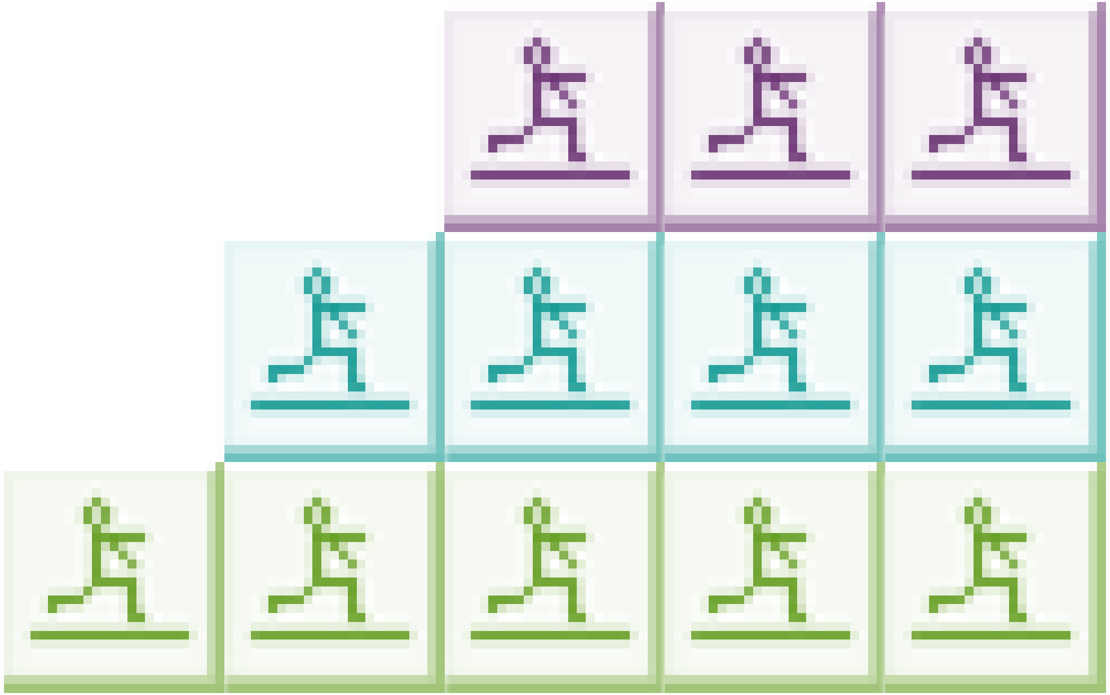
Two RAS Approaches to Analyzing High Flows on a Stream Restoration Site

1D Quasi-Unsteady Sediment Modeling vs.
2D Unsteady Flow Modeling

Kristine Mosuela, EIT
MAFSM 2019

Summary

- Background / Context
- Problem / Questions
- Model Approach
- Results / Conclusions

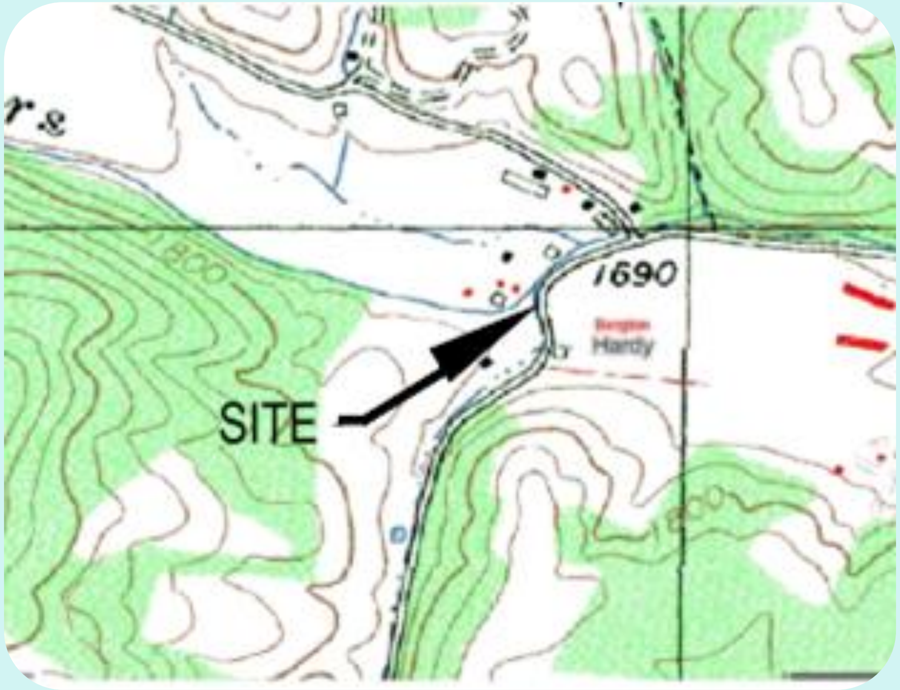


Disclaimer

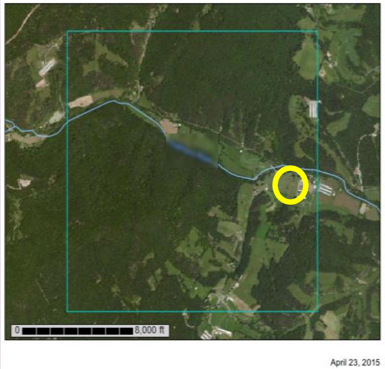
Fall
2018

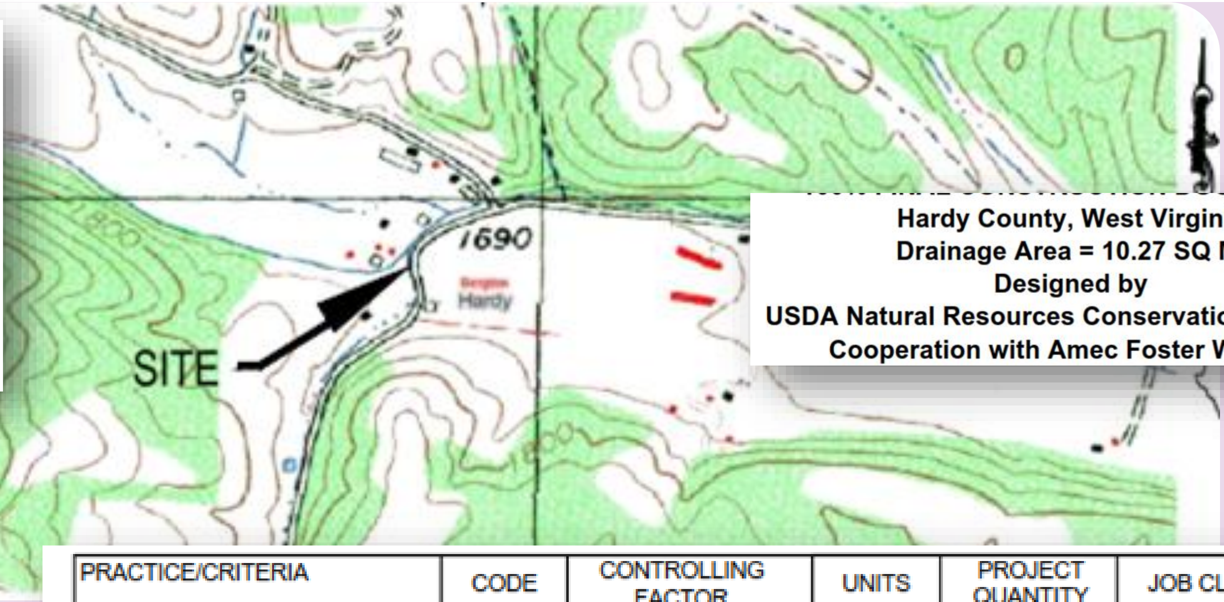
Modelling Environmental Flows

Background / Context



Background / Context

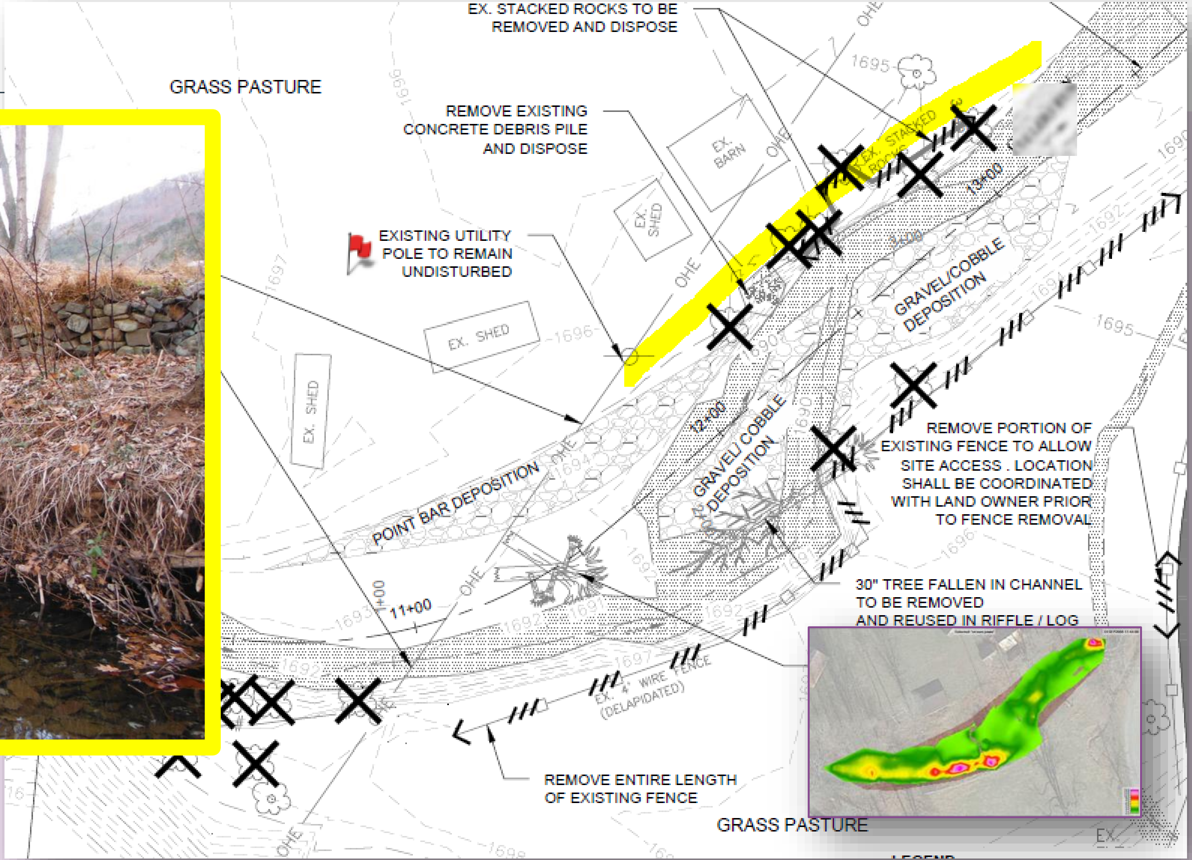




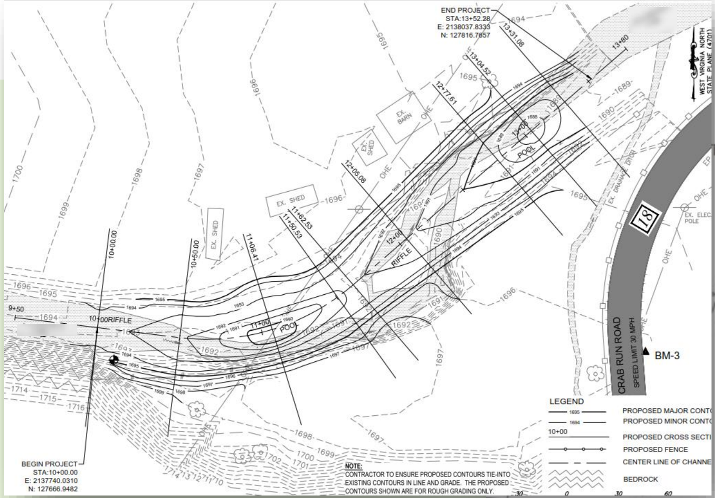
Hardy County, West Virginia
Drainage Area = 10.27 SQ MI
Designed by
USDA Natural Resources Conservation Service in Cooperation with Amec Foster Wheeler

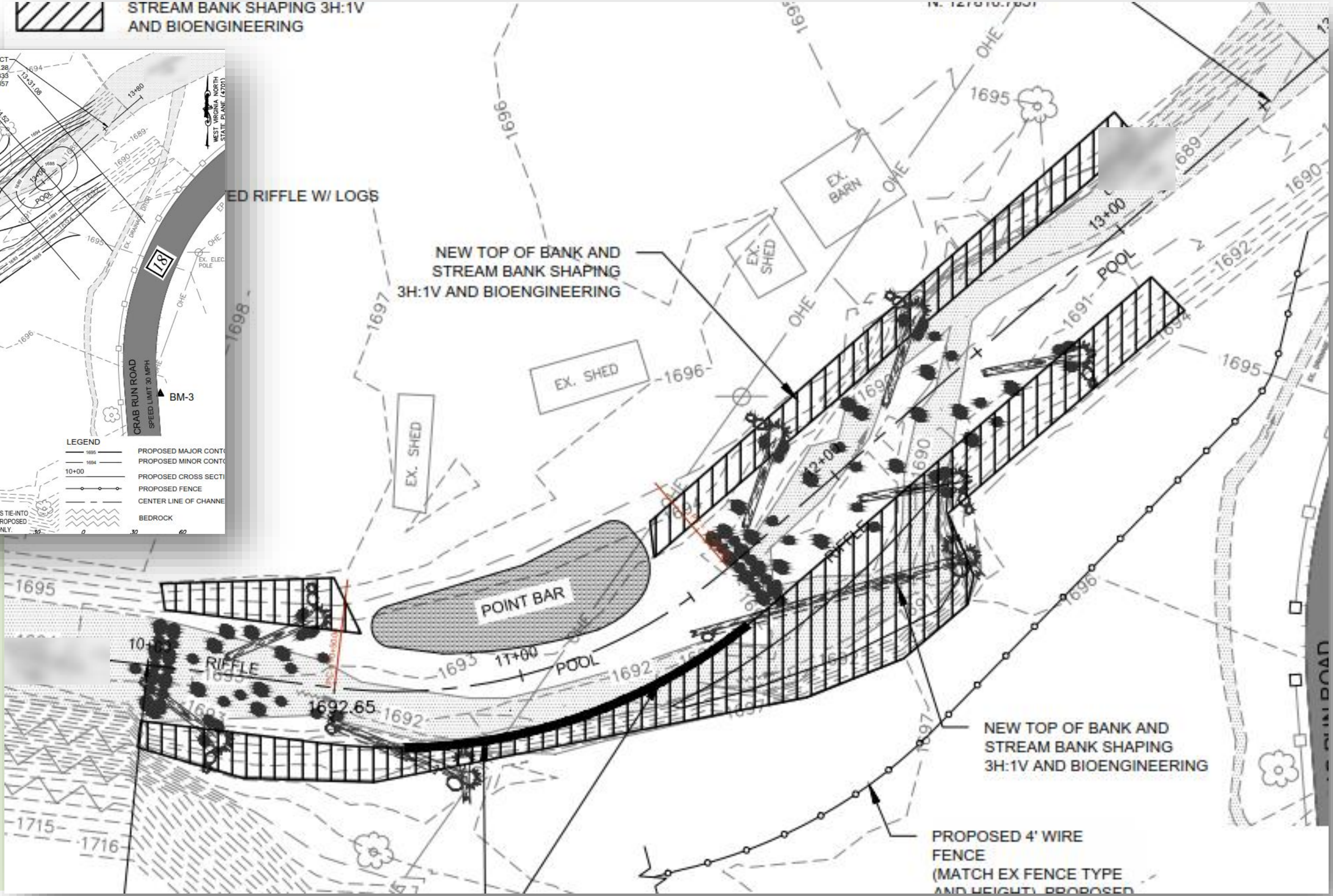
PRACTICE/CRITERIA	CODE	CONTROLLING FACTOR	UNITS	PROJECT QUANTITY	JOB CLASS
STREAMBANK PROTECTION	580	BANKFULL CAPACITY	CFS	275	II
		BANKFULL VELOCITY	FPS	5.1	III
HAZARD CLASS	ALL	HAZARD POTENTIAL	CLASS	LOW	V

Background

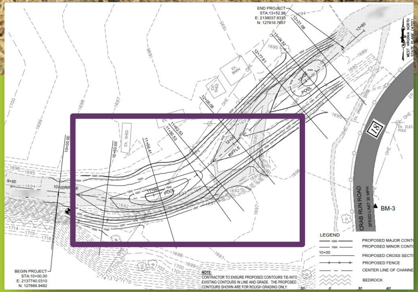


 A presentation by Wood.





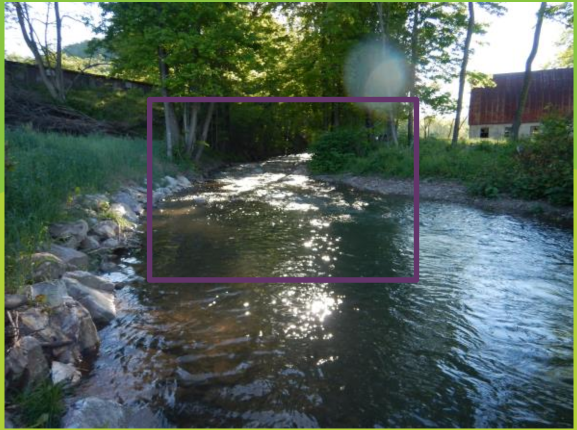
Restoration Design


END PROJECT
STA:13+52.28
E: 2138037.8333
N: 127816.7657
BEGIN PROJECT
STA:10+00.00
E: 2137740.0310
N: 127666.9482
EX. SHED
EX. BARN
POOL
RIFFLE
CRAB RUN ROAD
SPEED LIMIT 30 MPH
BM-3
18
LEGEND
PROPOSED FENCE
BEDROCK
NOTE:
CONTRACTOR TO ENSURE PROPOSED CONTOURS TIE-INTO EXISTING CONTOURS IN LINE AND GRADE. THE PROPOSED CONTOURS SHOWN ARE FOR ROUGH GRADING ONLY.


2017 03 09

2017 03 09



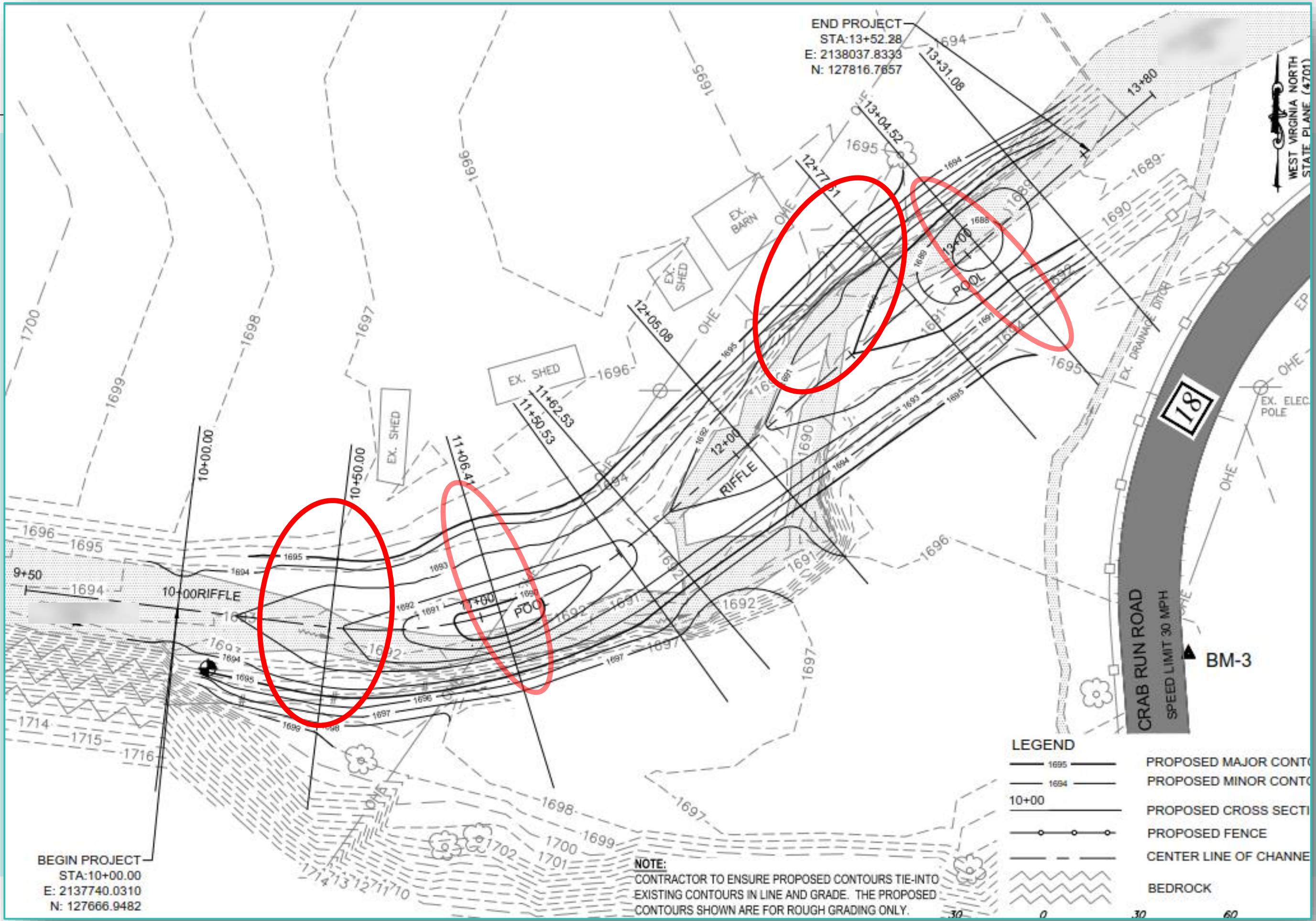





Post-Restoration Storms

Notable deposition

110 mm cobbles



Context

- 5 Analog
- 5 Empirical
- 2 Analytical

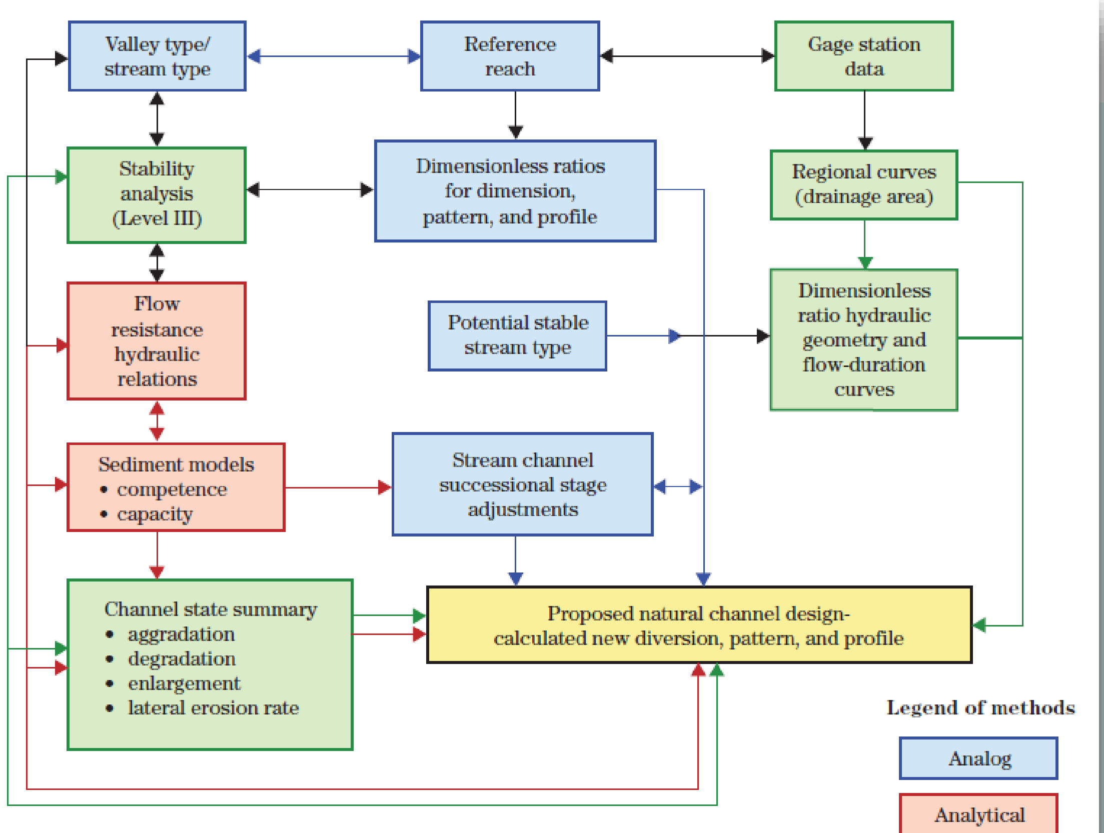


Figure 11–16 Generalized flowchart representing Rosgen geomorphic channel design utilizing analog, analytical, and empirical methodologies

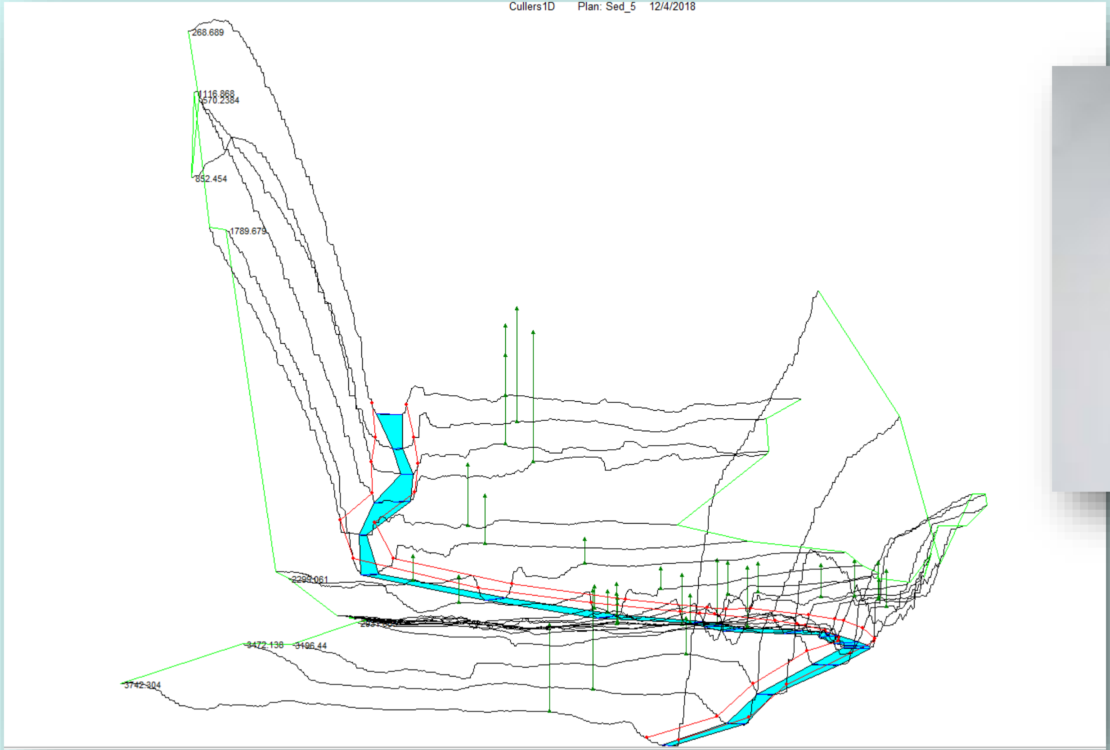
(210–VI–NEH, August 2007) 11–27

Questions Post-Restoration

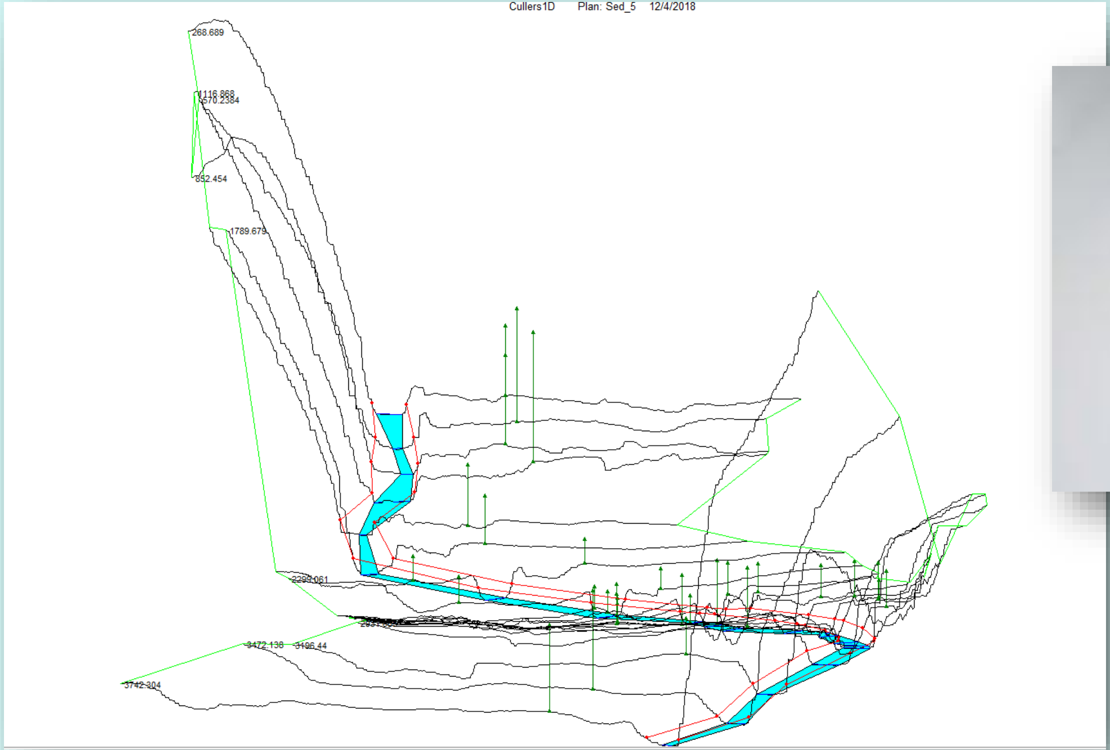
- Could a 1D model adequately predict the extent of the washout/deposition?
- How well does a 2D model perform?
- What kind of flows were needed to produce such a significant change in the bed?
- Which is the “best value” approach?

?

