Example Application of Sediment Impact Analysis Methods (SIAM) Model

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Challenges that face Sediment Managers

- **Need to manage sediment on a regional/watershed basis. Sediment impacts a variety of stakeholder interests.**
- **Time & budget constraints. Limit sediment model development, alternative analysis.**
- **Assessment of potential impacts of proposed projects on channel stability.**

Sediment can impact a variety of projects:

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

A need exists for a tool to assess the impacts of sediment management alternatives on sediment continuity of a stream network. The tool must be easy to apply and use data/resources that are readily available for most reconnaissance level studies.

Genesis of SIAM

- Initial development through ERDC/Colorado State University research effort on channel stability as part of Demonstration Erosion Control project.
- Formerly in RSM R&D unit, currently part of SWWRP R&D unit.
- Original computer programming done by David Mooney (CSU PhD candidate, USBR). Visual Basic code with data input through Excel interface.
- Incorporated into HEC-RAS through ERDC/HEC cooperative effort.

SIAM Highlights/Capabilities

- Reach-based sediment accounting model. Uses reach averaged hydraulic parameters for sediment transport computations by grain size class.
- Compares computed annual transport capacity with bed material supply to determine sediment balance on reach-by-reach basis.
- 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.
- User defined local sediment sources can easily be manipulated to customize sediment loading.
- Simple to use. Allows timely assessment of alternatives and sensitivity analyses.

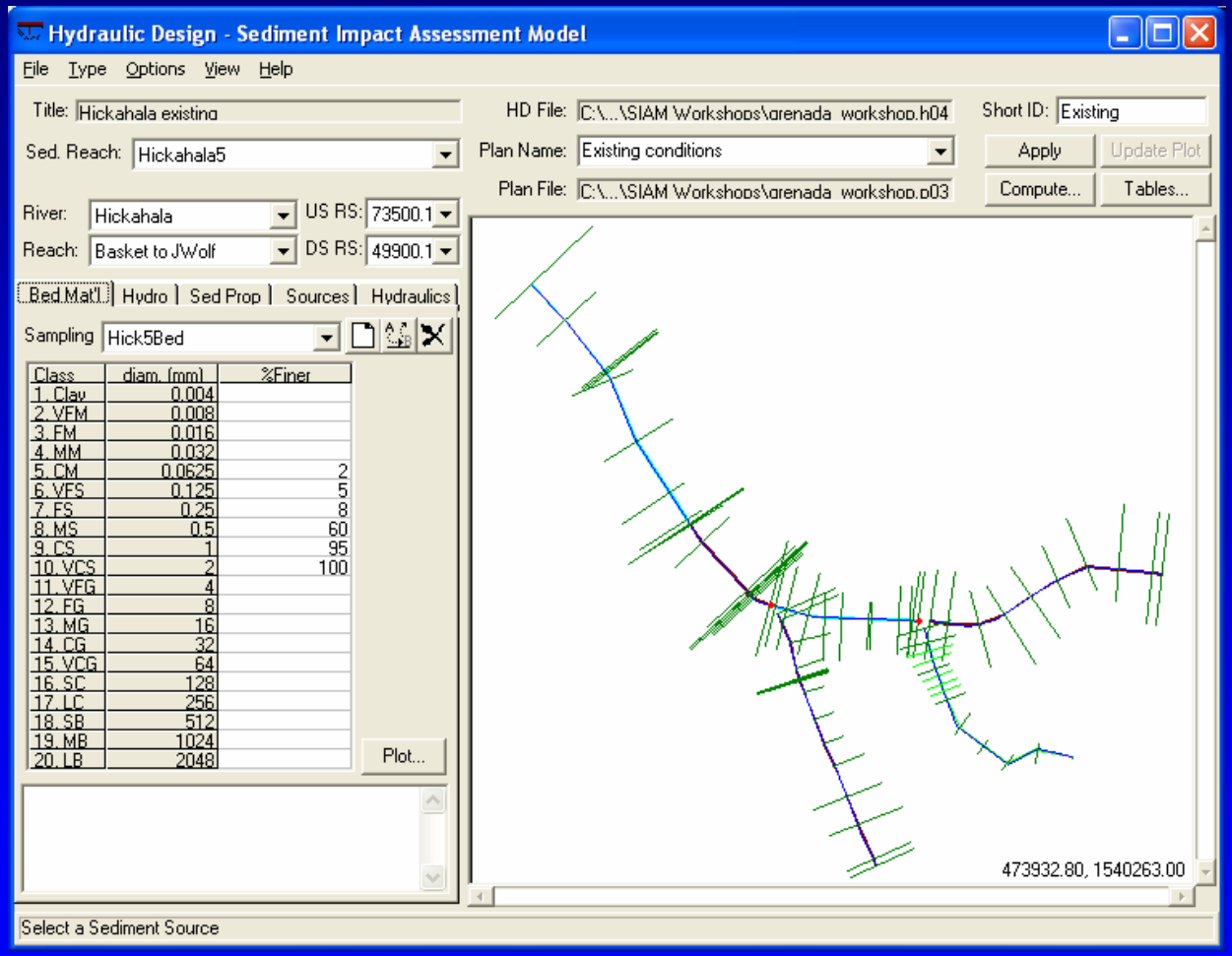
SIAM Limitations

- Not a sediment routing model/erosion model.
- Applicable as screening tool for reconnaissance/feasibility level studies.
- Steady state, 1-dimensional hydraulics only.
- Assumes supply of bed material not limited within a reach.
- Reach length selection can affect reach averaged values.
- User must determine local sediment source contributions and composition.
- Currently in Beta release (HEC-RAS Beta 4.0).

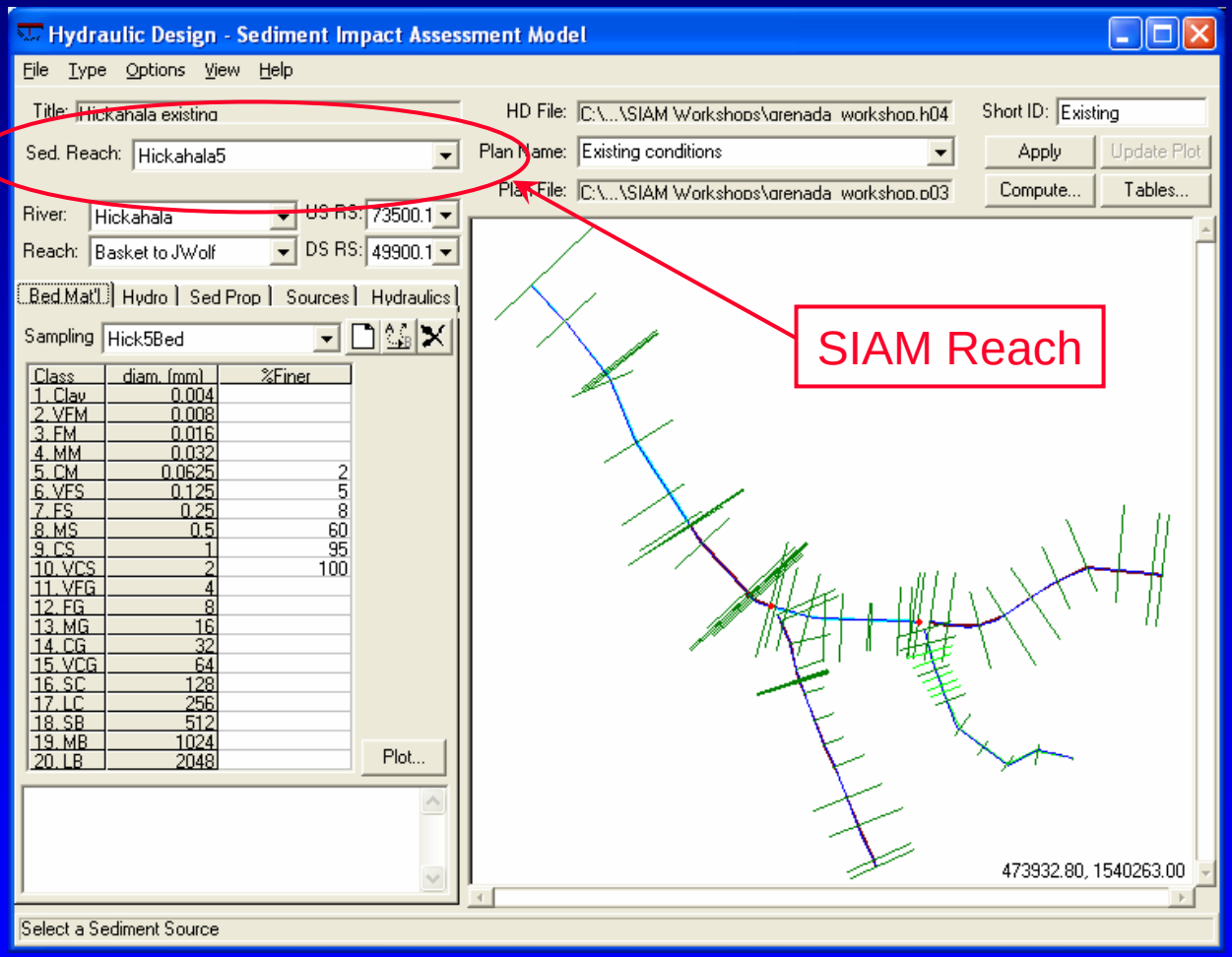
Benefits of incorporating SIAM in HEC-RAS

- Popular, widely-used hydraulic modeling format.
- 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.

