Parameter Sensitivity

Workshop

1 Objective

The goal of this workshop is to understand the sensitivity of model results to different model parameters, processes, and formulations. Specifically, the workshop covers hydraulic flow equations, transport functions, hiding and exposure, adaptation parameters, advection and diffusion, and the load correction factor.

2 Introduction

The model is based on a small reach of the Arkansas River. For the purposes of the workshop, the model is setup is relatively simple and fast. The model extent is relatively small model, and the mesh has a coarse resolution. The computational mesh, boundary condition lines, and terrain are shown in the figure below.



The base model has a constant flow upstream of 70,000 cfs, and a constant stage downstream of 172.936 ft. A morphologic acceleration factor of 10 is utilized to simulate 10 days of bed change over one day of simulation time. With this model setup, each run takes about 5-8 seconds to run which good for sensitivity analysis. It is important to note, that though the current model setup may not be good for final production runs of a project, the sensitivity analysis as applied here with a fast model setup is useful and recommended for projects.

3 Diffusion Wave vs Shallow Water Equations

In this section, an equilibrium sediment transport model is setup and results are compared between the Diffusion Wave and Shallow Water Equation solvers. The Diffusive Wave solver ignores advection and diffusion of momentum. An equilibrium sediment model is setup by using very aggressive adaptation coefficients which forces the actual concentrations to be equal to the equilibrium concentrations and ignoring diffusion and load corrections.

- 1. Start HEC-RAS.
- Open the HEC-RAS project names "ArkansasPool2.prj" in the "Parameter Sensitivity" Workshop folder.
- 3. From the main HEC-RAS editor, click on the **Run** menu and select **Run Multiple plans...**



4. Click on "DW-Wu-CapacOnly" and "SW-Wu-CapacOnly" plans and then click on **Run All Checked Plans**.

After the simulations are complete, open RAS Mapper 🔎

- 5. Begin inspecting the results by looking at the hydraulics.
- Add the Total-load Capacity, and variables to Ras Mapper by clicking on the plan Results layer and selecting Create a New Results Map Layer... as shown below



Copy Symbology Paste Symbology Reset Symbology

9. Inspect the sediment capacities and equilibrium bed change rates.

Question: Based on the hydraulics alone, do expect the sediment transport results to be similar between Diffusion-Wave Equation (DWE) and Shallow Water Equations (SWE)?

Question: What is the difference in water surface elevations at the upstream end of the model and that different significant?

Question: Do you think it is appropriate to utilize the DWE model for river hydraulics?

Question: Why are the DWE model water surfaces generally lower than the shallow water equations?

Question: Based on the SWE results, is the location of the upstream boundary condition well positioned if the goal is to study the effect of the dikes on the flow and sediment transport?

4 Sediment Transport Functions

In this section, several transport functions are compared. For simplicity, the simulations are run using **Capacity Only** simulation component, as in the previous section. This saves time and simplifies the analysis.

- 10. **Open** the plan called "SW-Wu-CapacConly".
- 11. Open the Sediment Data editor.
- 12. Click on File | Save Sediment Data As... and save the data as "VR CapacOnly"



- 13. In the **2D Bed Gradations** tab, select the **Van Rijn** from the **Transport Function** drop down menu.
- 14. **Save** the plan as "SW-VR-CapacOnly".
- 15. Run the plan.
- 16. Follow the same steps as above to create another plan using the **Ackers and White Transport Function** using the same naming conventions as above.
- 17. **Map** the sediment concentration capacities in **RAS Mapper**, and compare the **Capacity Only** plans with the three different transport functions.
- 18. **Plot** and **compare** the concentration capacities along the channel centerline and a few of the transverse profile lines.

Question: How much do the transport functions differ, in terms of magnitude and distribution?

5 Hiding and Exposure

In this section, the effect of hiding and exposure is studies by turning it off and comparing with using the Wu et al. (2000) hiding and exposure method.

- 19. **Open** the **Sediment Data** editor **Sediment Data**.
- 20. Click on File | Save Sediment Data As... and save the data as "VR CapacOnly NoHE"
- 21. **Save** the plan as "SW-VR-CapacOnly-NoHE".
- 22. Run the plan.
- 23. **Compare** the three **Capacity Only** plans with the **Van Rijn** transport function.