1D


Cullers1D Plan: Sed_5 12/4/2018
268.689
1116.868
570.2384
852.454
1789.679
2299.061
3472.138
3496.44
3742.304

1D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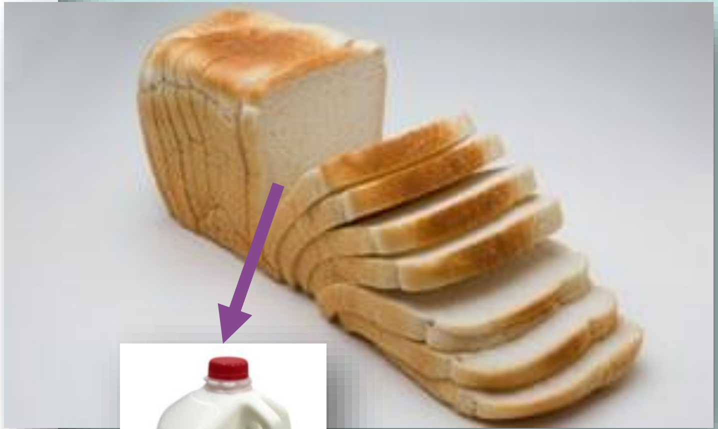
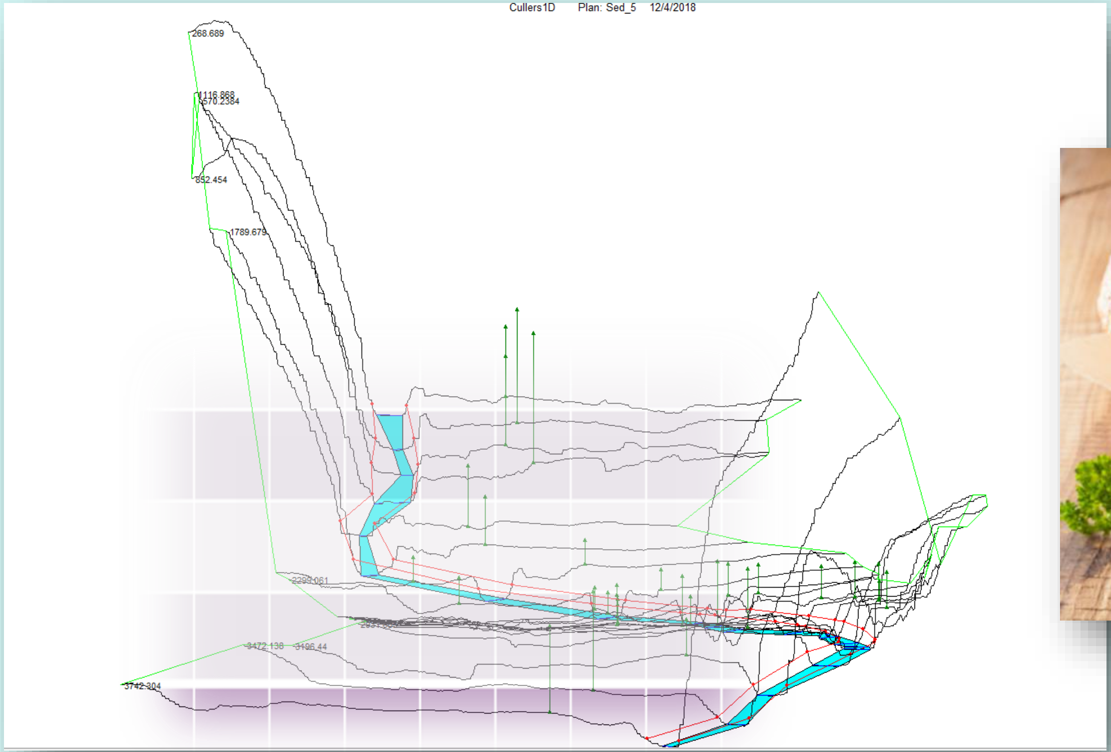


2D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268.689
1116.868
570.2384
852.454
1789.679
2299.061
3472.138
3196.44
3742.304

2 RAS Approaches

1D

- Sediment Transport dynamics
- Quasi-Unsteady
- 1D Flow multiple flood magnitudes
- 1D Sediment Transport

→ **Bed Composition**

2D

- Flow dynamics
- Unsteady
- 2D Flow multiple flood magnitudes
- NO Sediment Transport

→ **Velocities/Stream Power**

2 RAS Approaches

1D

- Sediment Transport dynamics
  - Quasi-Unsteady
- 1D Flow multiple flood magnitudes
  - 1D Sediment Transport

→ Bed Composition

1D Sediment Transport Model Development

1D

- Sediment Transport dynamics
  - Quasi-Unsteady
- 1D Flow multiple flood magnitudes
- 1D Sediment Transport

→ **Bed Composition**

DEM & Landuse

XS Placement

Bed gradation (soil composition)

Boundary conditions at US and DS

Temperature

1D Sediment Transport Model Development

1D

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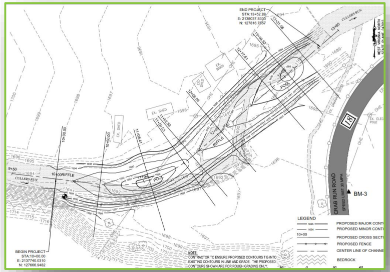
→ **Bed Composition**

DEM & Landuse

XS Placement



Bed gradation (soil composition)

Boundary conditions at US and DS

Temperature

1D Sediment Transport Model Development

Table 3 - Streambed Particle Distribution at project extents

Particle Distribution	Mean Diameter (mm)
D16 (mm)	36
D35 (mm)	57
D50 (mm)	76
D84 (mm)	**190**
D95 (mm)	250

Type	Percent
Silt/Clay (%)	0
Sand (%)	0
Gravel (%)	41
Cobble (%)	55
Boulder (%)	4

Table 2 - Streambed Particle Distribution at Point Bar

Particle Distribution	Mean Diameter (mm)
D16 (mm)	5.2
D35 (mm)	9.7
D50 (mm)	12
D84 (mm)	**41**
D95 (mm)	61

DEM & Landuse

XS Placement

Bed gradation (soil composition)

Boundary conditions at US and DS

Temperature

1D Sediment Transport Model Development

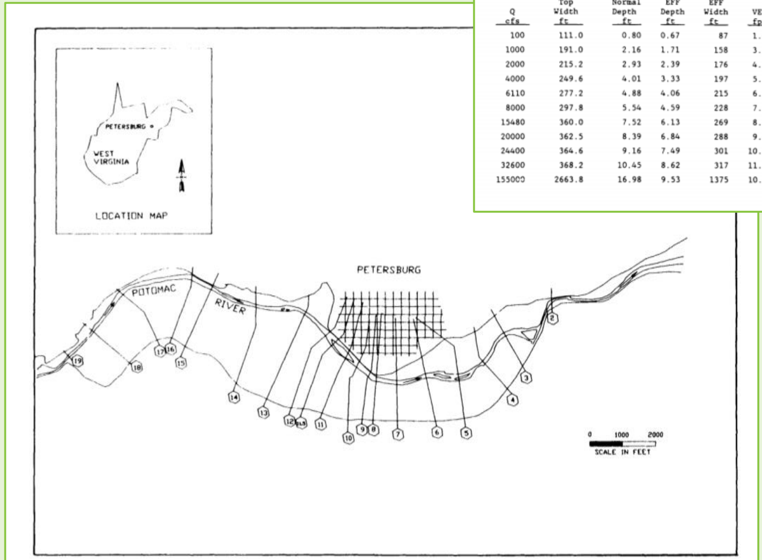


Figure 1. Location map

Table 3
Sediment Discharge Rating Curve
Inflowing Load
Cross-Section 17

Q cfs	Top Width ft	Normal Depth ft	EFF Depth ft	EFF Width ft	VEL fps	TAU psf	Sediment* Load in Tons/Day
100	111.0	0.80	0.67	87	1.62	0.128	1
1000	191.0	2.16	1.71	158	3.57	0.323	43
2000	215.2	2.93	2.39	176	4.59	0.450	119
4000	249.6	4.01	3.33	197	5.82	0.626	312
6110	277.2	4.88	4.06	215	6.66	0.763	554
8000	297.8	5.54	4.59	228	7.24	0.863	805
15480	360.0	7.52	6.13	269	8.81	1.151	1905
20000	362.5	8.39	6.84	288	9.65	1.283	2796
24400	364.6	9.16	7.49	301	10.37	1.404	3834
32600	368.2	10.45	8.62	317	11.54	1.614	5999
155000	2663.8	16.98	9.53	1375	10.54	1.831	19679

DEM & Landuse

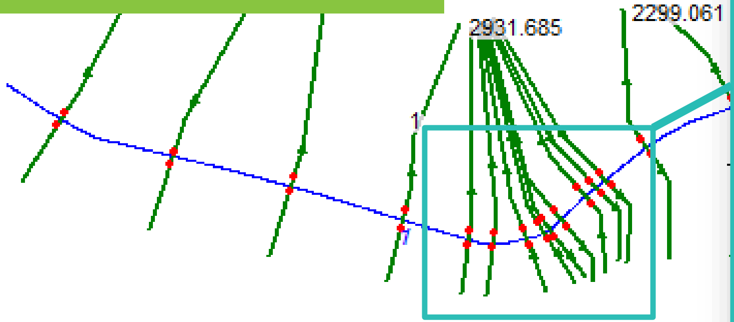
XS Placement

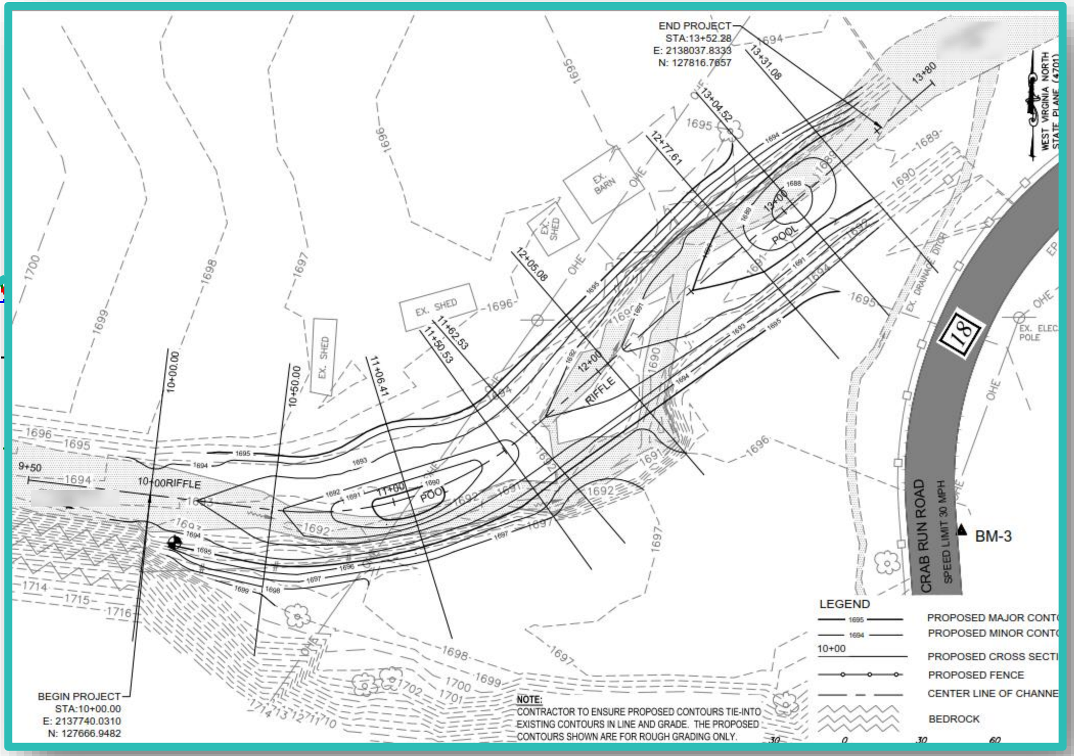
Bed gradation (soil composition)

Boundary conditions at US and DS

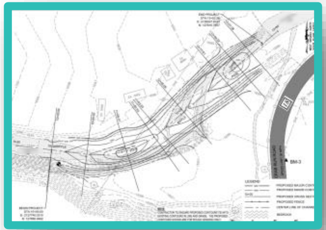
Temperature

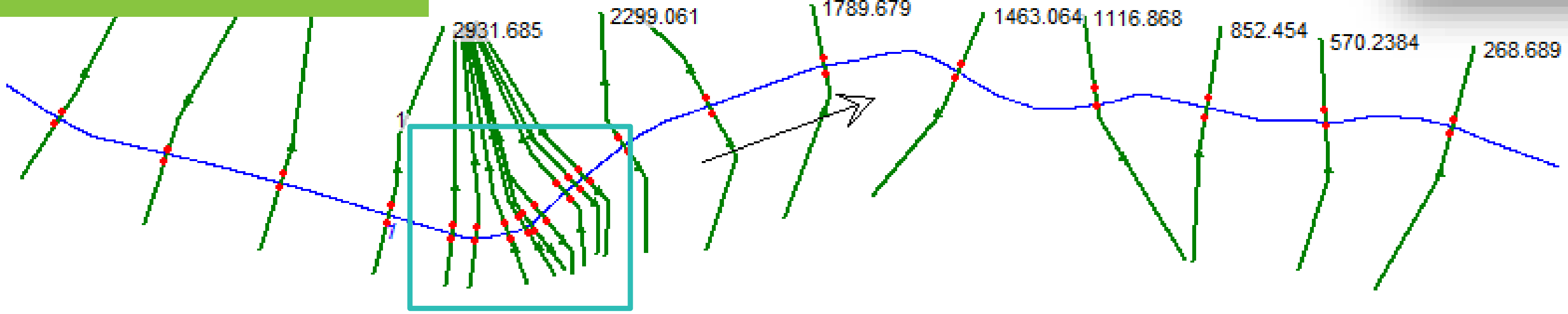
1D Quasi-Unsteady Sediment Transport





1D Quasi-Unsteady Sediment Transport



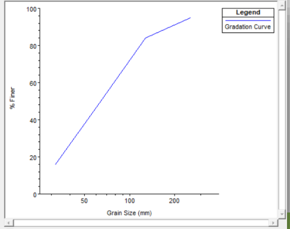


Bed Gradation Template: Riffle

Enter Multiple Gradations in a Table...

	Class	diam (mm)	% Finer
1	Clay	0.004	
2	VFM	0.008	
3	FM	0.016	
4	MM	0.032	
5	CM	0.0625	
6	VFS	0.125	
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	16
15	VCG	64	50
16	SC	128	84
17	LC	256	95
18	SB	512	
19	MB	1024	
20	LB	2048	

% Finer ○ Grain Class % Convert: %finer<-->%



Set Sample Specific Cohesive Parameters

Initial Conditions and Transport Parameters | Boundary Conditions | USDA-ARS Bank Stability and Toe Erosion Model (BSTEM) (Beta)

River: (All Rivers)
Reach:
Number of mobile bed channels: 1
Transport Function: Ackers-White
Sorting Method: Thomas (Ex5)
Fall Velocity Method: Ruby
Define/Edit Bed Gradation...
Define Layers...

	River	Reach	RS	Invert	Max Depth	Min Elev	Left Sta	Right Sta	Bed Gradation
1	1	1	3742.304	1705.24	2		543.8	578.76	OutsideExtent
2	1	1	3472.138	1701.14	2		494.72	525.78	OutsideExtent
3	1	1	3196.44	1698.2	2		445.74	479.11	OutsideExtent
4	1	1	2931.685	1695.86	2		445.71	488.11	OutsideExtent
5	1	1	2775.999	1694.24	5		455.83	490.11	Riffle
6	1	1	2719.291	1693	5		467.84	502.37	Riffle
7	1	1	2643.275	1689	5		468.77	508.7	PointBar
8	1	1	2600.885	1690	5		465.82	512.75	PointBar
9	1	1	2585.942	1691	5		464.82	513.76	Riffle
10	1	1	2552.674	1691	5		453.71	499.61	Riffle
11	1	1	2475.718	1687	5		424	475	PointBar
12	1	1	2446.354	1687	5		428.96	467.95	PointBar
13	1	1	2418.003	1689.75	5		429.64	468.53	OutsideExtent
14	1	1	2299.061	1688.14	2		304.63	346.5	OutsideExtent
15	1	1	2077.613	1685.56	2		275.86	314.51	OutsideExtent
16	1	1	1789.679	1681.98	2		127.67	168.57	OutsideExtent
17	1	1	1463.064	1679.92	2		132.47	167.91	OutsideExtent
18	1	1	1116.868	1675.86	2		175.79	217.74	OutsideExtent
19	1	1	852.454	1673.1	2		173.91	218.88	OutsideExtent
20	1	1	570.2384	1668.99	2		171.83	208.79	OutsideExtent
21	1	1	268.689	1666.46	2		179.28	212.63	OutsideExtent

Select/Enter the Data's Starting Time Reference
● Use Simulation Time: Date: 04DEC2018 Time: 00:00
○ Fixed Start Time: Date: Time:

Hydrograph Data

No. Ordinates | Interpolate Values | Del Row | Ins Row

	Simulation Time	Elapsed Time (hours)	Flow Duration (hours)	Computation Increment (hours)	Flow (cfs)
1	04Dec2018 0000	1	1	0.4	1
2	04Dec2018 0100	2	1	0.4	43
3	04Dec2018 0200	3	1	0.4	128
4	04Dec2018 0300	4	1	0.3	264
5	04Dec2018 0400	5	1	0.3	463
6	04Dec2018 0500	6	1	0.2	650
7	04Dec2018 0600	7	1	0.2	736
8	04Dec2018 0700	8	1	0.2	682

☑ Compute computation increments based on flow

	Qlow	Qhigh	CI
1	0	200	0.4
2	200	600	0.3
3	600	1200	0.2
4	1200	1800	0.1
5	1800	2400	0.04
6	2400	3600	0.02

Number of flow-load points: 4 sets

	Flow (cfs)	100	1000	2000	4000
	Total Load (tons/day)	1	43	119	312
1	Clay (0.002-0.004)	0.3	0.3	0.25	0.2
2	VFM (0.004-0.008)	0.2	0.15	0.15	0.15
3	FM (0.008-0.016)	0.2	0.25	0.3	0.35
4	MM (0.016-0.032)	0.2	0.2	0.15	0.1
5	CM (0.032-0.0625)	0.1	0.1	0.1	0.1
6	VFS (0.0625-0.125)			0.05	0.05
7	FS (0.125-0.25)				0.03
8	MS (0.25-0.5)				

2 RAS Approaches

2D

- Flow dynamics
- Unsteady
- 2D Flow multiple flood magnitudes
- NO Sediment Transport

→ **Velocities/Stream Power**

2D Model Development

DEM & Landuse

Grid development

Boundary conditions at US and DS

2D

- Flow dynamics
- Unsteady
- 2D Flow multiple flood magnitudes
- NO Sediment Transport

→ **Velocities/Stream Power**

2D Model Development

DEM & Landuse

Grid development

Boundary conditions at US and DS

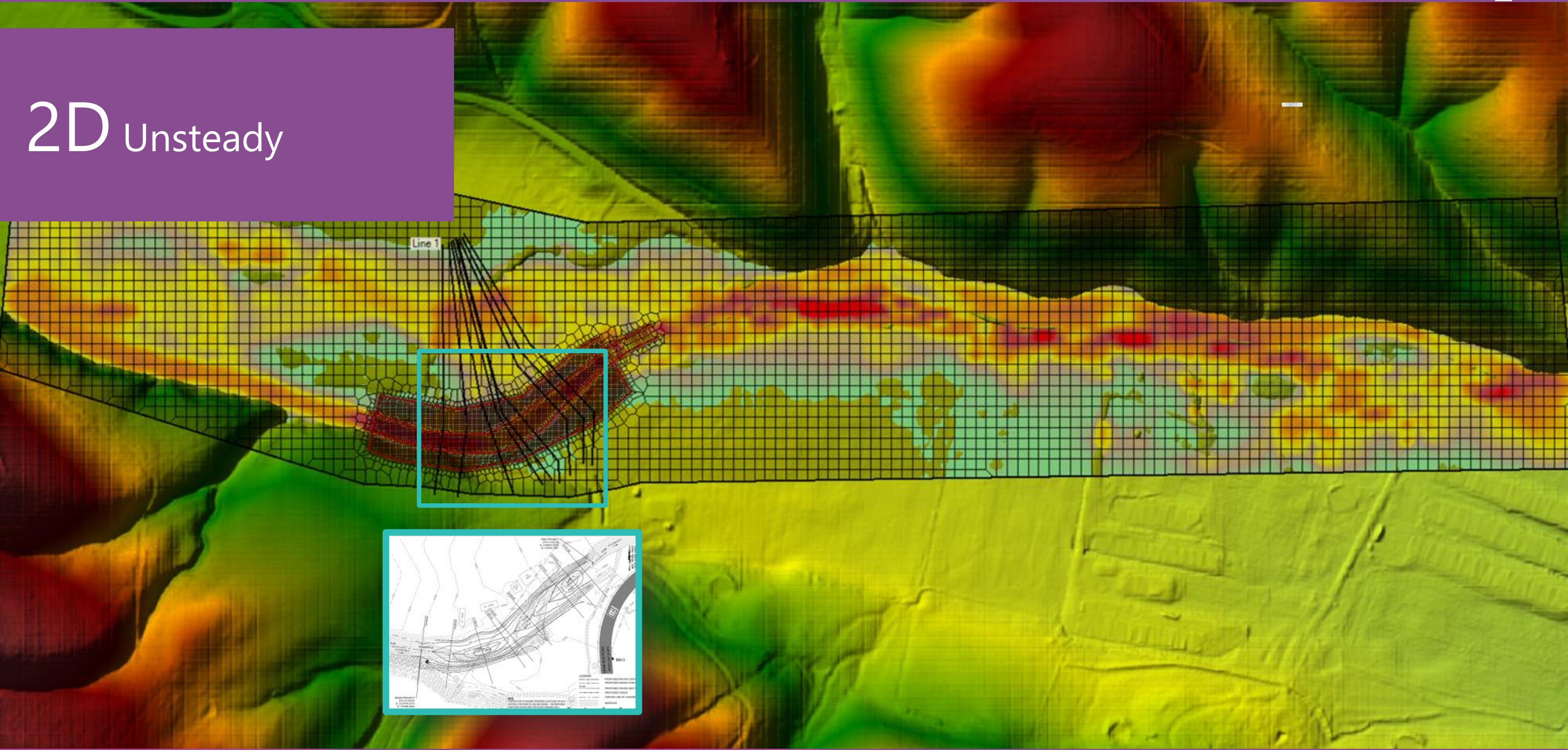
(flow only)

2D

- Flow dynamics
- Unsteady
- 2D Flow multiple flood magnitudes
- NO Sediment Transport

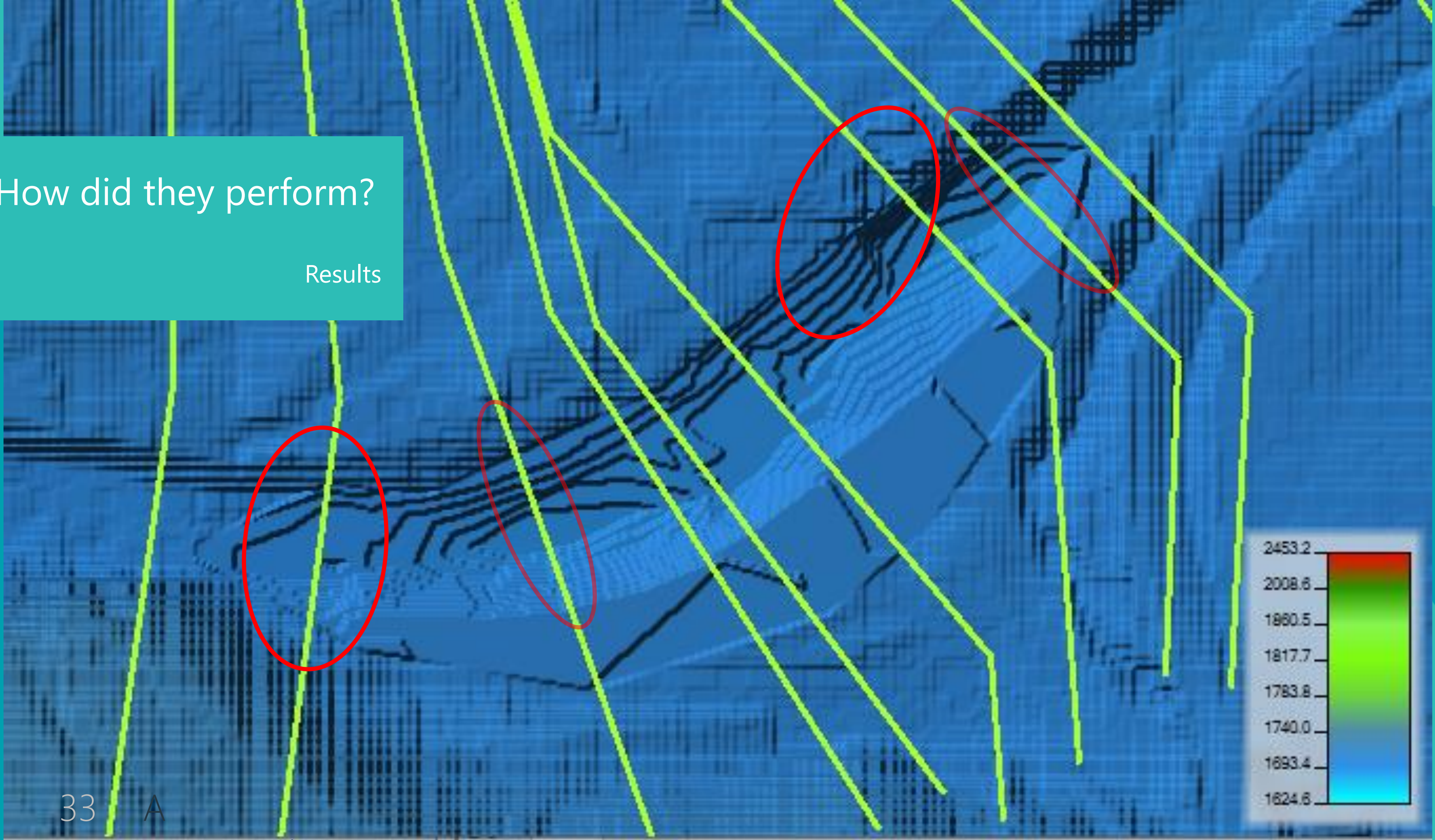
→ **Velocities/Stream Power**

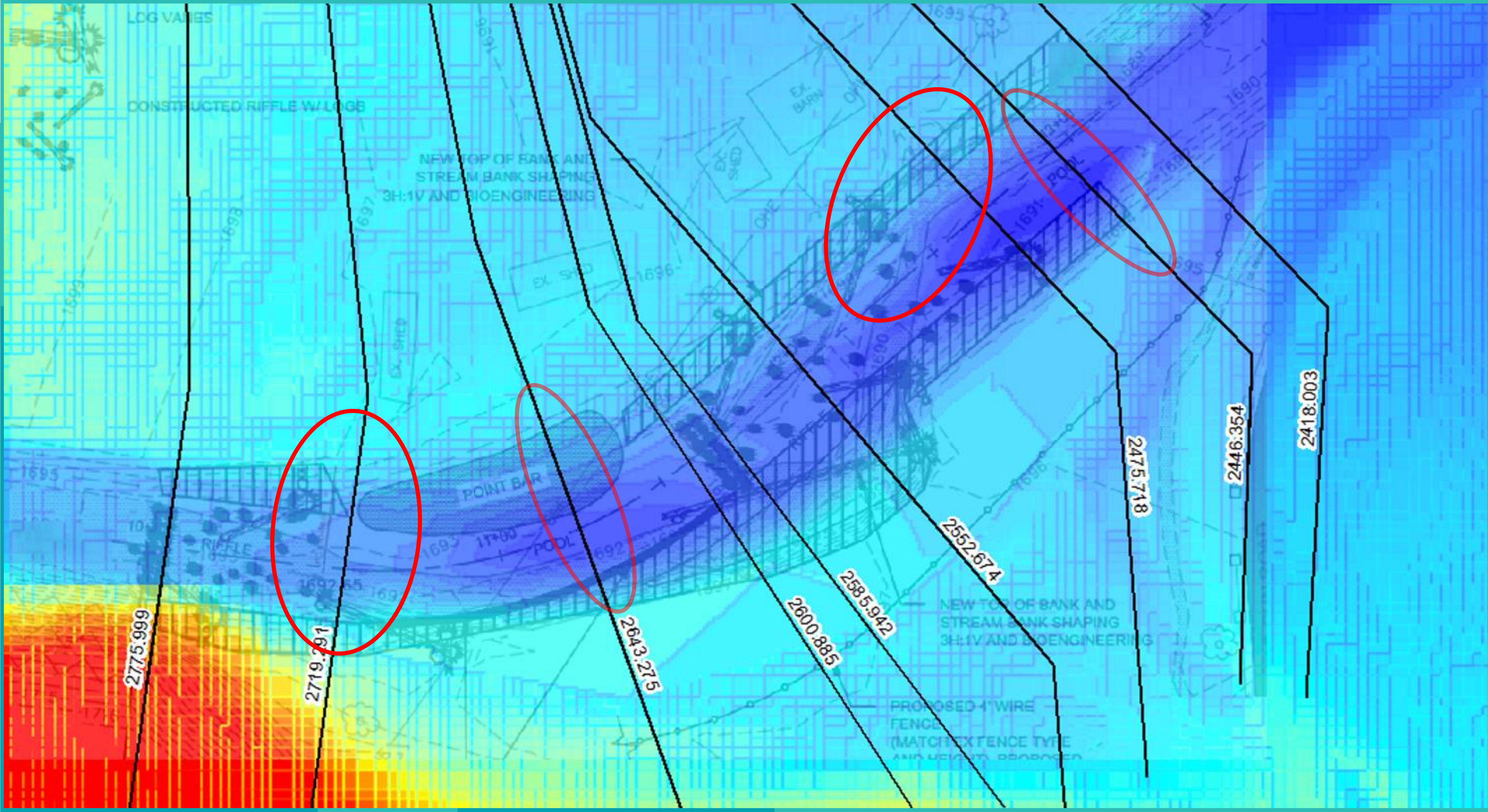
2D Unsteady



How did they perform?