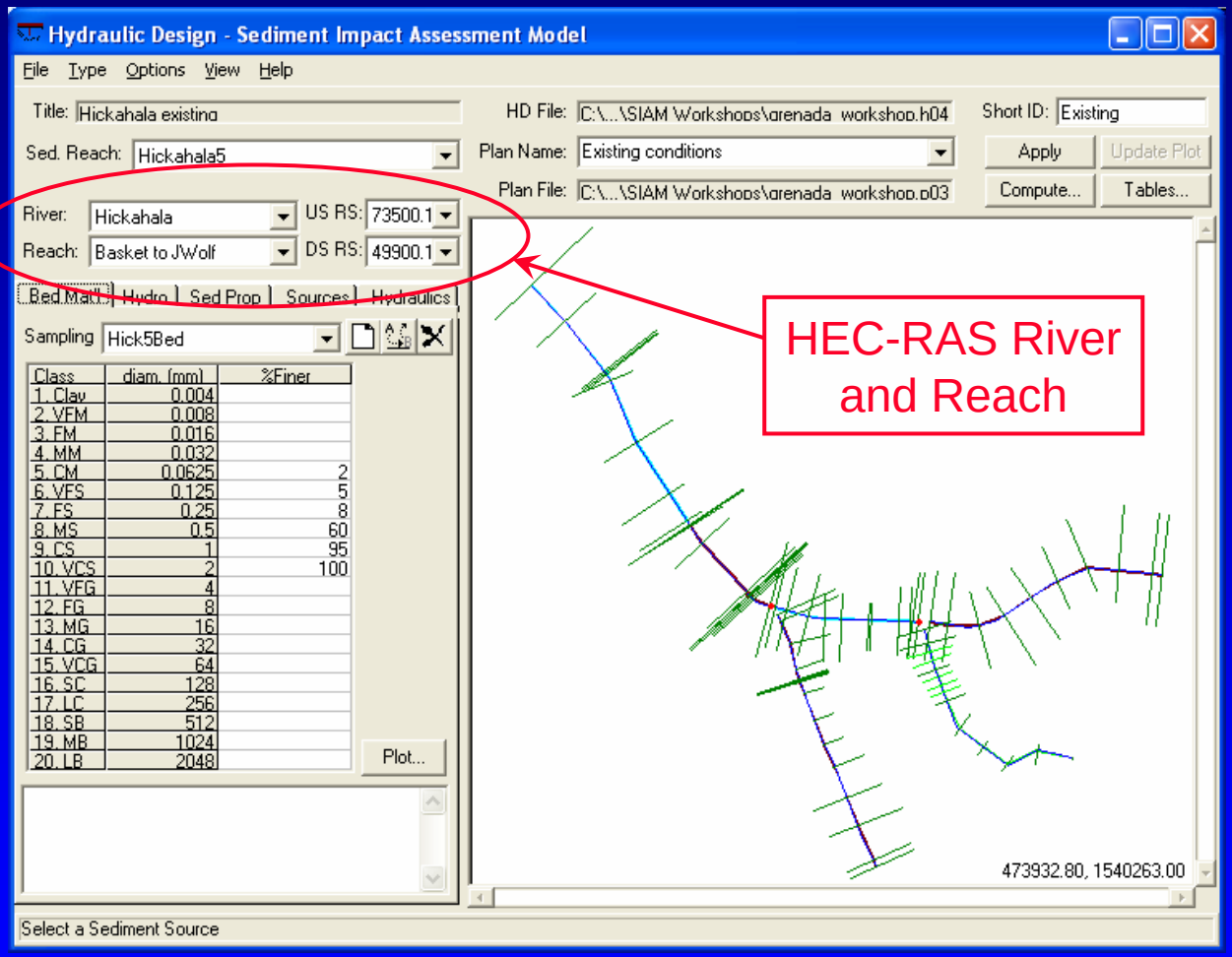
HEC-RAS/SIAM Interface



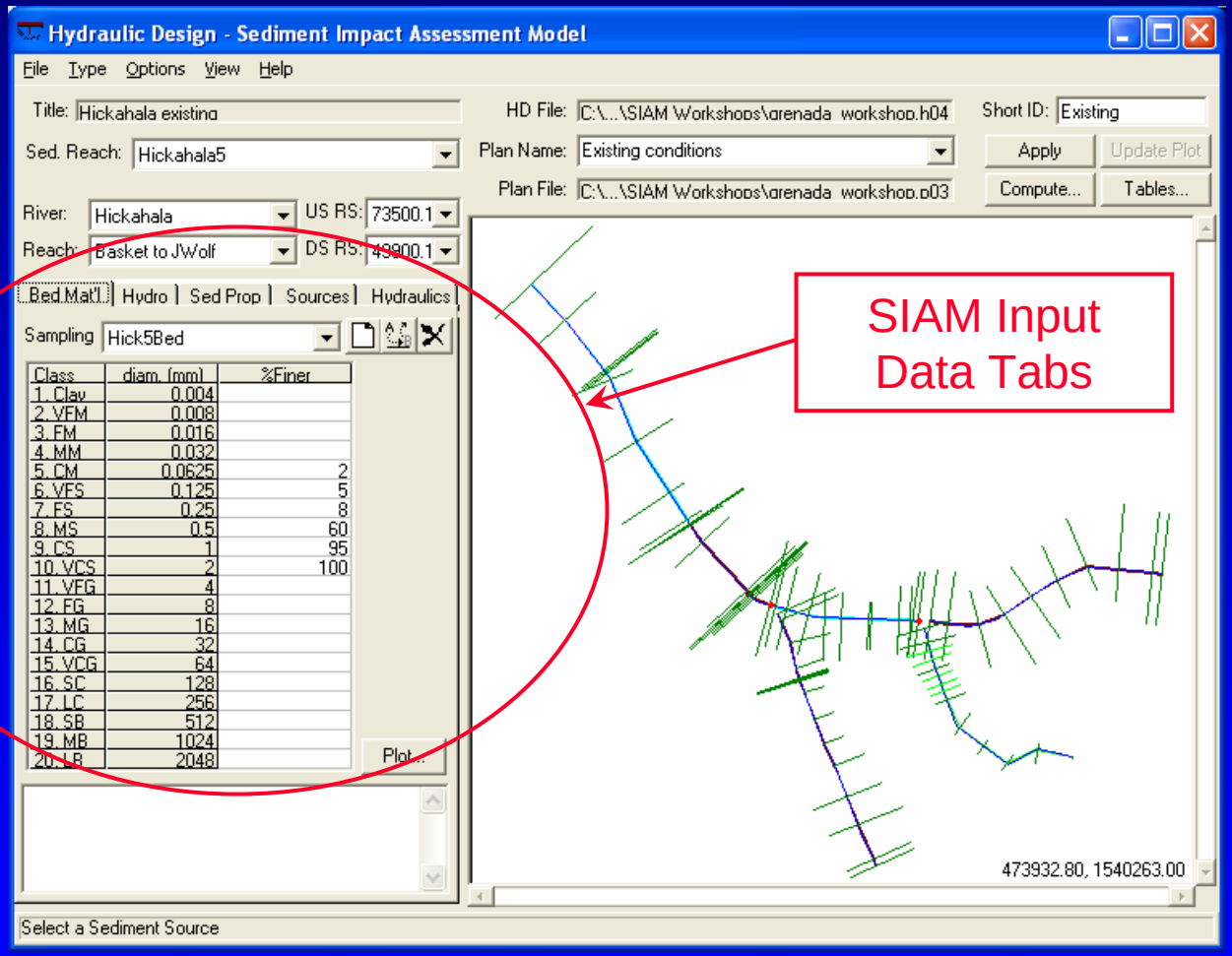
HEC-RAS/SIAM Interface



HEC-RAS/SIAM Interface

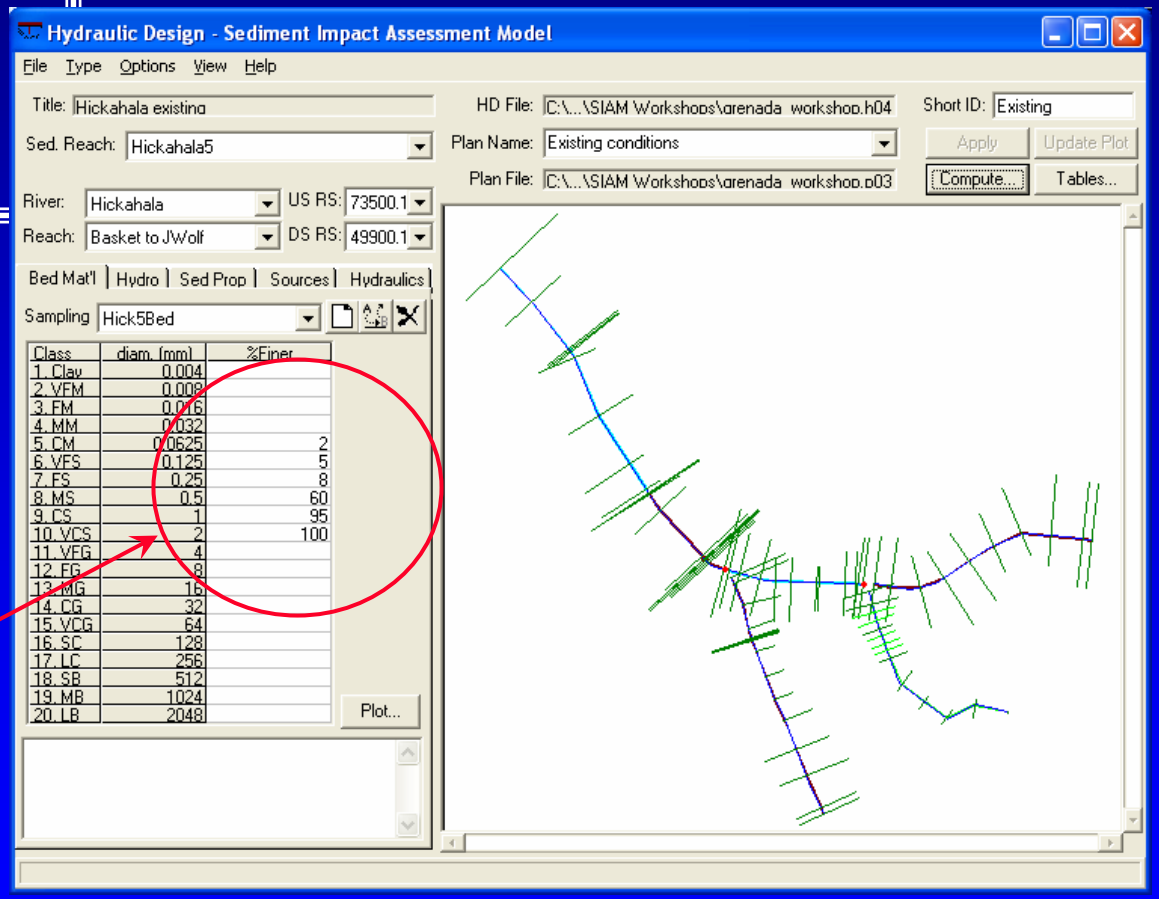


HEC-RAS/SIAM Interface



SIAM Input Data

- **Bed material gradation**
- Hydrology/flow duration
- Sediment properties
- Sediment sources/loadings
- Hydraulics

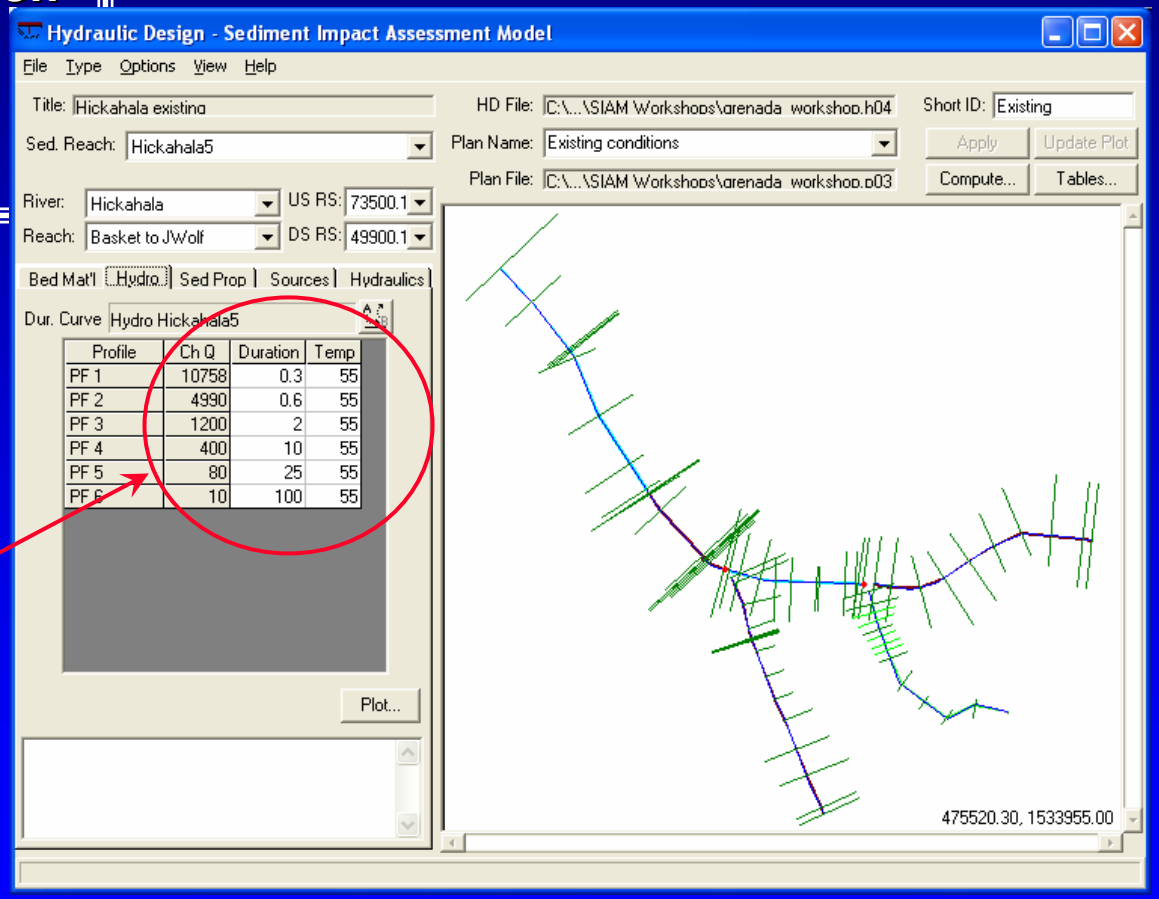


Class	diam. (mm)	%Finer
1. Clay	0.004	
2. VFM	0.008	
3. FM	0.016	
4. MM	0.032	
5. CM	0.0625	2
6. VFS	0.125	5
7. FS	0.25	8
8. MS	0.5	60
9. CS	1	95
10. VCS	2	100
11. VFG	4	
12. FG	8	
13. MG	16	
14. CG	32	
15. VCG	64	