Question: Does hiding and exposure increase or reduce the overall transport rates in the model and why?

Question: Based on these results would increased hiding and exposure effects increase/decrease bed change and model stability?

6 Total-load Adaptation Length

The default adaptation approach in HEC-RAS is the total-load adaptation length. For this reason, we'll begin by performing some sensitivity on this parameter.

- 24. Open the plan called "SW-Wu-Lt200". This plan has all simulation components turned on (i.e. concentrations, bed gradations, and bed change). It utilizes the Wu et al. (2000) transport function and a total-load adaptation length of 200 ft.
- 25. Run the plan.
- 26. Click on File | Save Sediment Data As... with the name "Wu Lt20"



27. Click on the menu Options | Transport Methods as shown below

▼Sediment Data - Lt 100ft					
File	Options	View	Help		
Initia	User Defined Grain Classes				
	Set	Set Cohesive Options			
	Bed Change Options (1D)				
Transport Methods			1ethods		
	Cali	Calibrate Transport Function			

28. In the **Erosion Parameters** tab, set the **Total-load Adaptation Length** to **20 ft** as shown below.

1D Methods: Routing Method (1D): Continuity ▼ Sediment Junction Split Method: Flow Weighted ▼ Pool Pass Through Method: Upstream Capacity ▼ 2D Methods: AD Parameters Erosion Parameters Adaptation Coefficent Total Length ↓ Suspended Adaptation Coefficient: Constant Coefficient Bed Load Adaptation Length: Constant Length ↑ Length ↑t	🛱 Transport Model and AD Parameters: 🛛 🗖 🗙					
AD Parameters Erosion Parameters Adaptation Coefficent Total Length Total Length: 20. ft Suspended Adaptation Coefficient: Constant Coefficient Bed Load Adaptation Length: Constant Length ft	1D Methods: Routing Method (1D): Sediment Junction Split Method: Pool Pass Through Method:	Continuity Flow Weighted Upstream Capacity				
Total Length Total Length: 20, ft Suspended Adaptation Coefficient: Constant Coefficient Constant Coefficient Bed Load Adaptation Length: Constant Length Length It	AD Parameters Erosion Parameters					
Suspended Adaptation Coefficient: Constant Coefficient Constant Coefficient Bed Load Adaptation Length: Constant Length Length ft	Total Load:	Total Length Total Length: 20. ft				
	Suspended Adaptation Coefficien Consta Bed Load Adaptation Length:	t: Constant Coefficient Int Coefficient Constant Length Length ft				

29. Save a new Plan with the Title and Short ID "SW-Lt20".

30. **Set** the **Sediment Computation Multiplier** to 1, by going to the Unsteady Flow Analysis editor, and clicking on Options | Sediment Computation Options and Tolerances... and then entering the value as shown in the figures below.