Results




LOG VANES
CONSTRUCTED RIFFLE W/ LOGS
NEW TOP OF BANK AND
STREAM BANK SHAPING
3H:1V AND BIOENGINEERING
EX. SHED
EX. BARN
POINT BAR
11+00
POOL
RIFFLE
POOL
NEW TOP OF BANK AND
STREAM BANK SHAPING
3H:1V AND BIOENGINEERING
PROPOSED 4' WIRE
FENCE
(MATCH EX FENCE TYPE
2775.999
2719.291
2643.275
2600.885
2585.942
2552.674
2475.718
2446.354
2418.003

2 RAS Results

2D

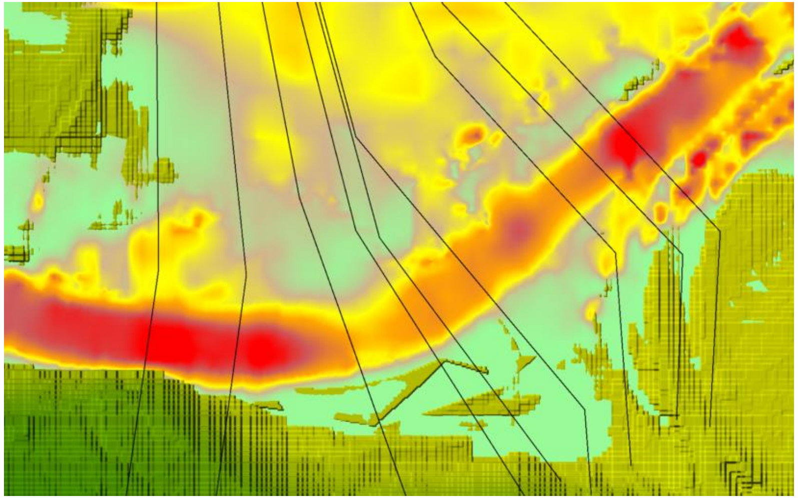
1D

Peak Flows		
Event	*Flow*	
1.11- year	199	*cfs*
1.5 year	319	*cfs*
2-year	415	*cfs*
5-year	739	*cfs*
10-year	1,031	*cfs*
25-year	1,470	*cfs*
50-year	1,848	*cfs*
100-year	2,249	*cfs*
200-year	2,699	*cfs*
500-year	3,344	*cfs*

275 cfs Bankfull

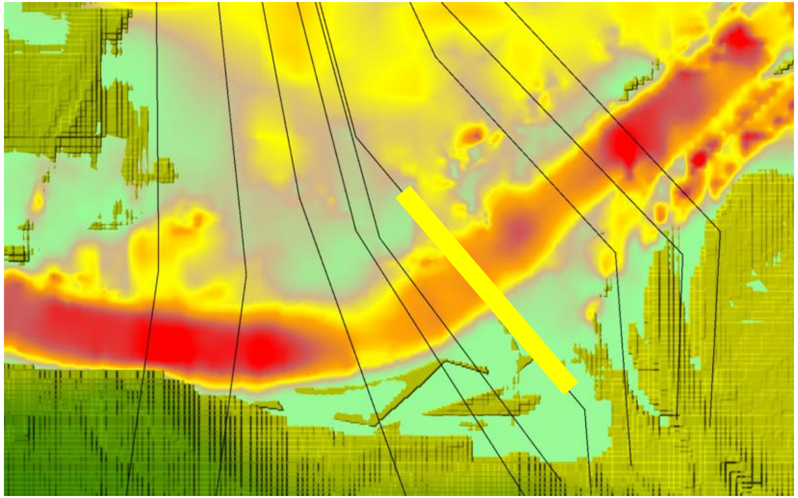
2 RAS Results

2D	1D

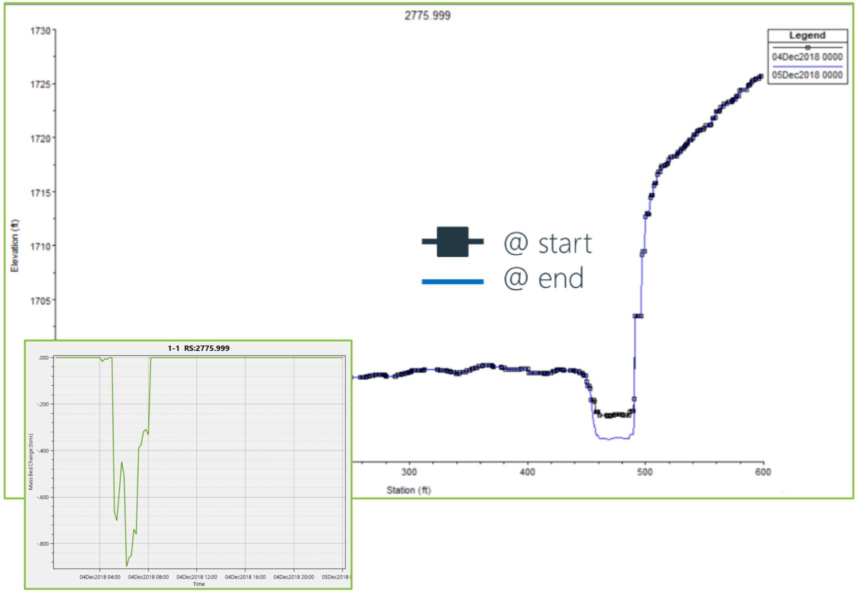


2 RAS Results

2D



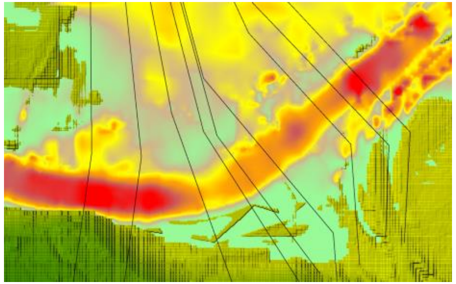
1D

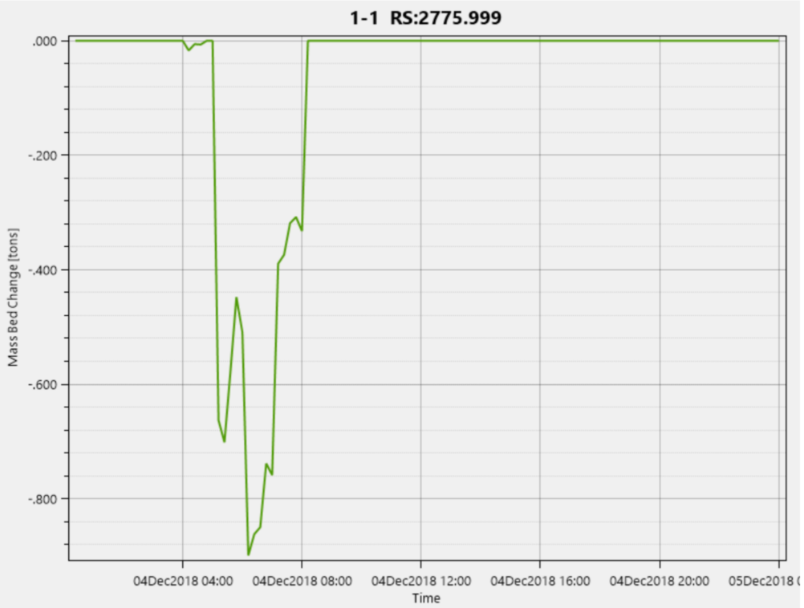


2 RAS Results

2D

1D





2 RAS Results

2D

1D

Mass Bed Change [tons]

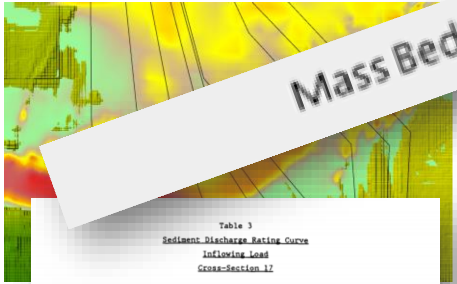


Table 3

Sediment Discharge Rating Curve

Inflowing Load

Cross-Section 17

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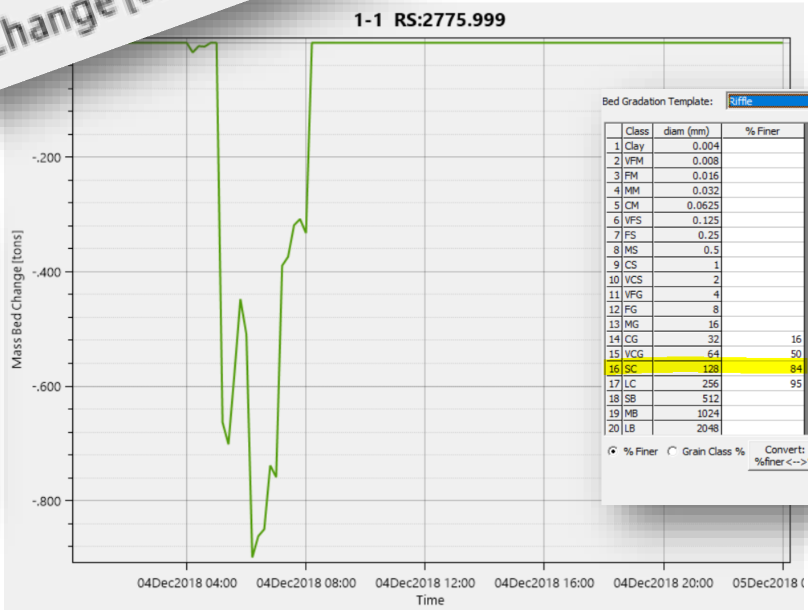

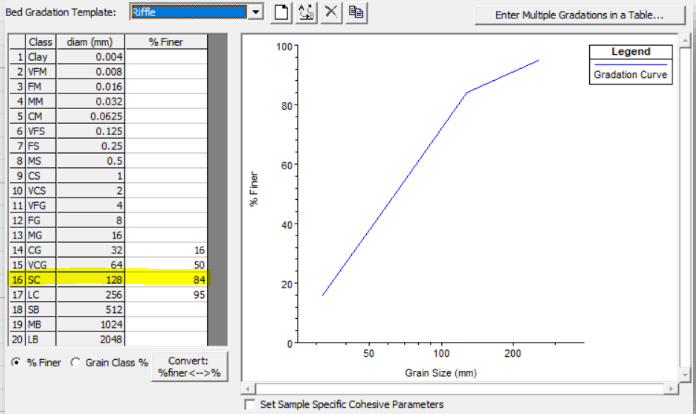

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8	MS	0.5	
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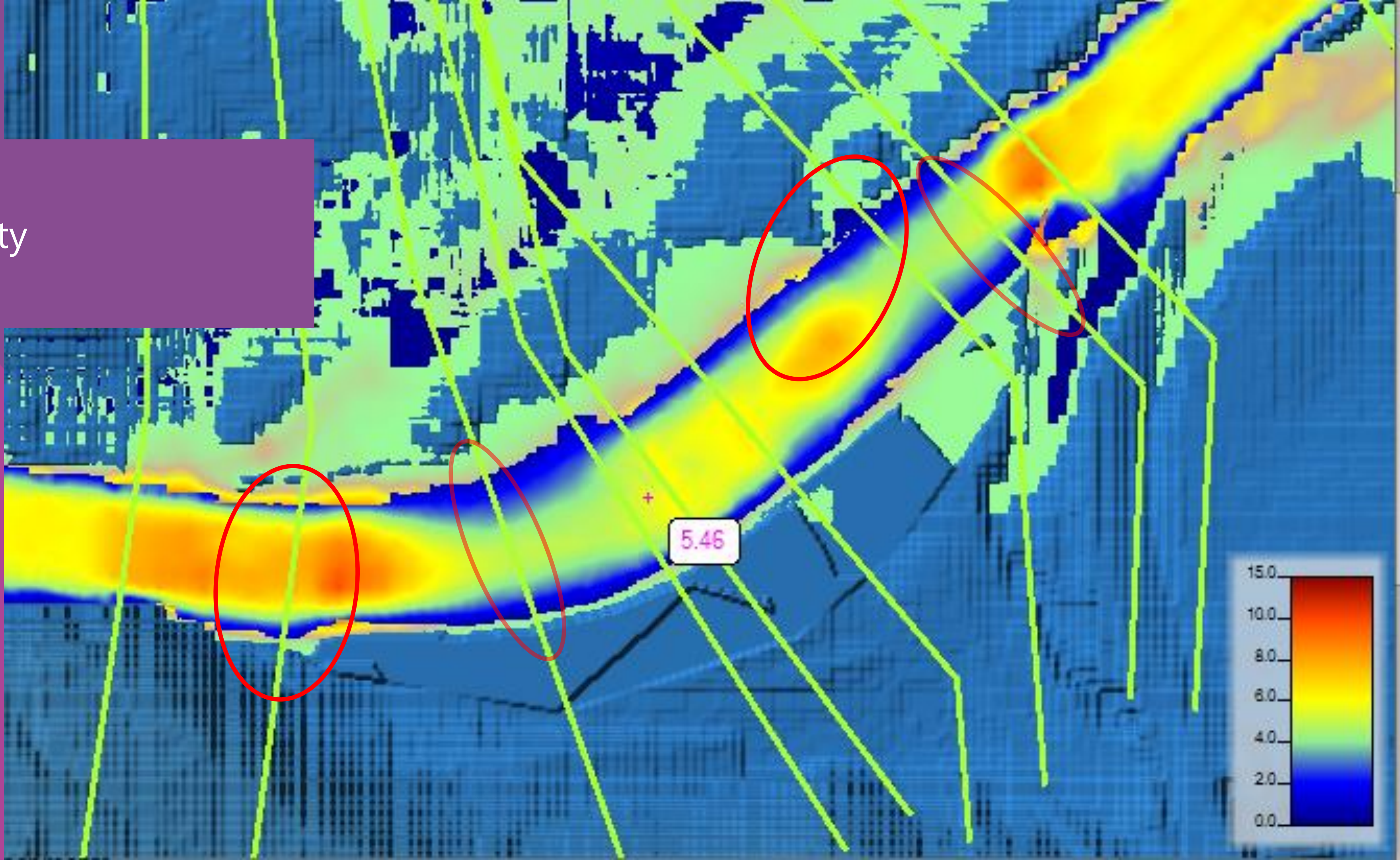
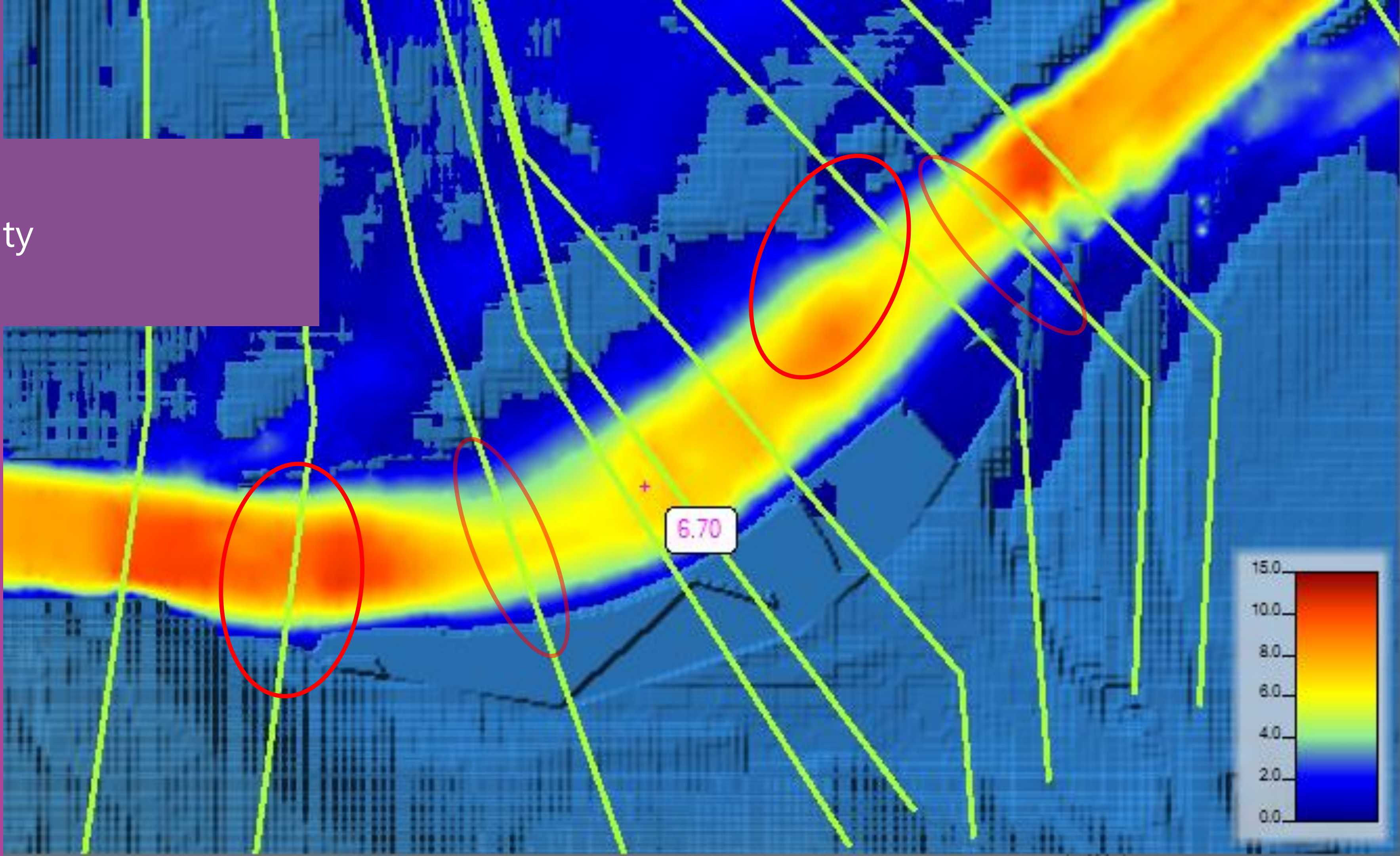
10	VCS	2	
11	VFG	4	
12	FG	8	
13	MG	16	
14	CG	32	16
15	VCG	64	50
16	SC	128	84
17	LC	256	95
18	SB	512	
19	MB	1024	
20	LB	2048	

Velocity

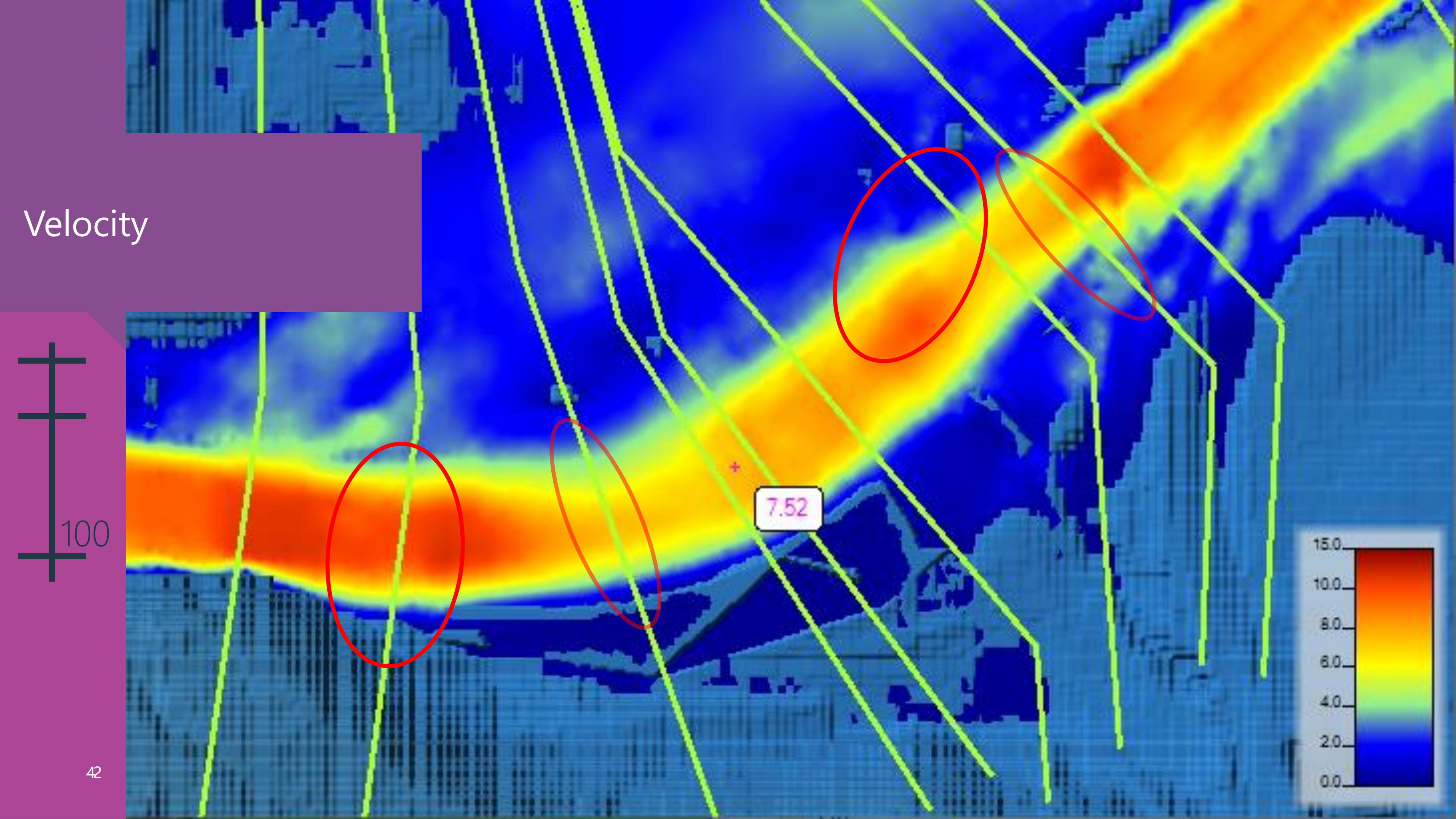
5



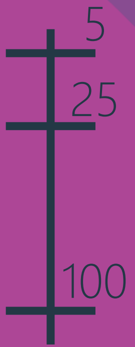
Velocity



Velocity



Stream Power



From Wikipedia, the free encyclopedia

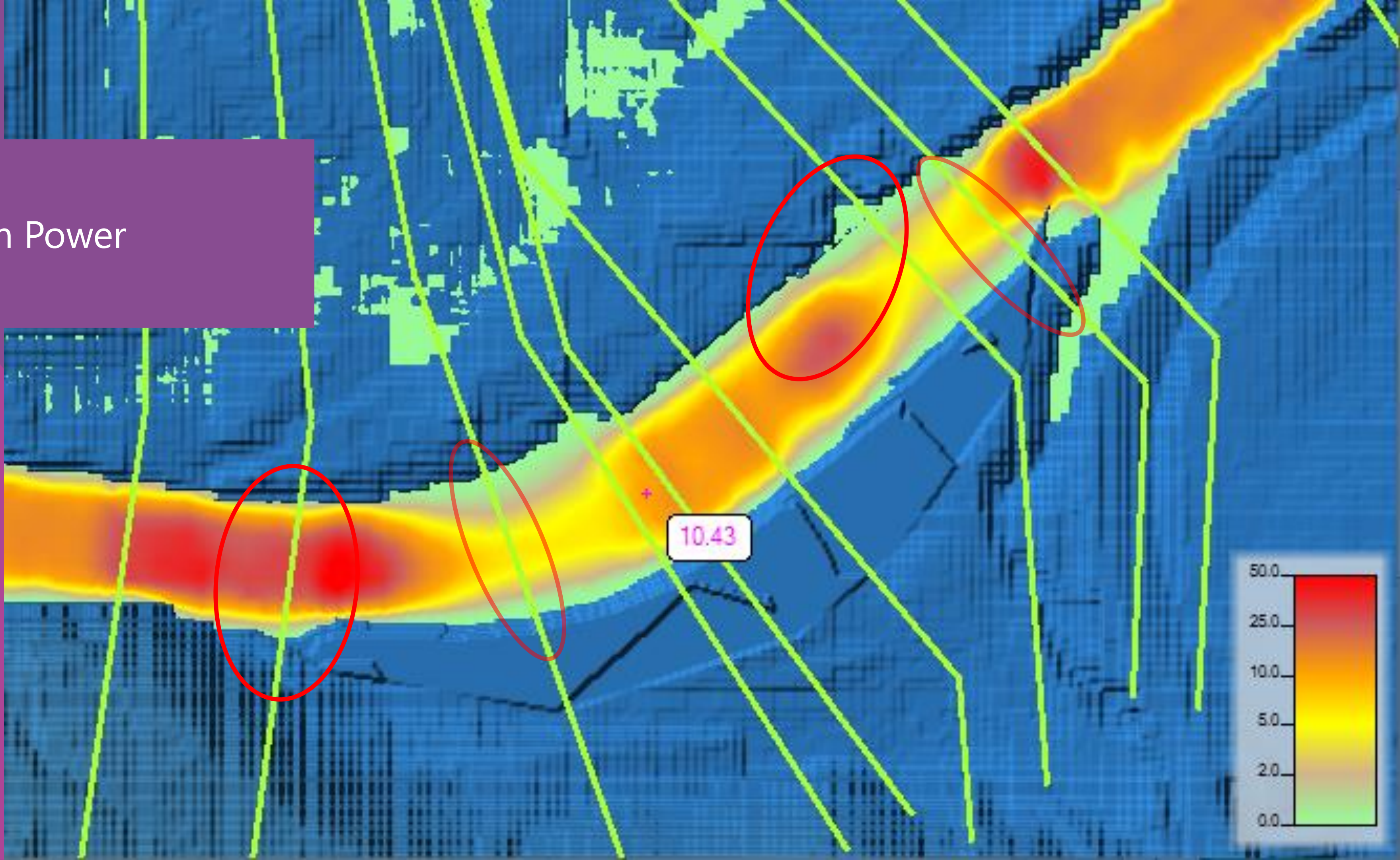
Stream power is the rate of energy dissipation against the bed and banks of a river or stream per unit downstream length. It is given by the equation:

$$\Omega = \rho g Q S$$

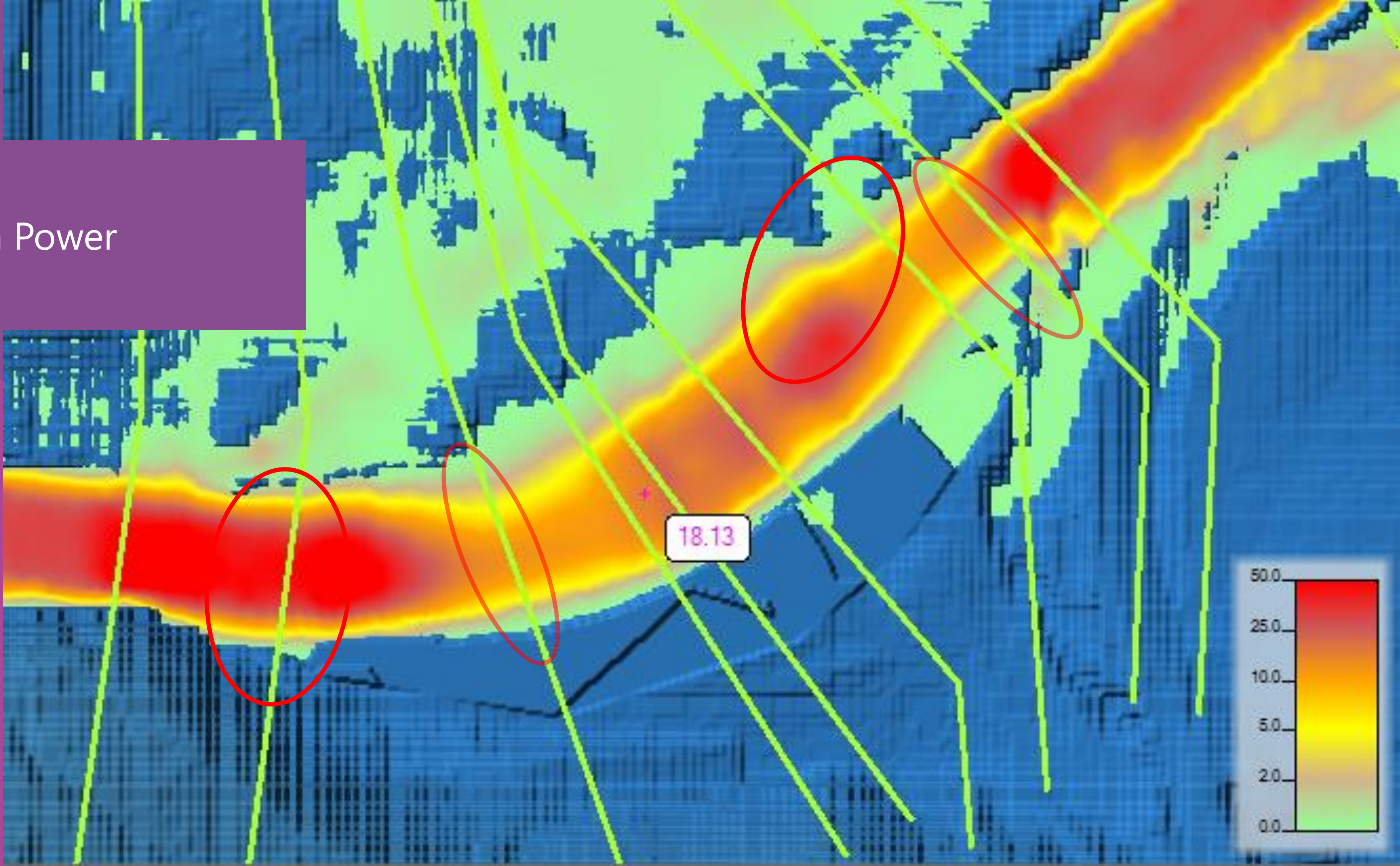
where Ω is the stream power, ρ is the density of water (1000 kg/m^3), g is acceleration due to gravity (9.8 m/s^2), Q is discharge (m^3/s), and S is the channel slope.