16. SC	128	
17. LC	256	
18. SB	512	
19. MB	1024	
20. LB	2048	

Enter percent finer of average bed material gradation for reach

SIAM Input Data

- Bed material gradation
- **Hydrology/flow duration**
- Sediment properties
- Sediment sources/loadings
- Hydraulics



Enter duration in days for each HEC-RAS profile

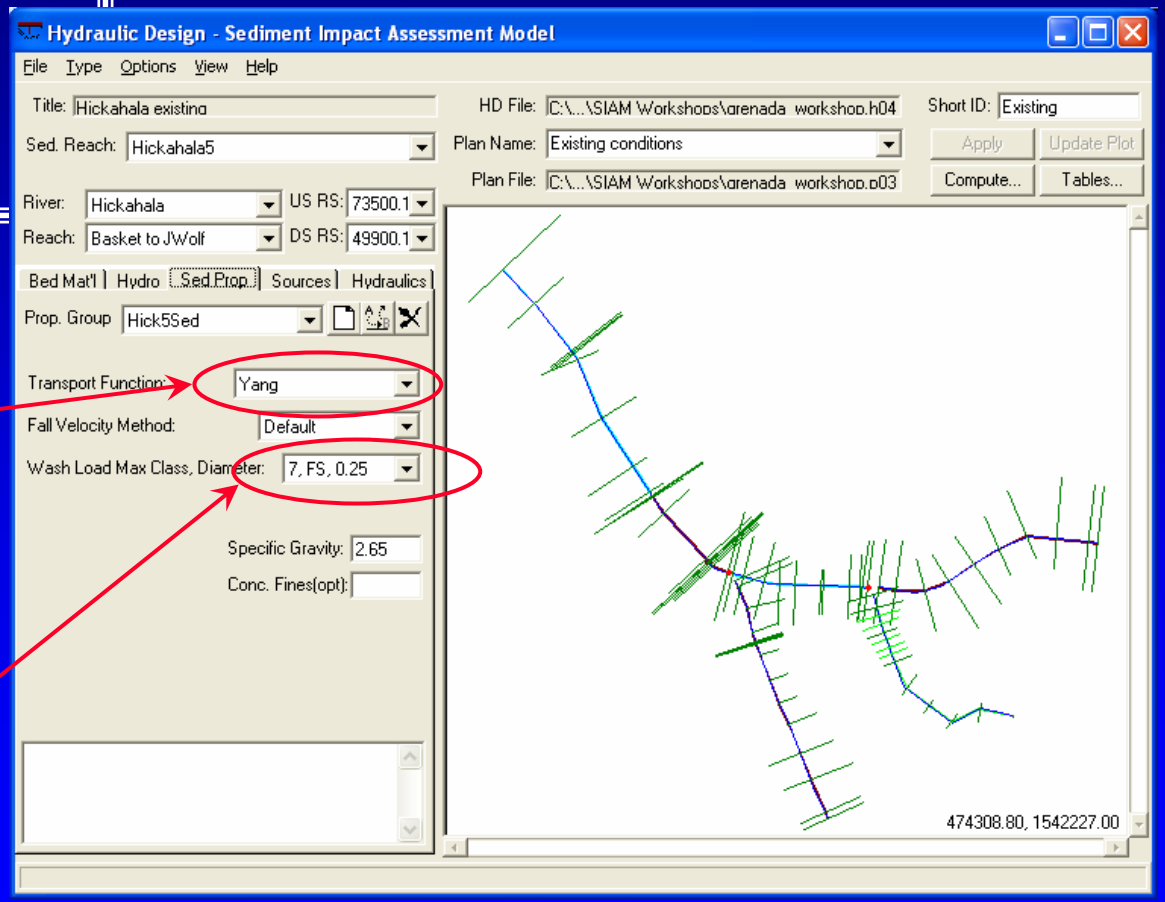
SIAM Input Data

- Bed material gradation
- Hydrology/flow duration
- **Sediment properties**
- Sediment sources/loadings
- Hydraulics

Sediment transport functions available:

Ackers-White, Engelund-Hansen, Laursen-Copeland, Meyer-Peter Muller, Toffaleti, Yang

