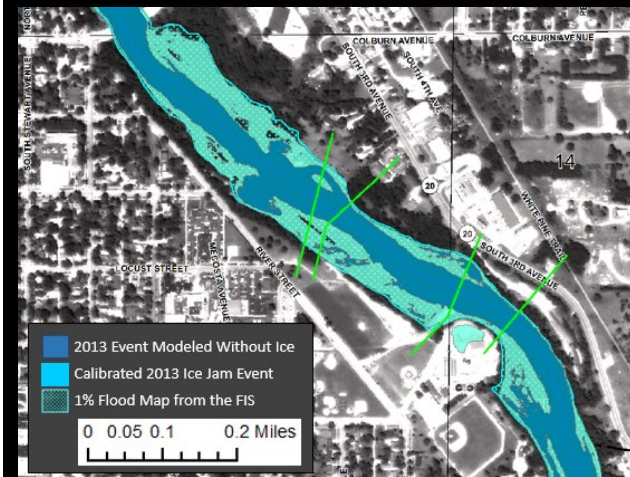
Steady Flow Hydraulics:

Introduction, Examples, and Work Flow



Stanford Gibson, PhD

1

Steady Flow Hydraulics:

Introduction and Examples

I. What is Steady Flow?

II. When Would I Use Steady Flow?

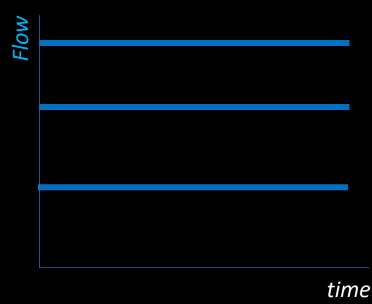
III. What are the Components of a Steady Flow Model?

2

1. What is Unsteady Flow?

Steady Flow

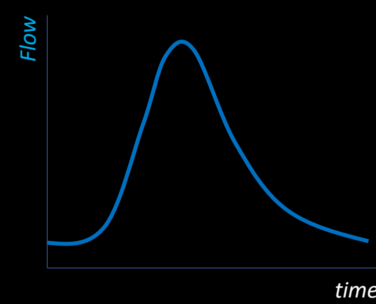
Q(~~*t*~~)



changes gradually
Flow ~~does not change~~ with time

Unsteady Flow

Q(t)



Flow changes with time

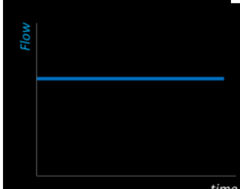
3

3

1. What is Unsteady Flow?

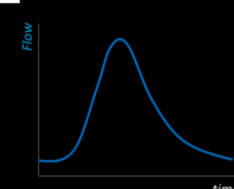
Steady Flow

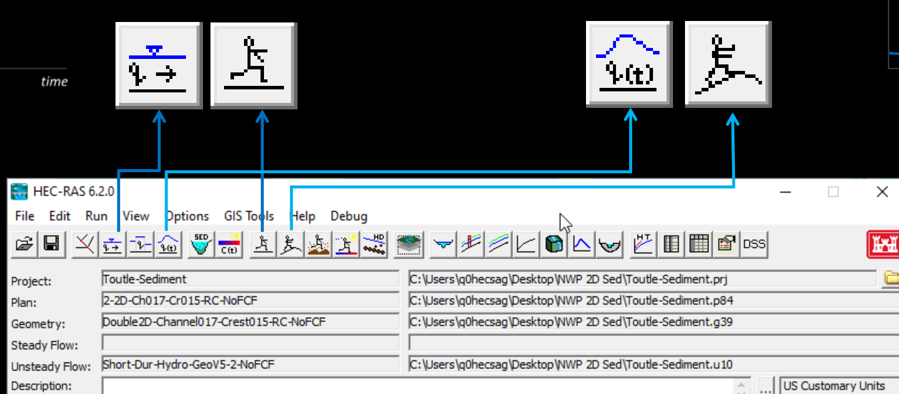
Q(~~*t*~~)



Unsteady Flow

Q(t)





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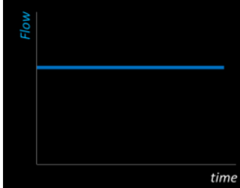
4

1. What is Unsteady Flow?

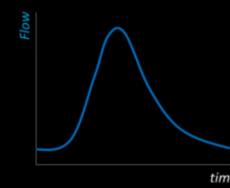


Steady Flow

Q(~~t~~)

Unsteady Flow

Q(t)



5

5

Steady Flow Hydraulics:

Introduction and Examples

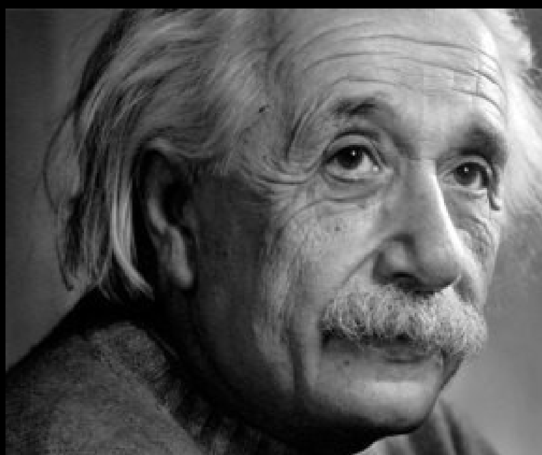
I. What is Steady Flow?

II. When Would I Use Steady Flow?

III. What are the Components of a Steady Flow Model?

6

II. ~~When~~ Would I Use Steady Flow?
Why



"It can scarcely be denied
that the supreme goal of all theory
is to make
the irreducible basic elements
as simple and as few as possible
without having to surrender
the adequate representation
of a single datum of experience."
-Actually Einstein (Sr)
1933 Lecture

The Principle of Parsimony = the simplest model is the null hypothesis

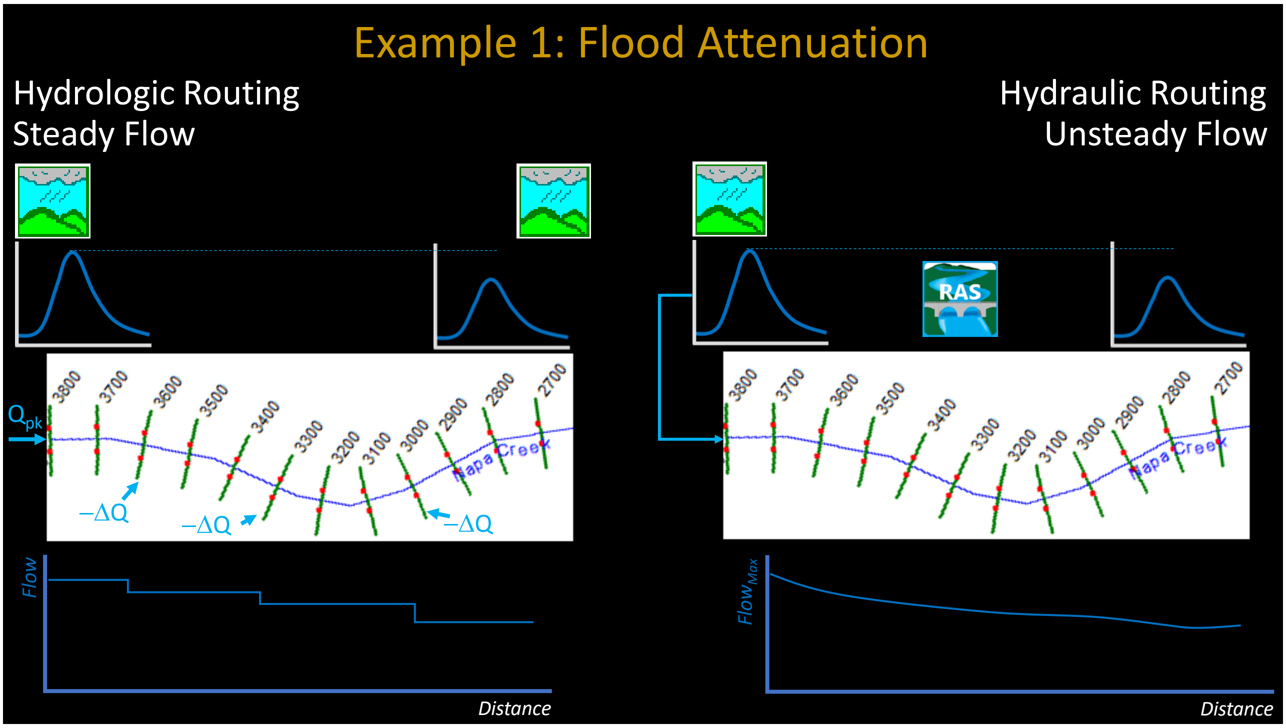
7

II. When ~~Would~~ I Use Steady Flow?
Wouldn't

As yourself two questions:

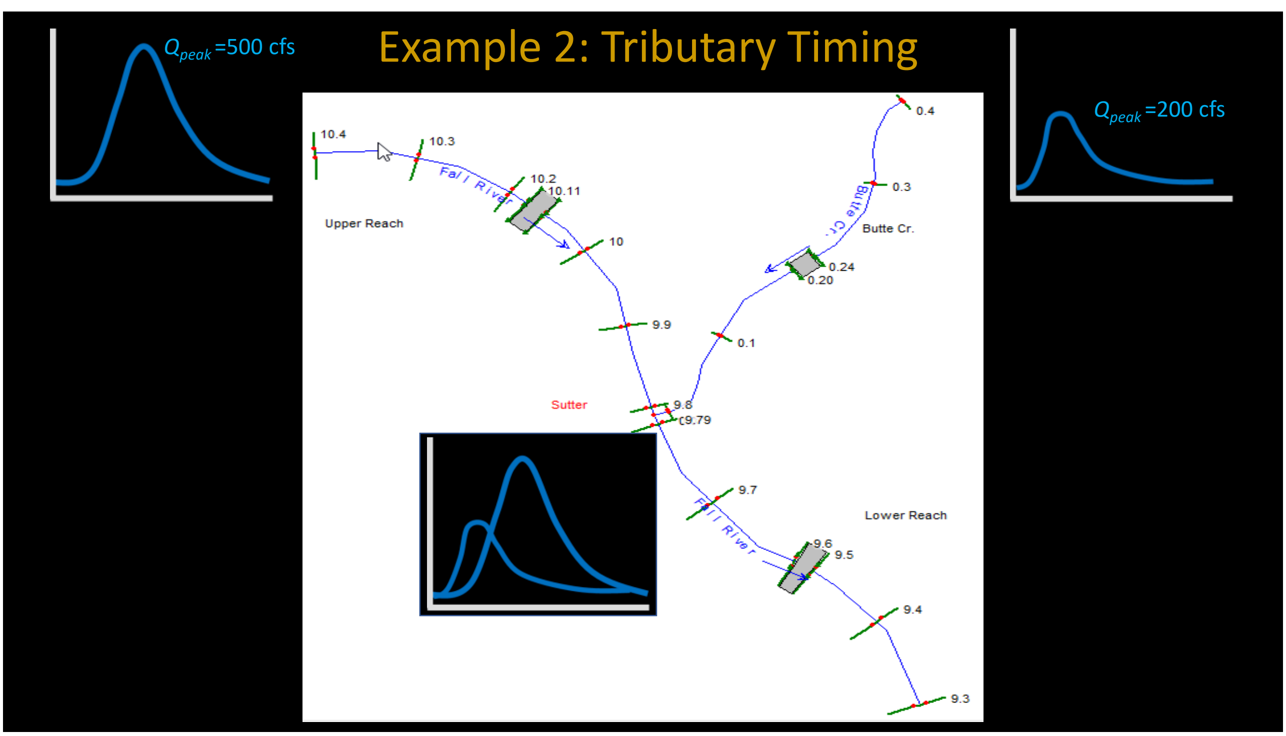
- Does Volume Matter
- Does Timing Matter

8



Example 1: Flood Attenuation
Hydrologic Routing
Steady Flow
Hydraulic Routing
Unsteady Flow
RAS
3800
3700
3600
3500
3400
3300
3200
3100
3000
2900
2800
2700
Napa Creek
−ΔQ
−ΔQ
−ΔQ
Flow
Distance
Distance

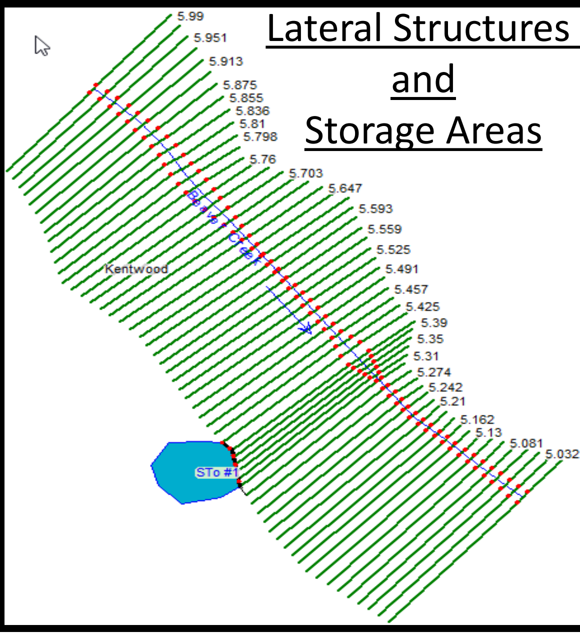
9

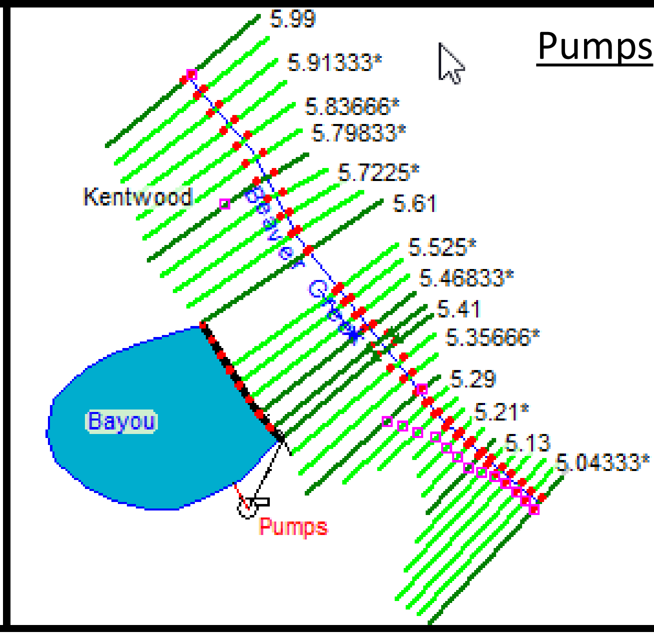


Example 2: Tributary Timing
Qpeak =500 cfs
Qpeak =200 cfs
10.4
10.3
10.2
10.11
10
Upper Reach
Fall River
9.9
Sutter
9.8
9.79
9.7
9.6
9.5
9.4
9.3
Lower Reach
0.4
0.3
Butte Cr.
0.24
0.20
0.1