Stream Power

5



Stream Power



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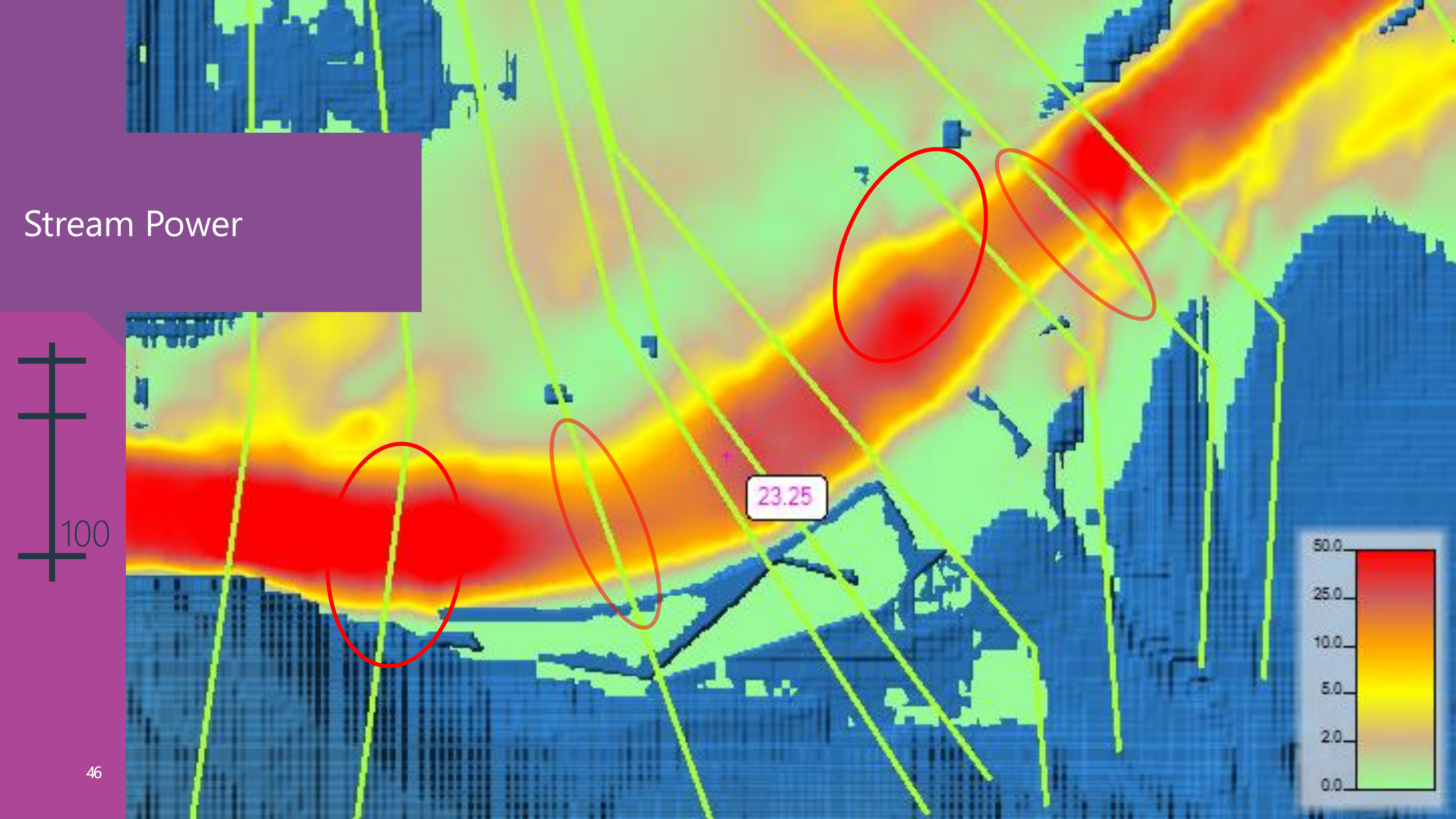
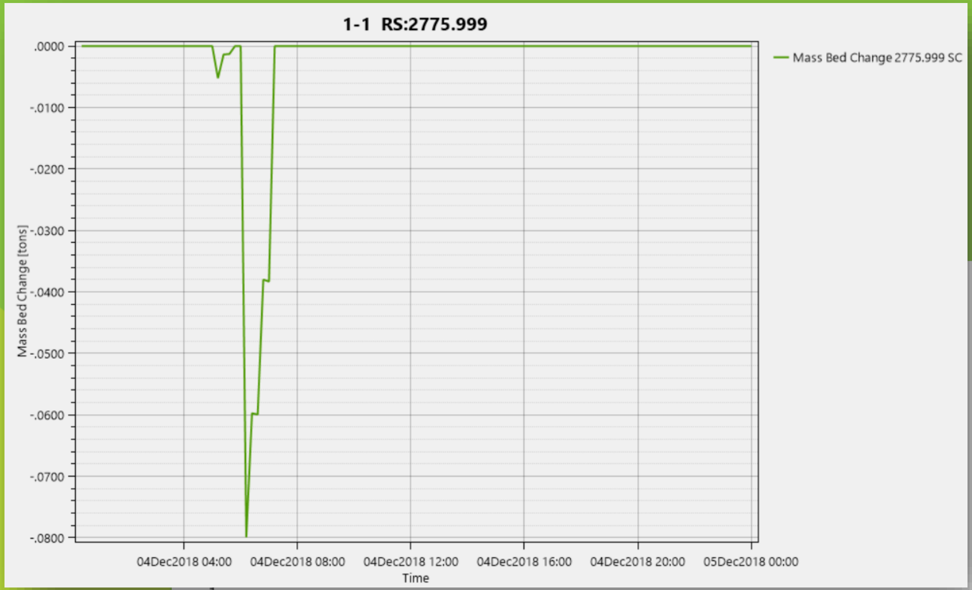
Stream Power



2775.999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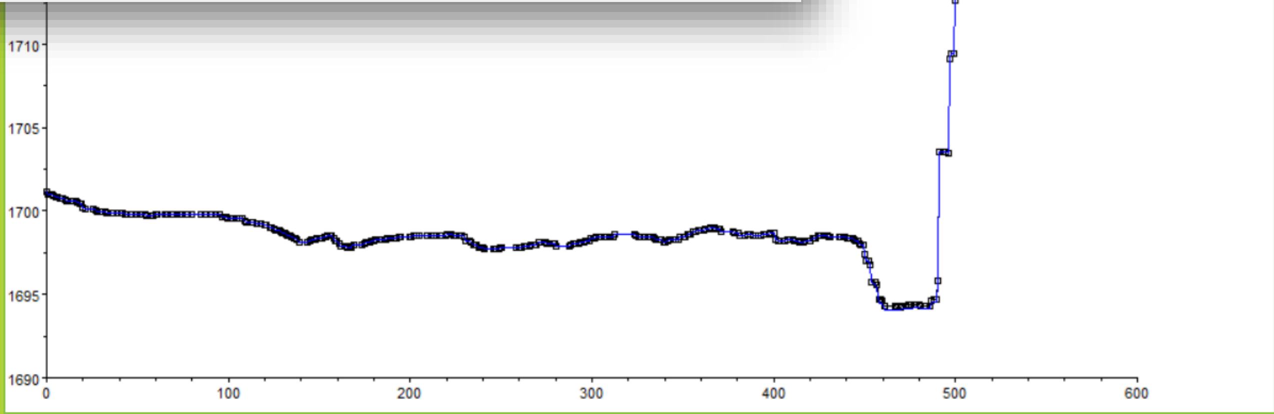
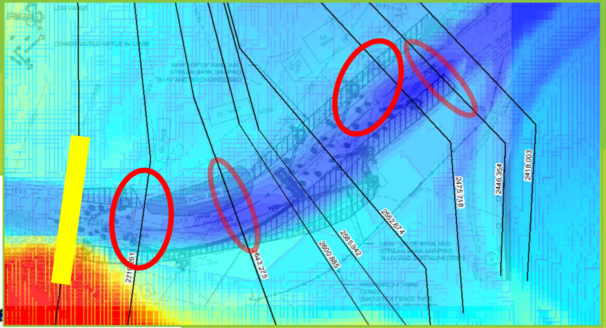
Mass Bed Change 2775.999 SC
Mass Bed Change [tons]
.0000
-.0100
-.0200
-.0300
-.0400
-.0500
-.0600
-.0700
-.0800
04Dec2018 04:00
04Dec2018 08:00
04Dec2018 12:00
04Dec2018 16:00
04Dec2018 20:00
05Dec2018 00:00
Time


1710
1705
1700
1695
1690
0
100
200
300
400
500
600



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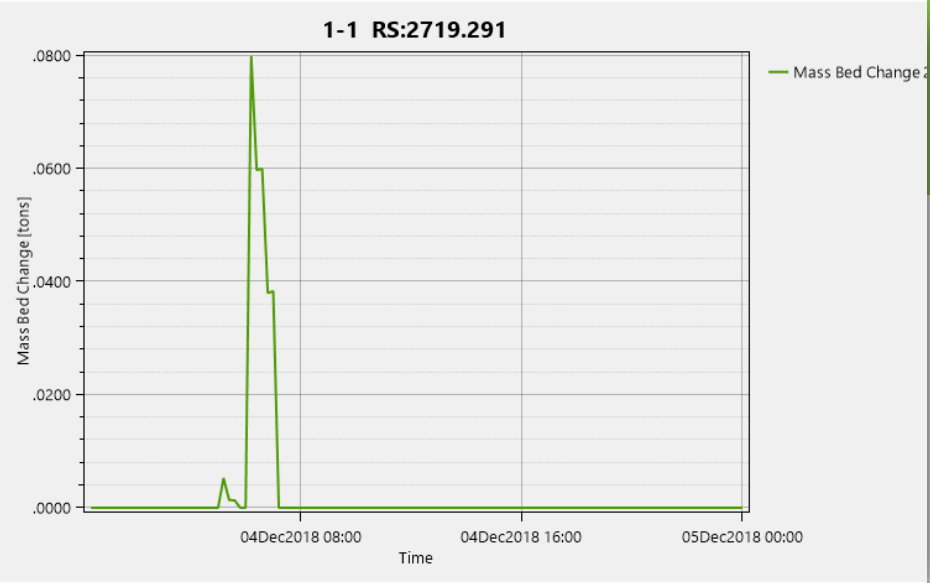
2719.291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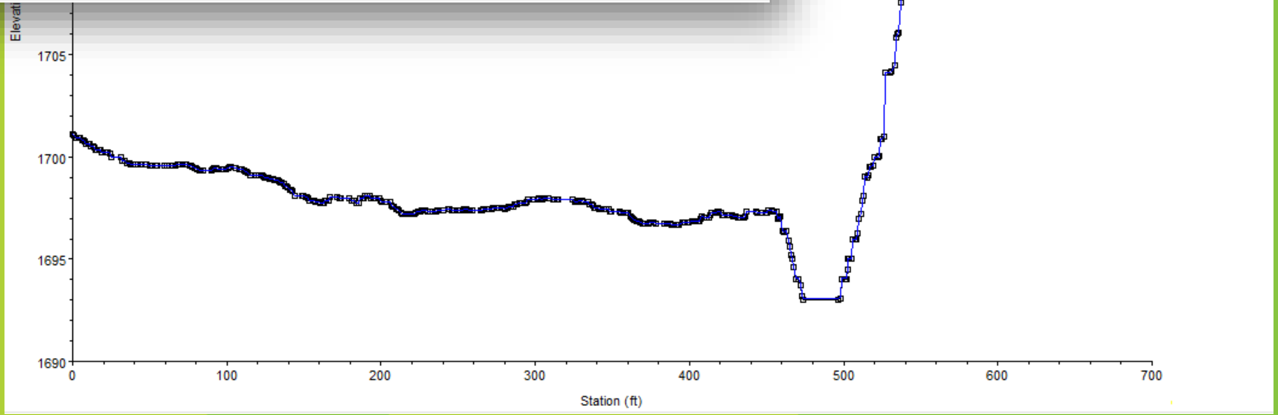
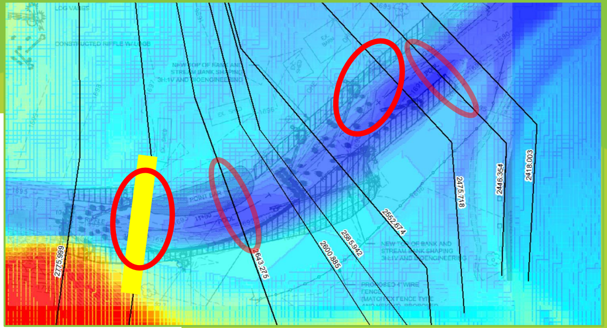
.0800
.0600
.0400
.0200
.0000
Mass Bed Change [tons]
Mass Bed Change
04Dec2018 08:00
04Dec2018 16:00
05Dec2018 00:00
Time


1705
1700
1695
1690
0
100
200
300
400
500
600
700
Station (ft)



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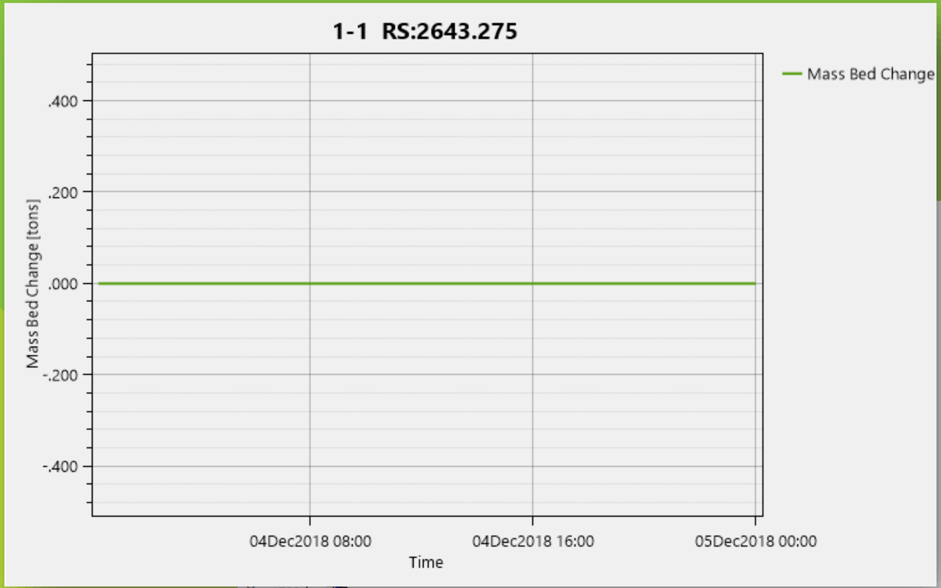
2643.275


1-1 RS:2643.275
Mass Bed Change
Mass Bed Change [tons]
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.200
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-.400
04Dec2018 08:00
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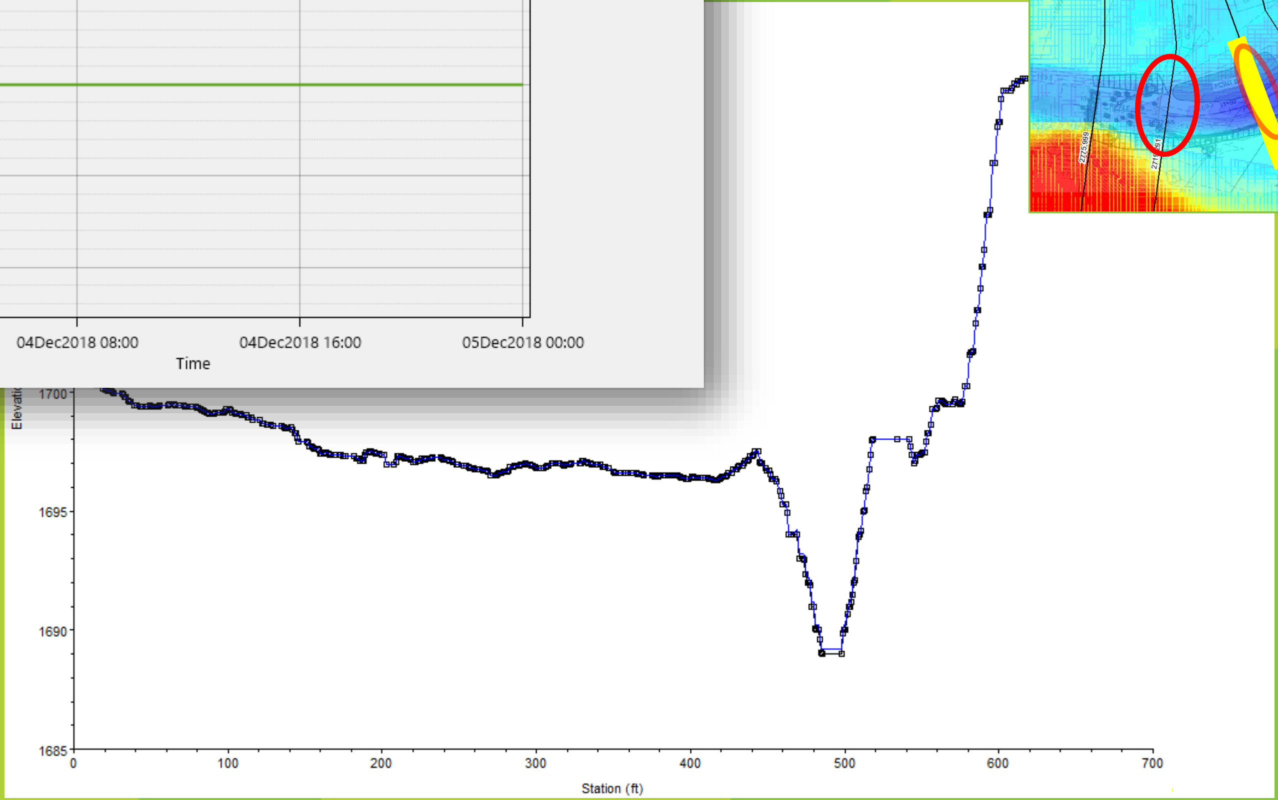
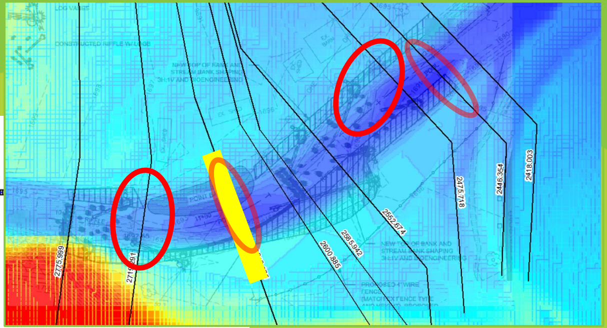
Time


1700
1695
1690
1685
0
100
200
300
400
500
600
700
Station (ft)

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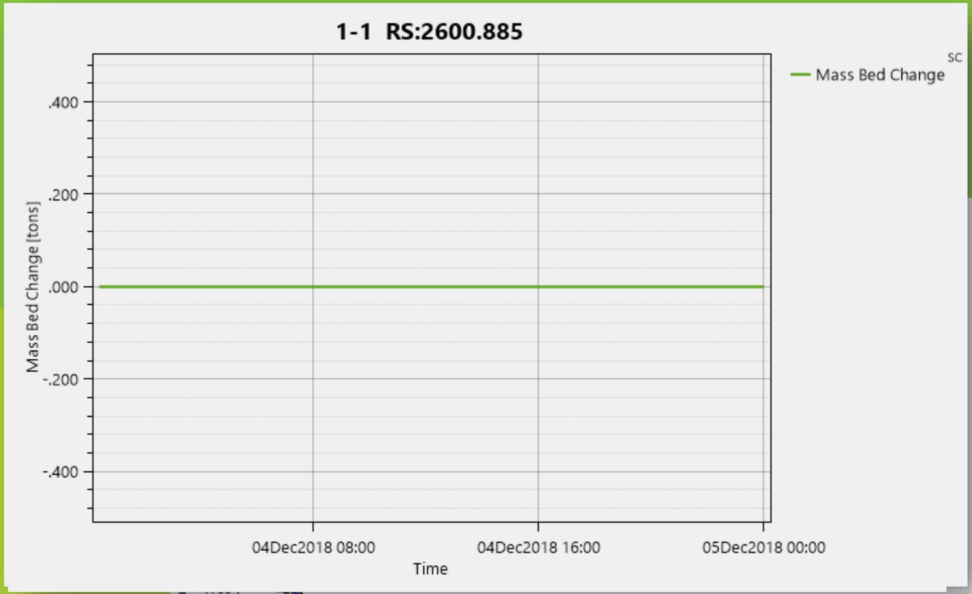
2600.885


1-1 RS:2600.885
SC
Mass Bed Change
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.200
.000
-.200
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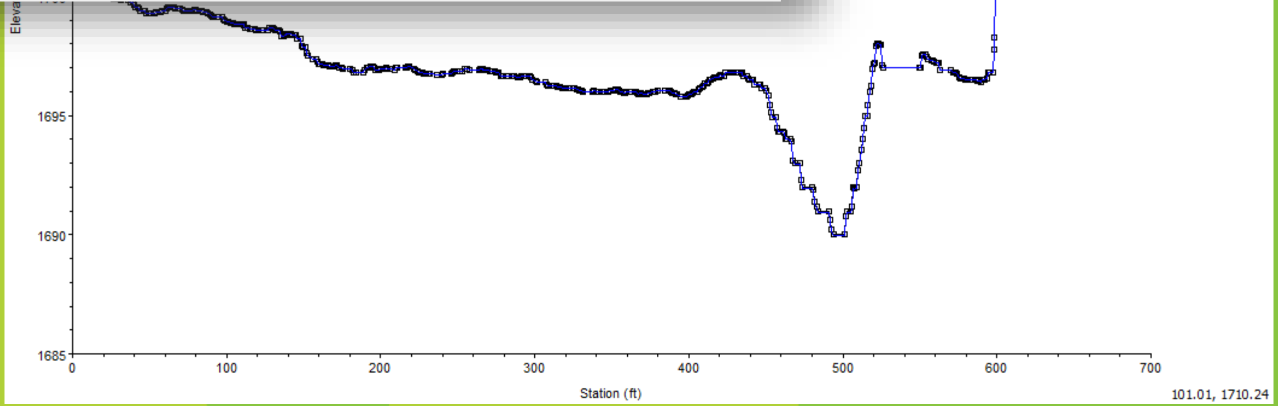
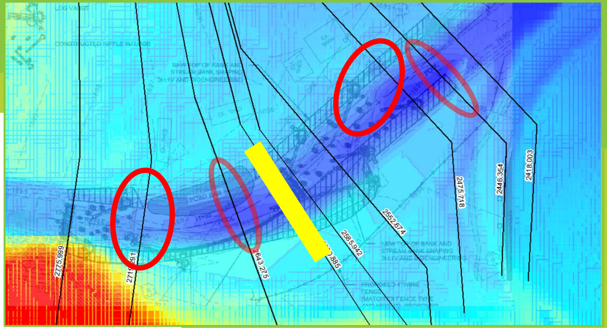
Mass Bed Change [tons]
04Dec2018 08:00
04Dec2018 16:00
05Dec2018 00:00
Time


1695
1690
1685
0
100
200
300
400
500
600
700
Station (ft)
101.01, 1710.24

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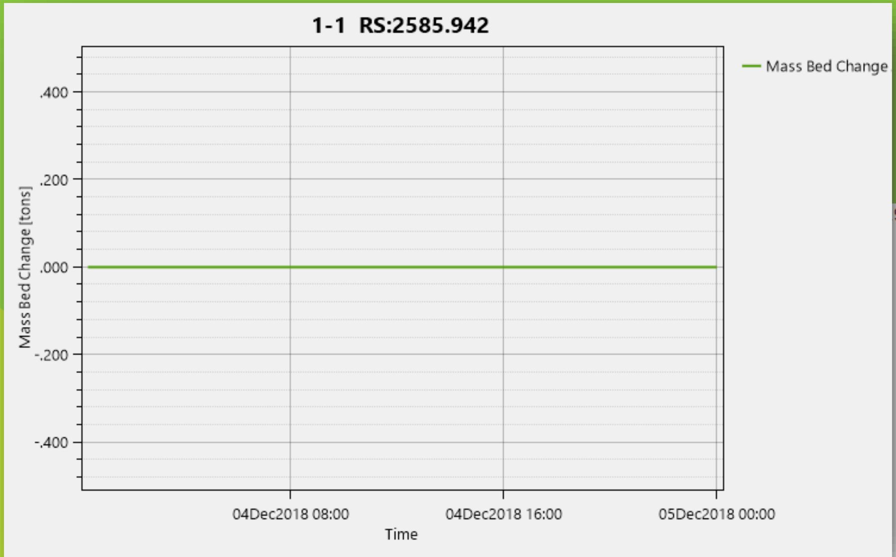
2585.942



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Mass Bed Change [tons]
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.000
-.200
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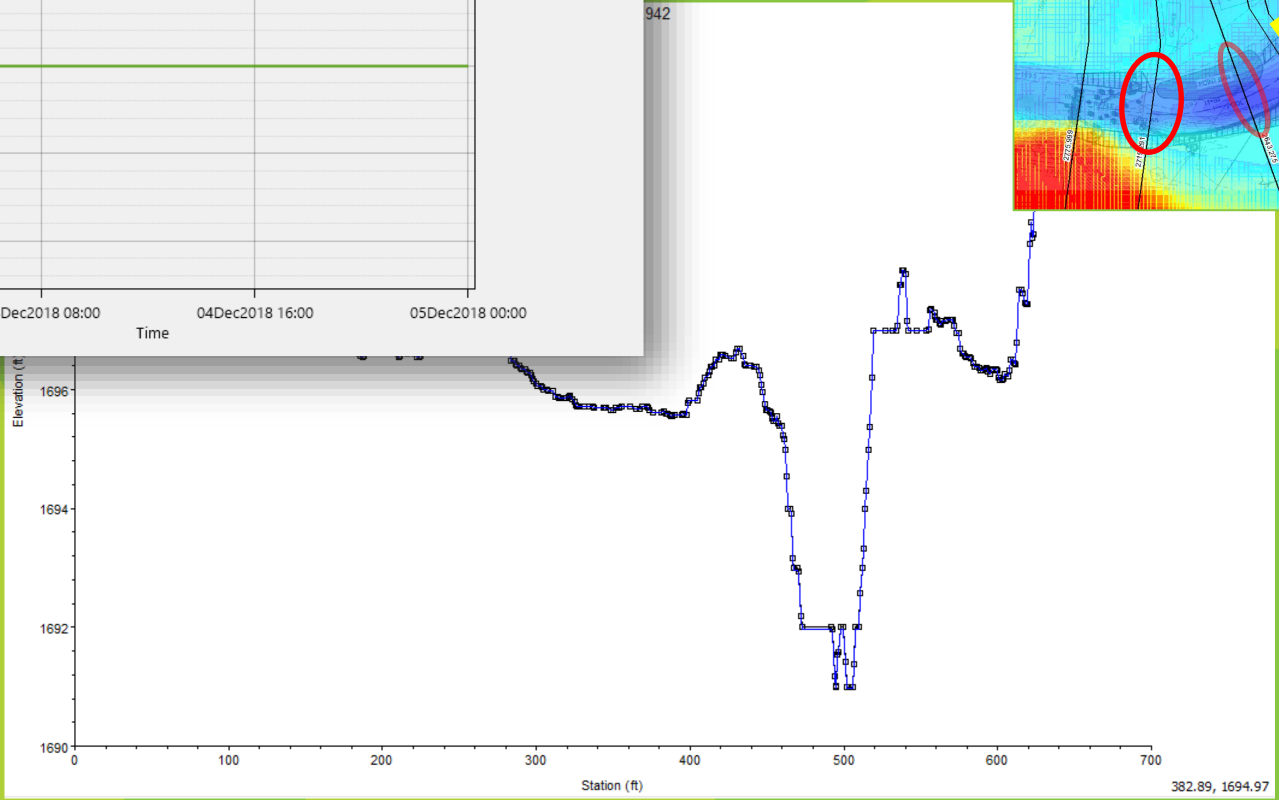
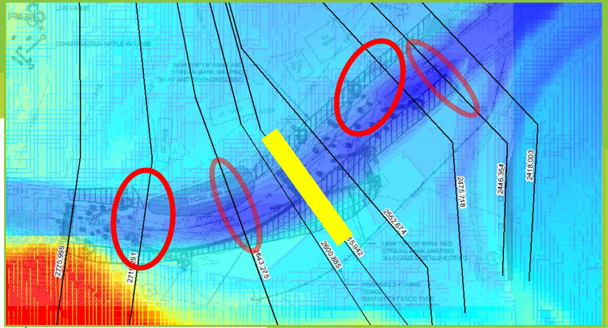
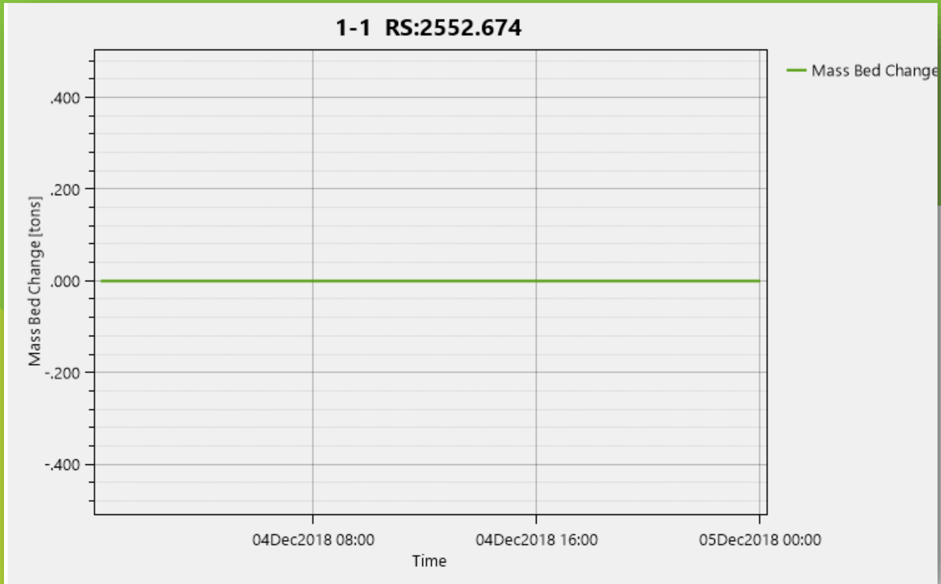
04Dec2018 08:00
04Dec2018 16:00
05Dec2018 00:00
Time



1696
1694
1692
1690
0
100
200
300
400
500
600
700
Station (ft)
382.89, 1694.97



2552.674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Mass Bed Change
Mass Bed Change [tons]
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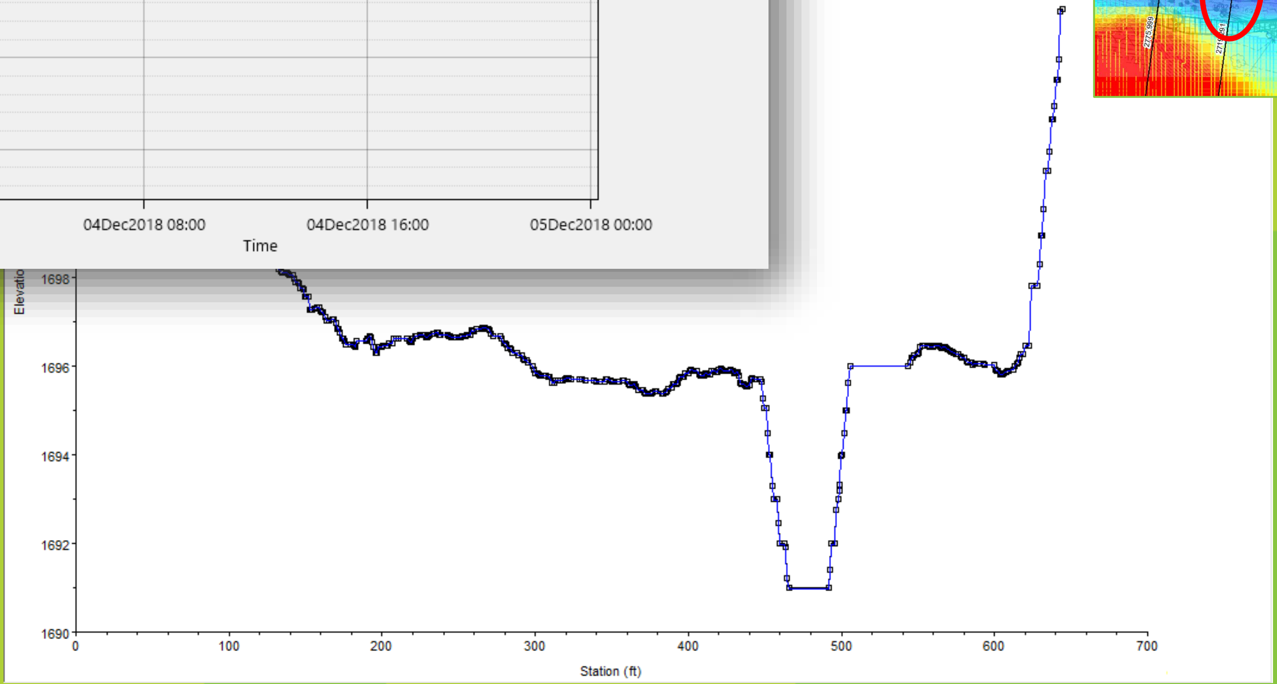
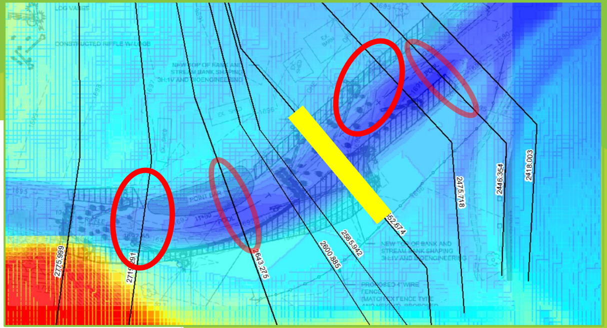
.200
.000
-.200
-.400
04Dec2018 08:00
04Dec2018 16:00
05Dec2018 00:00
Time