File Options Help Plan: Stage and Flow Output Locations Ht20 Flow Roughness Factors Seasonal Roughness Factors Image: Complexity of the season of the s	L Unsteady Flow Analysis X				
Plan: Stage and Flow Output Locations	File Options Help				
Flow Roughness Factors Seasonal Roughness Factors Automated Roughness Calibration Automated Flow Optimization V Unsteady Encroachments Ungaged Lateral Inflows Dam (Inline Structure) Breach Levee (Lateral Structure) Breach Levee (Lateral Structure) Breach Computation Options and Tolerances Cor Output Options Friction Slope Method for Cross Sections Friction Slope Method for Bridges Initial Backwater Flow Optimizations Sediment Computation Options and Tolerances Sediment Computation Options and Tolerances Sediment Dredging Options HEC-RAS Sediment Computation Options and Tolerances Sediment Dredging Options HEC-RAS Sediment Computation Options and Tolerances Sediment Dredging Options Bed exchange iterations per time step (SPI) ID Min bed change before updating Cross Section (ft): 0.02 Min XS change before recomputation of hydraulics (ft): 0.02 Perform Volume Error Check/Carry Over: Transport Energy S	Plan:	\checkmark	Stage and Flow Output Locations	I-Lt20	
Seasonal Roughness Factors Automated Roughness Calibration Automated Flow Optimization Unsteady Encroachments Ungaged Lateral Inflows Dam (Inline Structure) Breach Levee (Lateral Structure) Breach Computation Options and Tolerances Sim SA Connection Breach Computation Options and Tolerances Output Options Friction Slope Method for Cross Sections Friction Slope Method for Bridges Initial Backwater Flow Optimizations Sediment Computation Options and Tolerances Sediment Dredging Options Sediment Dredging Options Sediment Dredging Options Sediment Dredging Options Sediment Dredging Cross Section (ft): 0.02 Min bed change before updating Cross Section (ft): 0.02 Min XS change before recomputation of hydraulics (ft): 0.02 Perform Volume Error Check/Carry Over: Transport Energy Slope Method: Local: (Q/K)^2 Sediment Computation Multiplier: 1 X the hydraulic time step <t< td=""><td></td><td></td><td>Flow Roughness Factors</td><td>-</td></t<>			Flow Roughness Factors	-	
Automated Roughness Calibration Automated Flow Optimization Unsteady Encroachments Ungaged Lateral Inflows Dam (Inline Structure) Breach Levee (Lateral Structure) Breach Levee (Lateral Structure) Breach Computation Options and Tolerances Computation Options and Tolerances Corr Output Options Friction Slope Method for Bridges Initial Backwater Flow Optimizations Sediment Computation Options and Tolerances Sediment Output Options Free Sediment Computation Options and Tolerances Sediment Output Options Sediment Output Options HEC-RAS Sediment Computation Options and Tolerances Bed exchange iterations per time step (SP1) ID Min bed change before updating Cross Section (ft): 0.02 Min XS change before recomputation of hydraulics (ft): 0.02 Perform Volume Error Check/Carry Over: Transport Energy Slope Method: Local: (Q/K)^2 Sediment Computation Multiplier: X the hydraulic time step Sedim			Seasonal Roughness Factors	•	
Pro Automated Flow Optimization Unsteady Encroachments Ungaged Lateral Inflows Dam (Inline Structure) Breach Evee (Lateral Structure) Breach Levee (Lateral Structure) Breach Evee (Lateral Structure) Breach Computation Options and Tolerances 0000 Cord Output Options Friction Slope Method for Cross Sections rval: 30 Minute Image: 30 Minute			Automated Roughness Calibration	•	
W Unsteady Encroachments Ungaged Lateral Inflows Dam (Inline Structure) Breach Levee (Lateral Structure) Breach E Sim SA Connection Breach Computation Options and Tolerances Friction Slope Method for Cross Sections Friction Slope Method for Bridges Friction Slope Method for Bridges Initial Backwater Flow Optimizations Sediment (3 🖉 ×) Sediment Computation Options and Tolerances Sediment (3 ể ×) Sediment Dredging Options Friction Slope Method for Bridges May Friction Slope Method for Bridges Sediment Computation Options and Tolerances Sediment (3 ể ×) Sediment Output Options Sediment Oreging Options HEC-RAS Sediment Computation Options and Tolerances Image: Sediment Options Section (ft): 0.02 ID Computational Options Image: Section (ft): 0.02 Min XS change before updating Cross Section (ft): 0.02 Perform Volume Error Check/Carry Over: Transport Energy Slope Method: Local: (Q/K)^2 Image: Sectiment Computation Multiplier: 1 X the hydraulic time step Sediment Computation Multiplier: 1 X the hydraulic time step Sediment Warnup Periods:	Pro		Automated Flow Optimization		