10

Example 3: Time Sensitive Diversions or Attenuating Storage





11

II. When Would I Use Steady Flow?

1. Big
2. Quick
3. Perks

12

II. When Would I Use Steady Flow?

1. Big – Need Fast Runtimes

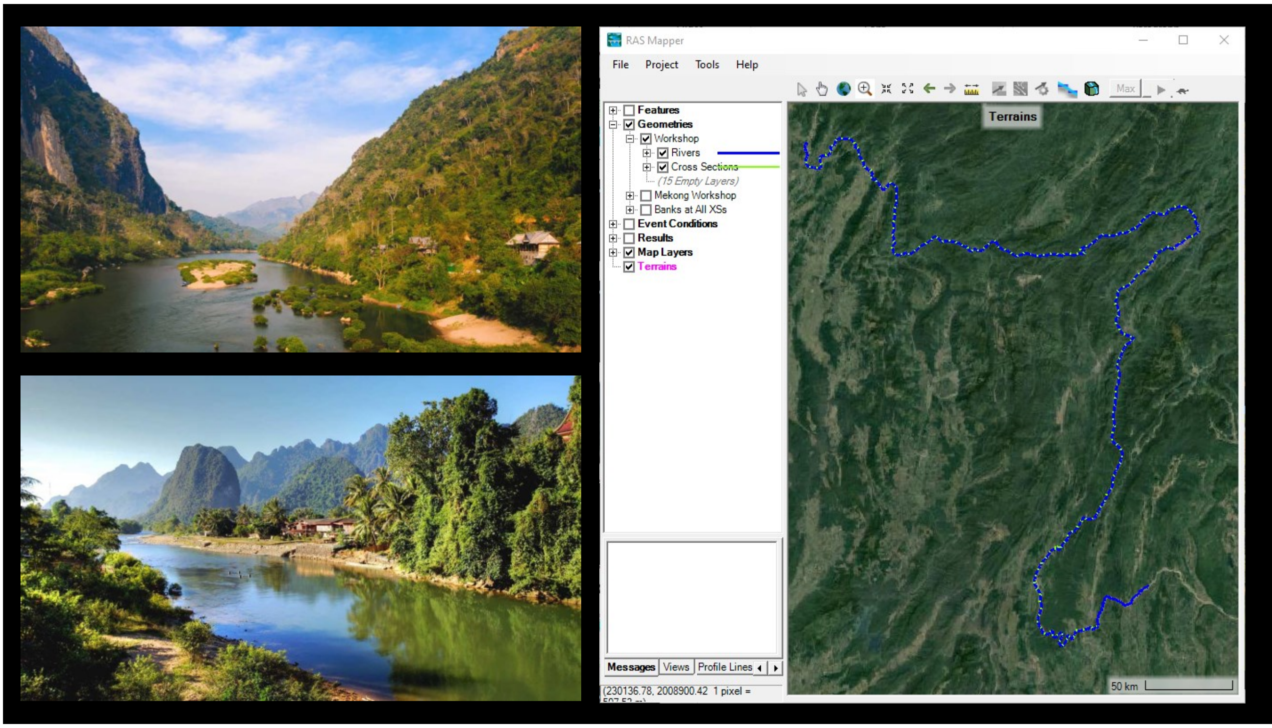
2. Quick

3. Perks

13

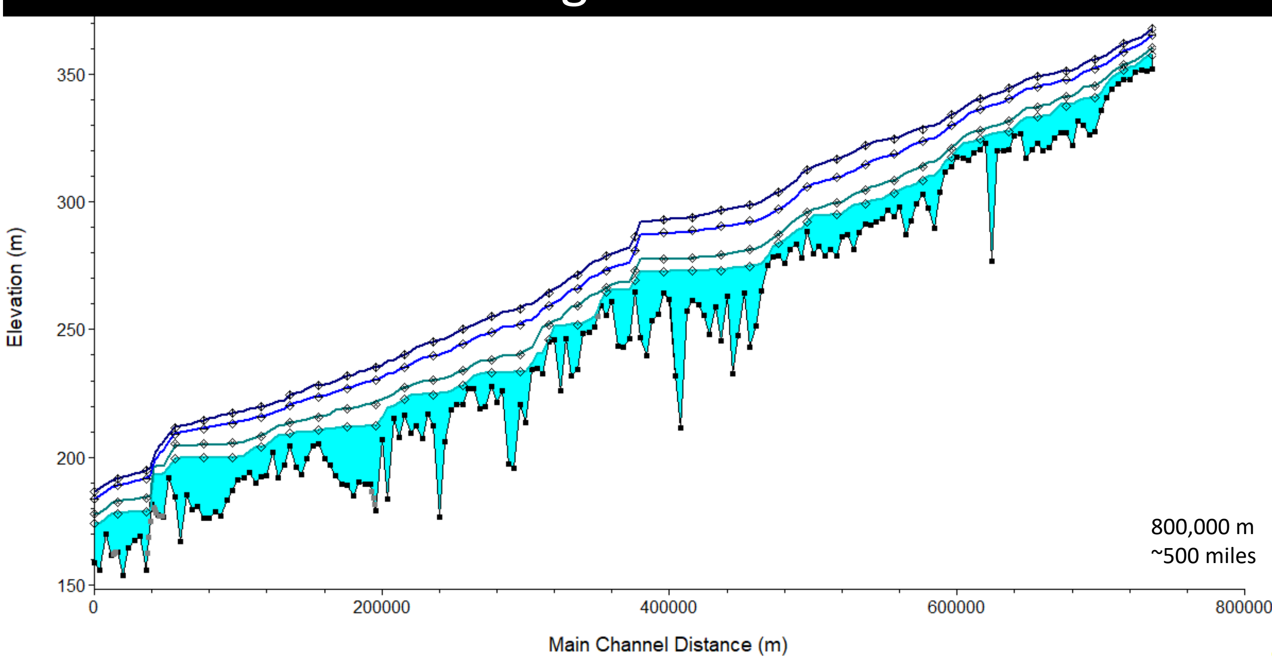
Mekong River Model

14



15

Mekong River Model



16

II. When Would I Use Steady Flow?

1. Big

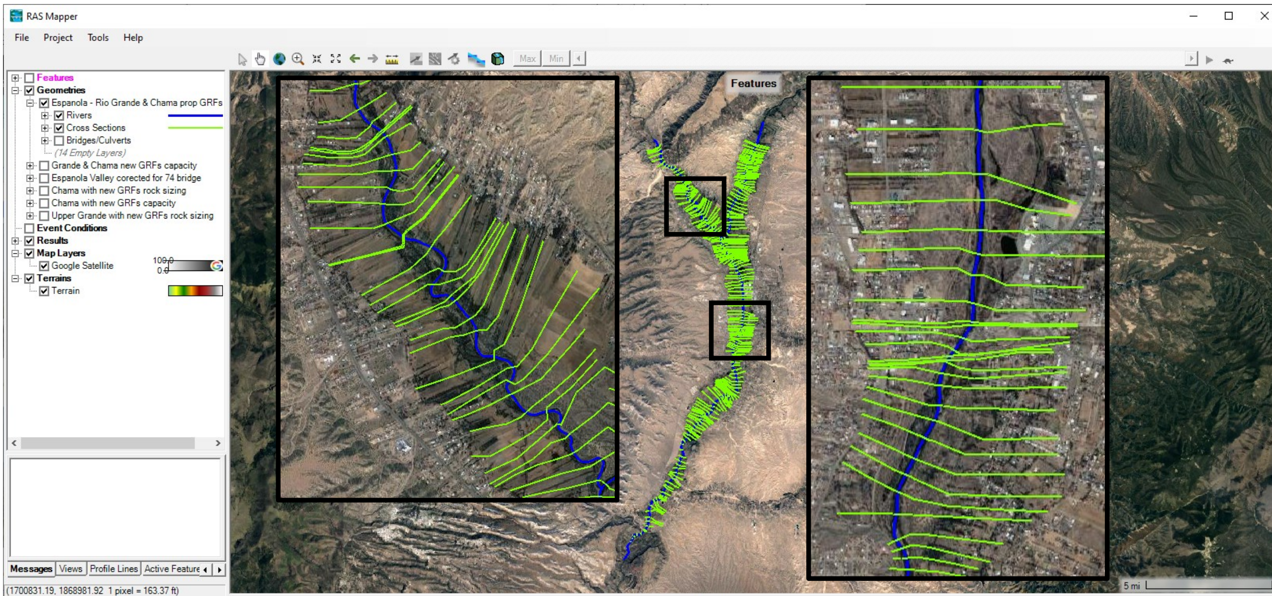
2. Quick – Expedited Analysis

3. Perks

17

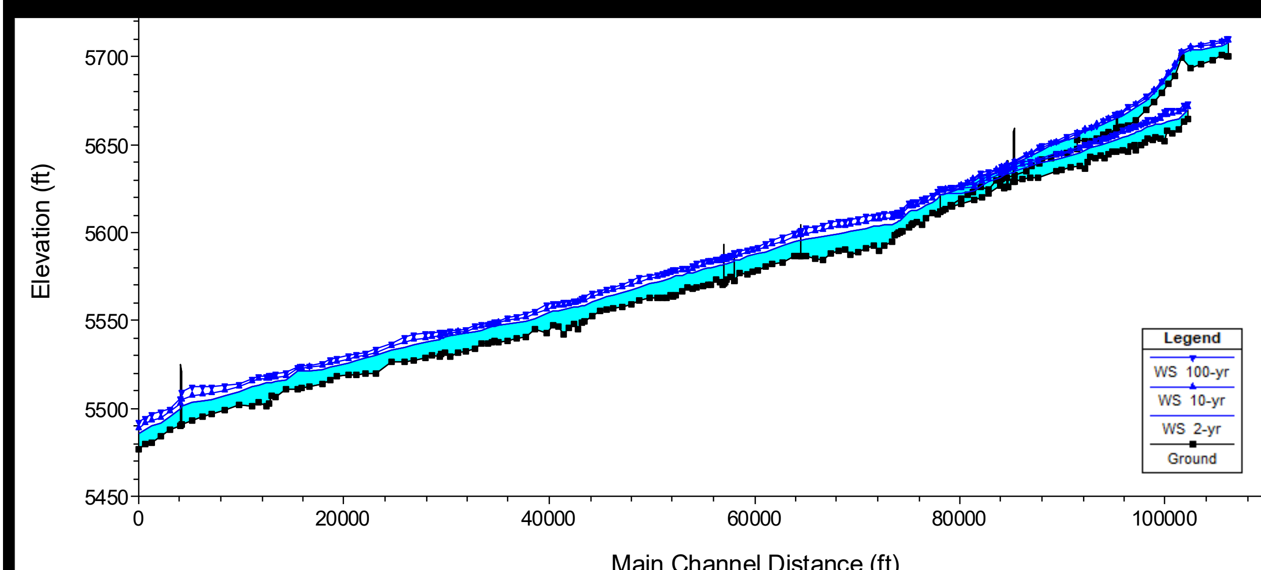
Espanola Valley Ecosystem Restoration

18

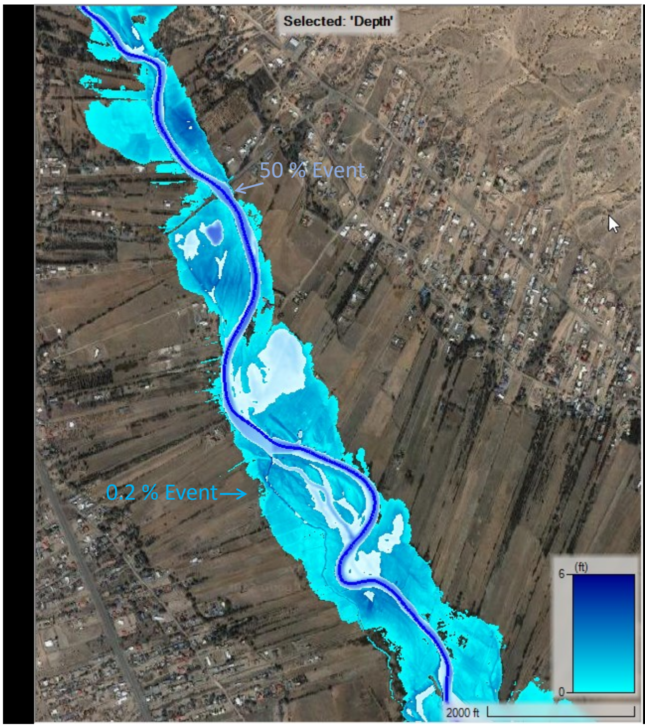


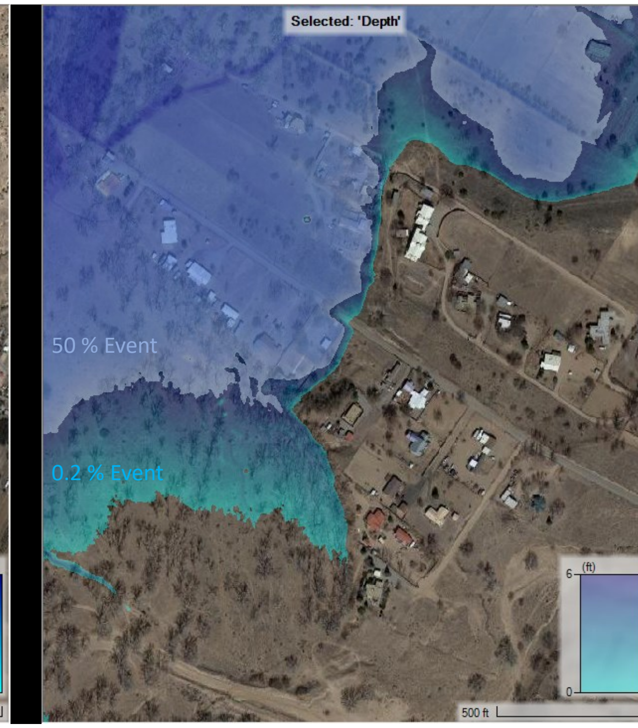
- Steady State Model developed with recurrence peaks