Elevatio
1698
1696
1694
1692
1690
0
100
200
300
400
500
600
700
Station (ft)



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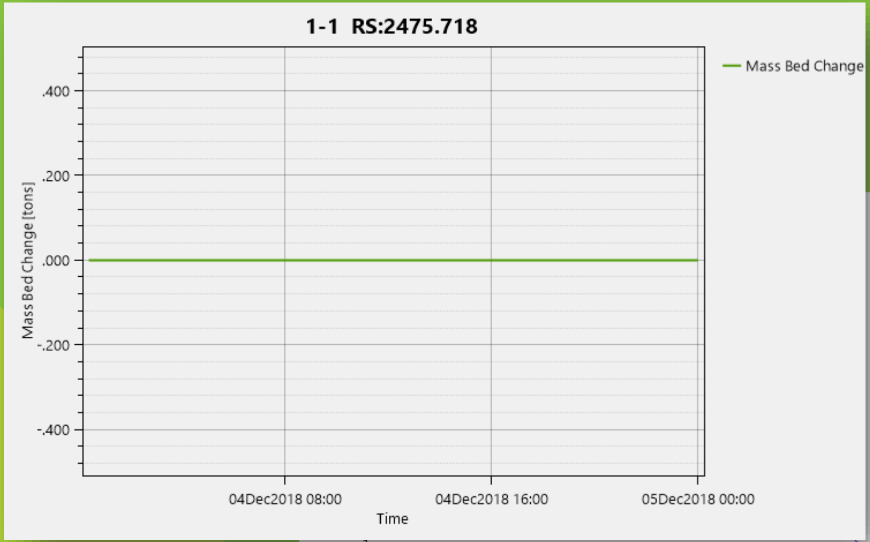
2475.718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Mass Bed Change
Mass Bed Change [tons]
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.000
-.200
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04Dec2018 08:00
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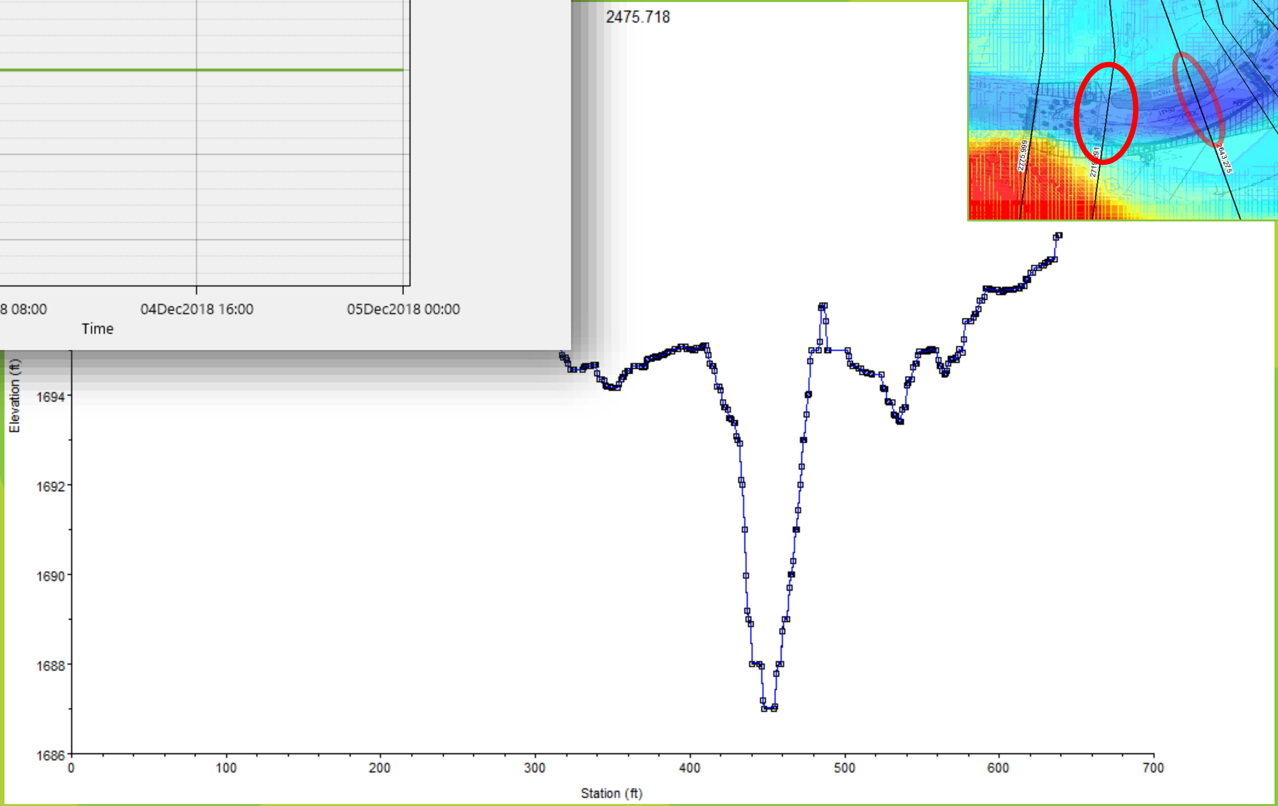
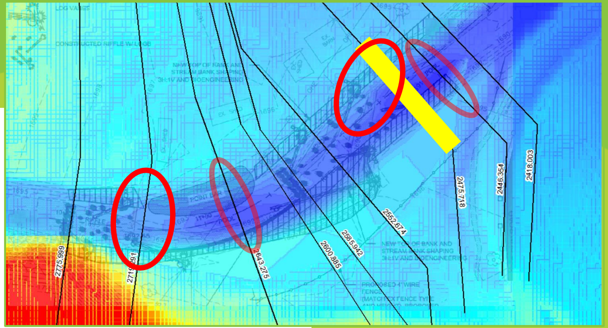
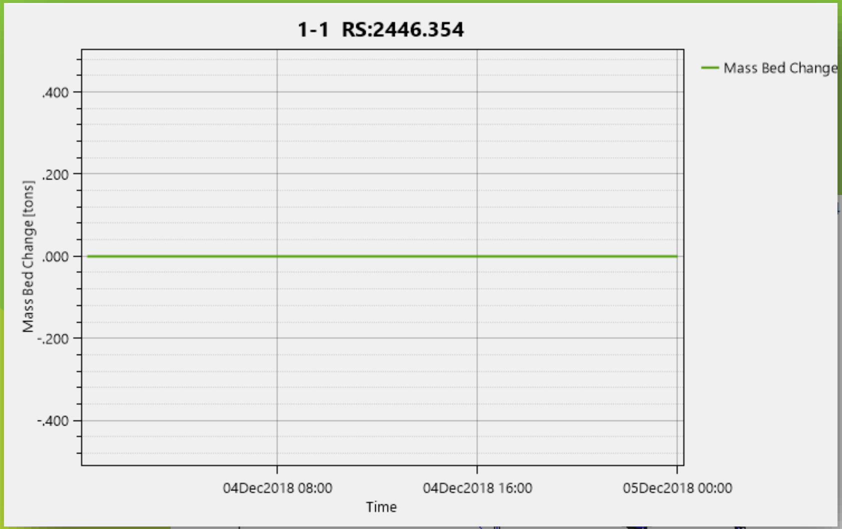
05Dec2018 00:00
Time


2475.718
Elevation (ft)
1694
1692
1690
1688
1686
0
100
200
300
400
500
600
700
Station (ft)


2775.999
2475.718
2446.354
2418.003

2446.354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.000
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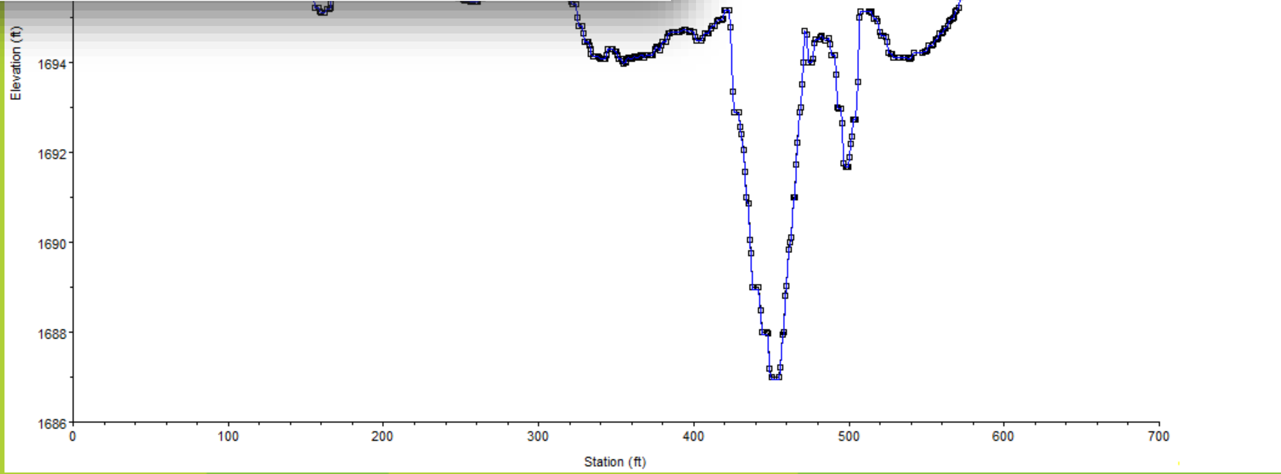
Mass Bed Change [tons]
04Dec2018 08:00
04Dec2018 16:00
05Dec2018 00:00
Time


Elevation (ft)
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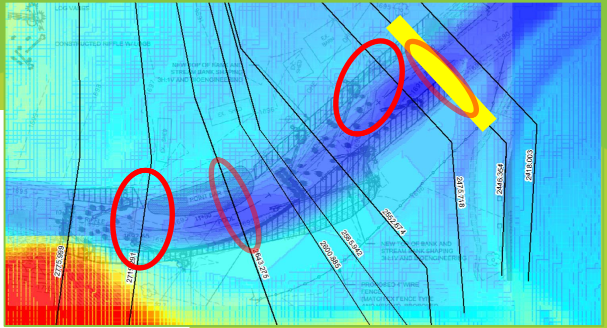
1692
1690
1688
1686
0
100
200
300
400
500
600
700
Station (ft)



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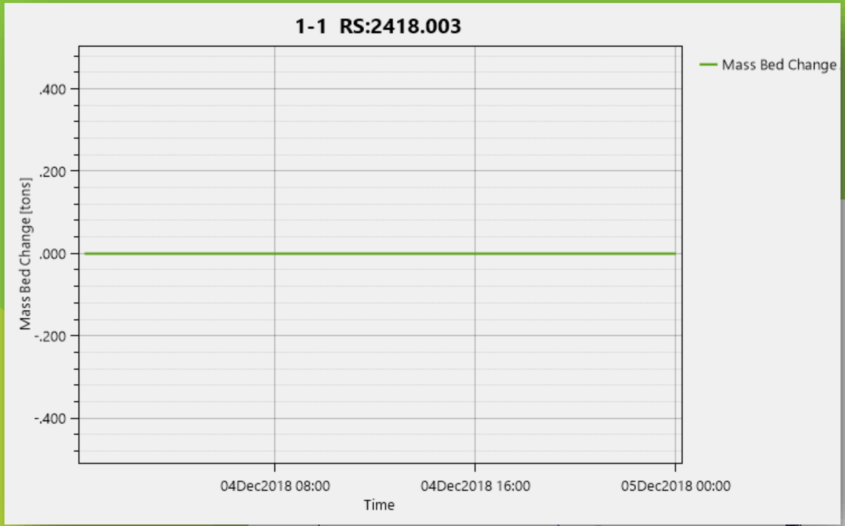
2418.003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Mass Bed Change [tons]
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.200
.000
-.200
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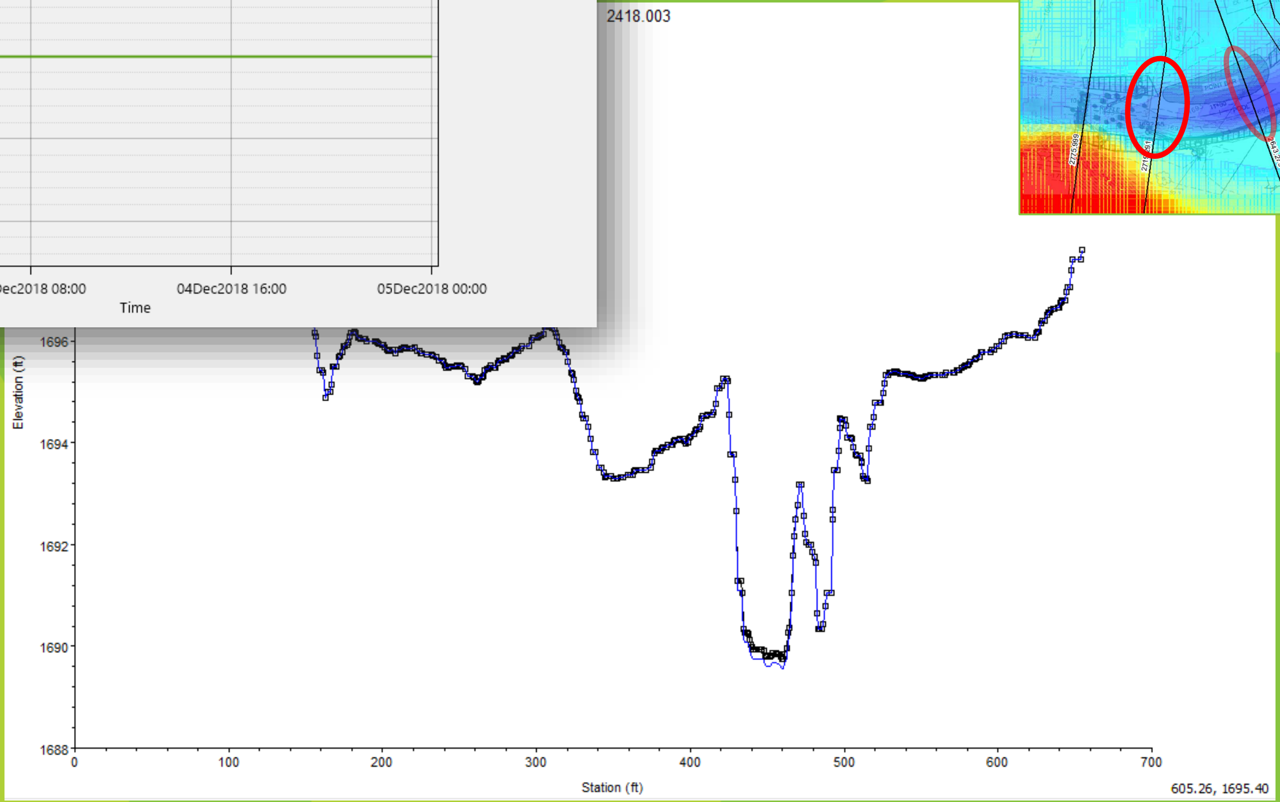
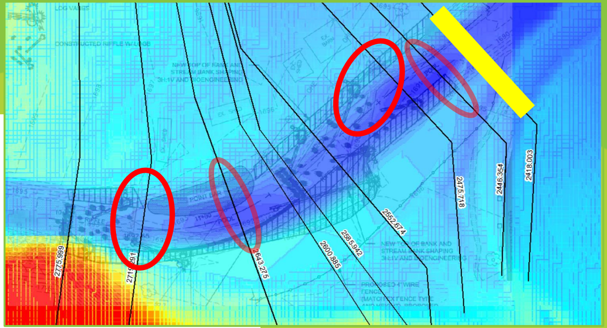
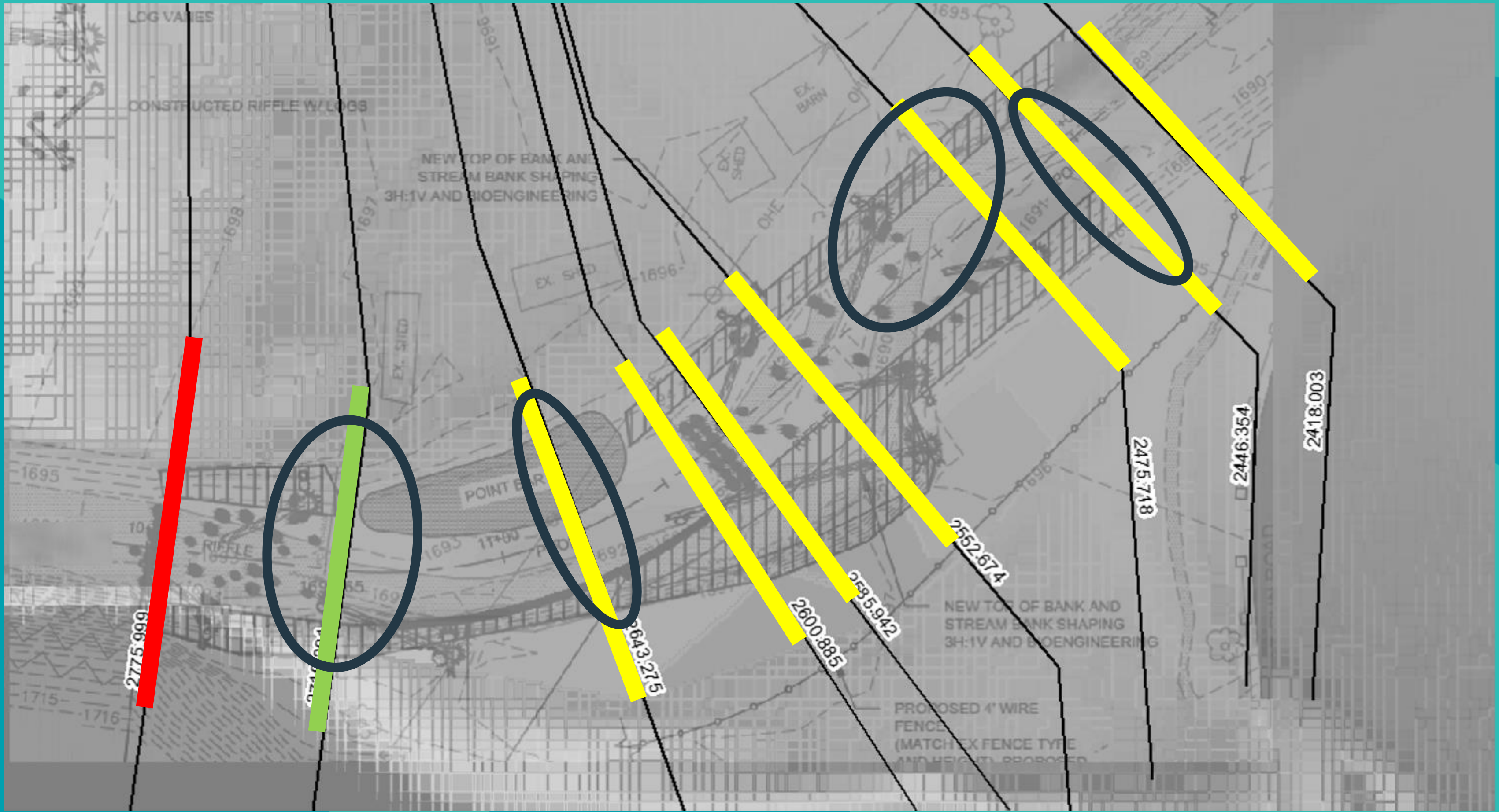
04Dec2018 08:00
04Dec2018 16:00
05Dec2018 00:00
Time


2418.003
Elevation (ft)
1696
1694
1692
1690
1688
0
100
200
300
400
500
600
700
Station (ft)
605.26, 1695.40


2418.003
2446.354
2475.718

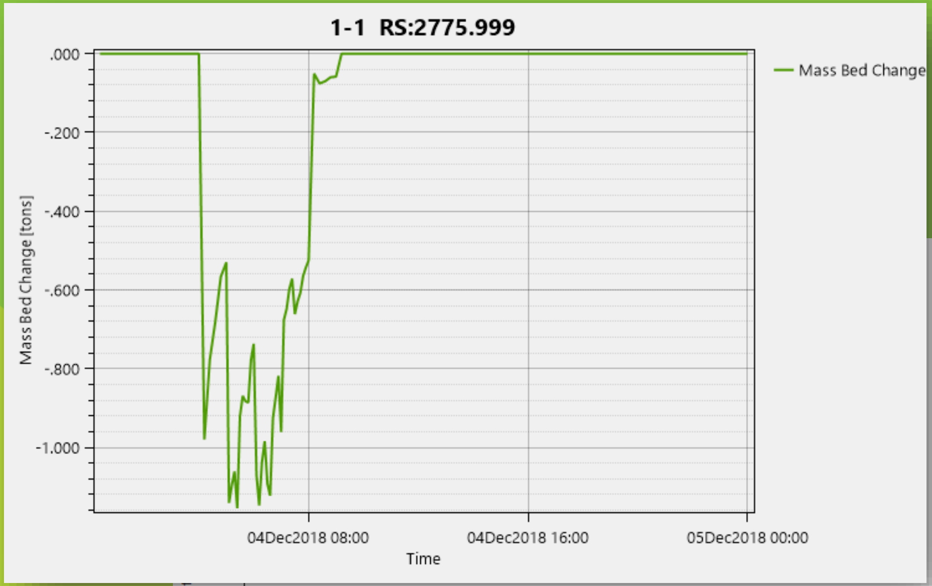
Plan View



LOG VANES
CONSTRUCTED RIFFLE W/ LOGS
NEW TOP OF BANK AND STREAM BANK SHAPING 3H:1V AND BIOENGINEERING
EX. SHED
POINT BAR
RIFFLE
11+00
EX. BARN
OHE
NEW TOP OF BANK AND STREAM BANK SHAPING 3H:1V AND BIOENGINEERING
PROPOSED 4' WIRE FENCE (MATCH EX FENCE TYPE
2775.999
2643.275
2600.885
2585.942
2552.674
2475.718
2446.354
2418.003

5

2775.999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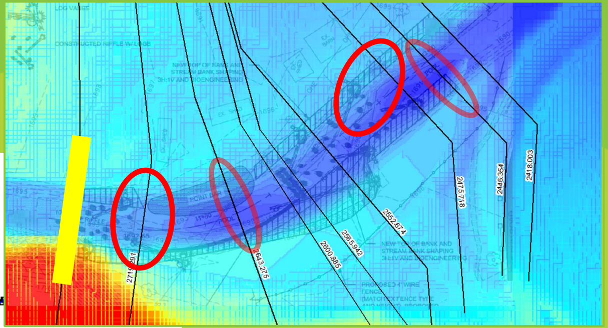
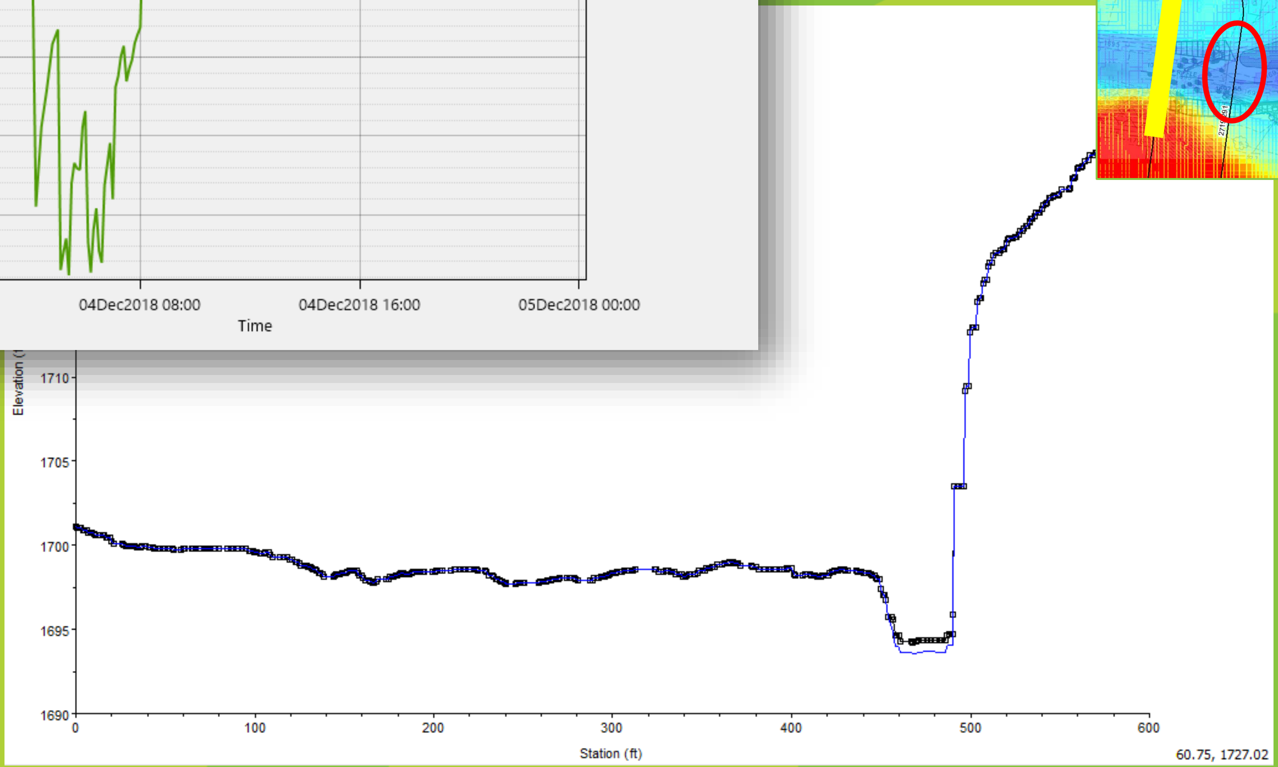
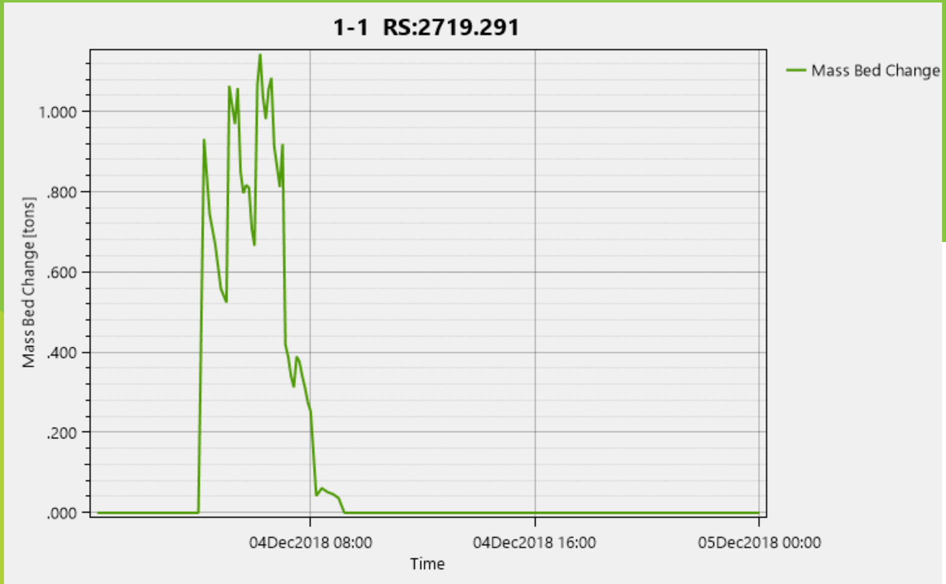
Mass Bed Change
Mass Bed Change [tons]
.000
-.200
-.400
-.600
-.800
-1.000
04Dec2018 08:00
04Dec2018 16:00
05Dec2018 00:00
Time




Elevation (
1710
1705
1700
1695
1690
0
100
200
300
400
500
600
Station (ft)
60.75, 1727.02


25

2719.291



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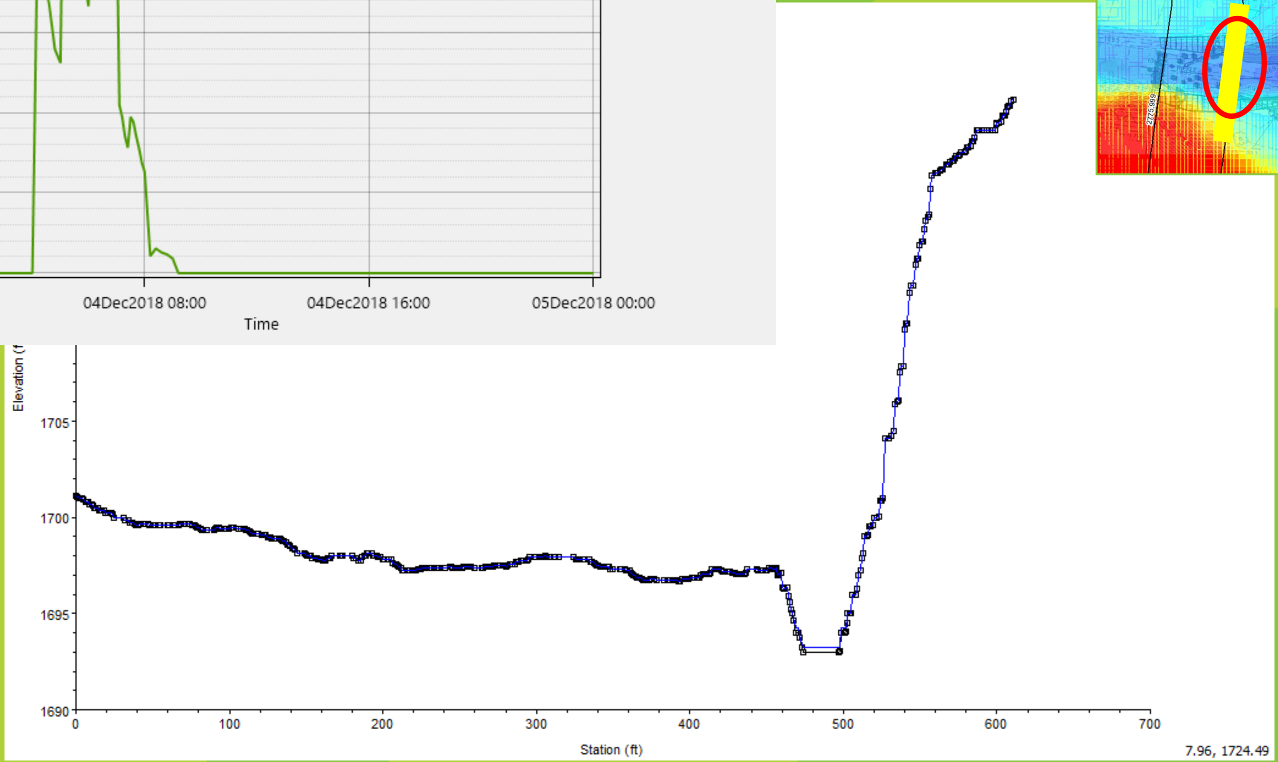
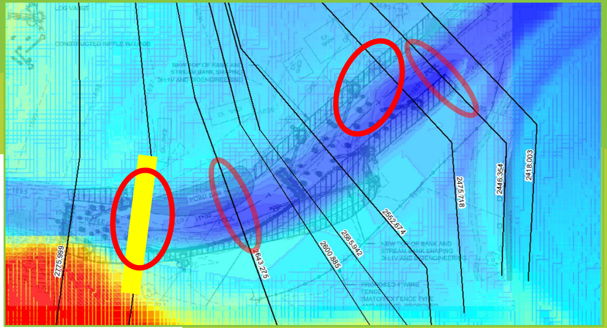
Mass Bed Change
Mass Bed Change [tons]
1.000
.800
.600
.400
.200
.000
04Dec2018 08:00
04Dec2018 16:00
05Dec2018 00:00
Time