Wash load threshold diameter

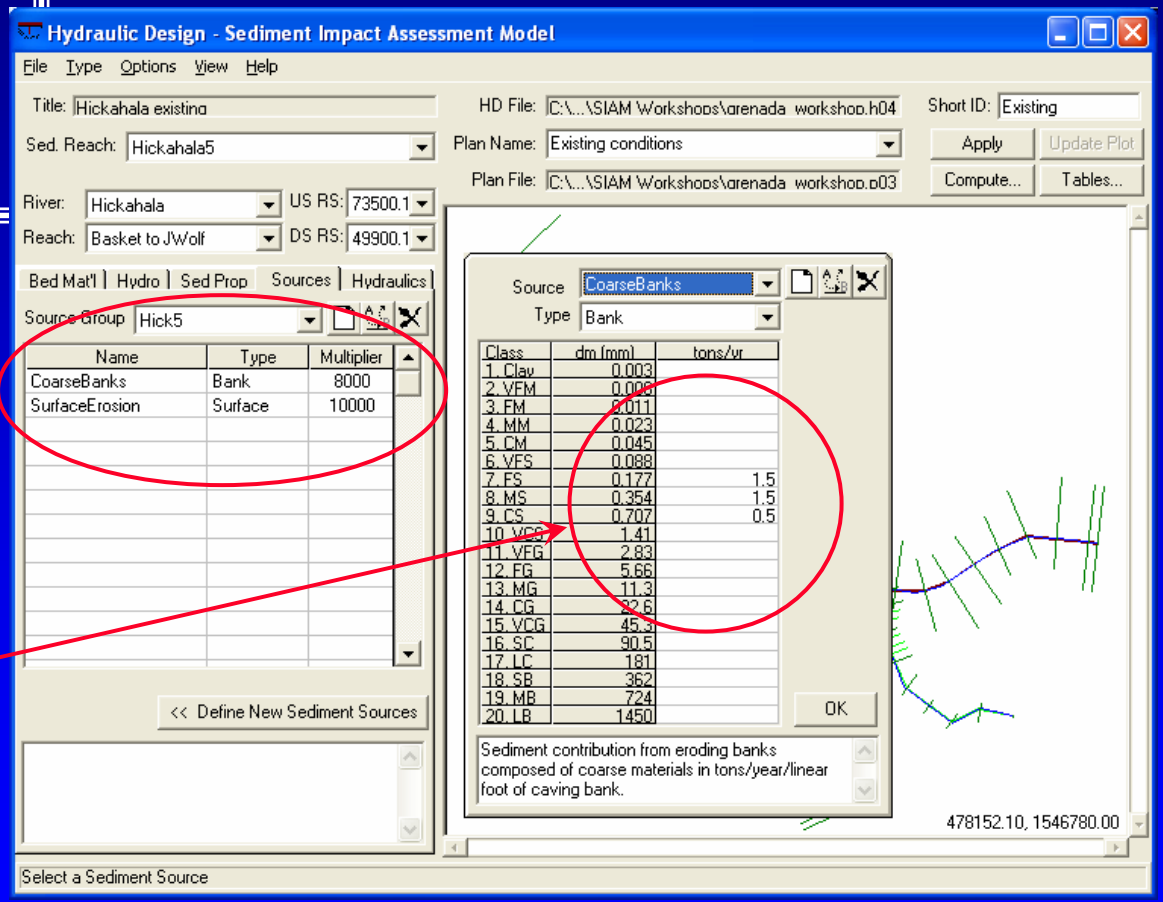


SIAM Input Data

- Bed material gradation
- Hydrology/flow duration
- Sediment properties
- **Sediment sources/loadings**
- Hydraulics

Sediment source loads for reach

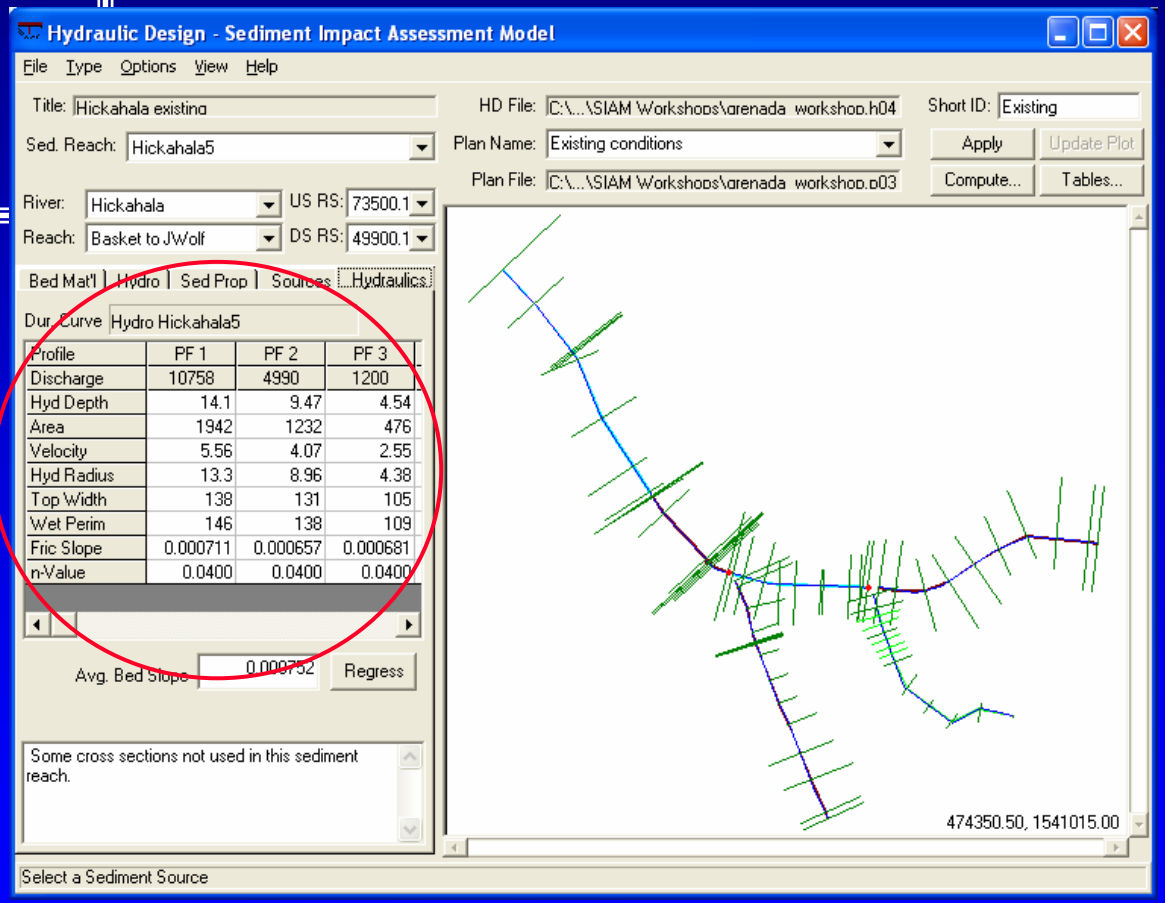
Rate and distribution of sediment source



SIAM Input Data

- Bed material gradation
- Hydrology/flow duration
- Sediment properties
- Sediment sources/loadings
- **Hydraulics**

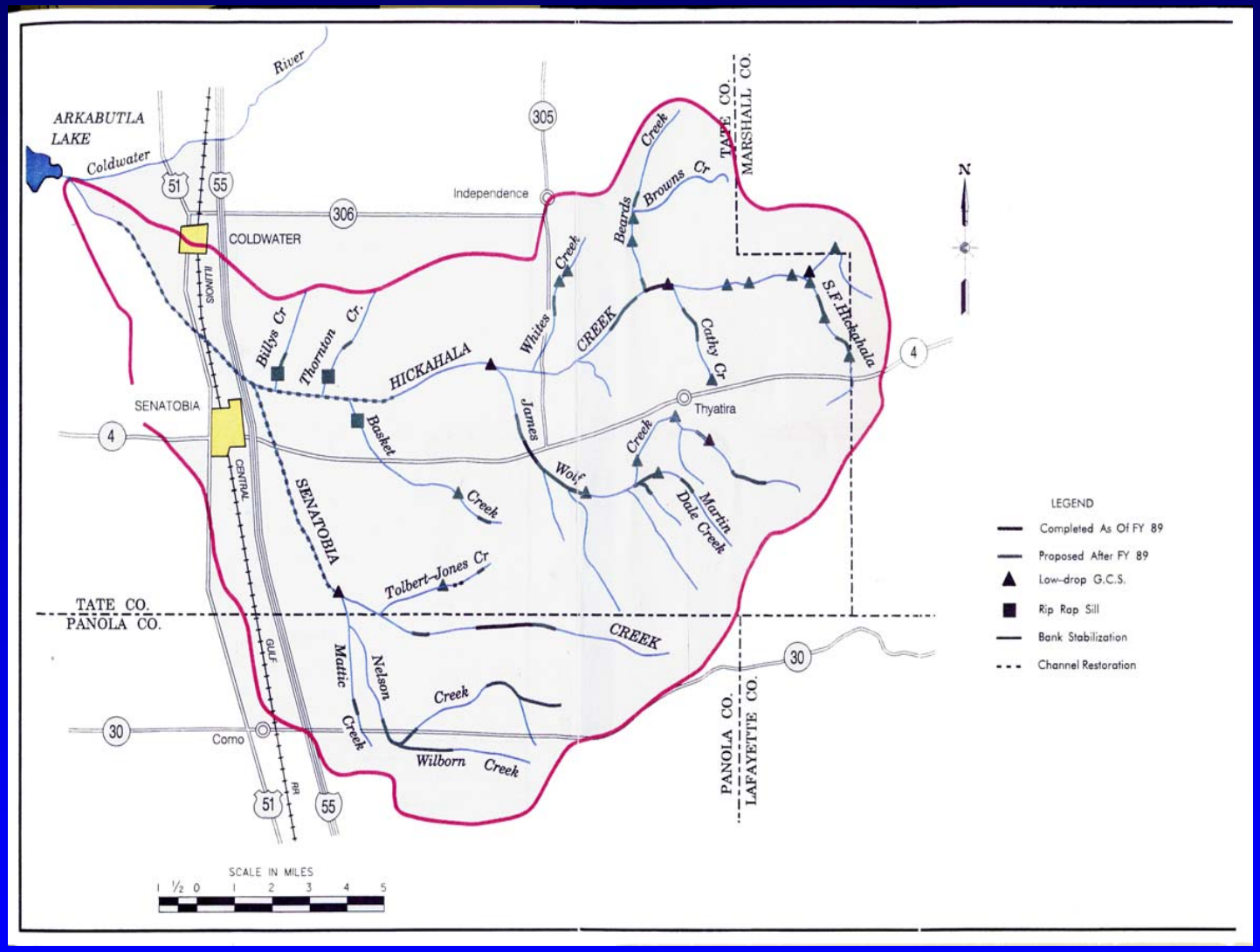
Reach averaged hydraulics from HEC-RAS results