- Used to evaluate inundation and upstream and downstream connections of restoration features
- Quick and inexpensive.

19



20





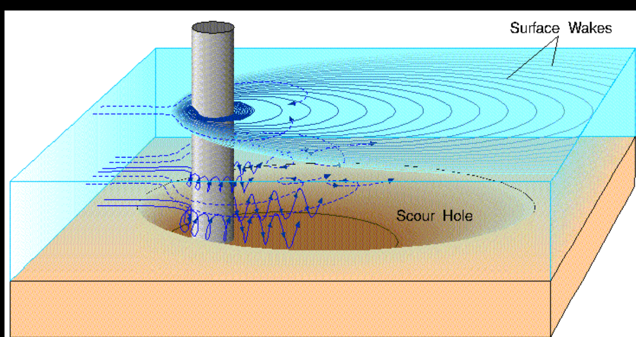
21

II. When Would I Use Steady Flow?

1. Big Models (Fast Runtime)
2. Quick Analyses
3. Perks - Steady Flow Only Options
   - i. Scour
   - ii. Floodways (for now)
   - iii. Ice

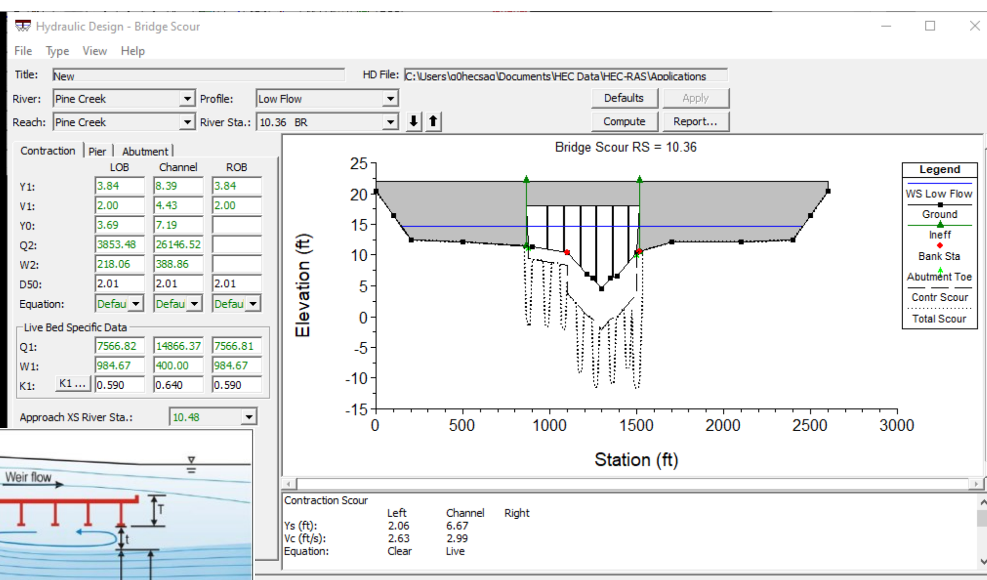
22

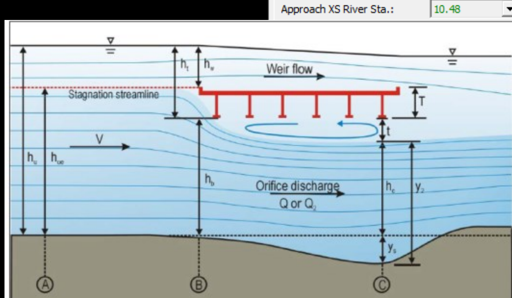
Bridge Scour



23

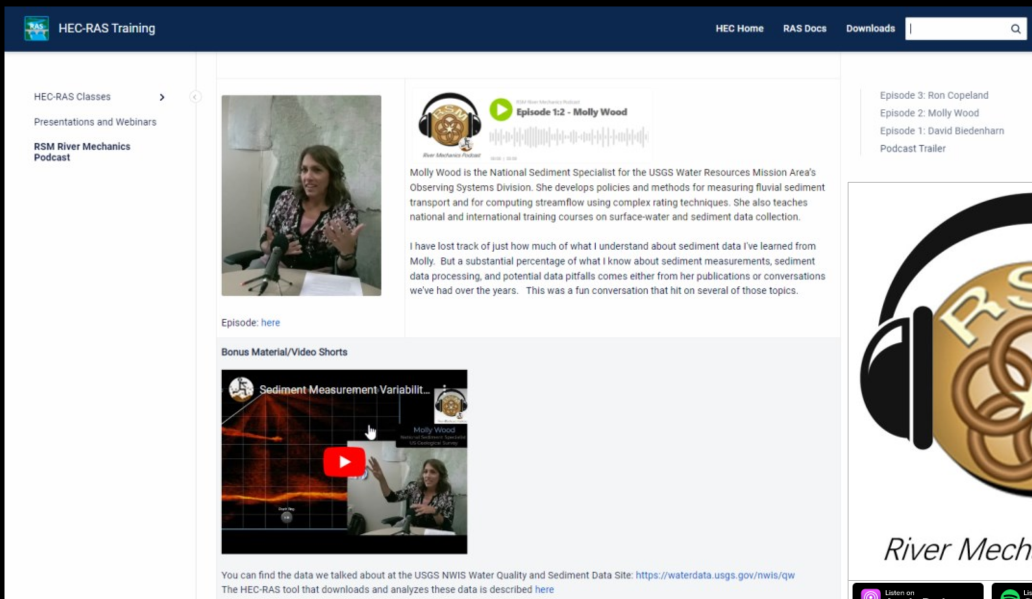
Bridge Scour





24

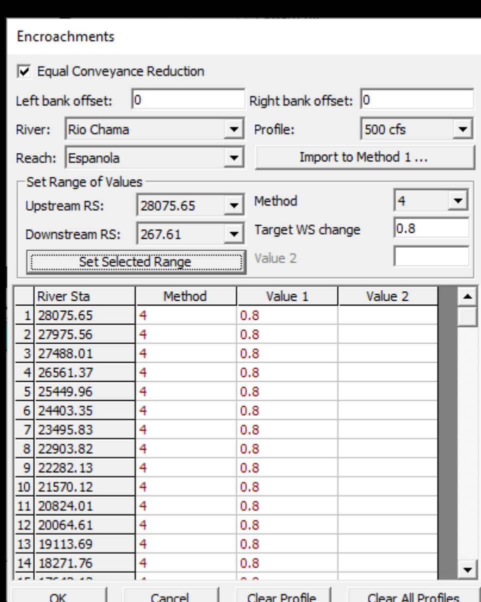
River Mechanics Podcast

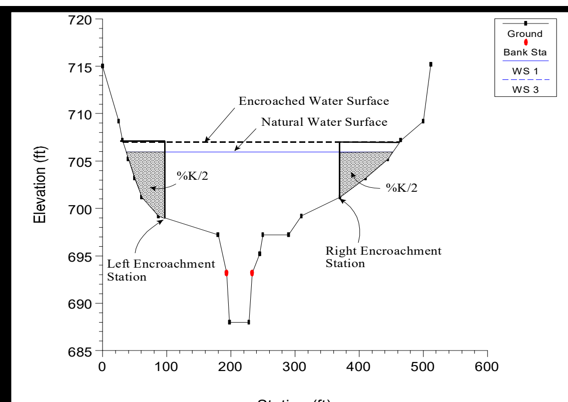


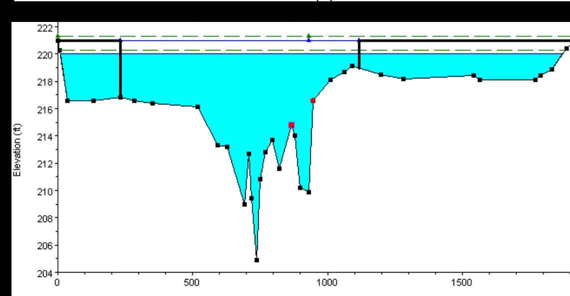
https://www.hec.usace.army.mil/confluence/rasdocs/rastraining/latest/rsm-river-mechanics-podcast