Elevation (f
1705
1700
1695
1690
0
100
200
300
400
500
600
700
Station (ft)
7.96, 1724.49



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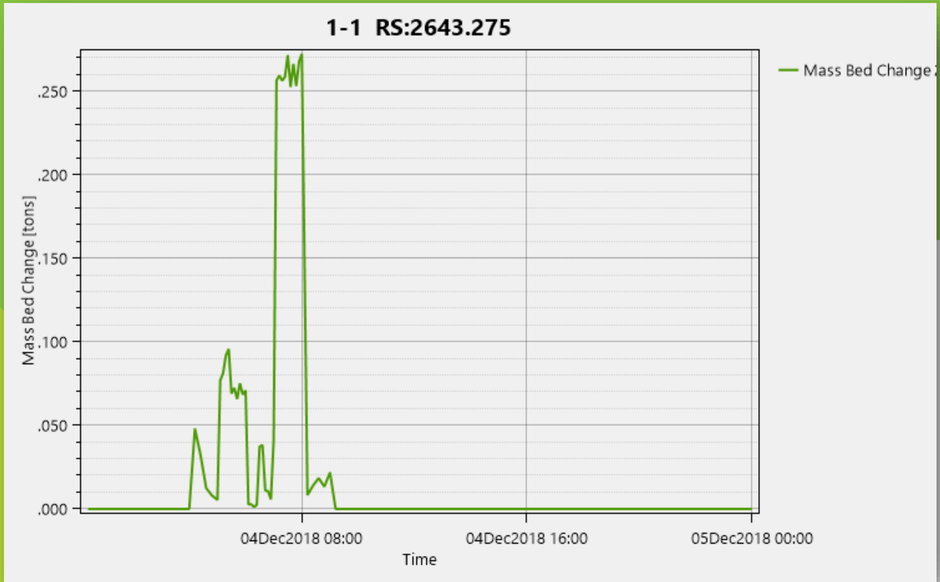
2643.275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Mass Bed Change
Mass Bed Change [tons]
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.200
.150
.100
.050
.000
04Dec2018 08:00
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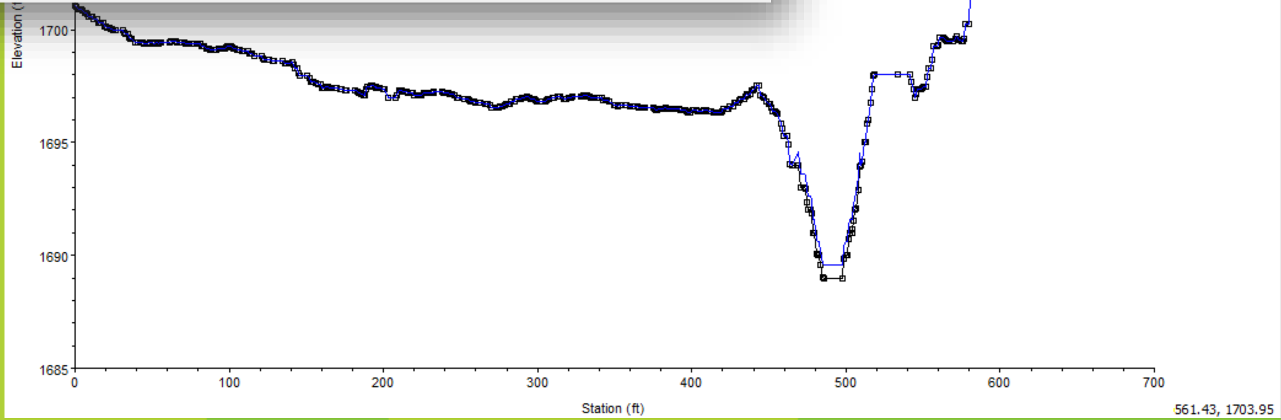
05Dec2018 00:00
Time


Elevation
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1690
1685
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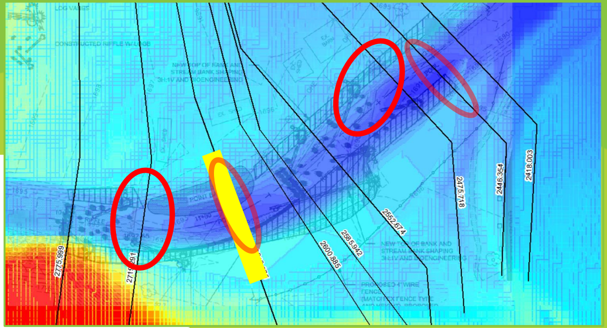
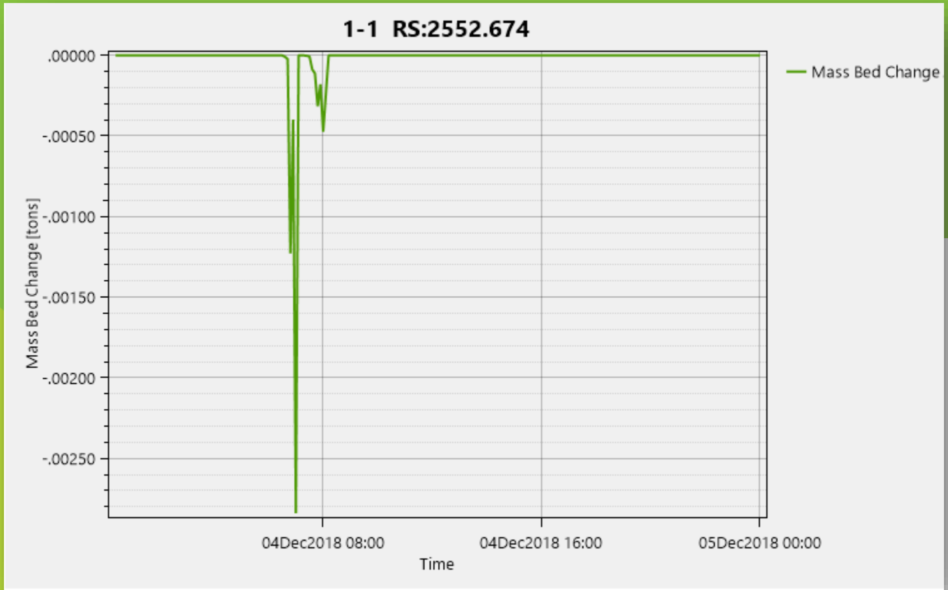
100
200
300
400
500
600
700
Station (ft)
561.43, 1703.95




25

2552.674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Mass Bed Change
Mass Bed Change [tons]
.00000
-.00050
-.00100
-.00150
-.00200
-.00250
04Dec2018 08:00
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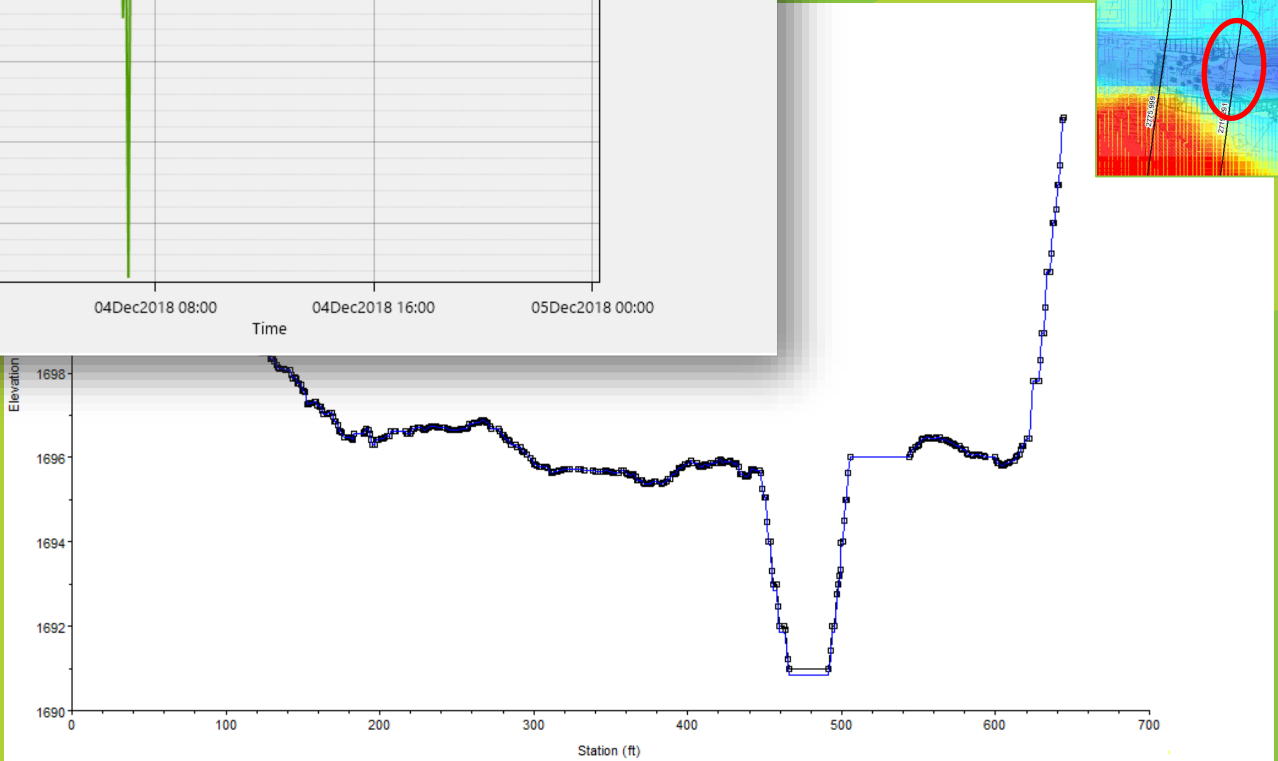
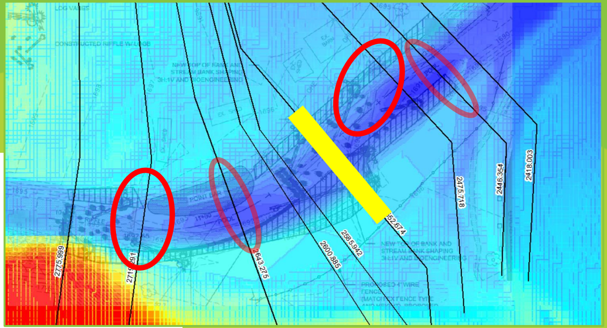
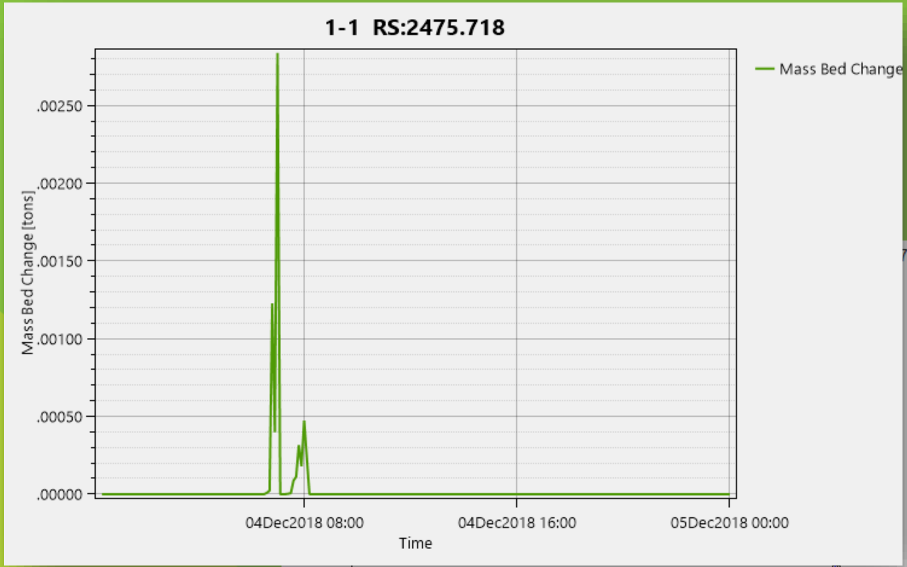
05Dec2018 00:00
Time


Elevation
1698
1696
1694
1692
1690
0
100
200
300
400
500
600
700
Station (ft)




25

2475.718



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Mass Bed Change
Mass Bed Change [tons]
.00250
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.00150
.00100
.00050
.00000
04Dec2018 08:00
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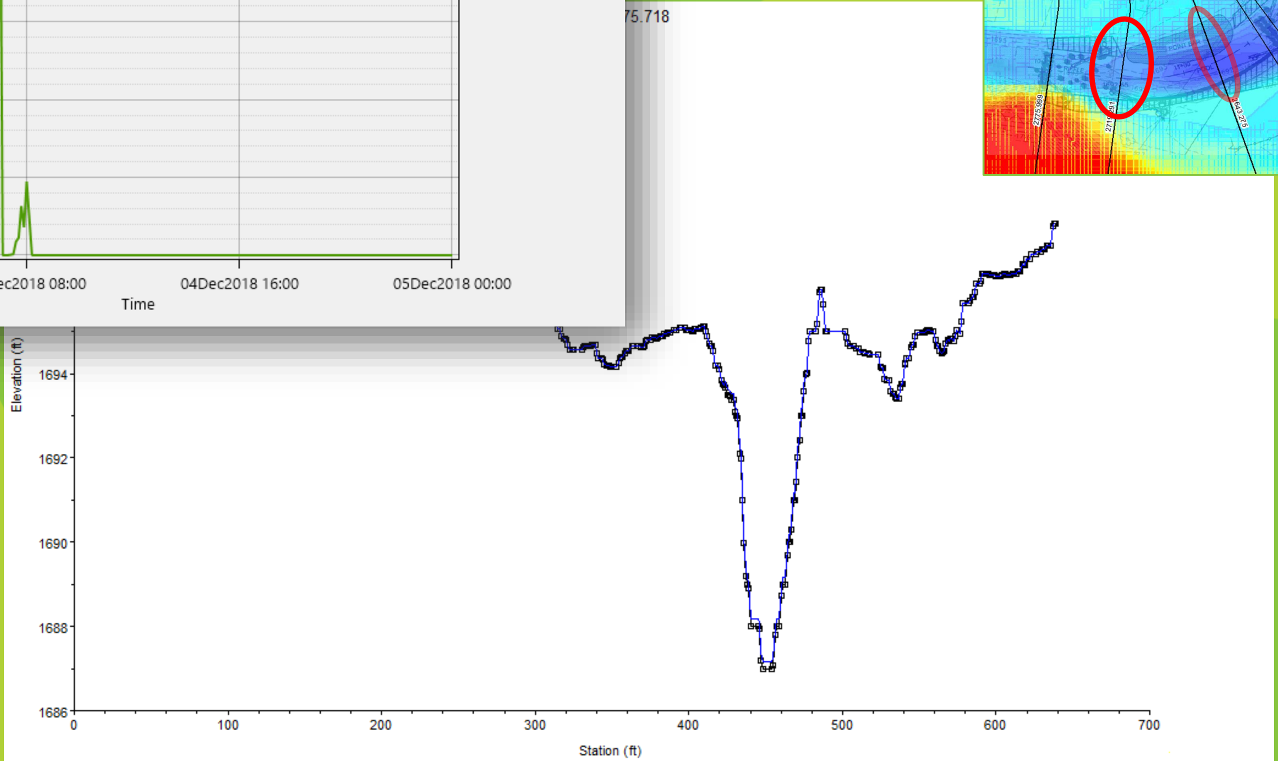
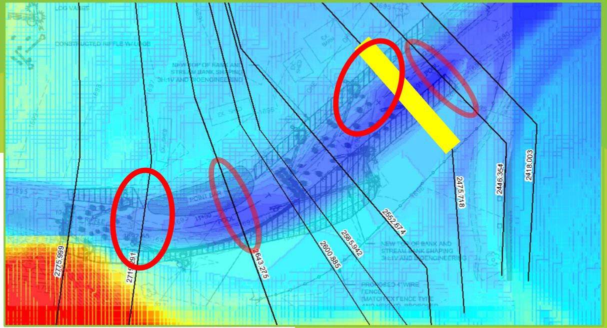
05Dec2018 00:00
Time



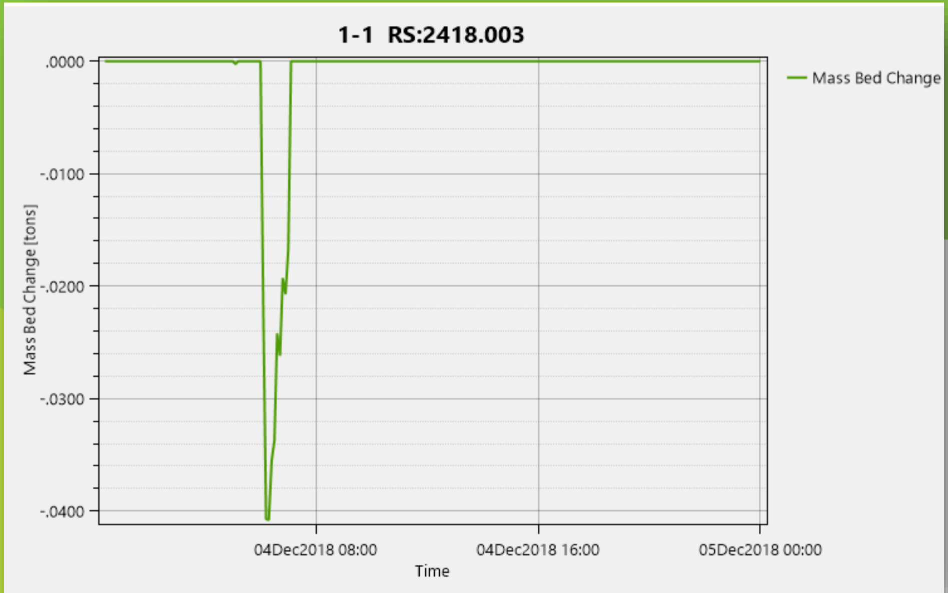
75.718
Elevation (ft)
1694
1692
1690
1688
1686
0
100
200
300
400
500
600
700
Station (ft)



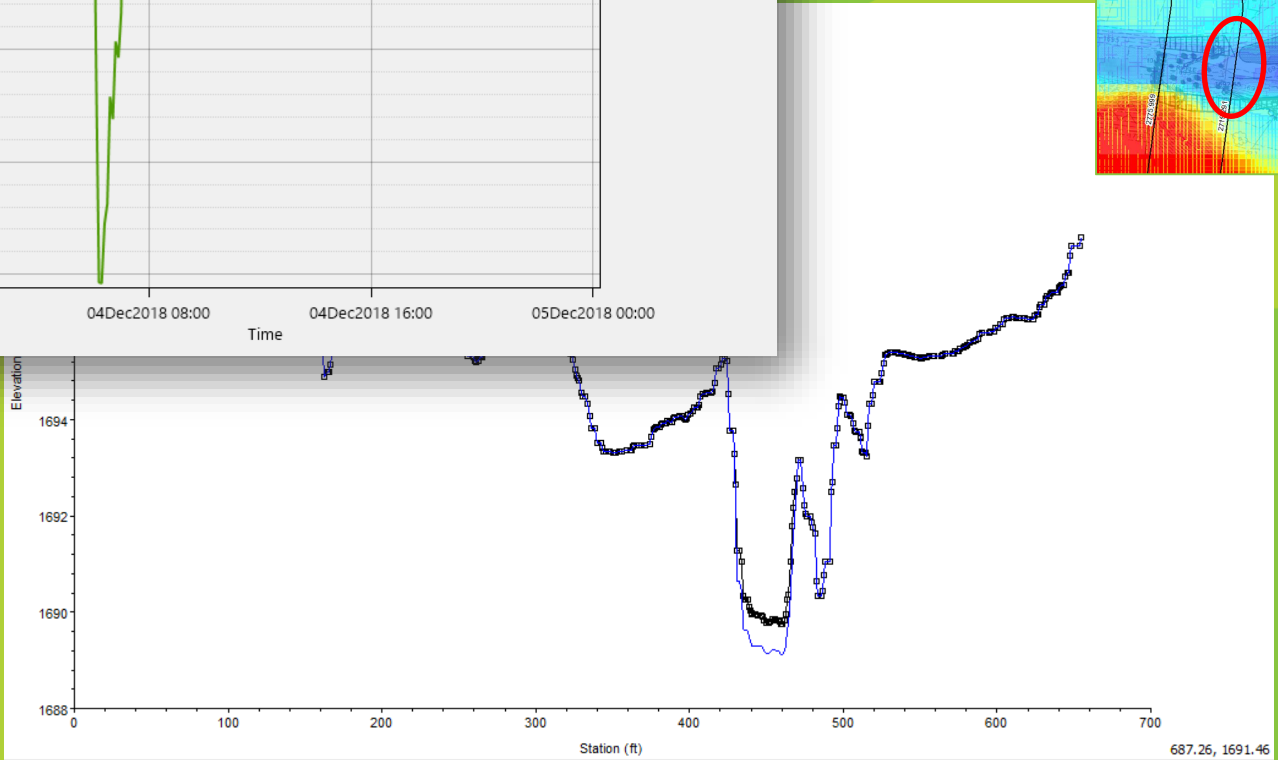
2475.718
2446.354
2418.003

25

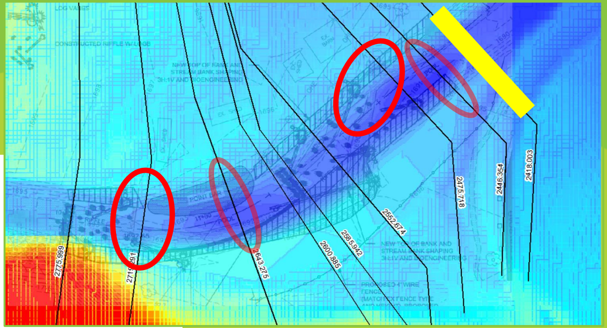
2418.003



1-1 RS:2418.003
Mass Bed Change [tons]
.0000
-.0100
-.0200
-.0300
-.0400
Mass Bed Change
04Dec2018 08:00
04Dec2018 16:00
05Dec2018 00:00
Time

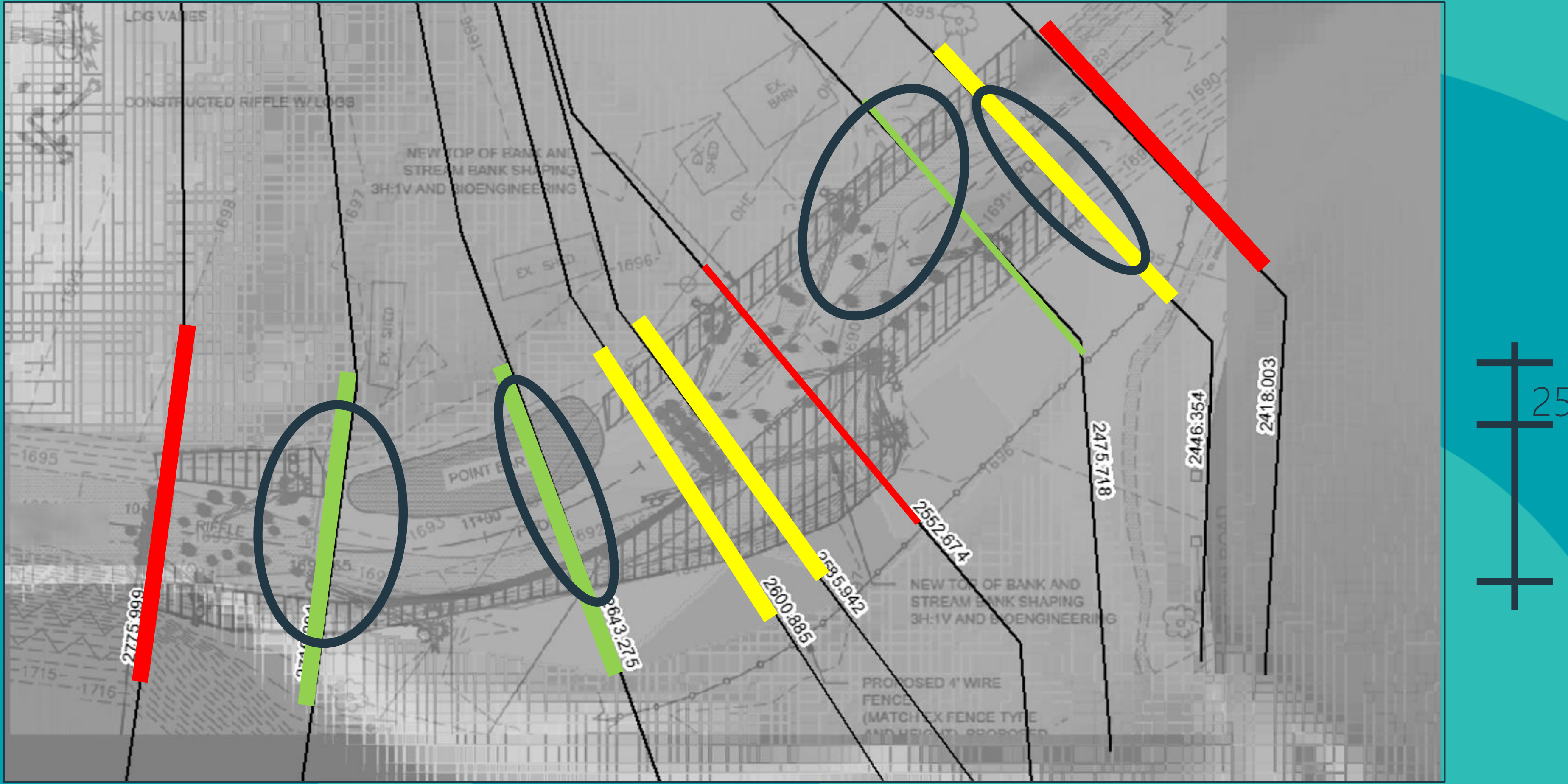


Elevation
1694
1692
1690
1688
0
100
200
300
400
500
600
700
Station (ft)
687.26, 1691.46



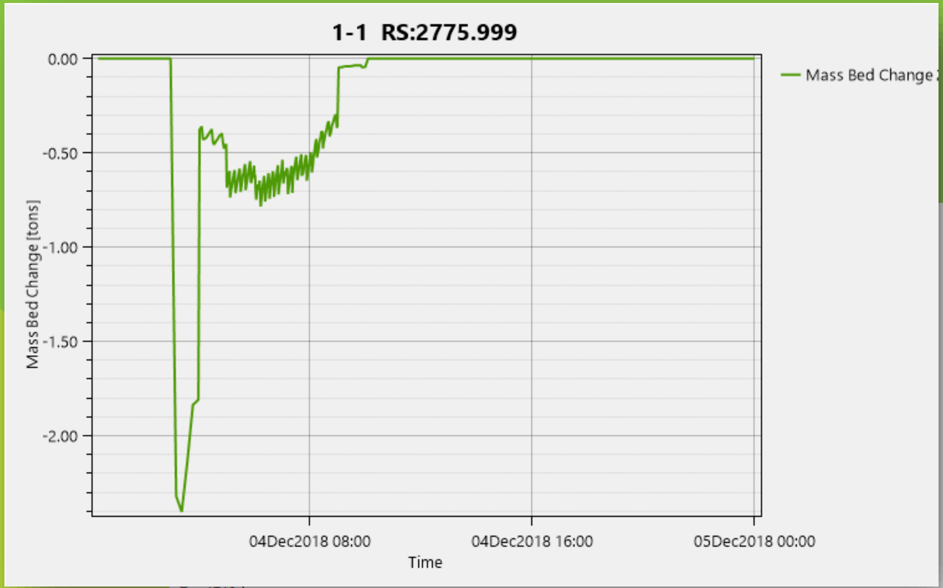
25

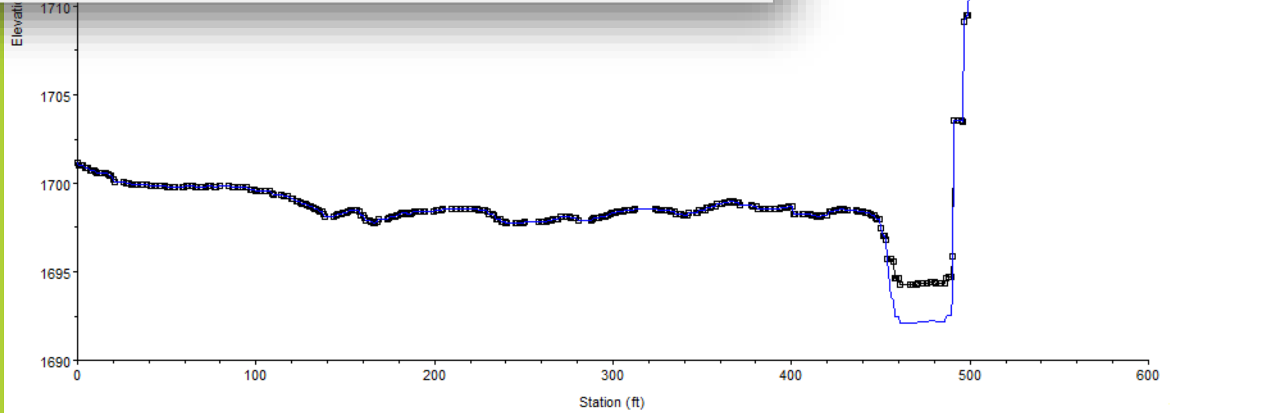
Plan View

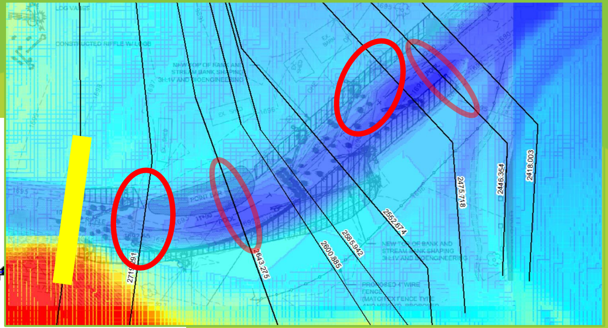


LOG VANES
CONSTRUCTED RIFFLE W/ LOGS
NEW TOP OF BANK AND STREAM BANK SHAPING 3H:1V AND BIOENGINEERING
EX. SHED
EX. BARN
POINT BAR
RIFFLE
11+00
NEW TOP OF BANK AND STREAM BANK SHAPING 3H:1V AND BIOENGINEERING
PROPOSED 4' WIRE FENCE
(MATCH EX FENCE TYPE
2775.999
2643.275
2600.885
2585.942
2552.674
2475.718
2446.354
2418.003
25