SIAM Output for each Reach

- Local balance
- Average annual transport capacity
- Bed material supply
- Wash material supply
- Local supply
- All results reported by grain size

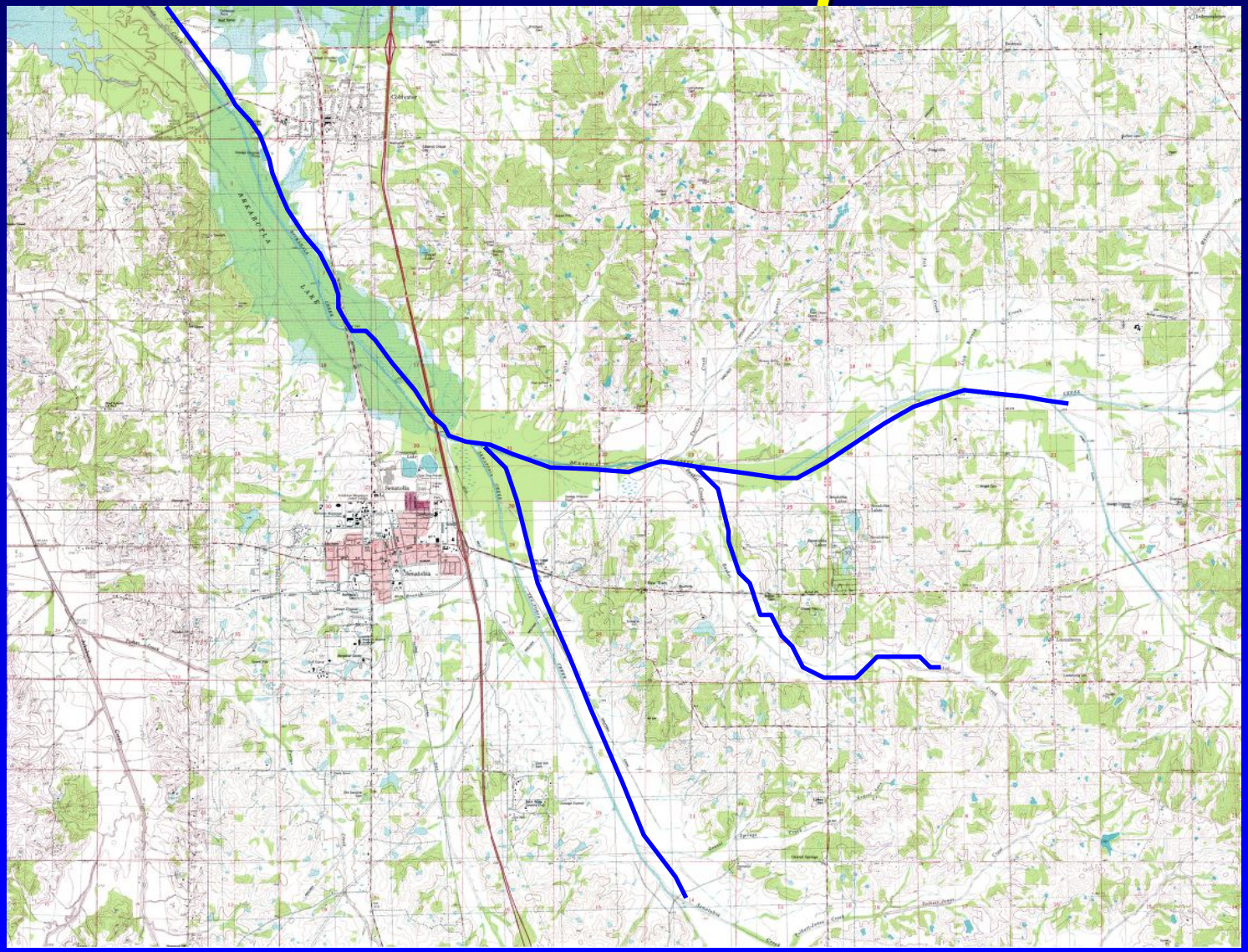
Hickahala Creek Watershed



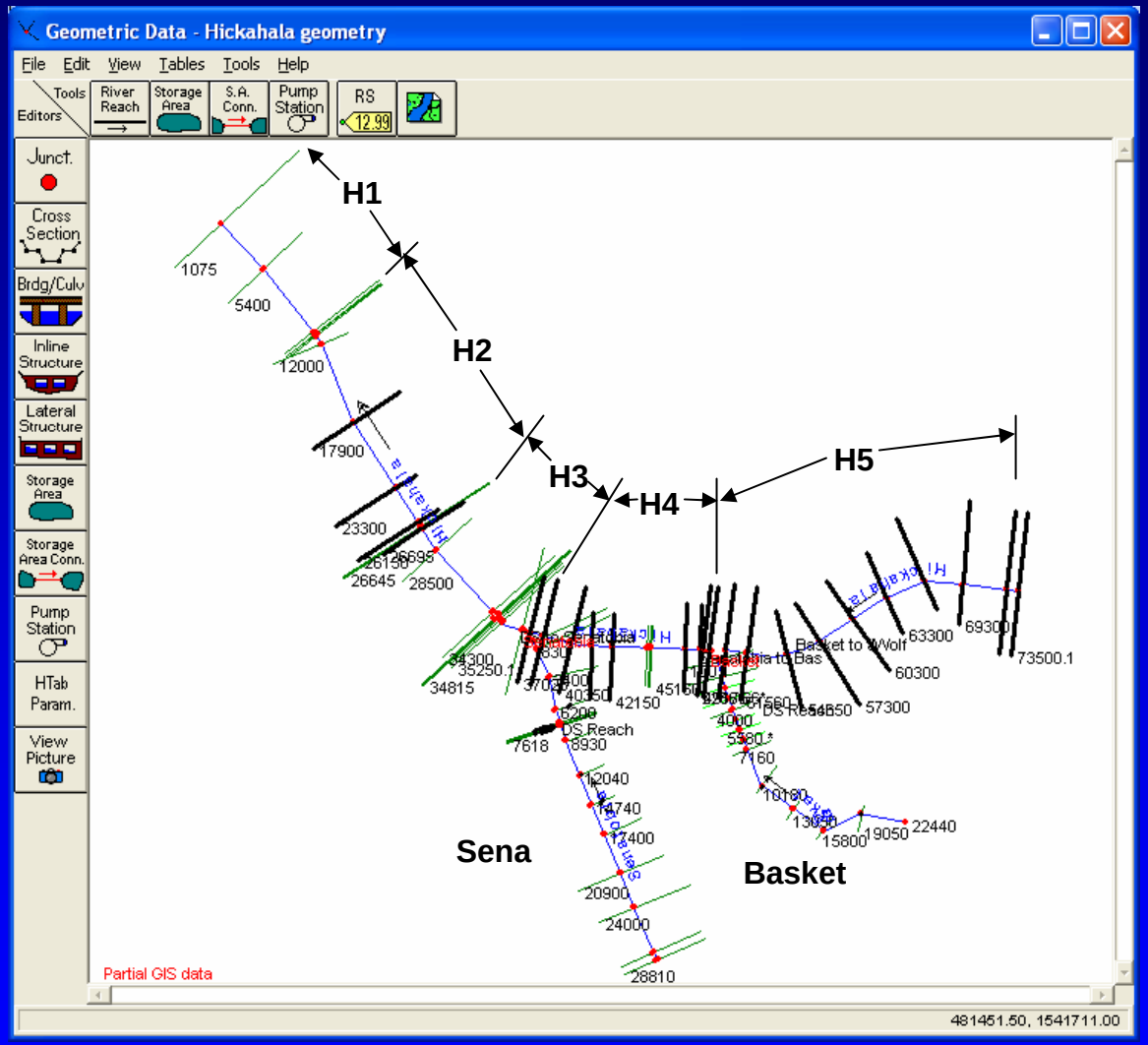
US Army Corps of Engineers

Engineer Research & Development Center

Hickahala Creek Example Network



Hickahala Creek HEC-RAS Model



US Army Corps of Engineers

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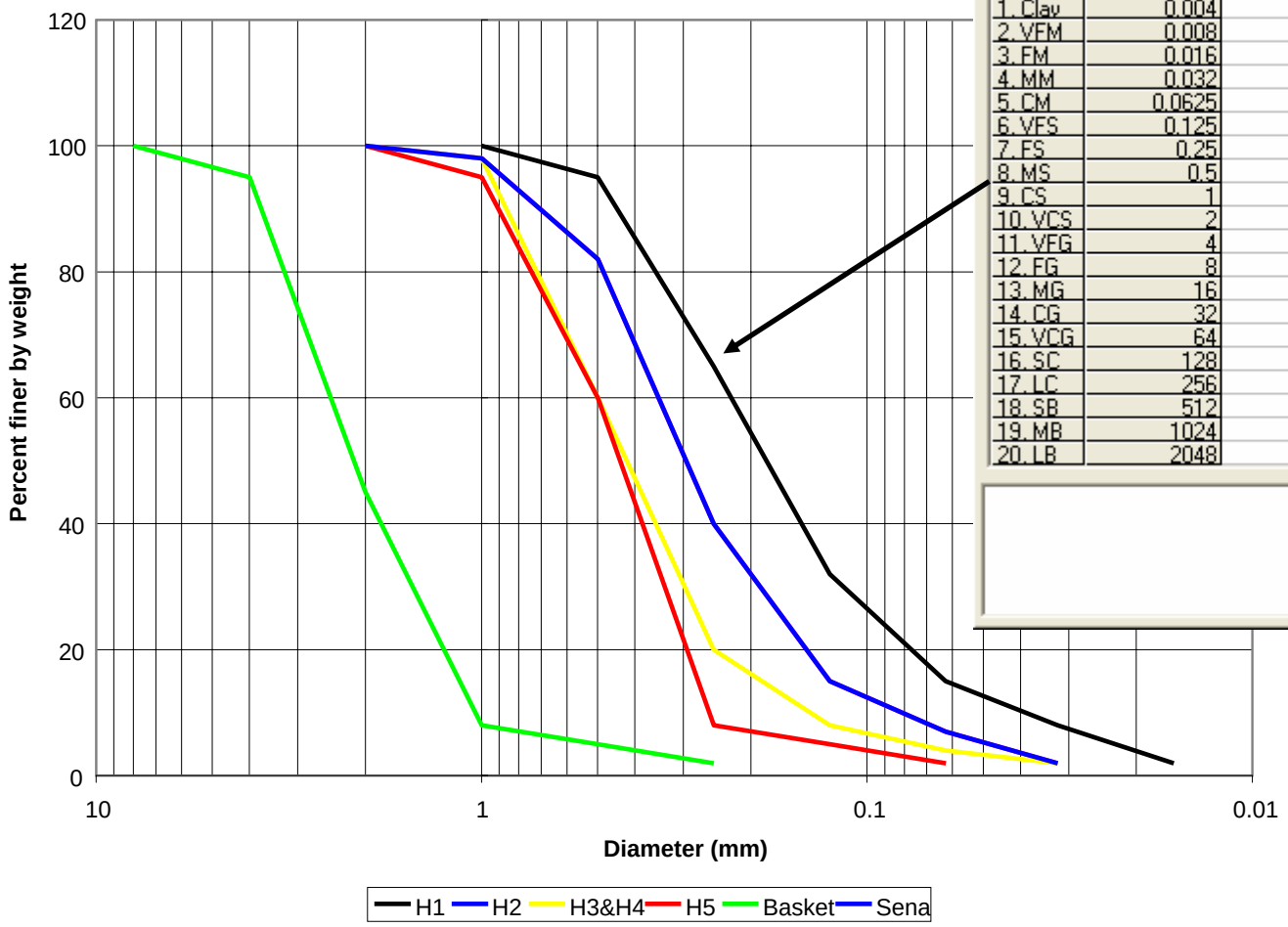
Bed Material Gradations



Bed Mat'l | Hydro | Sed Prop | Sources | Hydraulics

Sampling Hick1Bed

Class	diam. (mm)	%Finer
1. Clay	0.004	
2. VFM	0.008	
3. FM	0.016	2
4. MM	0.032	8
5. CM	0.0625	15
6. VFS	0.125	32
7. FS	0.25	65
8. MS	0.5	95
9. CS	1	100
10. VCS	2	
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	

Plot...