25

Floodways/Encroachments

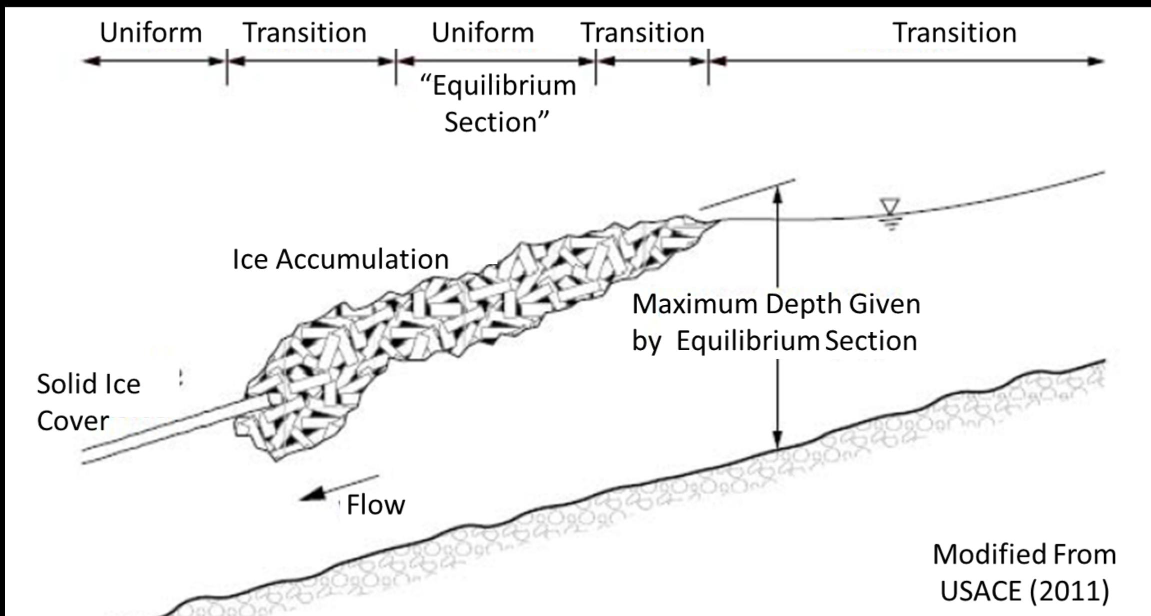






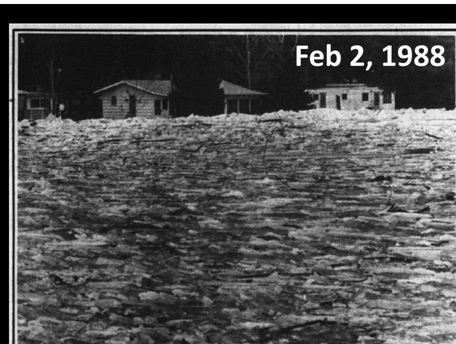
26

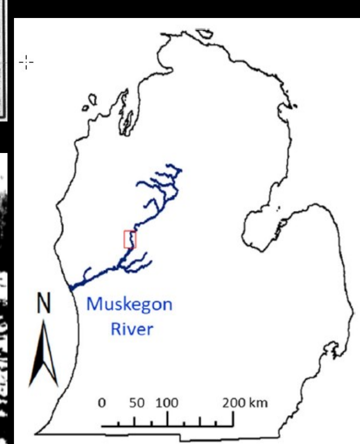
Ice Jam



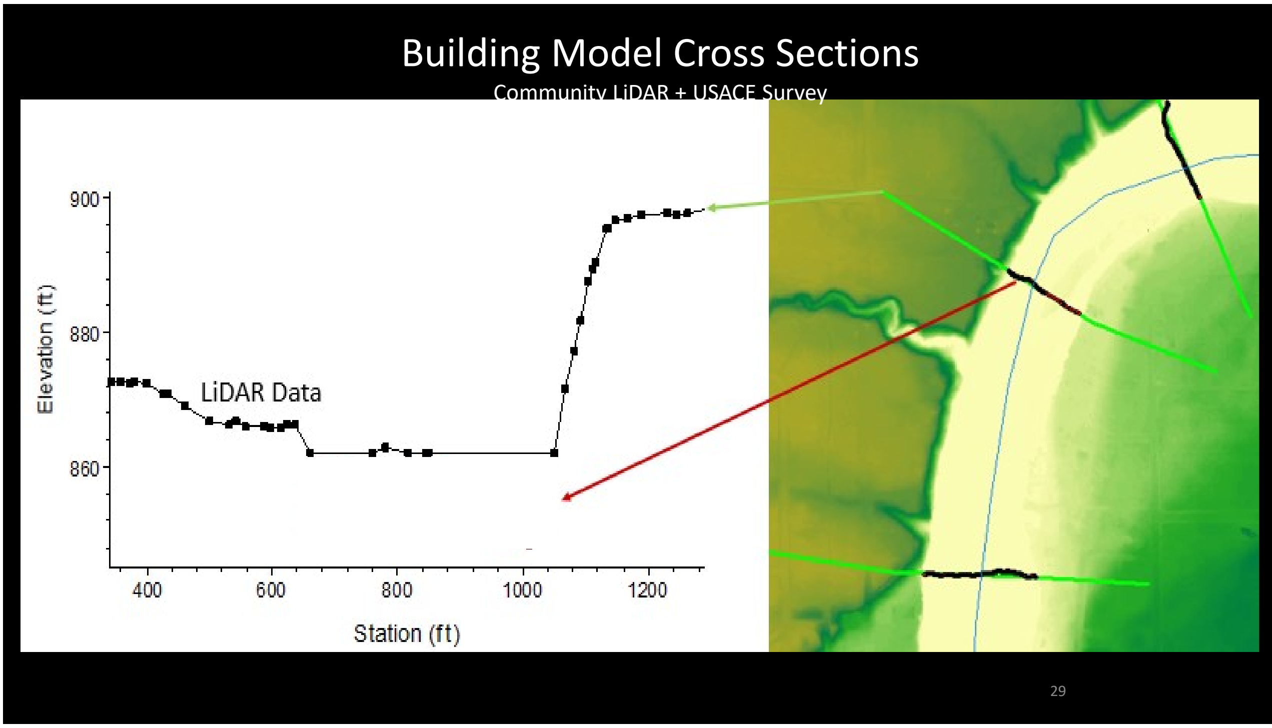
27

Muskegon Ice Jam Model





28



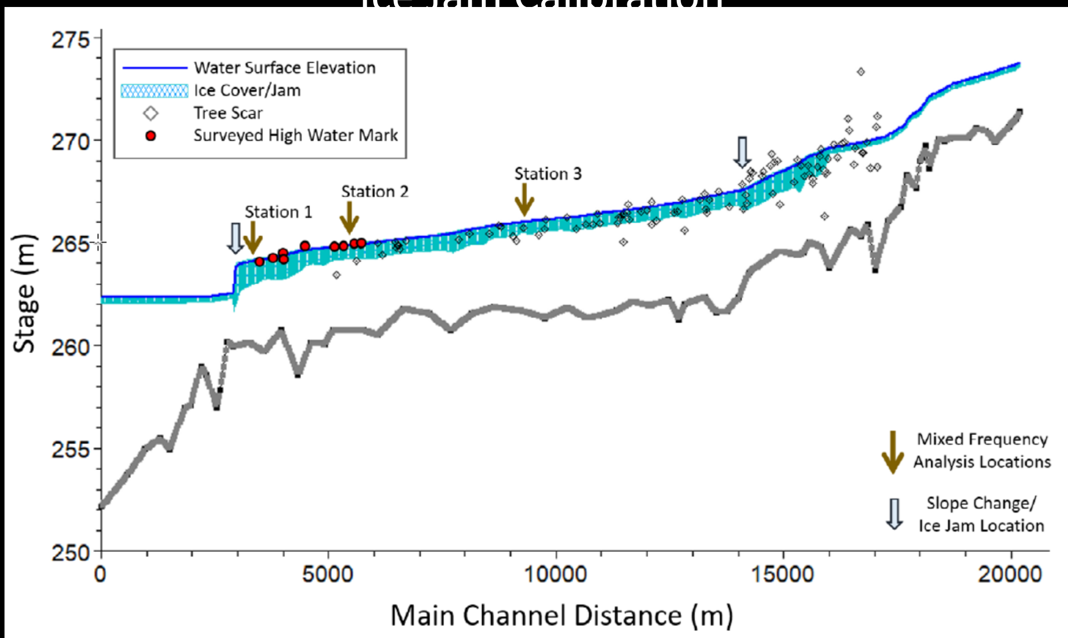
Building Model Cross Sections
Community LiDAR + USACE Survey
900
880
860
Elevation (ft)
LiDAR Data
400
600
800
1000
1200
Station (ft)
29

