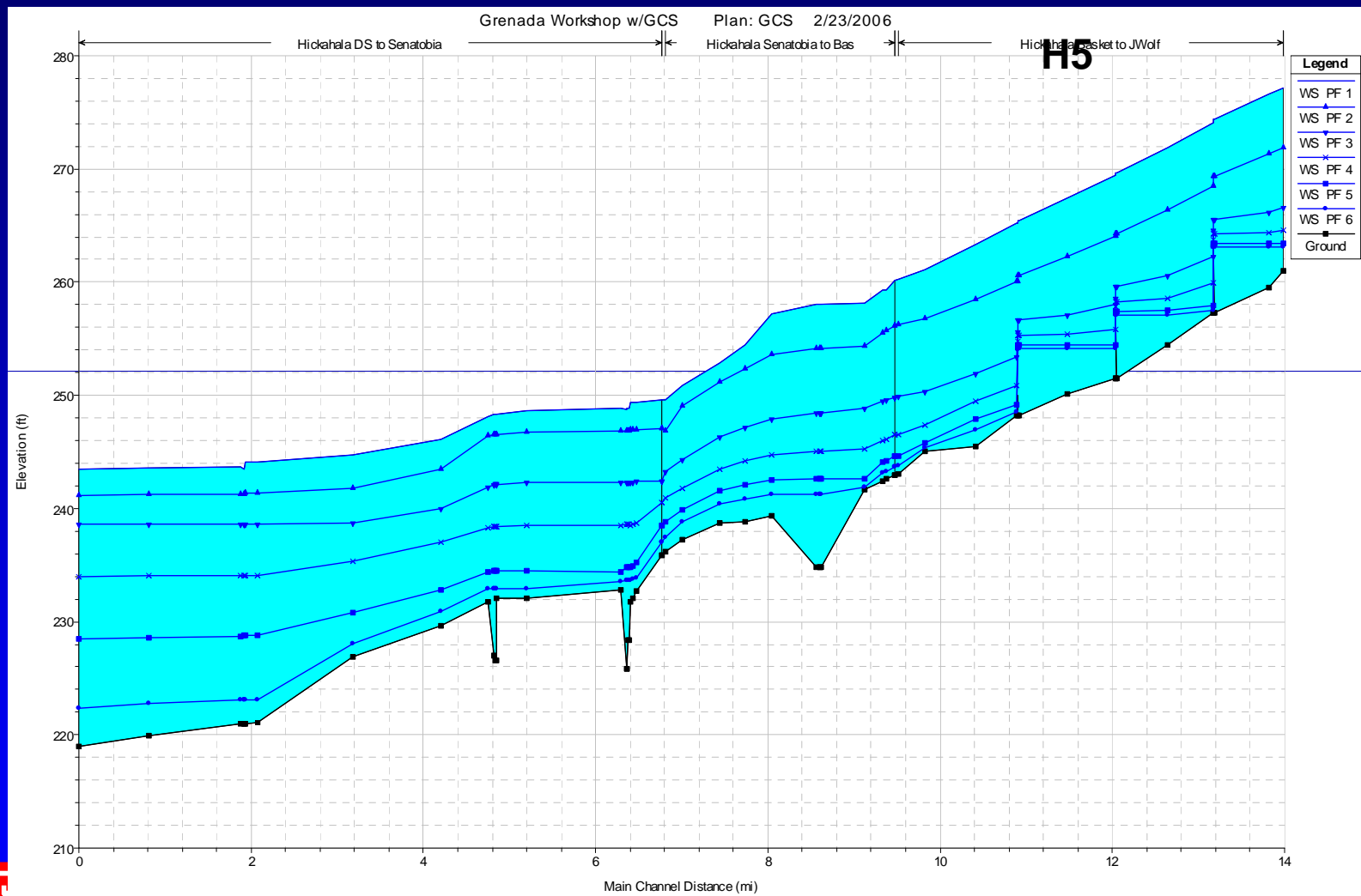


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Grade control structures added to Reach H5



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SIAM results: Grade control in H5

Total Bed Material Budget - Grenada Workshop

File Type

HD File ▼ Reaches ... Aggradation/Degradation (tons/year)

Table Plot

Sed Reach	Existing	Coarse	Coarse+Fine	CB+FB+LT	CB+FB+LT+GCS
BasketCree	-1563	-1563	-1563	-1563	-1562
SenatobiaC	-1.22E+04	-1.22E+04	-1.22E+04	-4.82E+04	-4.82E+04
Hickahala1	6.29E+04	6.29E+04	4.29E+04	6943	6943
Hickahala2	1.04E+05	1.04E+05	8.43E+04	8.43E+04	8.43E+04
Hickahala3	-3.12E+04	-3.12E+04	-3.12E+04	-3.12E+04	-3.12E+04
Hickahala4	2.06E+04	8601	8601	8601	-6866
Hickahala5	-3045	-1.90E+04	-1.90E+04	-1.90E+04	-3578

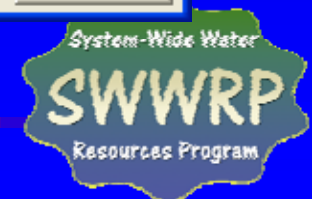
Red values indicate bed degradation.
Blue values indicate bed aggradation.
Green values indicate bed equilibrium.

Close



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Questions?



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