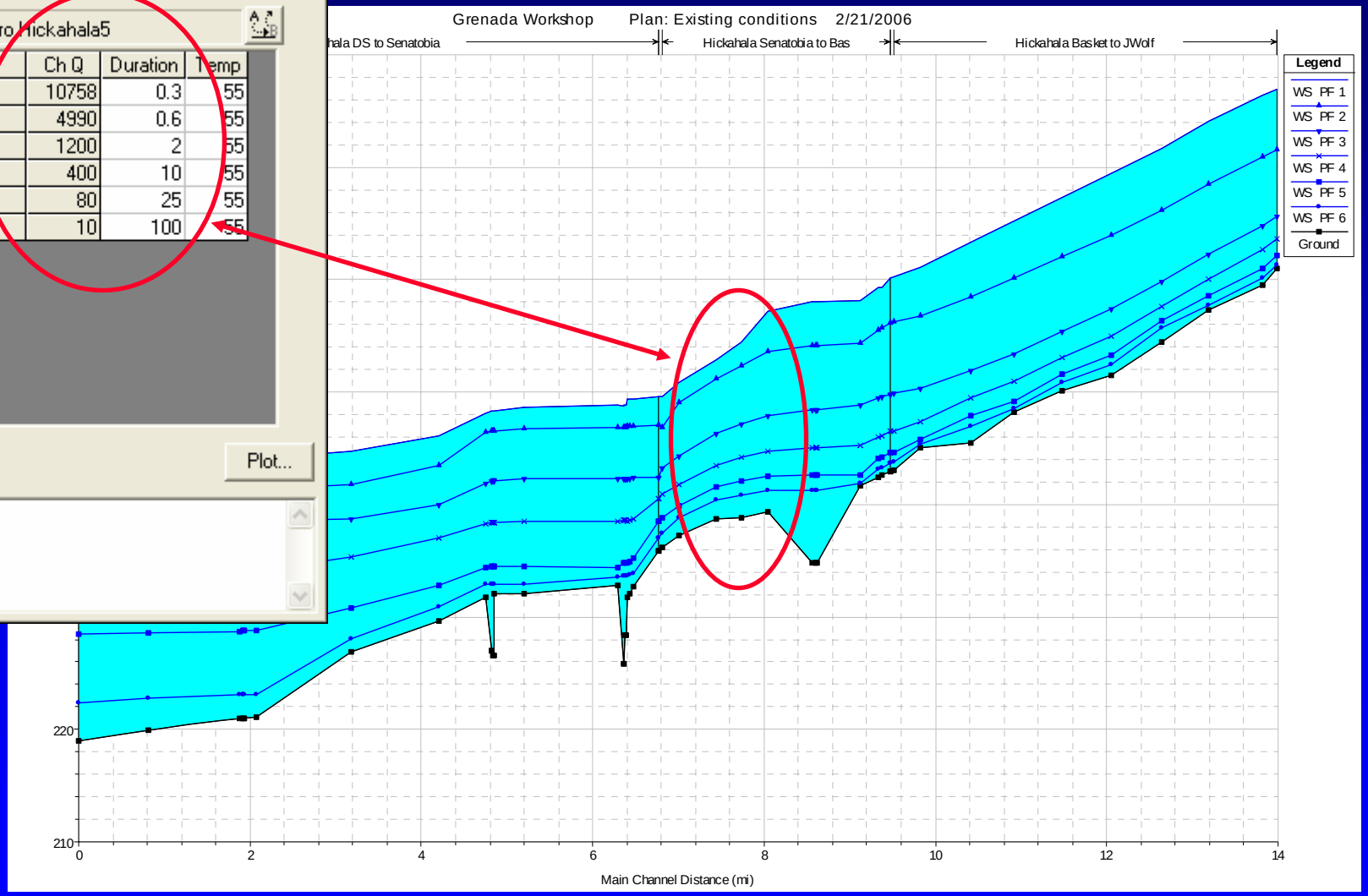
Flow Duration Input

Bed Mat'l | Hydro | Sed Prop | Sources | Hydraulics

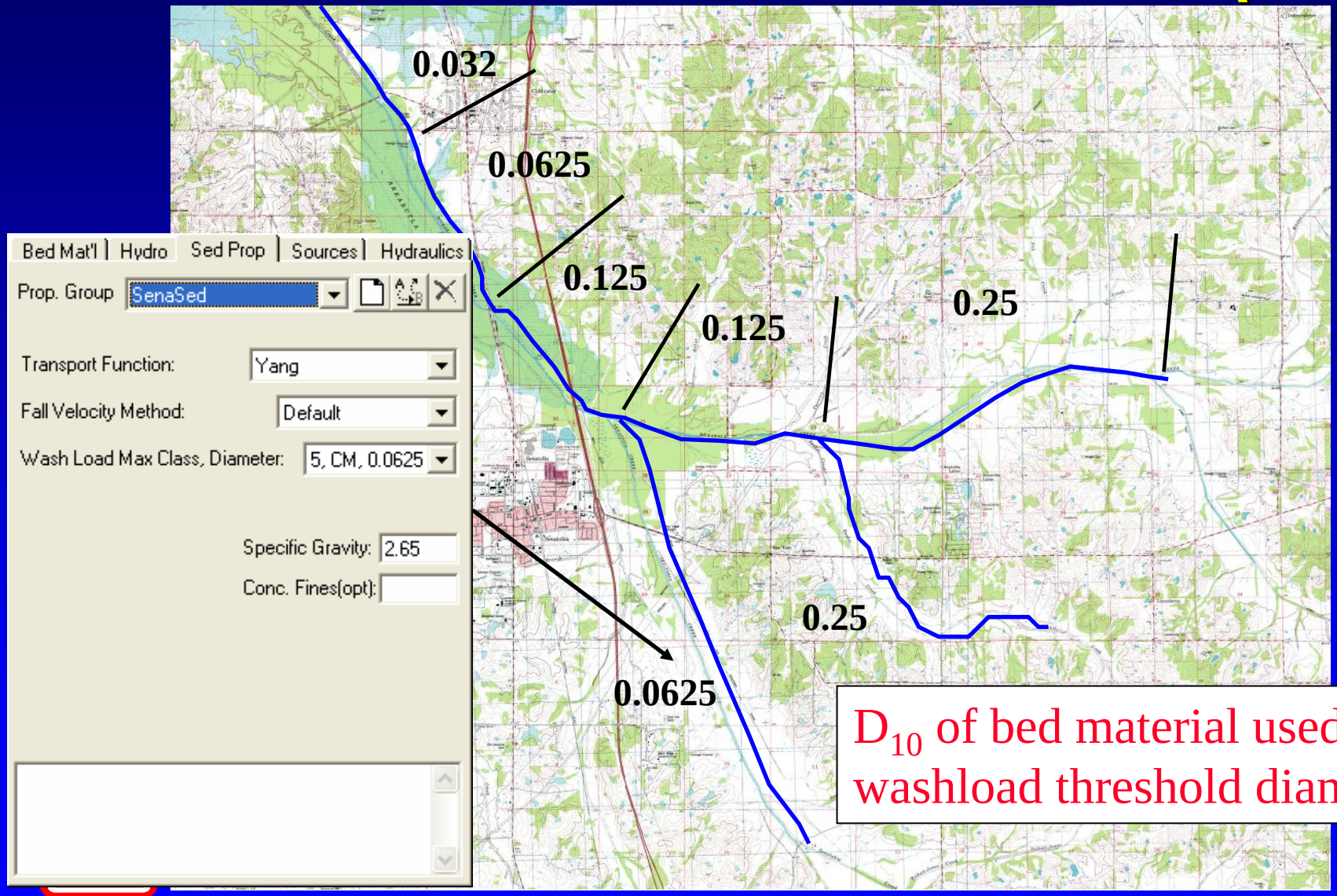
Dur. Curve Hydro Hickahala5

Profile	Ch Q	Duration	Temp
PF 1	10758	0.3	55
PF 2	4990	0.6	55
PF 3	1200	2	55
PF 4	400	10	55
PF 5	80	25	55
PF 6	10	100	55

Plot...

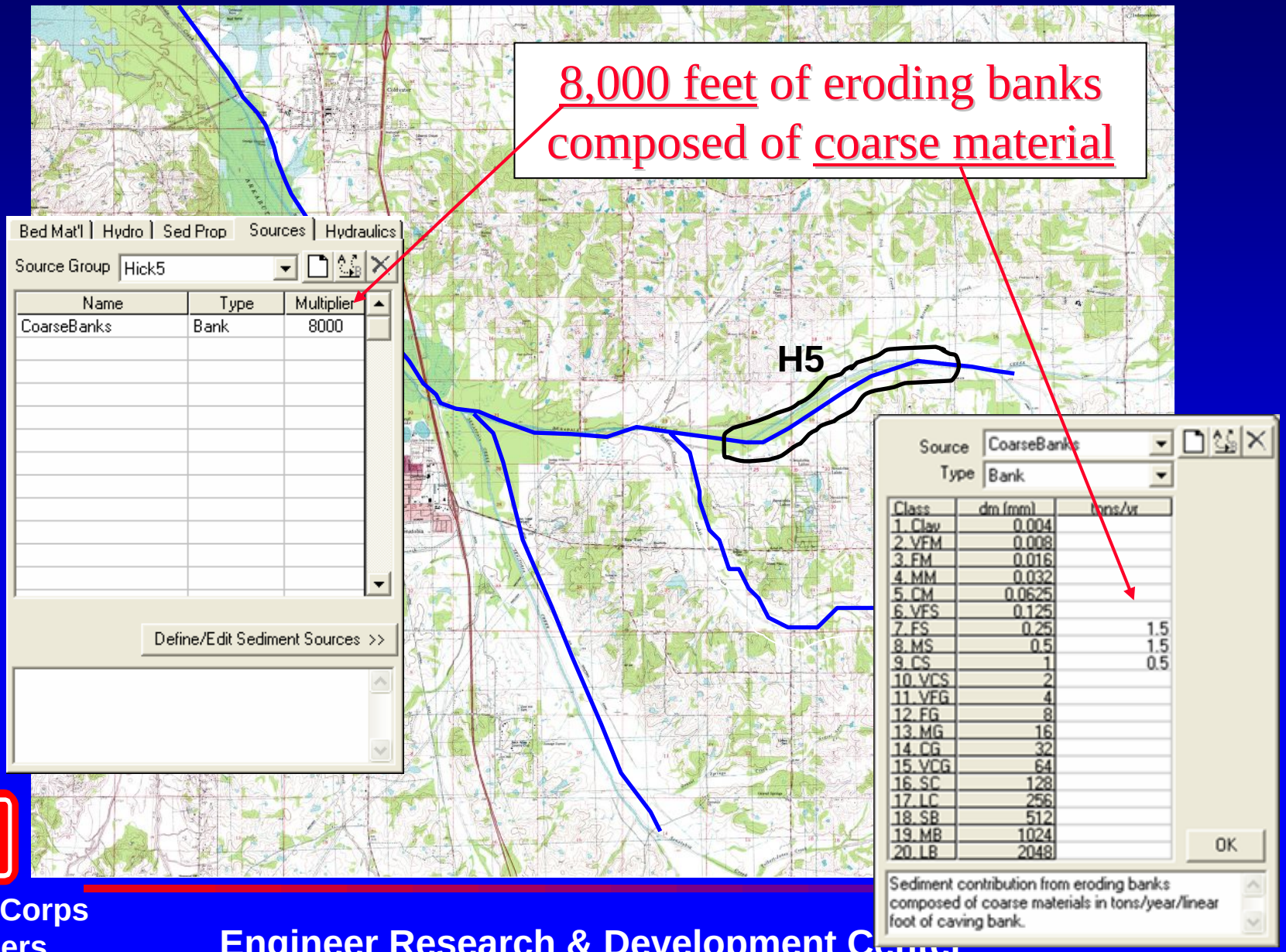


Wash Material Threshold Diameters (mm)



D_{10} of bed material used as washload threshold diameter

Coarse Bank Sediment Source – Reach "H5"



Fine Bank Sediment Source – Reach "Bask"

10,000 feet of eroding banks composed of fine material