29

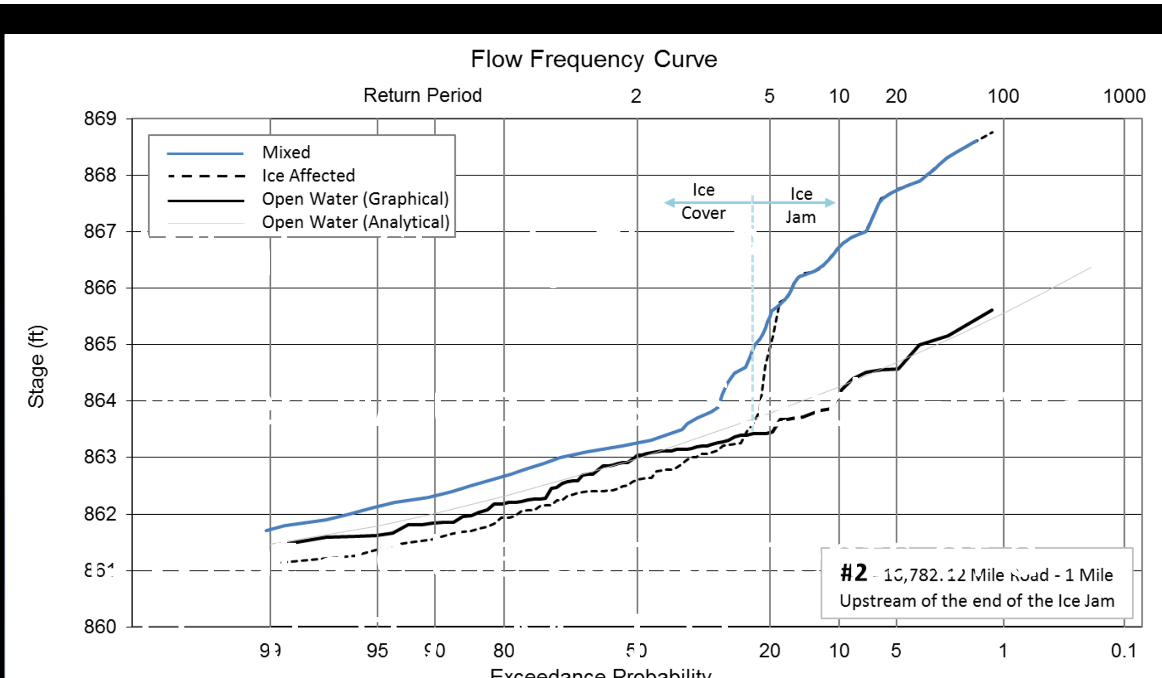
Calibration Data
05 055 023 000
1/31

30

Ice Jam Calibration



31



32

II. When Would I Use Steady Flow?

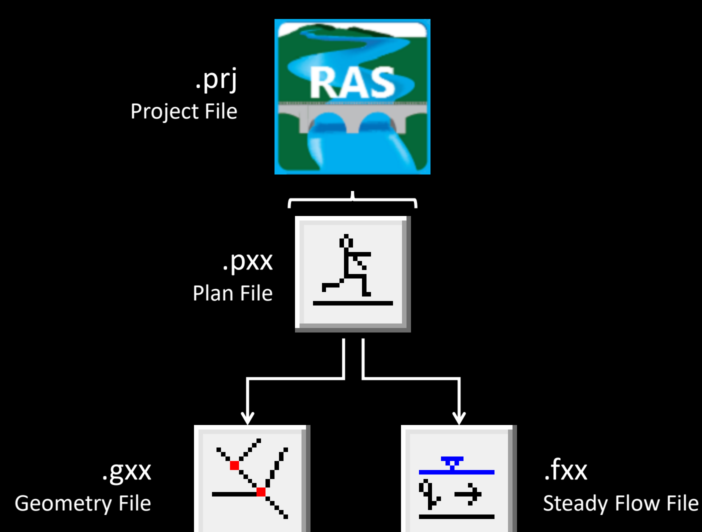
I. What is Steady Flow?

II. When Would I Use Steady Flow?

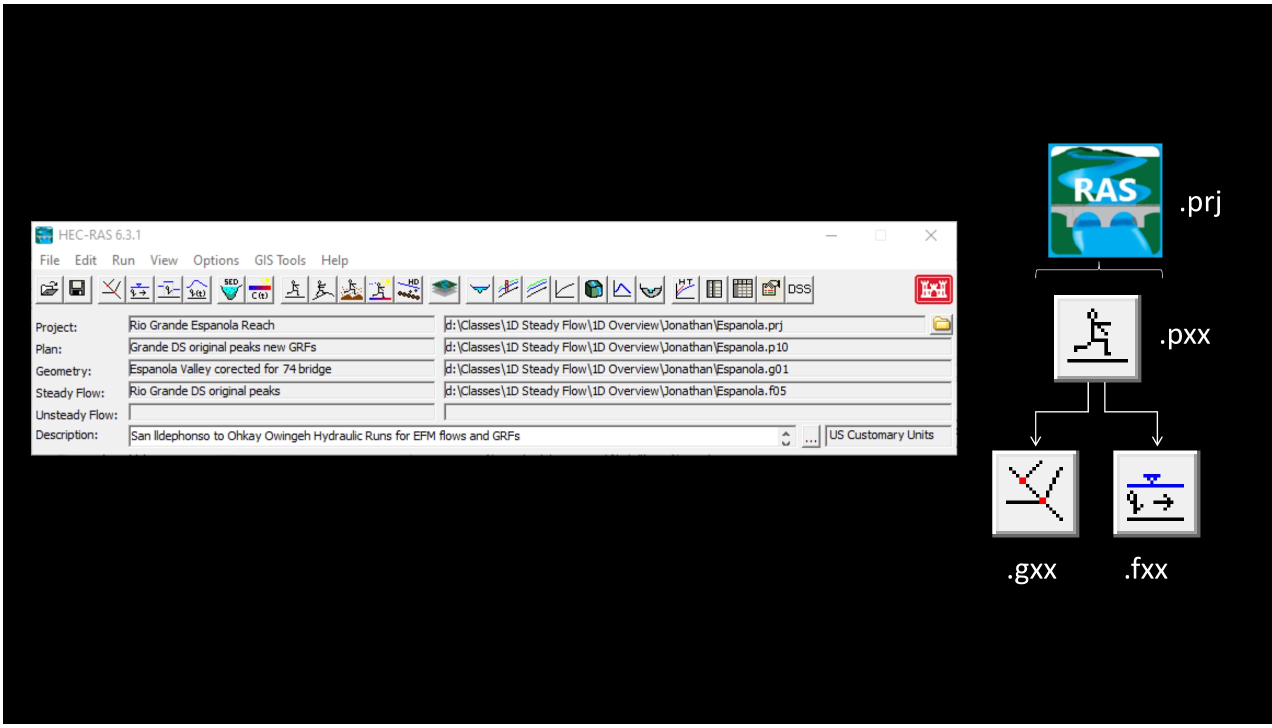
III. What are the Components of a Steady Flow Model?