Ungaged Lateral Inflows Dam (Inline Structure) Breach Levee (Lateral Structure) Breach Computation Options and Tolerances Output Options Friction Slope Method for Cross Sections Friction Slope Method for Bridges Initial Backwater Flow Optimizations Sediment Computation Options and Tolerances Sediment Output Options Friction Slope Method for Bridges Initial Backwater Flow Optimizations General Sediment Computation Options and Tolerances Sediment Dredging Options HEC-RAS Sediment Computation Options and Tolerances General 2D Computational Options Bed exchange iterations per time step (SP1) 10 Min XS change before updating Cross Section (ft): 0.02 Perform Volume Error Check/Carry Over: Transport Energy Slope Method: Invasor Energy Slope Method: Local: (Q/K)^2 Sediment Computation Multiplier: 1 X the hydraulic time step Sediment Warmup Periods:			Unsteady Encroachments	^	
Dam (Inline Structure) Breach Levee (Lateral Structure) Breach Sim SA Connection Breach Computation Options and Tolerances Output Options Friction Slope Method for Cross Sections Friction Slope Method for Bridges Initial Backwater Flow Optimizations Sediment Computation Options and Tolerances Sediment Output Options Sediment Dredging Options HEC-RAS Sediment Computation Options and Tolerances Sediment Dredging Options HEC-RAS Sediment Computation Options and Tolerances General 2D Computational Options Bed exchange iterations per time step (SPI) 10 Min bed change before updating Cross Section (ft): 0.02 Min XS change before recomputation of hydraulics (ft): 0.02 Perform Volume Error Check/Carry Over: Transport Energy Slope Method: Local: (Q/K)^2 Sediment Computation Multiplier: X the hydraulic time step Sediment Computation Multiplier: X the hydraulic time step			Ungaged Lateral Inflows		
Sim SA Connection Breach Sim SA Connection Breach Computation Options and Tolerances e: 0000 Cor Output Options Friction Slope Method for Cross Sections erval: 30 Minute • Friction Slope Method for Bridges i: 30 Minute • Initial Backwater Flow Optimizations Sediment Computation Options and Tolerances Sediment Computation Options Sediment Output Options HEC-RAS Sediment Computation Options and Tolerances Sediment Dredging Options HEC-RAS Sediment Computation Options and Tolerances Minute options Sediment Dredging Options Firstional Options Bed exchange iterations per time step (SPI) 10 Min XS change before updating Cross Section (ft): 0.02 Min XS change before recomputation of hydraulics (ft): 0.02 Perform Volume Error Check/Carry Over: Transport Energy Slope Method: Local: (Q/K)^2 Sediment Computation Multiplier: 1 X the hydraulic time step Sediment Computation Periods: <td></td> <td></td> <td>Dam (Inline Structure) Breach</td> <td></td>			Dam (Inline Structure) Breach		
Sim SA Connection Breach Computation Options and Tolerances Protein Stope Method for Cross Sections Friction Slope Method for Bridges Initial Backwater Flow Optimizations Sediment Computation Options and Tolerances Sediment Output Options Sediment Dredging Options HEC-RAS Sediment Computation Options and Tolerances Max Sediment Computation Options and Tolerances MEC-RAS Sediment Computation Options and Tolerances General 2D Computational Options Bed exchange iterations per time step (SPI) Min bed change before updating Cross Section (ft): 0.02 Min XS change before recomputation of hydraulics (ft): 0.02 Perform Volume Error Check/Carry Over: Transport Energy Slope Method: Local: (Q/K)^2 Sediment Computation Multiplier: 1 X the hydraulic time step Sediment Warmup Periods:			Levee (Lateral Structure) Breach	~	