Bed Mat'l | Hydro | Sed Prop | Sources | Hydraulics

Source Group: Basket

Name	Type	Multiplier
FineBanks	Bank	10000

Define/Edit Sediment Sources >>

Bask

Source: FineBanks

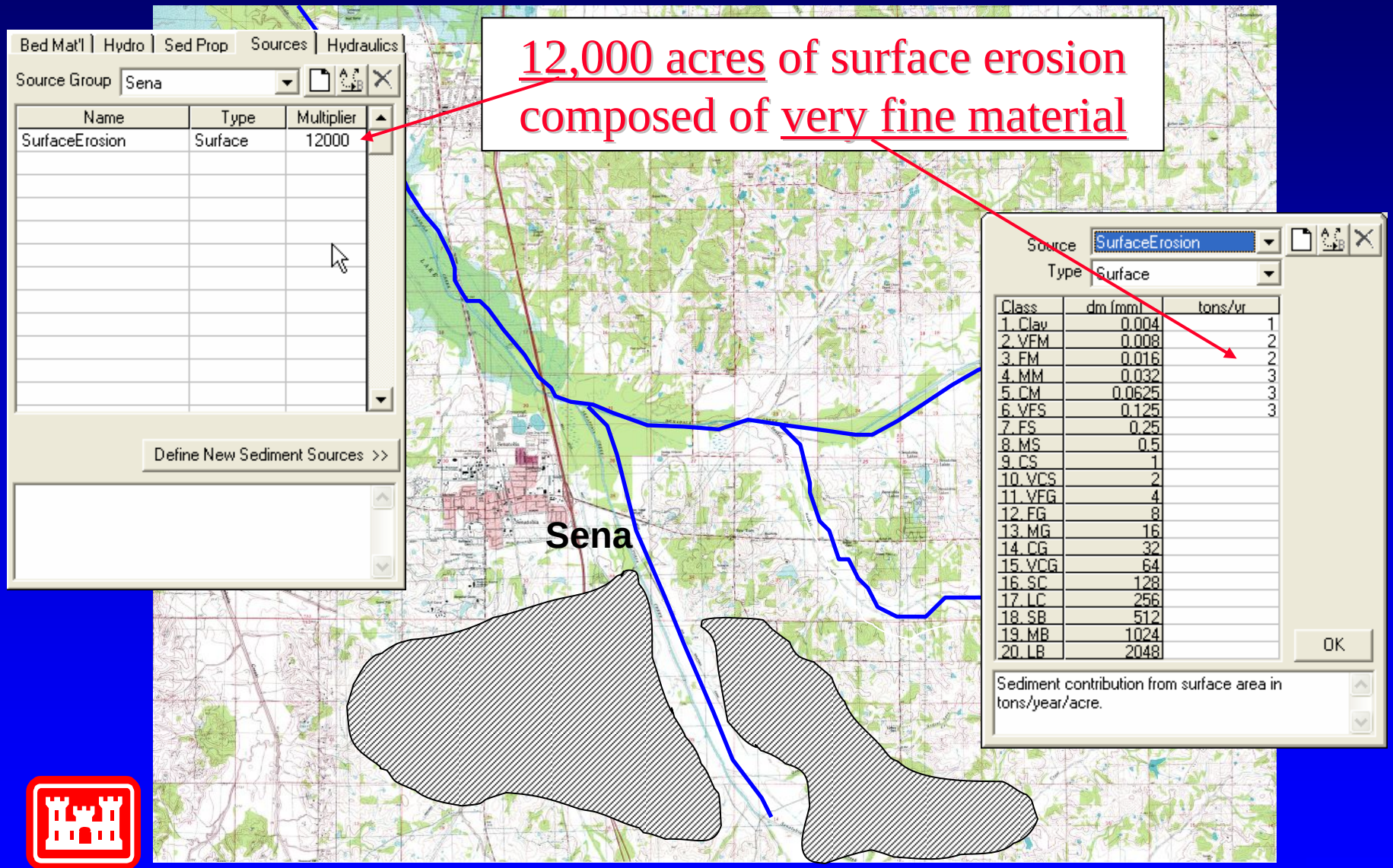
Type: Bank

Class	dm (mm)	tons/yr
1. Clay	0.004	
2. VFM	0.008	
3. FM	0.016	
4. MM	0.032	2
5. CM	0.0625	2
6. VFS	0.125	2
7. FS	0.25	
8. MS	0.5	
9. CS	1	
10. VCS	2	
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	

OK

Sediment contribution from eroding banks composed of coarse materials in tons/year/linear foot of caving bank.