33

Steady Flow Model Components

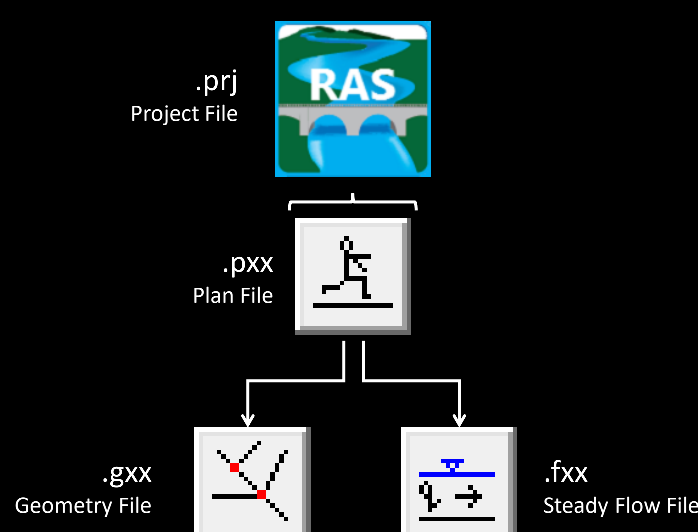


34



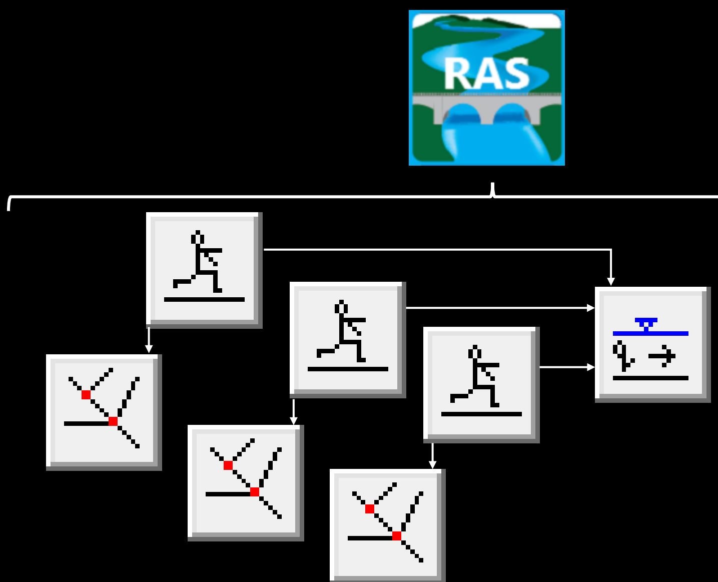
35

Steady Flow Model Components



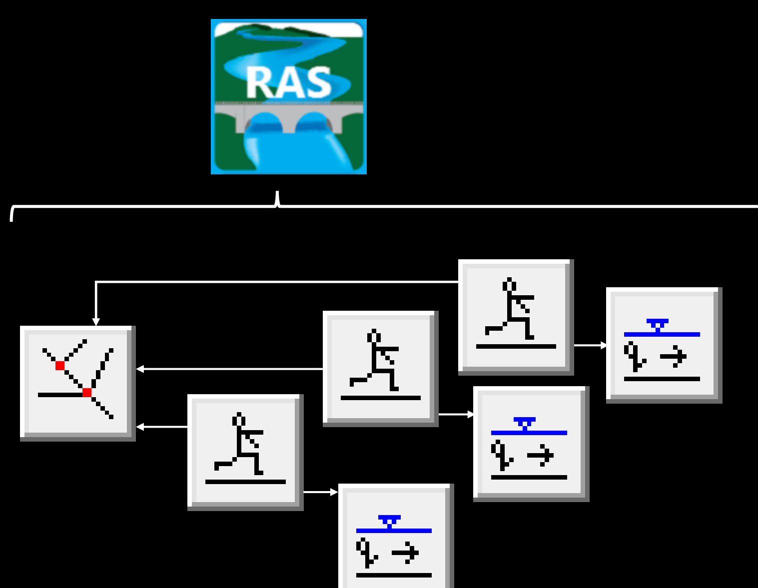
36

Steady Flow Model Components

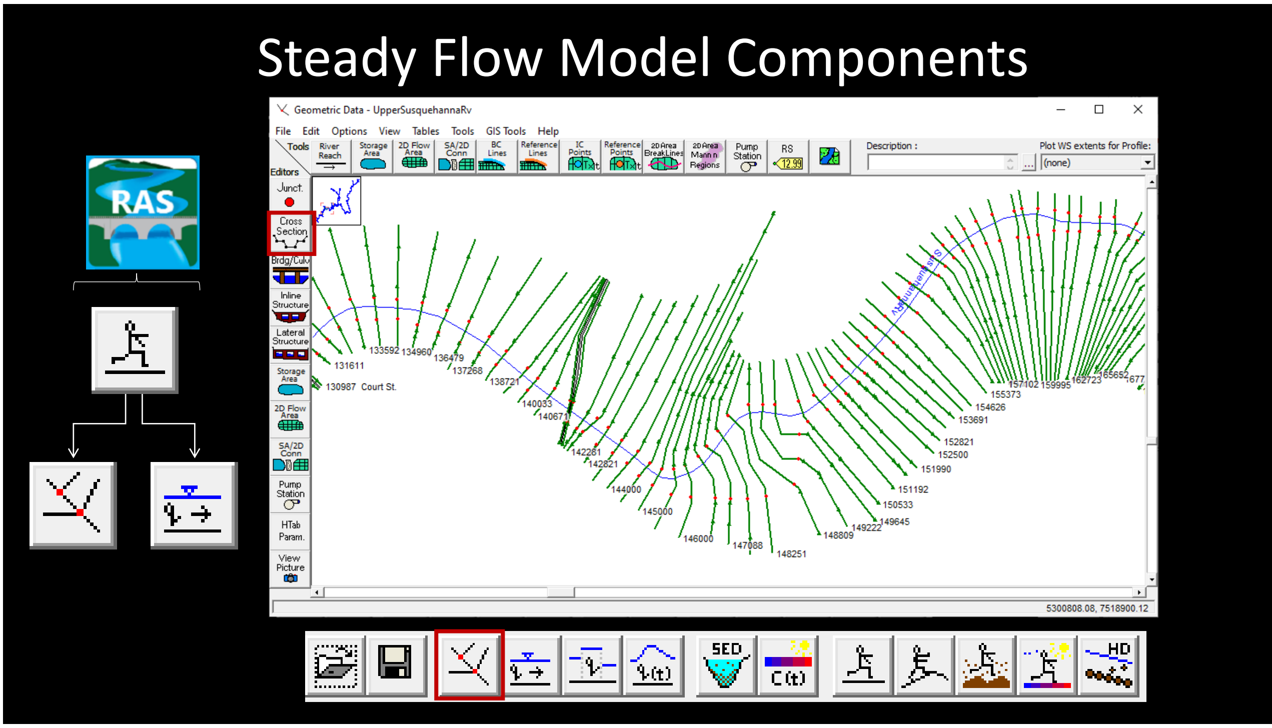


37

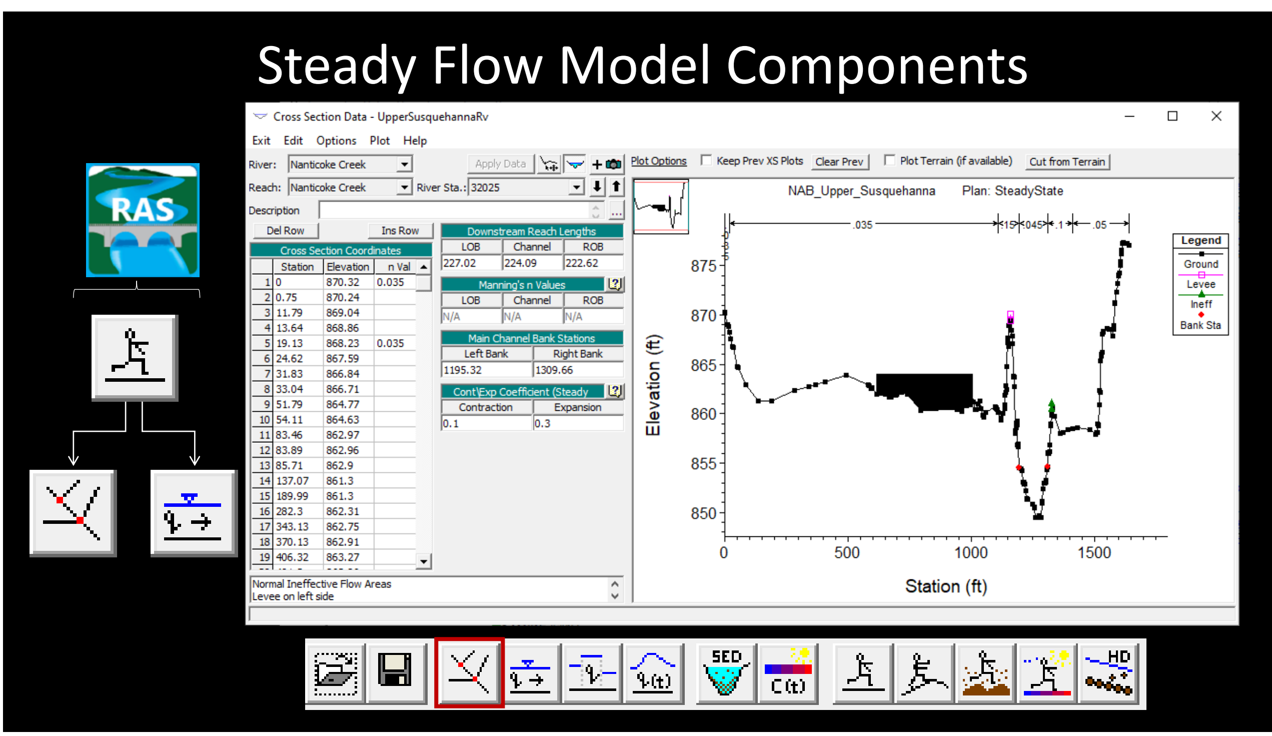
Steady Flow Model Components



38

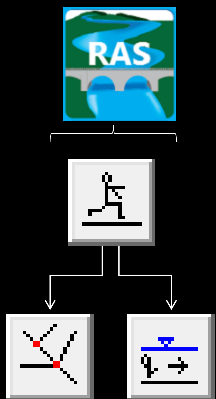

Steady Flow Model Components
RAS
Geometric Data - UpperSusquehannaRv
File Edit Options View Tables Tools GIS Tools Help
Tools
River Reach
Storage Area
2D Flow Area
SA/2D Conn
BC Lines
Reference Lines
IC Points
Reference Points
2D Area BreakLines
2D Area Mann n Regions
Pump Station
RS
Description :
Plot WS extents for Profile:
(none)
Editors
Junct.
Cross Section
Brdg/Culv
Inline Structure
Lateral Structure
Storage Area
2D Flow Area
SA/2D Conn
Pump Station
HTab Param.
View Picture
130987 Court St.
131611
133592
134960
136479
137268
138721
140033
140671
142281
142821
144000
145000
146000
147088
148251
148809
149222
149645
150533
151192
151990
152500
152821
153691
154626
155373
157102
159995
162723
165652
5300808.08, 7518900.12
SED
C(t)
HD