Computation Options and Tolerances e: 10000 Cor Output Options erval: 30 Minute Friction Slope Method for Cross Sections erval: 30 Minute Pre Initial Backwater Flow Optimizations Sediment (3 🛎 ×) Sediment Computation Options and Tolerances Sediment (3 🛎 ×) Sediment Dutput Options Sediment Output Options Sediment Dredging Options Sediment Output Options HEC-RAS Sediment Computation Options and Tolerances General 2D Computational Options ID Computational Options Bed exchange iterations per time step (SPI) 10 Min XS change before updating Cross Section (ft): 0.02 Min XS change before recomputation of hydraulics (ft): 0.02 Perform Volume Error Check/Carry Over: r Transport Energy Slope Method: Local: (Q/K)^2 v Sediment Computation Multiplier: X the hydraulic time step Sediment Warmup Periods:	Sim		SA Connection Breach		
Computation Options and Tolerances Computation Options and Tolerances Preval: 30 Minute Sediment Computation Options and Tolerances Sediment Computation Options and Tolerances Sediment Dredging Options HEC-RAS Sediment Computation Options and Tolerances General 2D Computational Options Bed exchange iterations per time step (SPI) Min bed change before updating Cross Section (ft): 0.02 Min XS change before recomputation of hydraulics (ft): 0.02 Perform Volume Error Check/Carry Over: Transport Energy Slope Method: Local: (Q/K)^2 Sediment Computation Multiplier: 1 X the hydraulic time step Sediment Warmup Periods:				e: 0000	
Cor Output Options Friction Slope Method for Cross Sections Friction Slope Method for Bridges Prc Initial Backwater Flow Optimizations Sediment Computation Options and Tolerances Sediment (3 🛎 ×) Sediment Dredging Options Idebug parameters Sediment Dredging Options Sediment Output Options and Tolerances HEC-RAS Sediment Computation Options and Tolerances Image: Computational Options and Tolerances ID Computational Options Image: Computational Options and Tolerances ID Computational Options Image: Computation Options and Tolerances ID Computational Options Image: Computational Options ID Computational Options Image: Computation of hydraulics (ft): Image: Computation of hydraulics (ft): Image: Computation of hydraulics (ft): Image: Computation Multiplier:			Computation Options and Iolerances	: 10000	
Mar Friction Slope Method for Cross Sections :: 30 Minute Friction Slope Method for Bridges Initial Backwater Flow Optimizations :: 30 Minute Sediment Computation Options and Tolerances Sediment (3 Image: Computation Options and Tolerances Sediment (3 Image: Computation Options and Tolerances Sediment Dredging Options Sediment Computation Options and Tolerances Image: Computation Options and Tolerances HEC-RAS Sediment Computation Options Image: Computation Options Image: Computation Options 1D Computational Options Image: Computation Options Image: Computation Options ID Computational Options Image: Computation Options Image: Computation Options ID Computational Options Image: Computation of hydraulics Image: Computation of hydraulics Min bed change before updating Cross Section (ft): Image: Computation of hydraulics Image: Computation of hydraulics Min XS change before recomputation of hydraulics Image: Computation Multiplier: Image: Computation Computation of hydraulics Image: Computation Multiplier: Sediment Computation Multiplier: Image: Computation Multiplier: Image: Computation Multiplier: Image: Computation Multiplier: Sediment Computation Multiplier: Image: Computation Multiplier: Image: Computa	Cor		Output Options	erval: 30 Minute 💌	
Friction Slope Method for Bridges Sediment Computation Optimizations Sediment Computation Options and Tolerances Sediment (3 Sediment (S Se	Mar		Friction Slope Method for Cross Sections	al: 30 Minute 💌	
Initial Backwater Flow Optimizations Sediment Computation Options and Tolerances Sediment Dutput Options Bediment Dredging Options HEC-RAS Sediment Computation Options and Tolerances General 2D Computational Options 1D Computational Options Bed exchange iterations per time step (SPI) 10 Min bed change before updating Cross Section (ft): 0.02 Min XS change before recomputation of hydraulics (ft): 0.02 Perform Volume Error Check/Carry Over: Transport Energy Slope Method: Local: (Q/K)^2 Sediment Computation Multiplier: 1 X the hydraulic time step Sediment Warmup Periods:	Pro		Friction Slope Method for Bridges	D Sediment (3 🖙 🗙	
Sediment Computation Options and Tolerances Gebug parameters Sediment Output Options Sediment Dredging Options HEC-RAS Sediment Computation Options and Tolerances General 2D Computational Options 1D Computational Options Bed exchange iterations per time step (SPI) Min bed change before updating Cross Section (ft): 0.02 Min XS change before recomputation of hydraulics (ft): 0.02 Perform Volume Error Check/Carry Over: Transport Energy Slope Method: Local: (Q/K)^2 Sediment Computation Multiplier: 1 X the hydraulic time step Sediment Warmup Periods:	-		Initial Backwater Flow Optimizations		