2775.999

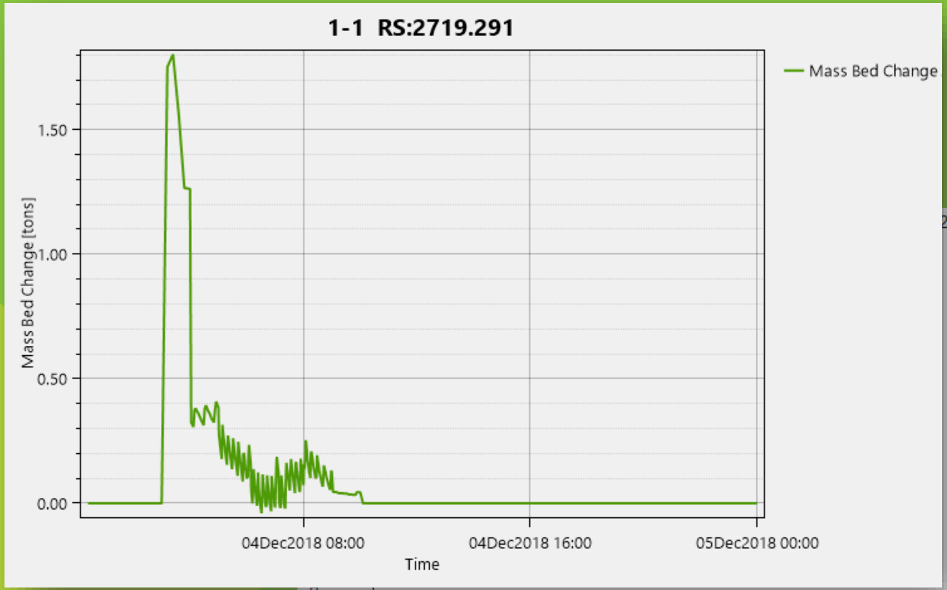

1-1 RS:2775.999
Mass Bed Change [tons]
0.00
-0.50
-1.00
-1.50
-2.00
04Dec2018 08:00
04Dec2018 16:00
05Dec2018 00:00
Time
Mass Bed Change


1710
1705
1700
1695
1690
0
100
200
300
400
500
600
Station (ft)

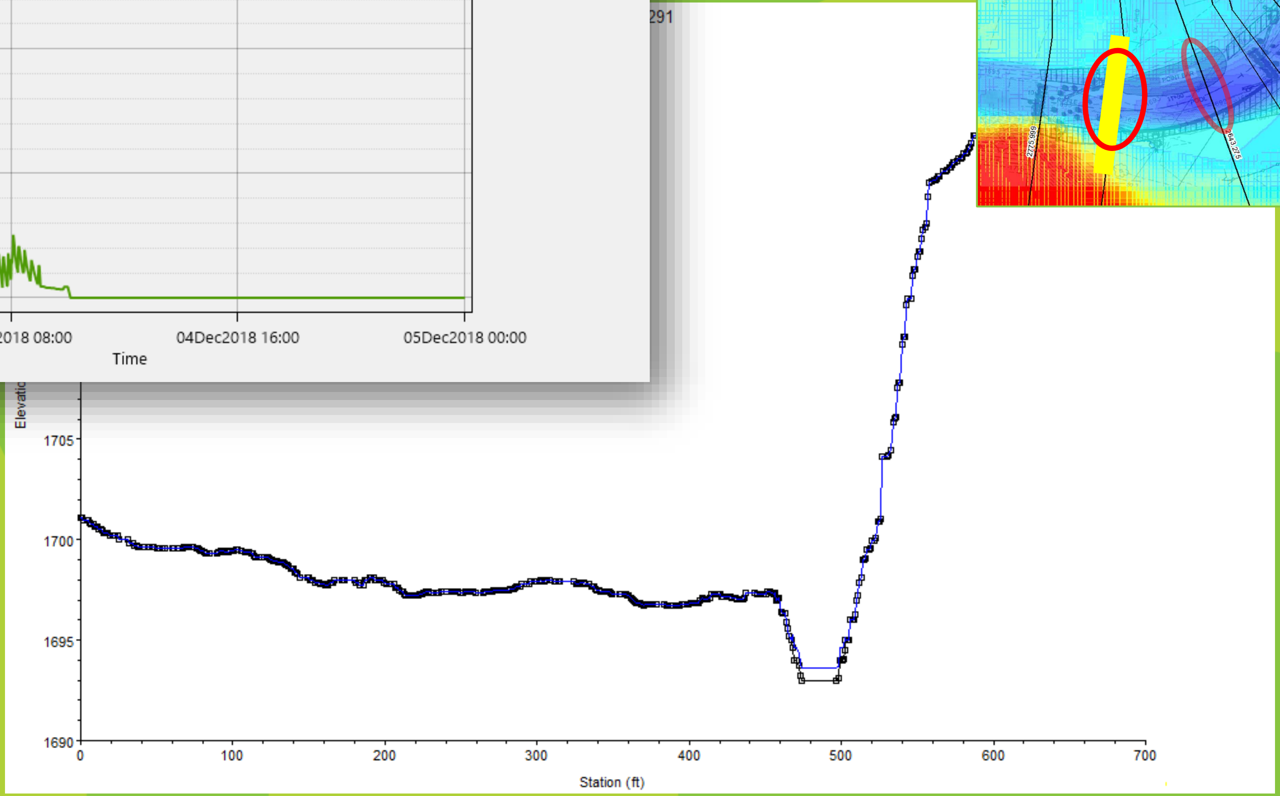


100

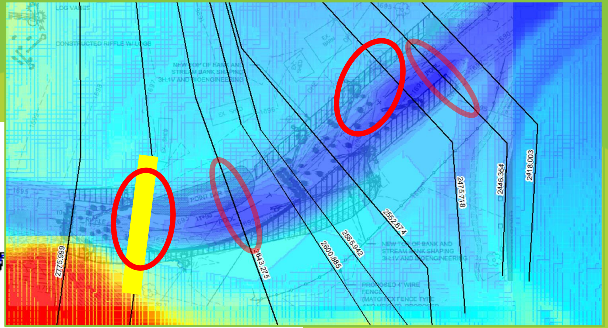
2719.291



1-1 RS:2719.291
Mass Bed Change
Mass Bed Change [tons]
1.50
1.00
0.50
0.00
04Dec2018 08:00
04Dec2018 16:00
05Dec2018 00:00
Time

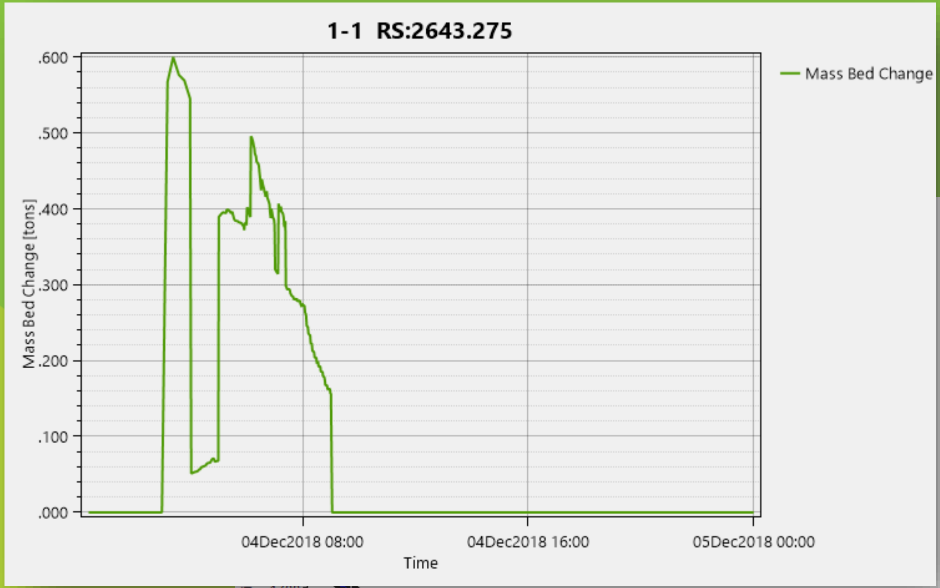


Elevation
1705
1700
1695
1690
0
100
200
300
400
500
600
700
Station (ft)

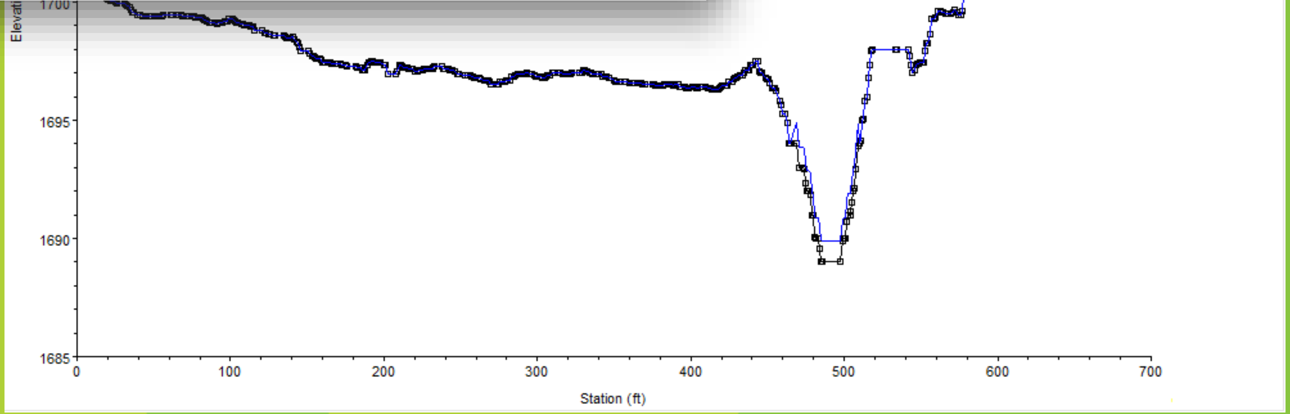


100

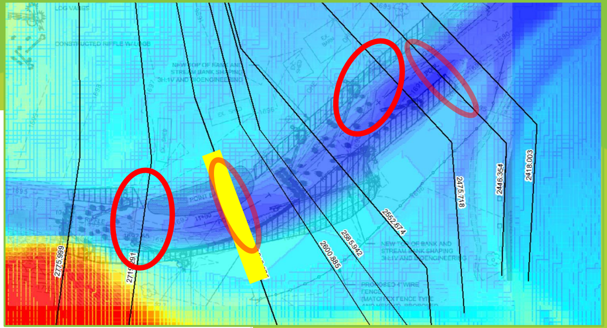
2643.275



1-1 RS:2643.275
Mass Bed Change
Mass Bed Change [tons]
.600
.500
.400
.300
.200
.100
.000
04Dec2018 08:00
04Dec2018 16:00
05Dec2018 00:00
Time

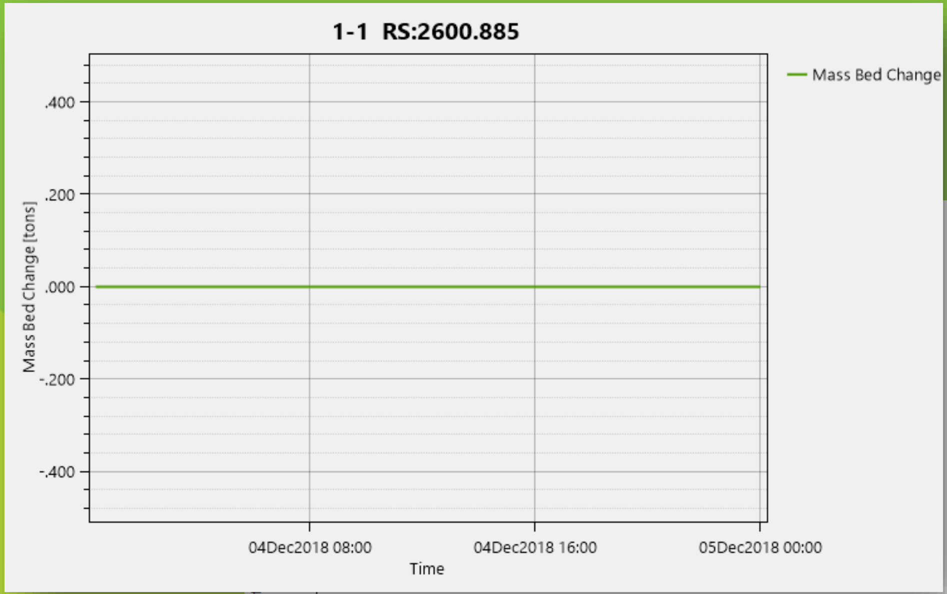


Elevati
1700
1695
1690
1685
0
100
200
300
400
500
600
700
Station (ft)

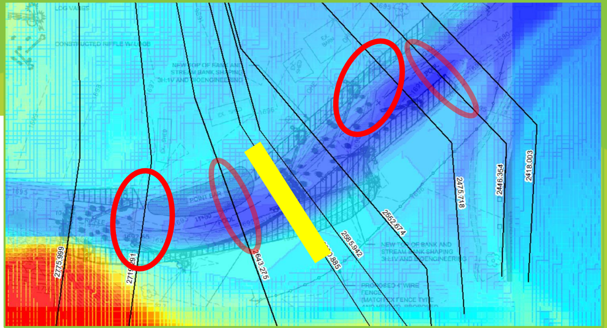


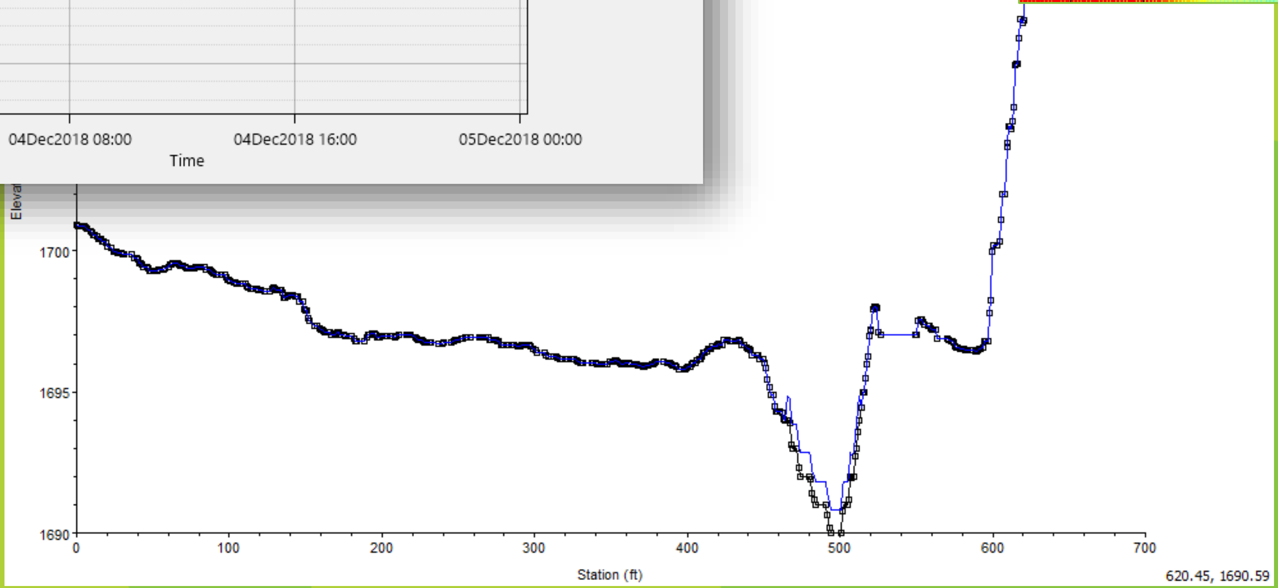
100

2600.885



1-1 RS:2600.885
Mass Bed Change
Mass Bed Change [tons]
.400
.200
.000
-.200
-.400
04Dec2018 08:00
04Dec2018 16:00
05Dec2018 00:00
Time

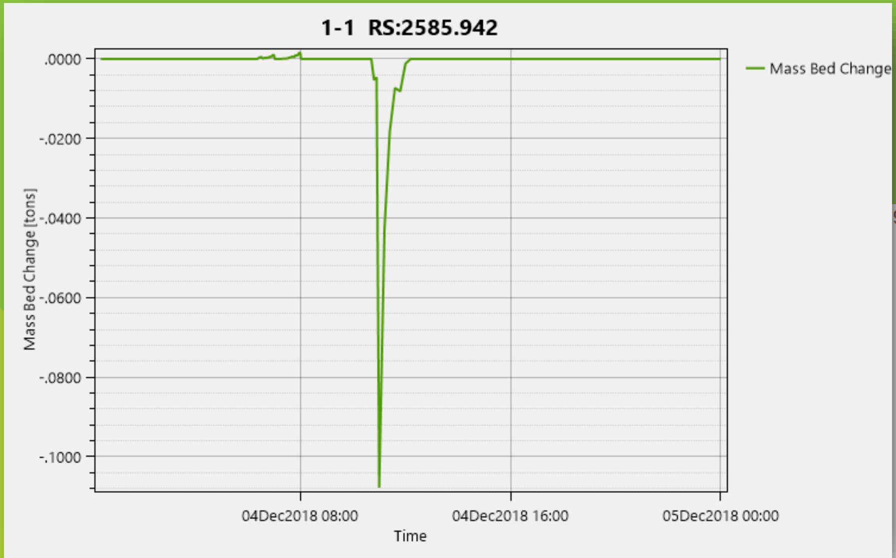


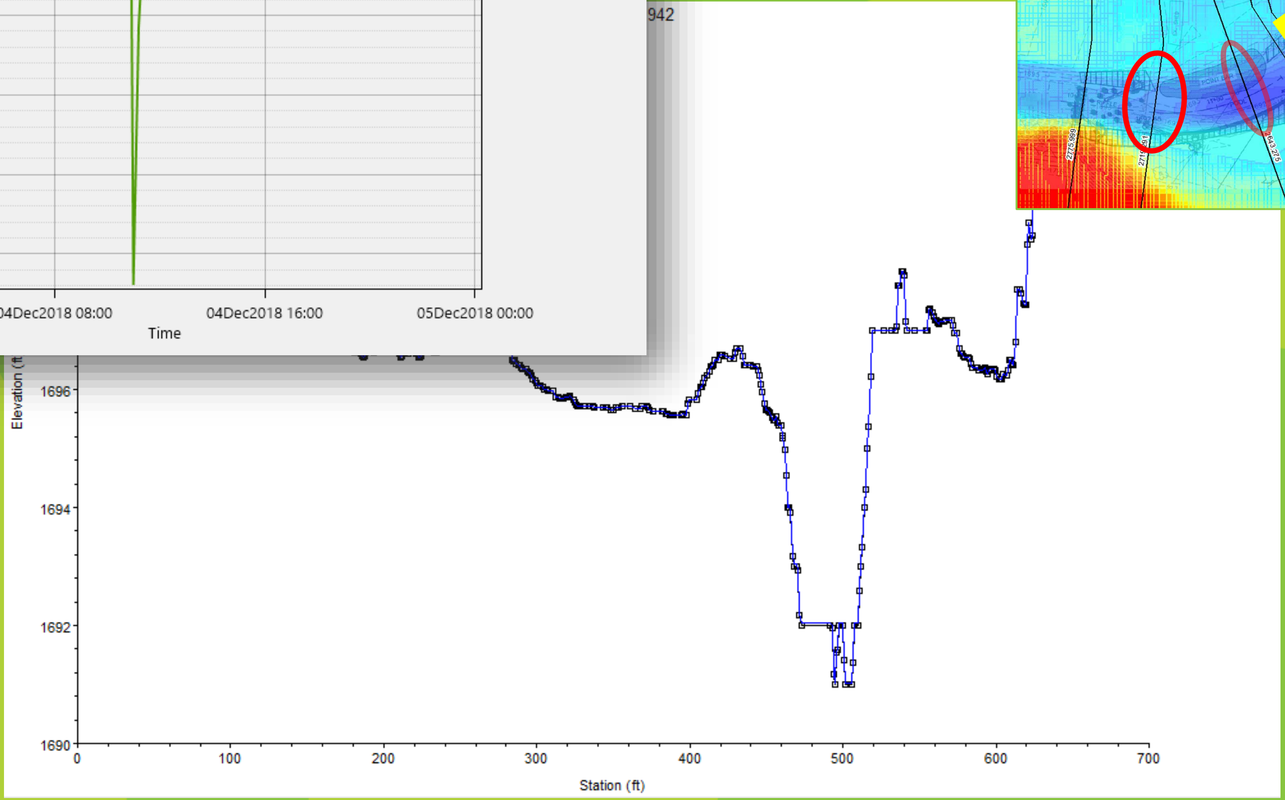


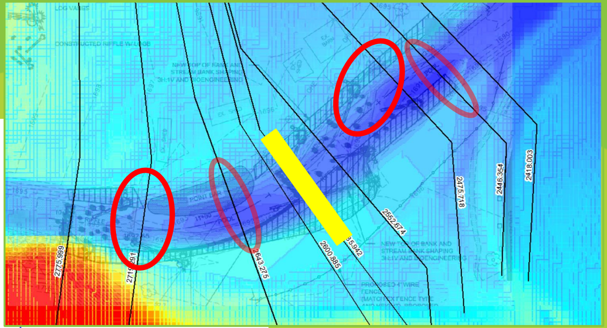
1700
1695
1690
0
100
200
300
400
500
600
700
Station (ft)
620.45, 1690.59

100

2585.942

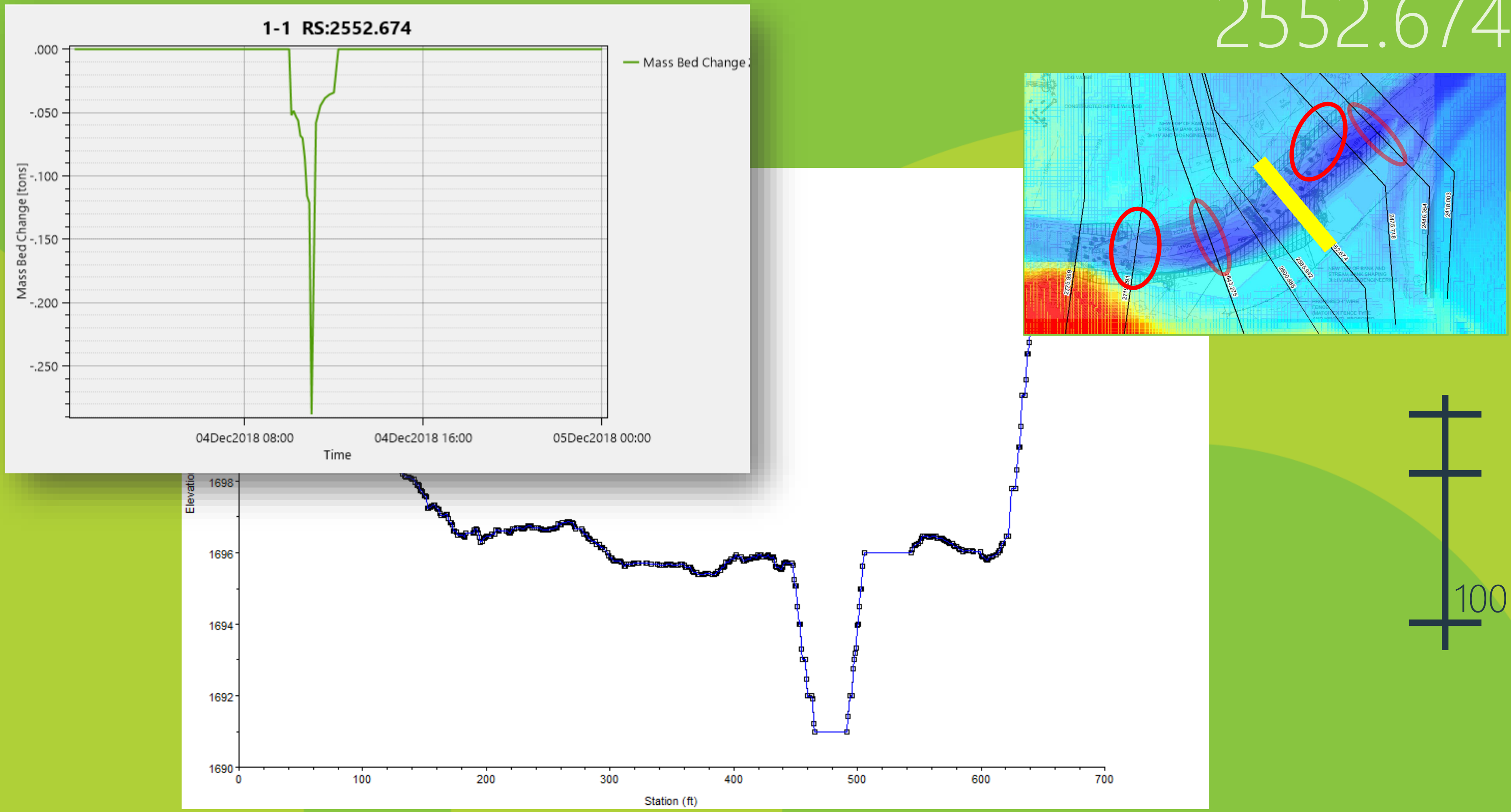

1-1 RS:2585.942
Mass Bed Change
Mass Bed Change [tons]
.0000
-.0200
-.0400
-.0600
-.0800
-.1000
04Dec2018 08:00
04Dec2018 16:00
05Dec2018 00:00
Time


942
Elevation (ft
1696
1694
1692
1690
0
100
200
300
400
500
600
700
Station (ft)

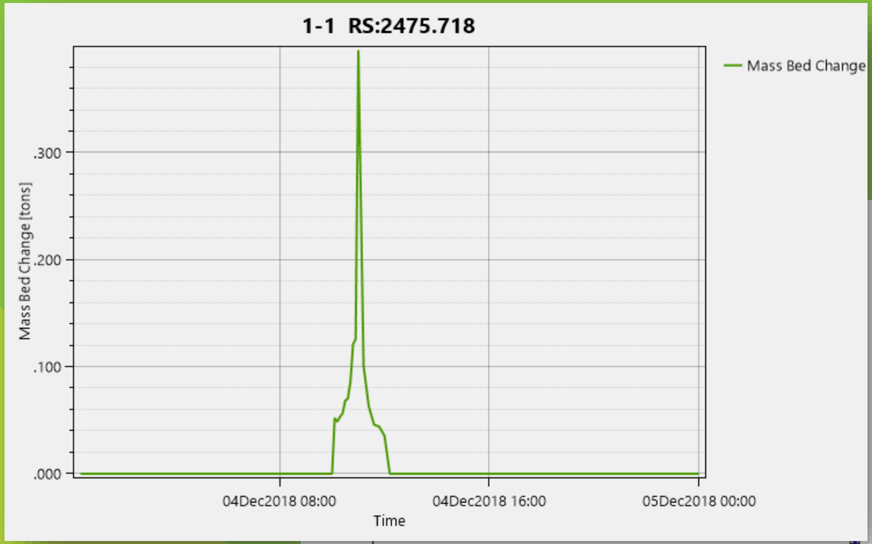



100

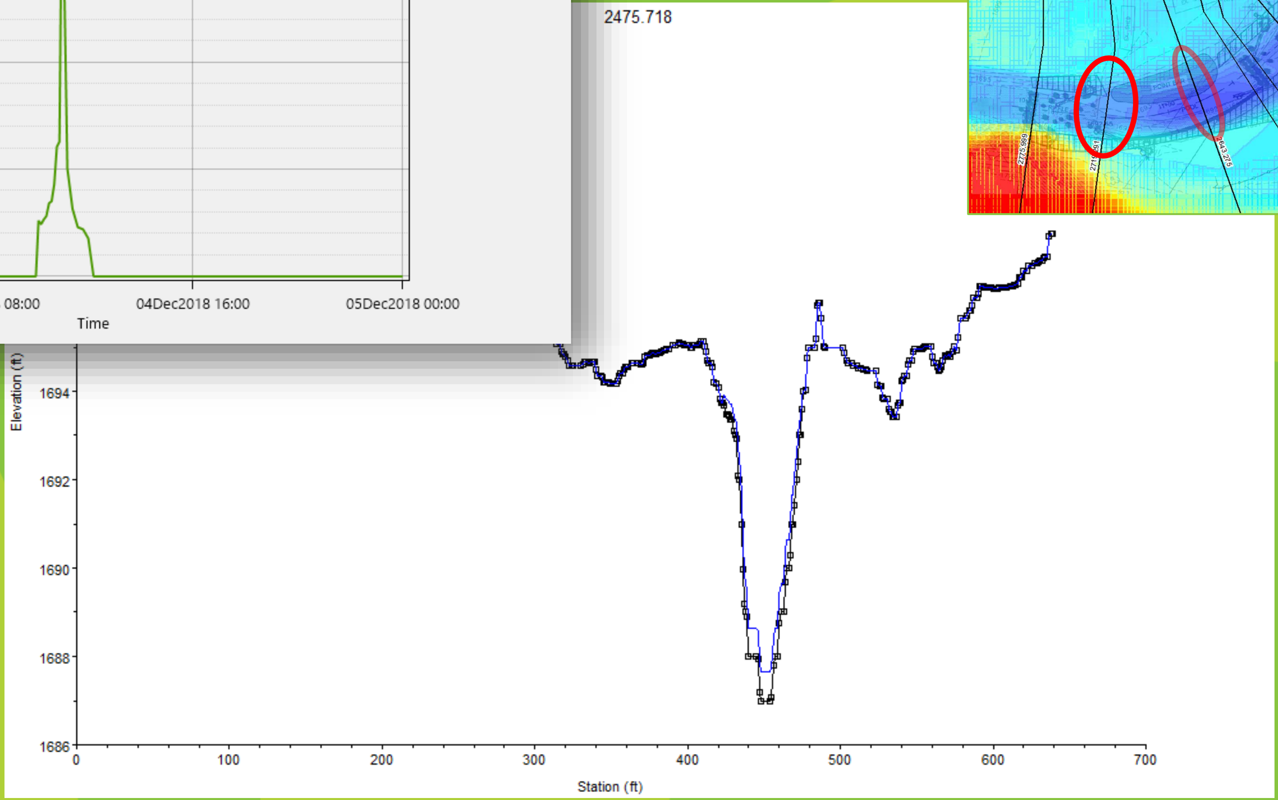
2552.674


1-1 RS:2552.674
Mass Bed Change [tons]
Mass Bed Change
Time
04Dec2018 08:00
04Dec2018 16:00
05Dec2018 00:00
.000
-.050
-.100
-.150
-.200
-.250
Station (ft)
1698
1696
1694
1692
1690
0
100
200
300
400
500
600
700
100

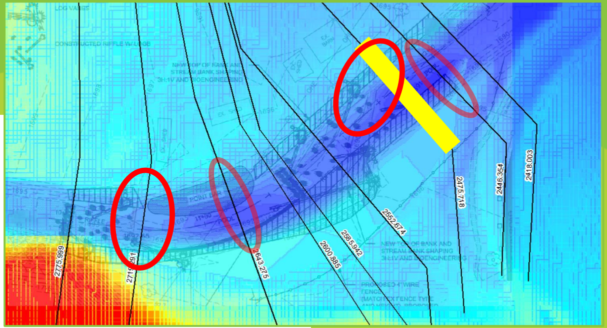
2475.718



1-1 RS:2475.718
Mass Bed Change
Mass Bed Change [tons]
.300
.200
.100
.000
04Dec2018 08:00
04Dec2018 16:00
05Dec2018 00:00
Time