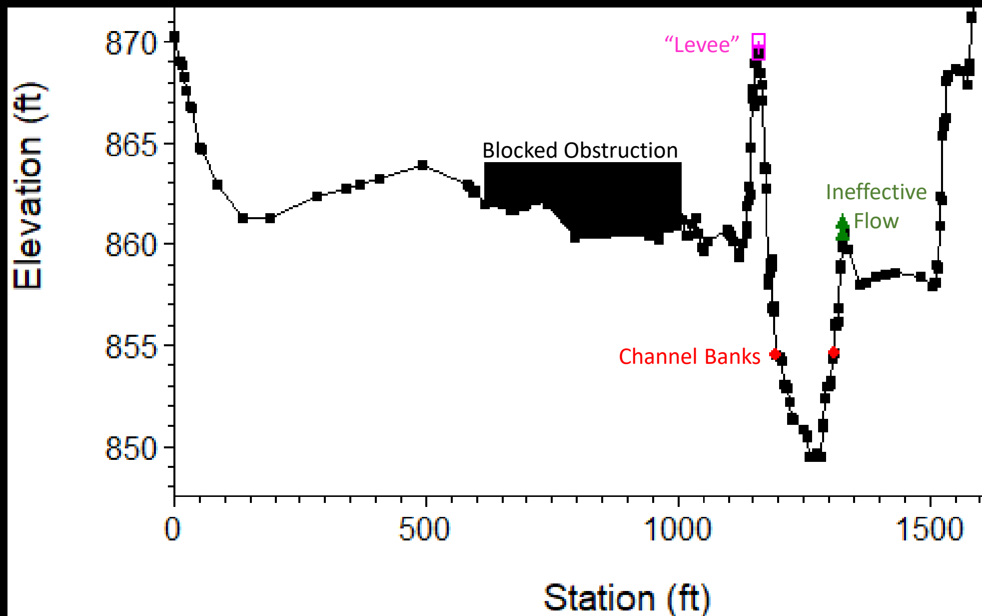
39


Steady Flow Model Components
RAS
Cross Section Data - UpperSusquehannaRv
Exit Edit Options Plot Help
River: Nanticoke Creek
Reach: Nanticoke Creek
River Sta.: 32025
Apply Data
Description
Del Row
Ins Row
Cross Section Coordinates
Station Elevation n Val
1 0 870.32 0.035
2 0.75 870.24
3 11.79 869.04
4 13.64 868.86
5 19.13 868.23 0.035
6 24.62 867.59
7 31.83 866.84
8 33.04 866.71
9 51.79 864.77
10 54.11 864.63
11 83.46 862.97
12 83.89 862.96
13 85.71 862.9
14 137.07 861.3
15 189.99 861.3
16 282.3 862.31
17 343.13 862.75
18 370.13 862.91
19 406.32 863.27
Downstream Reach Lengths
LOB Channel ROB
227.02 224.09 222.62
Manning's n Values
LOB Channel ROB
N/A N/A N/A
Main Channel Bank Stations
Left Bank Right Bank
1195.32 1309.66
Cont\Exp Coefficient (Steady
Contraction Expansion
0.1 0.3
Normal Ineffective Flow Areas
Levee on left side
Plot Options
Keep Prev XS Plots
Clear Prev
Plot Terrain (if available)
Cut from Terrain
NAB_Upper_Susquehanna Plan: SteadyState
.035
.15
.045
.1
.05
Legend
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
875
870
865
860
855
850
0
500
1000
1500
SED
C(t)
HD

40

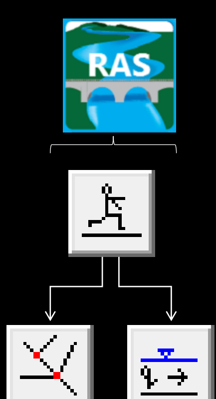
Steady Flow Model Components

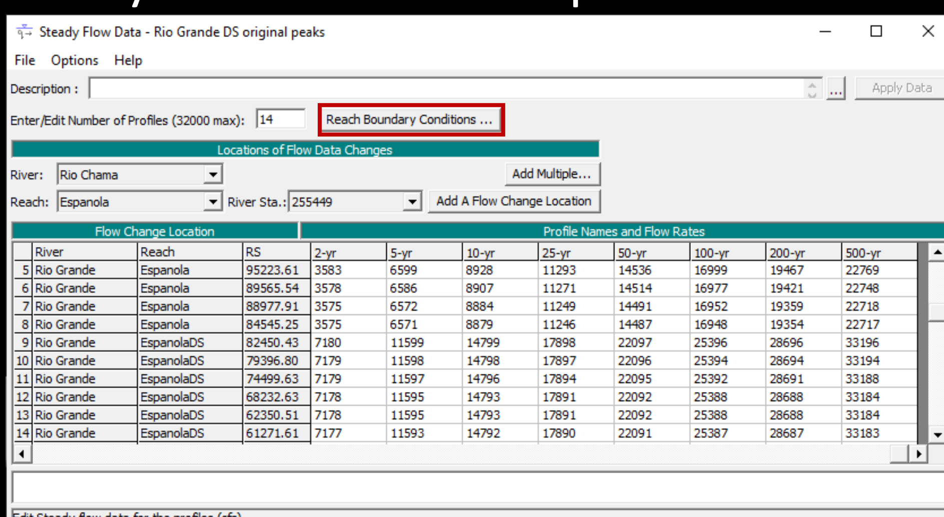




41

Steady Flow Model Components

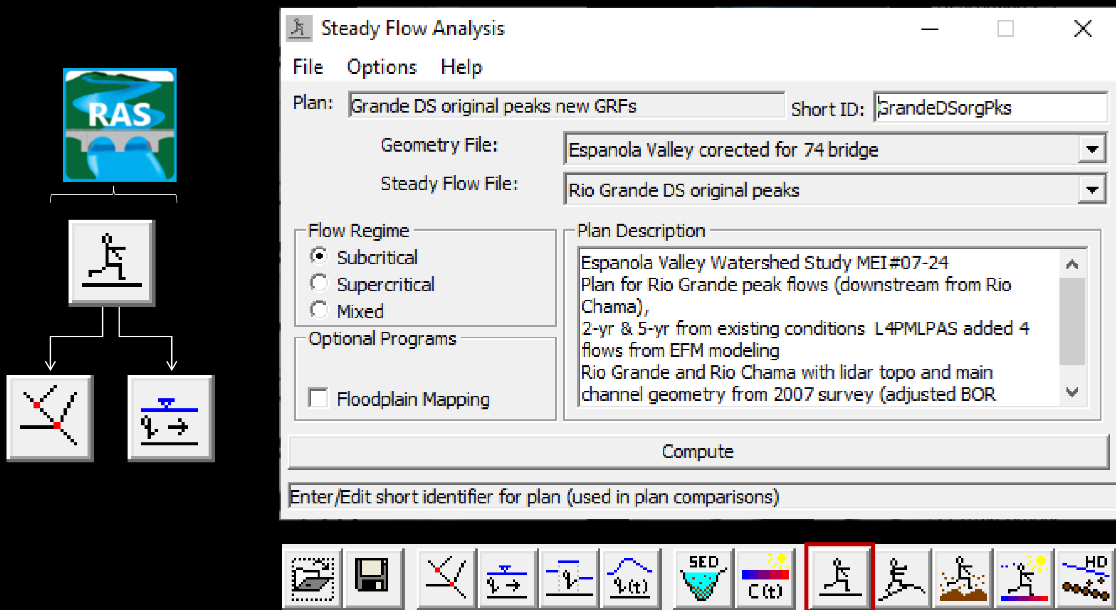




	River	Reach	RS	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr	200-yr	500-yr
5	Rio Grande	Espanola	95223.61	3583	6599	8928	11293	14536	16999	19467	22769
6	Rio Grande	Espanola	89565.54	3578	6586	8907	11271	14514	16977	19421	22748
7	Rio Grande	Espanola	88977.91	3575	6572	8884	11249	14491	16952	19359	22718
8	Rio Grande	Espanola	84545.25	3575	6571	8879	11246	14487	16948	19354	22717
9	Rio Grande	EspanolaDS	82450.43	7180	11599	14799	17898	22097	25396	28696	33196
10	Rio Grande	EspanolaDS	79396.80	7179	11598	14798	17897	22096	25394	28694	33194
11	Rio Grande	EspanolaDS	74499.63	7179	11597	14796	17894	22095	25392	28691	33188
12	Rio Grande	EspanolaDS	68232.63	7178	11595	14793	17891	22092	25388	28688	33184
13	Rio Grande	EspanolaDS	62350.51	7178	11595	14793	17891	22092	25388	28688	33184
14	Rio Grande	EspanolaDS	61271.61	7177	11593	14792	17890	22091	25387	28687	33183

42

Steady Flow Model Components



43