Sediment Output Options Sediment Dredging Options HEC-RAS Sediment Computation Options and Tolerances General 2D Computational Options 1D Computational Options Bed exchange iterations per time step (SPI) 10 Min bed change before updating Cross Section (ft): 0.02 Min XS change before recomputation of hydraulics (ft): 0.02 Perform Volume Error Check/Carry Over: Transport Energy Slope Method: Local: (Q/K)^2 Sediment Computation Multiplier: 1 X the hydraulic time step Sediment Warmup Periods:			Sediment Computation Options and Tolerances	debug parameters	
Sediment Dredging Options HEC-RAS Sediment Computation Options and Tolerances General 2D Computational Options 1D Computational Options Bed exchange iterations per time step (SPI) Min bed change before updating Cross Section (ft): 0.02 Min XS change before recomputation of hydraulics (ft): 0.02 Perform Volume Error Check/Carry Over: Transport Energy Slope Method: Local: (Q/K)^2 Sediment Computation Multiplier: 1 X the hydraulic time step Sediment Warmup Periods:			Sediment Output Options		
HEC-RAS Sediment Computation Options and Tolerances General 2D Computational Options 1D Computational Options Bed exchange iterations per time step (SPI) Min bed change before updating Cross Section (ft): 0.02 Min XS change before recomputation of hydraulics (ft): 0.02 Perform Volume Error Check/Carry Over: Transport Energy Slope Method: Local: (Q/K)^2 Sediment Computation Multiplier: 1 X the hydraulic time step Sediment Warmup Periods:			Sediment Dredging Options		
General 2D Computational Options 1D Computational Options Bed exchange iterations per time step (SPI) 10 Min bed change before updating Cross Section (ft): 0.02 Min XS change before recomputation of hydraulics (ft): 0.02 Perform Volume Error Check/Carry Over: Transport Energy Slope Method: Local: (Q/K)^2 Sediment Computation Multiplier: 1 X the hydraulic time step Sediment Warmup Periods:	HEC	-RAS	5 Sediment Computation Options and Tolerances		
1D Computational Options Bed exchange iterations per time step (SPI) 10 Min bed change before updating Cross Section (ft): 0.02 Min XS change before recomputation of hydraulics (ft): 0.02 Perform Volume Error Check/Carry Over: Transport Energy Slope Method: Local: (Q/K)^2 Sediment Computation Multiplier: 1 X the hydraulic time step Sediment Warmup Periods:	Ge	nera	D Computational Options		
Bed exchange iterations per time step (SPI) 10 Min bed change before updating Cross Section (ft): 0.02 Min XS change before recomputation of hydraulics (ft): 0.02 Perform Volume Error Check/Carry Over: Transport Energy Slope Method: Local: (Q/K)^2 Sediment Computation Multiplier: 1 X the hydraulic time step Sediment Warmup Periods: 2	1	D Co	mputational Options		
Min bed change before updating Cross Section (ft): 0.02 Min XS change before recomputation of hydraulics (ft): 0.02 Perform Volume Error Check/Carry Over: Transport Energy Slope Method: Local: (Q/K)^2 Sediment Computation Multiplier: 1 X the hydraulic time step Sediment Warmup Periods:	Bed exchange iterations per time step (SPI) 10				
Min XS change before recomputation of hydraulics (ft): 0.02 Perform Volume Error Check/Carry Over: Transport Energy Slope Method: Local: (Q/K)^2 Sediment Computation Multiplier: 1 X the hydraulic time step Sediment Warmup Periods:	Min bed change before updating Cross Section (ft): 0.02				
Perform Volume Error Check/Carry Over: Transport Energy Slope Method: Local: (Q/K)^2 Sediment Computation Multiplier: 1 X the hydraulic time step Sediment Warmup Periods:	Min XS change before recomputation of hydraulics (ft): 0.02				
Transport Energy Slope Method: Local: (Q/K)^2 Sediment Computation Multiplier: 1 X the hydraulic time step Sediment Warmup Periods:	Perform Volume Error Check/Carry Over:				
Sediment Computation Multiplier: 1 X the hydraulic time step Sediment Warmup Periods:	Transport Energy Slope Method: Local: (Q/K)^2				
Sediment Warmup Periods:	Sediment Computation Multiplier: 1 X the hydraulic time step				
	Sed				