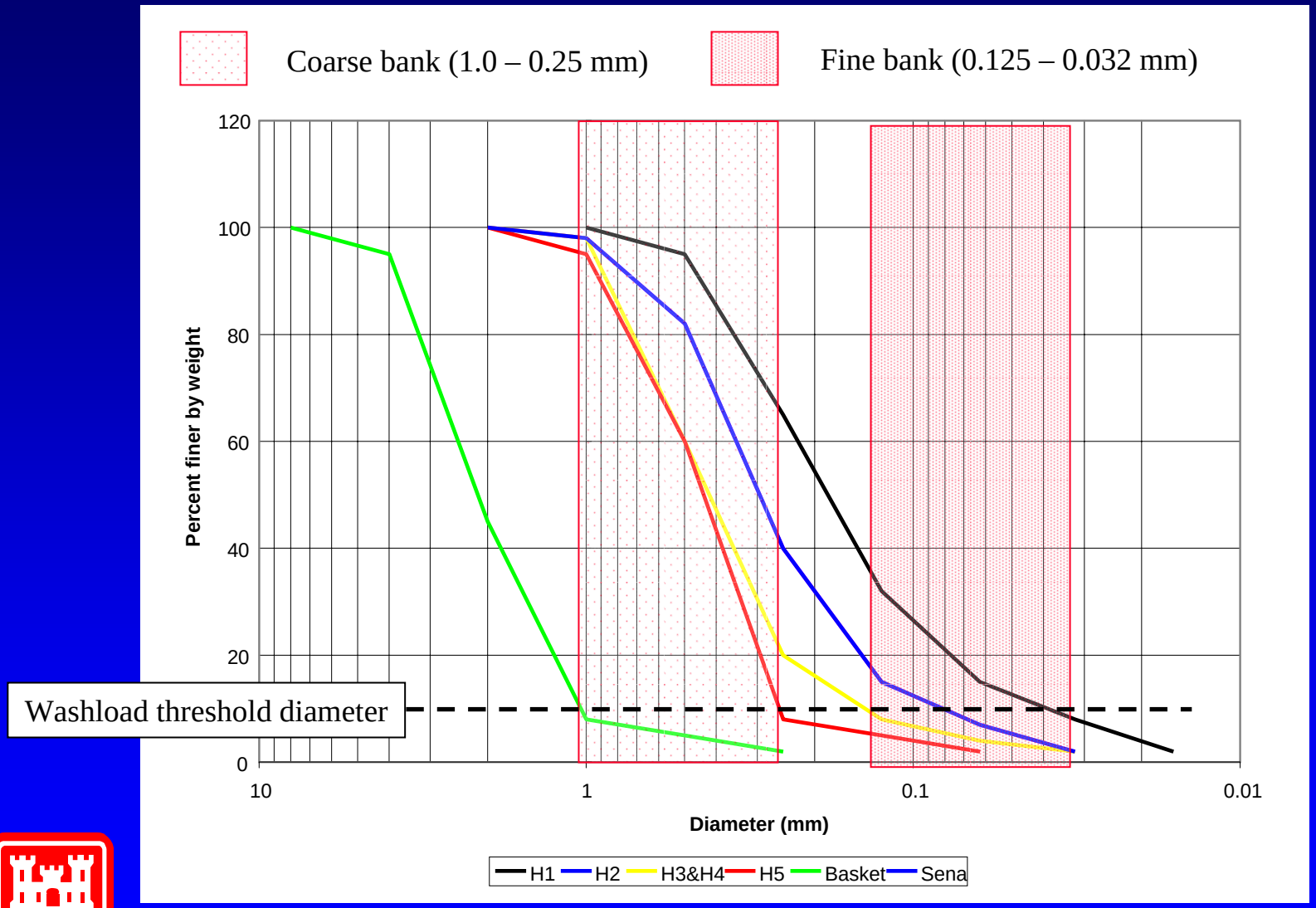
Upland Sediment Source – Reach "Sena"



Example scenarios for Hickahala Creek SIAM application

1. Existing conditions, with sediment source from coarse material bank erosion, fine material bank erosion, and very fine material surface erosion.
2. Coarse material bank erosion source removed (bank stabilization).
3. Coarse & fine material bank erosion source removed (bank stabilization).
4. Coarse & fine material bank erosion source removed, and surface erosion source controlled (land treatments).
5. Addition of grade control structures in Reach H5.

Relation of bank sources to bed material



Summary of SIAM results

Total Bed Material Budget - Grenada Workshop

File Type

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

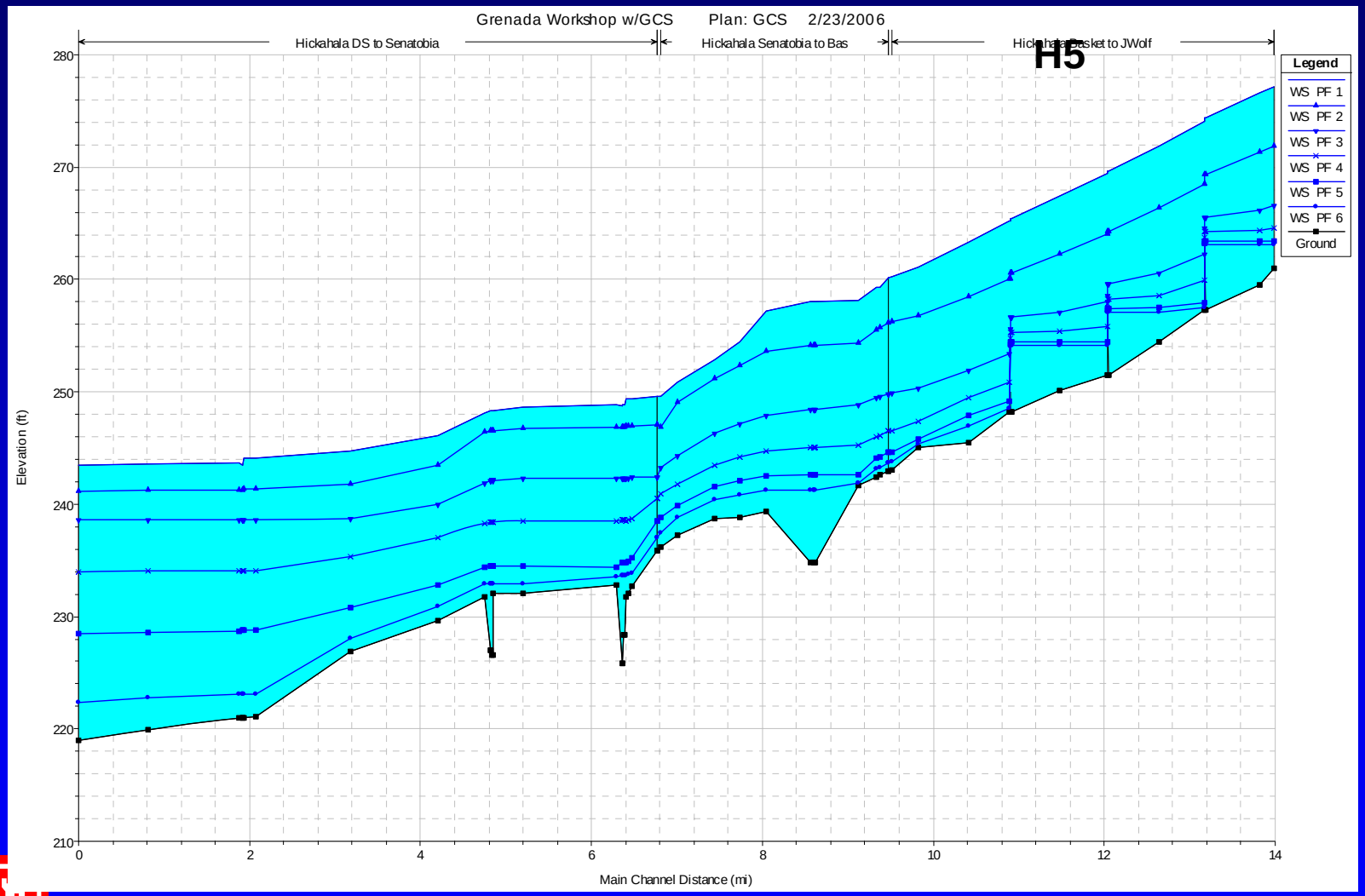
Table | Plot

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

Grade control structures added to Reach H5



Summary of SIAM results

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

Future for SIAM

- Currently in Beta release (Beta ver. 4.0).
- Options for supply limited conditions and cohesive bed.
- Conversion of local balances to average channel bed displacements.
- Computation of stable channel slope to achieve equilibrium.
- Improved graphics for output visualization.

Thank you for your attention.

Questions?