This plan has a relatively large time step with morphologic acceleration. Using a **Sediment Computation Multiplier** larger than 1, will cause erosion limiters to reduce the sediment transport capacities. This feature is intended to prevent a single active layer from eroding in a single time step but can cause problems for artificially small adaptation lengths, since this greatly increases the magnitude of the erosion rates.

- 31. Run the plan.
- 32. **Add** the bed change, sediment concentration capacities, and concentrations sediment results layers in **RAS Mapper**.
- 33. **Compare** the Total-load Concentrations and Capacities as before. Remember to copy-paste the layer symbology so that the result maps being compared have the same color ramp and data limits. Below is an example of the what the fields should look at the end of the simulation.
- 34. **Compare** the bed change for the plans with 20-ft and 200-ft adaptation lengths. Remember to copy-paste the colormap limits so that the results can be compared directly. Toggle quickly between the two get a better understanding of the differences.

Question: Does reducing the adaptation length, make the actual concentrations more like the capacities and why?

Question: What would happen if the adaptation length were set to a very small number?

Question: What effect did reducing the adaptation length cause on the bed change results?

7 Advection and Diffusion

In this section, several new plans are created and compared with the previous plan with only advection. In total, three plans are created in section with different settings for the diffusion coefficient calculation method.

7.1 Constant Diffusion Coefficient

The simplest method for the diffusion coefficient is a constant value. In this section, diffusion is introduced by specifying a constant diffusion coefficient.

- 35. Open the plan titled "SW-Wu-Lt200".
- 36. **Open** the **Sediment Data** editor **S**.
- 37. Click on File | Save Sediment Data As... and save the data as "Wu Lt200 K10"



38. Click on the menu Options | Transport Methods as shown below



39. In the **Transport Model and AD Parameters** editor, under the **Diffusion Coefficient** section, select the drop-down menu for the **Total-load Diffusion Method** and select the **Define Constant** option as shown in the figure below.

🖏 Transport Model and AD Parameters: 🚽 🗆 🗙				
1D Methods: Routing Method (1D):				
Sediment Junction Split Method: Flow Weighted				
Pool Pass Through Method: Upstream Capacity 💌				
2D Methods:				
AD Parameters Erosion Parameters				
Load Correction Factor Total-load Correction Factor Bed-Load Correction Factor: No Correction Suspended-Load Correction: No Correction				
,				
Susp Diffusion Method: None				
Bed Load Diffusion Method: None				
OK Cancel				

40. Enter a constant diffusion coefficient of **10 ft²/s**.

Diffusion Coefficient		
Total-Load Diffusion Method: Define Constant		-
	К 10	ft2/s

- 41. Save the Sediment Data.
- 42. Save a new plan with the Title and Short ID "SW-Wu-Lt200-K10".
- 43. Run the plan
- 44. **Open RAS Mapper** and **add** the same sediment variables as described before.
- 45. **Map** the total-load concentration for both plans in RAS Mapper.
- 46. Plot the total-load concentration for both plans along one of the profiles to compare how diffusion affects the sediment concentrations. Do this by turning on the Profile Lines layer in the Features node. And then right-click on one of the profile lines, and select Plot Profile | Total-load Concentration | Cell Total-load Concentration Total as shown in the figures below.

Question: Why does the plan with diffusion show a lower peak concentration in the transverse profile plot?

47. Add the fraction of suspended sediments called Fraction Suspended.

Results Map Parameters X				
Map Type Hydraulics Sediment Bed Shear Stress Fraction Suspended Setting Velocity Total-load Cranspot Rate Total-load Transpot Rate	Unsteady Profile C Maximum C Minimum C Minimum C Profile 01MAY2019 00:00:00 01MAY2019 00:00:00 01MAY2019 00:00:00 01MAY2019 02:30:00 01MAY2019 02:30:00 01MAY2019 02:30:00 01MAY2019 03:30:00 01MAY2019 04:30:00 01MAY2019 04:30 01MAY2019 01MAY2019 01MAY2019 01MAY2019 01MAY2019 01MAY2019 01MAY2019 01M	Map (Genear C Ra C Poi Storec C Ra C Poi C Poi	Map Output Mode Generated for Current View (in memory) Raster (with Associated Terrain) Stored (saved to disk) Raster based on Terrain: Pool2_20221006_NM44 C Point Feature Layer: Polygon Boundary at Value: Map Type Layer Name Layer Na	
B-Additonal 2D Variables	,		FS MS CS	FS MS CS
Map Mode: Map results are generated on the fly for the current view.				

The fraction of suspended sediments should look something like the figure below.

Question: For this model, would the results be sensitive to changes in the bedload diffusion coefficient and why?

7.2 Exponential Scheme

The **Exponential Scheme** is linear scheme based on an analytical solution of the 1D steady-state advection diffusion. If you look at how this scheme is implemented, it is basically the upwind scheme with a reduction of the diffusion term to account for "excess" diffusion from the upwind scheme. The scheme also has the benefit of being inexpensive and linear which means it does not require significant additional computations or iterations to solve. In this section, a plan is setup and run with the **Exponential Scheme**.

- 48. Open the Unsteady Flow Analysis window 🔼
- 49. **Click on File | Save Plan As** and create a new plan with the Title and Short ID "Exponential".
- 50. Click on the menu **Options | Sediment Computation Options and Tolerances** as shown in the figure below.

L Unsteady Flow Analysis						
File	Options Help					
Plan:	~	Stage and Flow Output Locations Flow Distribution Locations Flow Roughness Factors Seasonal Roughness Factors Automated Roughness Calibration Unsteady Encroachments Ungaged Lateral Inflows				
Sim		Dam (Inline Structure) Breach Levee (Lateral Structure) Breach SA Connection Breach Computation Options and Tolerances	e: 0000 ; 0000			
Cor Cor Mar Pro		Output Options Friction Slope Method for Cross Sections Friction Slope Method for Bridges Initial Backwater Flow Optimizations	erval: 30 Minute 💌 II: 30 Minute 💌 Sediment (3 Dz 🗃			
		Sediment Computation Options and Tolerances Sediment Output Options Sediment Dredging Options				

51. Click on the **2D Computational Options** tab and within the section called select the **Transport** set the **Advection Scheme** to **Exponential** as shown in the figure below.

HEC-RAS Sediment Computation Options and Tolerances				
General 2D Computational Options				
Transport				
Advection Scheme:	Upwind 👻			
Sediment Matrix Solver:	Upwind			
	Exponential			
Implicit Sediment Weighting Fac	Minmod 10			
	narmonic			

W – Parameter Sensitivity

- 52. Click OK and close the Sediment Computation Options and Tolerances editor.
- 53. Run the plan.
- 54. **Open RAS Mapper** and **Add** the same sediment variables as described in Section 3.
- 55. **Compare** new results with previous two plans.

Question: How does the Exponential Scheme compare to the other plans?

Question: Considering the level of uncertainty in sediment transport, are the differences between the different concentration fields with different diffusion settings significant?

Question: Considering the level of uncertainty in sediment transport, are the differences between the different concentration fields with different diffusion settings significant?

8 Load Correction Factor

The 2D sediment transport model in HEC-RAS uses a velocity-weighted concentration. This means that the model does not have advection coefficients and instead has a load-correction factor in the temporal term. The load-correction factor is more important for dynamic datasets with rapid changes in hydraulics.

- 56. Open the Sediment Data editor 🕎.
- 57. Click on File | Save Sediment Data As... and save the data as "Lt200-K10-Exp-Bt"
- 58. Click on the menu Options | Transport Methods as shown below
- 59. In the **Transport Model and AD Parameters** editor, under the **Load Correction Factor** section, **check** the box next to **Total-load Correction Factor**, and set the methods as shown below.

🛱 Transport Model and AD Parameters: - 🗆 🗙					
1D Methods: Routing Method (1D): Continuity Sediment Junction Split Method: Flow Weighted Pool Pass Through Method: Upstream Capacity 2D Methods:					
Load Correction Factor Total-load Correction Factor Bedd oad Correction Factor	/an Riin-Wu				
Suspended-Load Correction:	Rouse Conc Profile				

- 60. Save the Sediment Data.
- 61. Save a new plan with the Title and Short ID "SW-Lt200-K10-Exp-Bt".
- 62. Run the plan.
- 63. **Open RAS Mapper** and **add** the same sediment variables as described in the previous section.
- 64. **Plot** a time series of concentrations comparing the "SW-Lt200-K10-Exp" and "SW-Lt200-K10-Exp-Bt" plans.

Question: Are differences significant?

Question: Where in the time series are the largest differences and why?