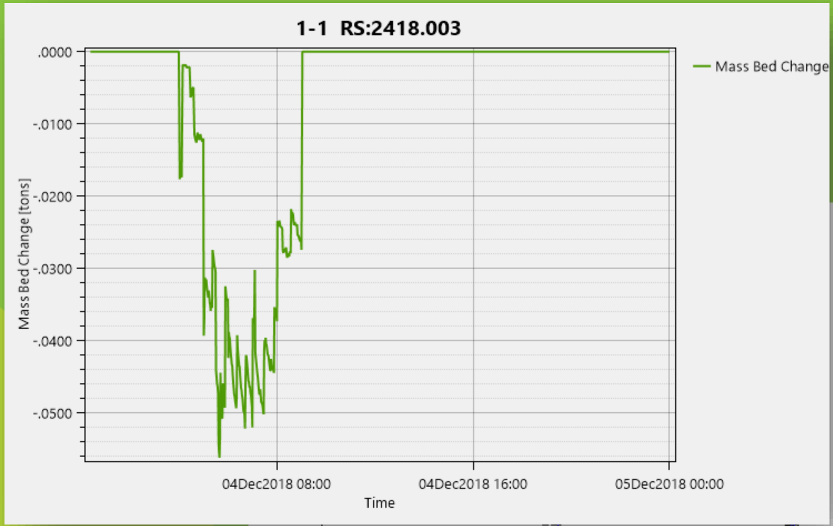
2475.718
Elevation (ft)
1694
1692
1690
1688
1686
0
100
200
300
400
500
600
700
Station (ft)



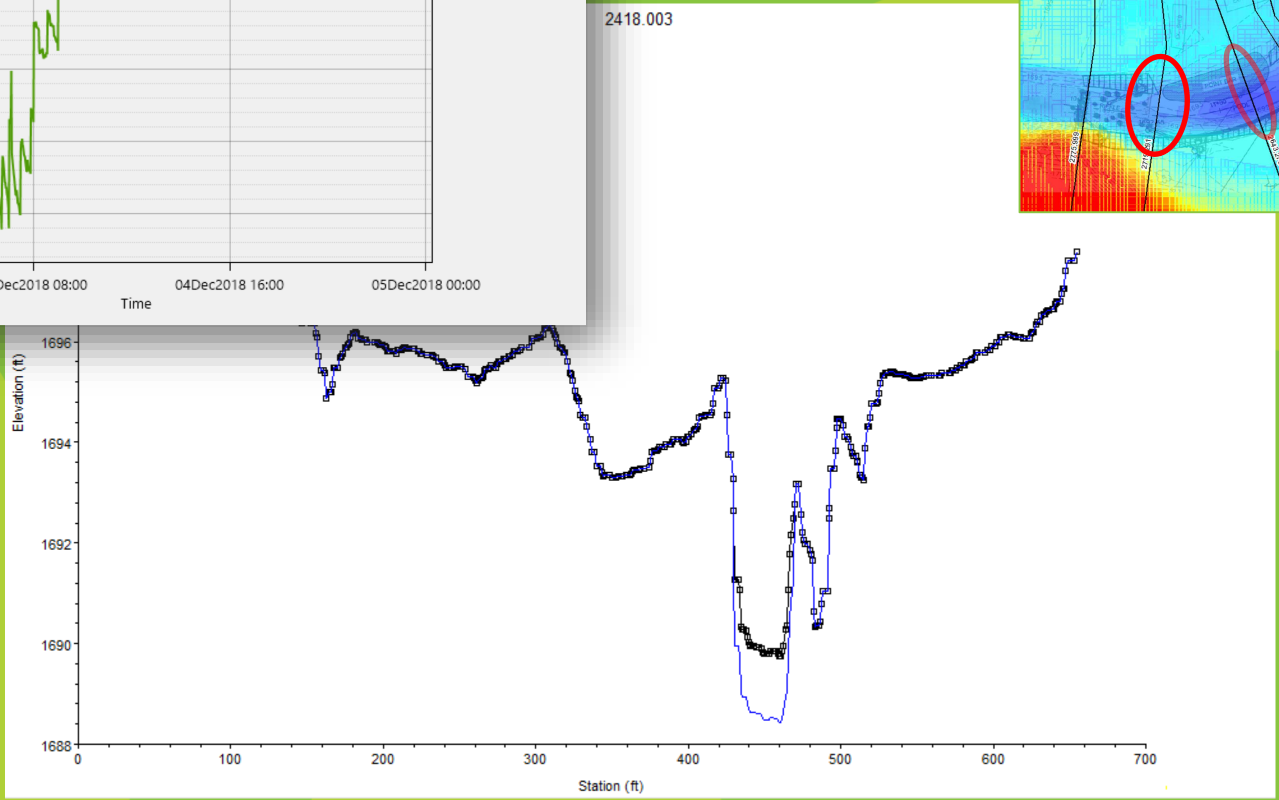
2475.718
2446.354
2418.003

100

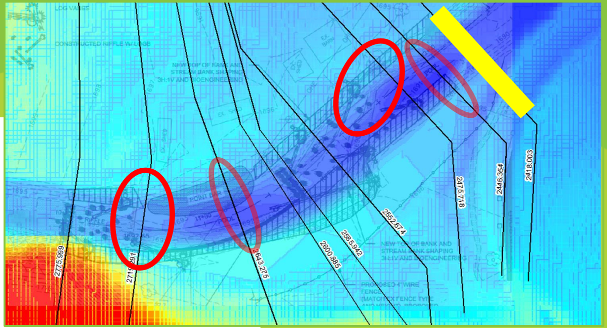
2418.003



1-1 RS:2418.003
Mass Bed Change
Mass Bed Change [tons]
.0000
-.0100
-.0200
-.0300
-.0400
-.0500
04Dec2018 08:00
04Dec2018 16:00
05Dec2018 00:00
Time

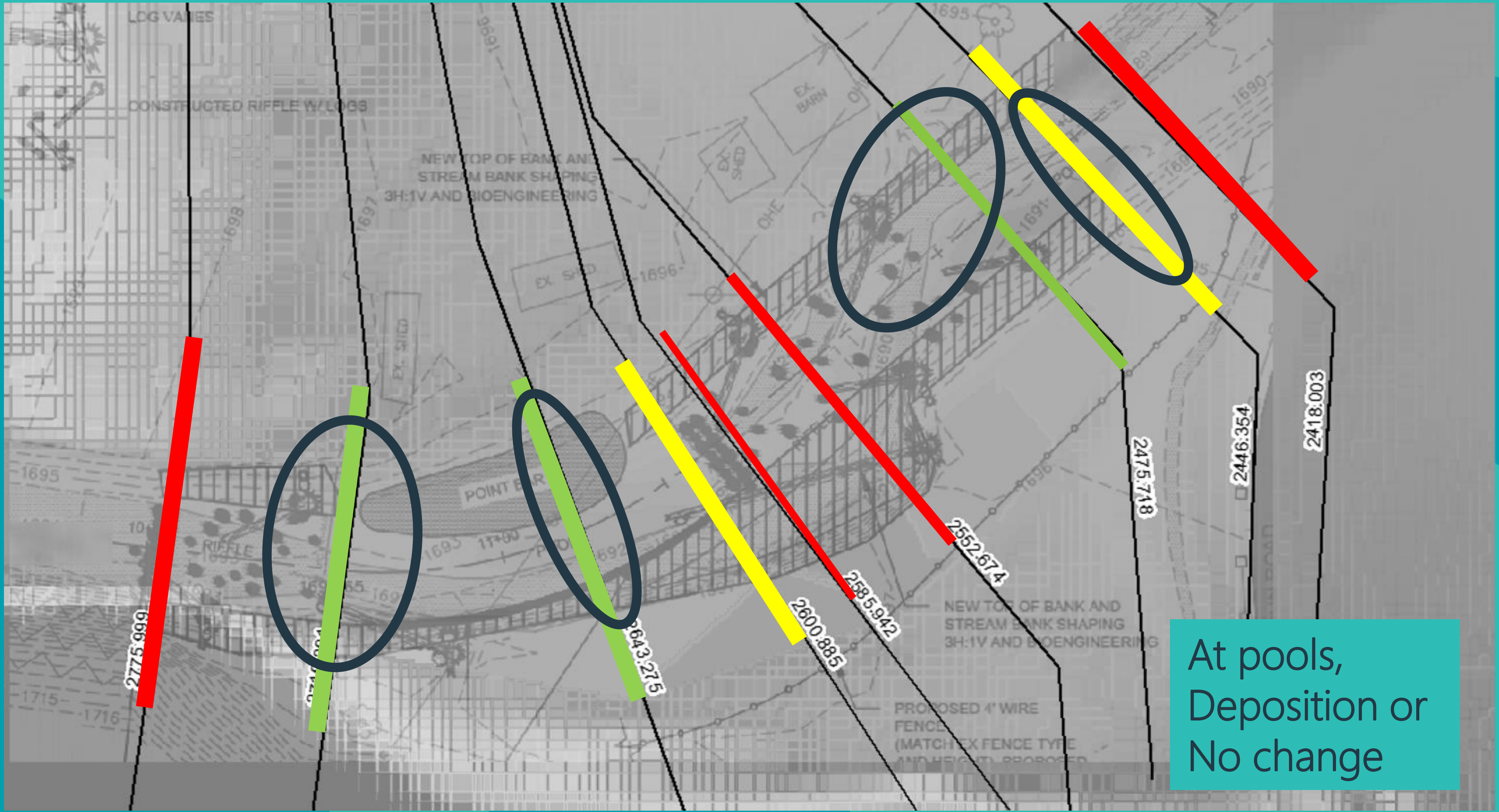


2418.003
Elevation (ft)
1696
1694
1692
1690
1688
0
100
200
300
400
500
600
700
Station (ft)



100

Plan View



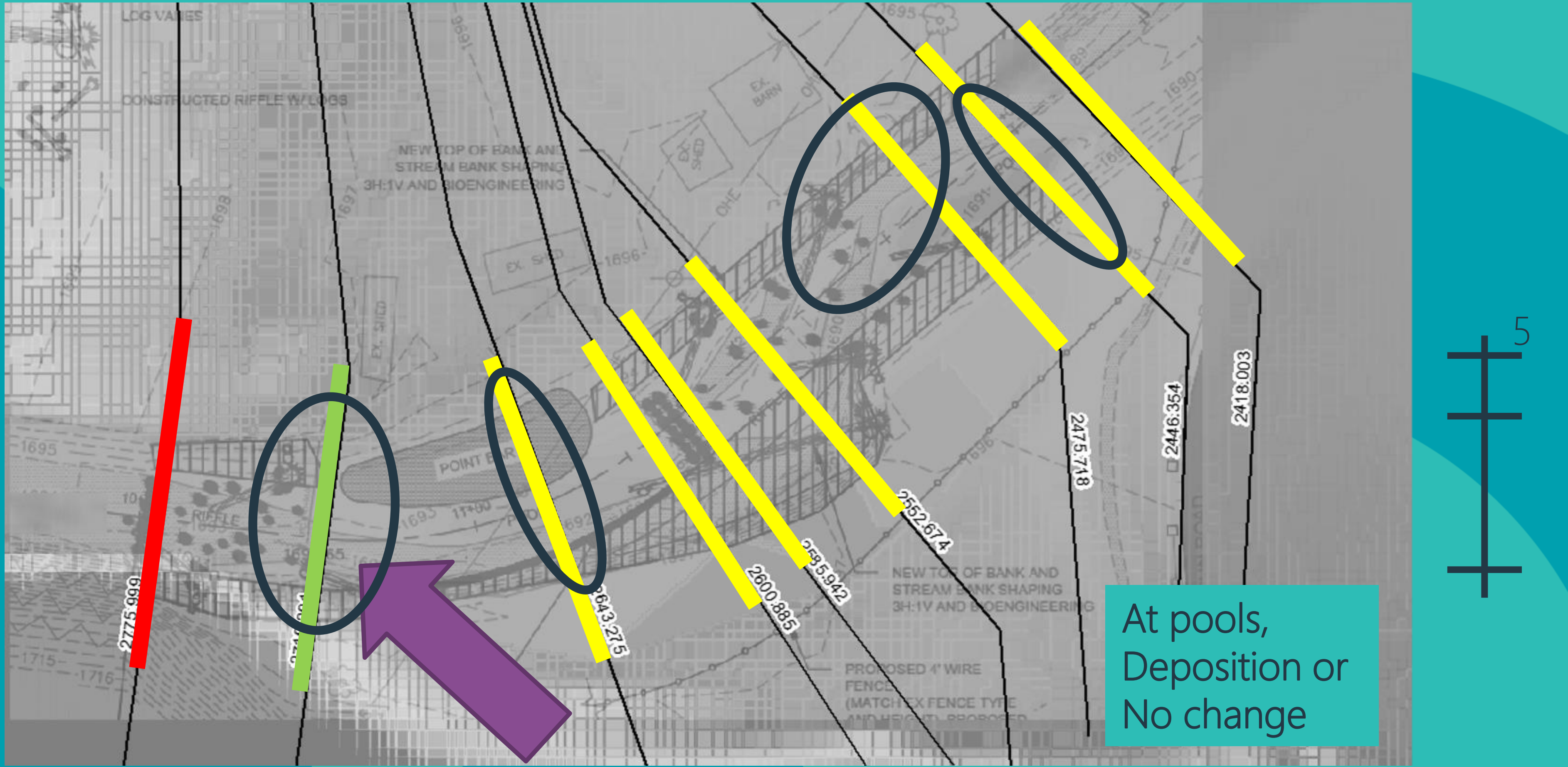
At pools, Deposition or No change

100

Plan View

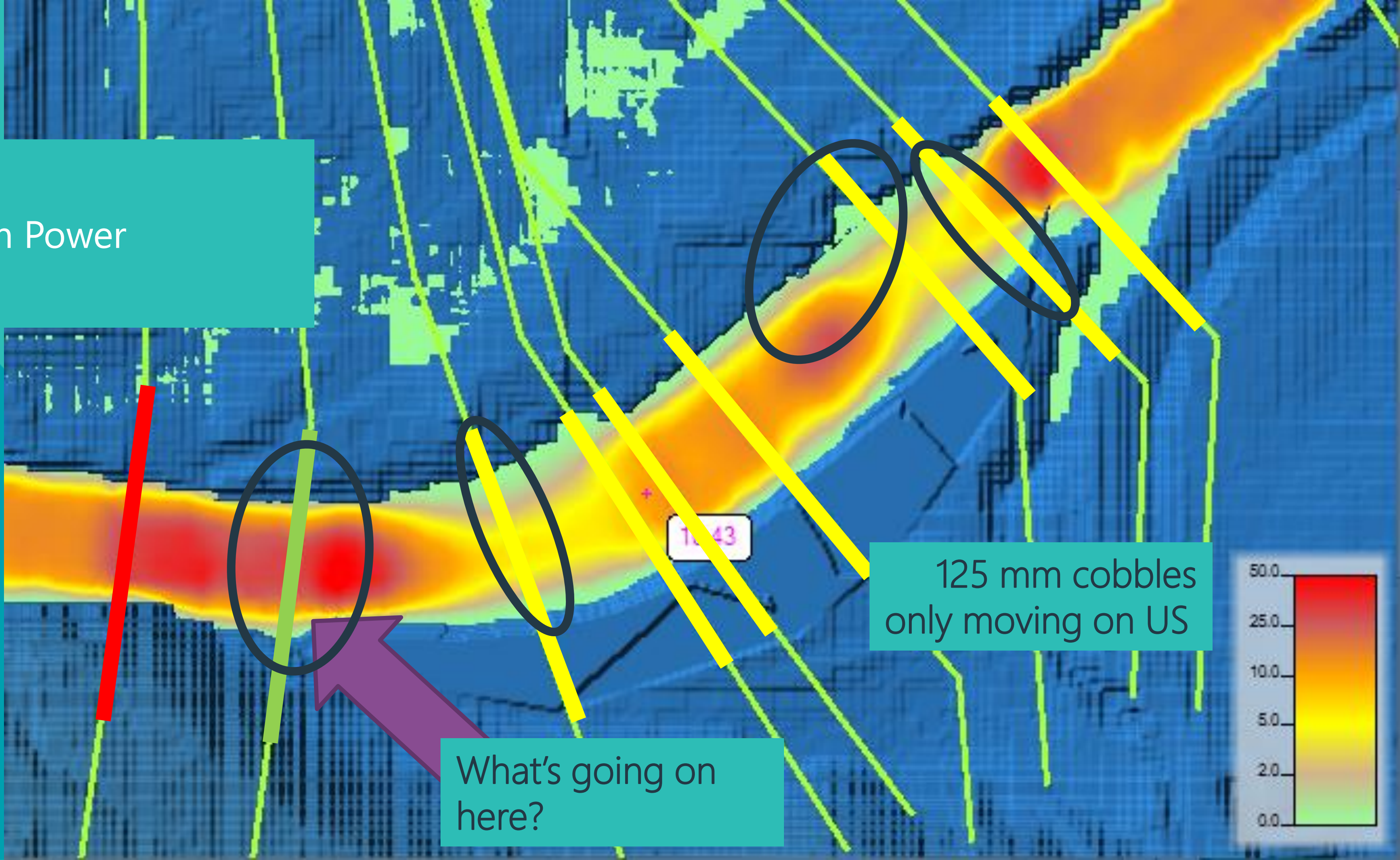
At pools,
Deposition or
No change

Plan View



At pools, Deposition or No change

Stream Power

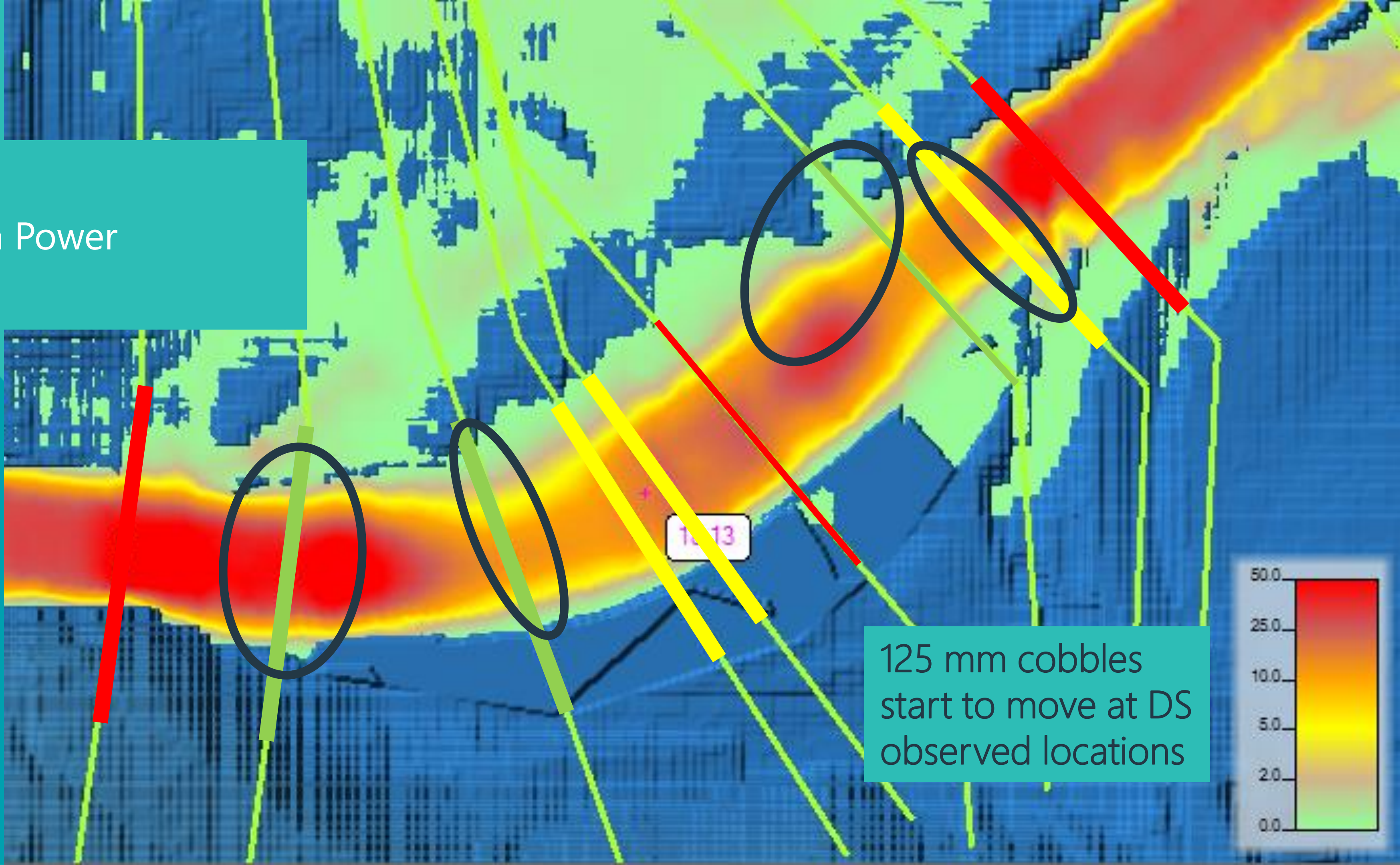


125 mm cobbles only moving on US

What's going on here?

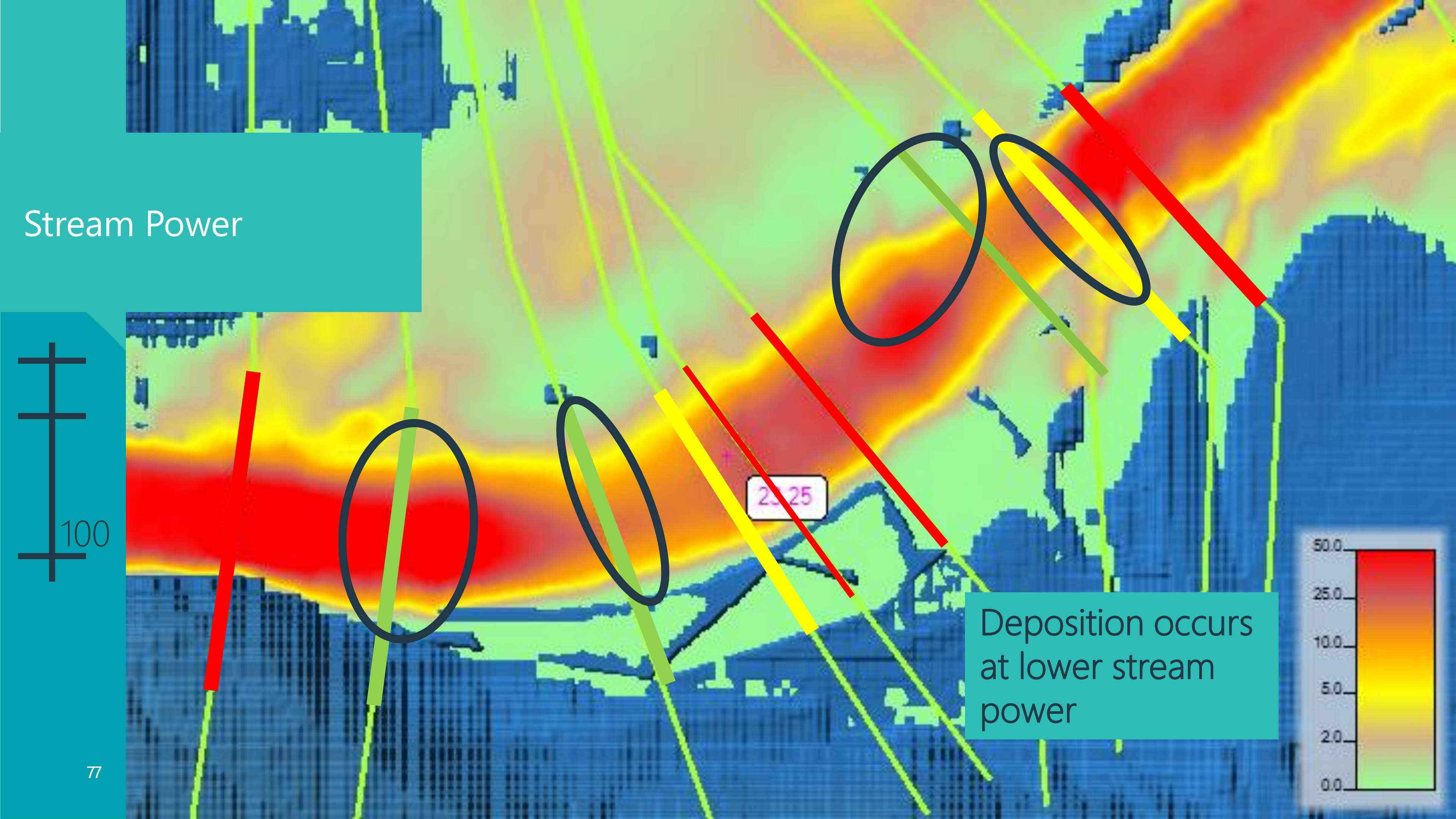
Stream Power

25



125 mm cobbles start to move at DS observed locations

Stream Power

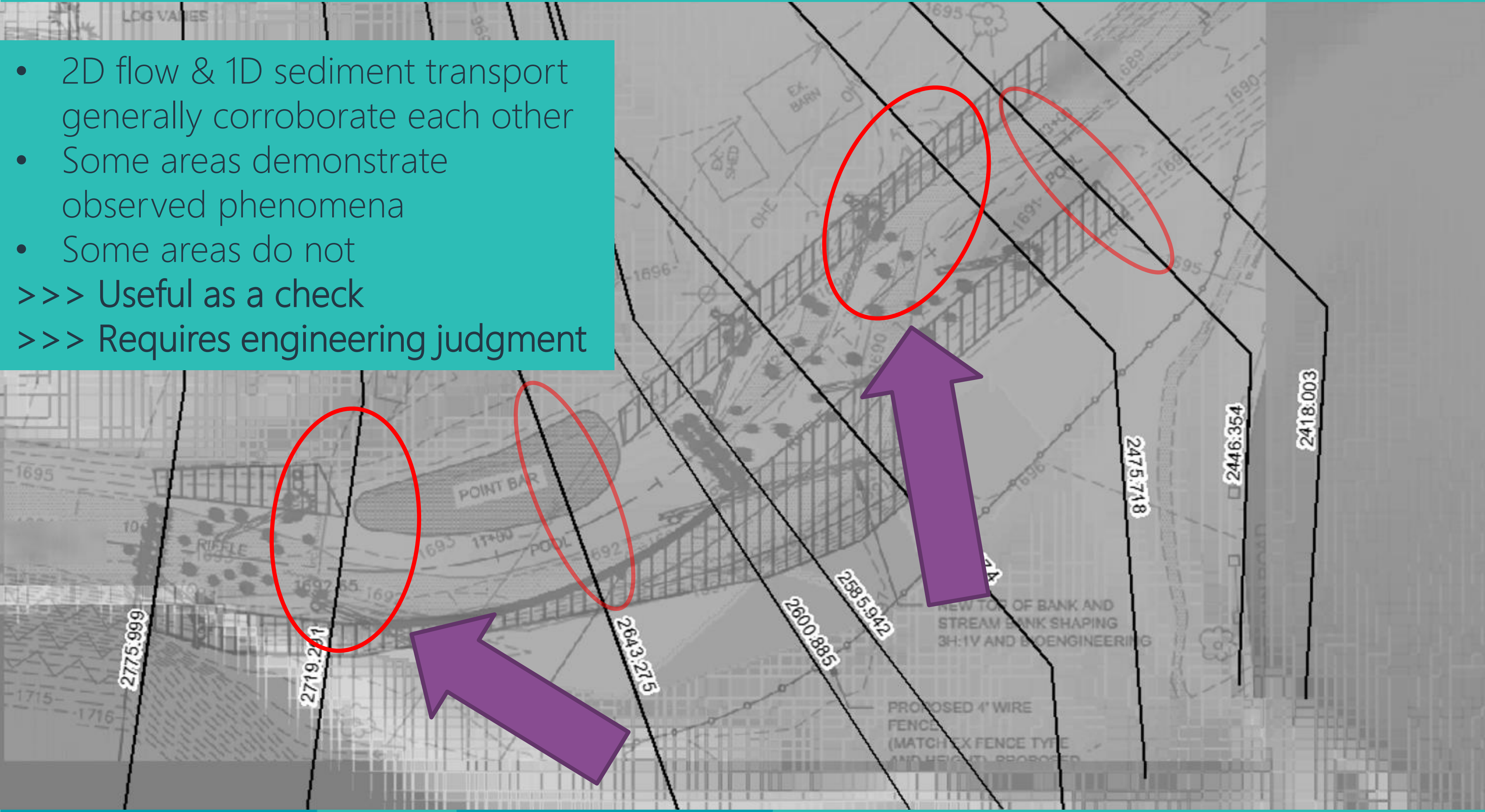


Deposition occurs at lower stream power

- 2D flow & 1D sediment transport generally corroborate each other
- Some areas demonstrate observed phenomena
- Some areas do not

>>> Useful as a check

>>> Requires engineering judgment



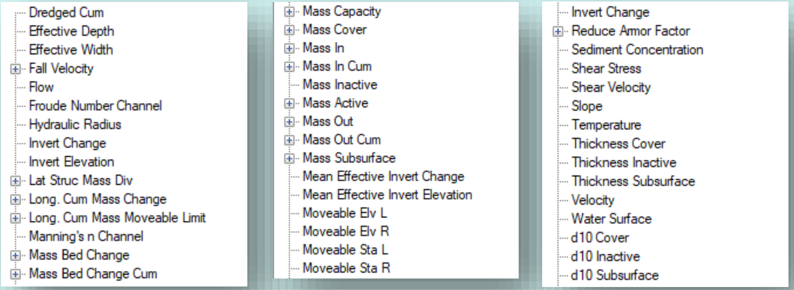
2 RAS Approaches

1D

- Higher Effort

+ More detail

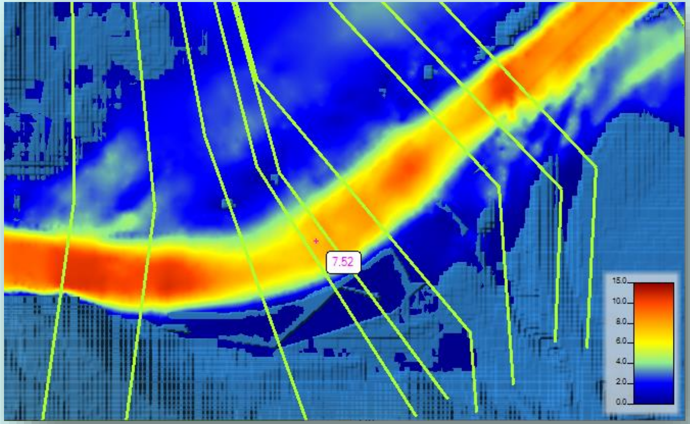
+ Dynamics of particular particles sizes US to DS



2D

+ Lower Effort

+ Big picture US/DS/side-side



Limitations/Improvements

- More comparisons: model vs. reality
  - Higher resolution XS/data within study area and outside of study area
- New models in RAS 5.0.3+
  - Unsteady Sediment Transport
  - BSTEM
    - Bank Stability & Toe Erosion model

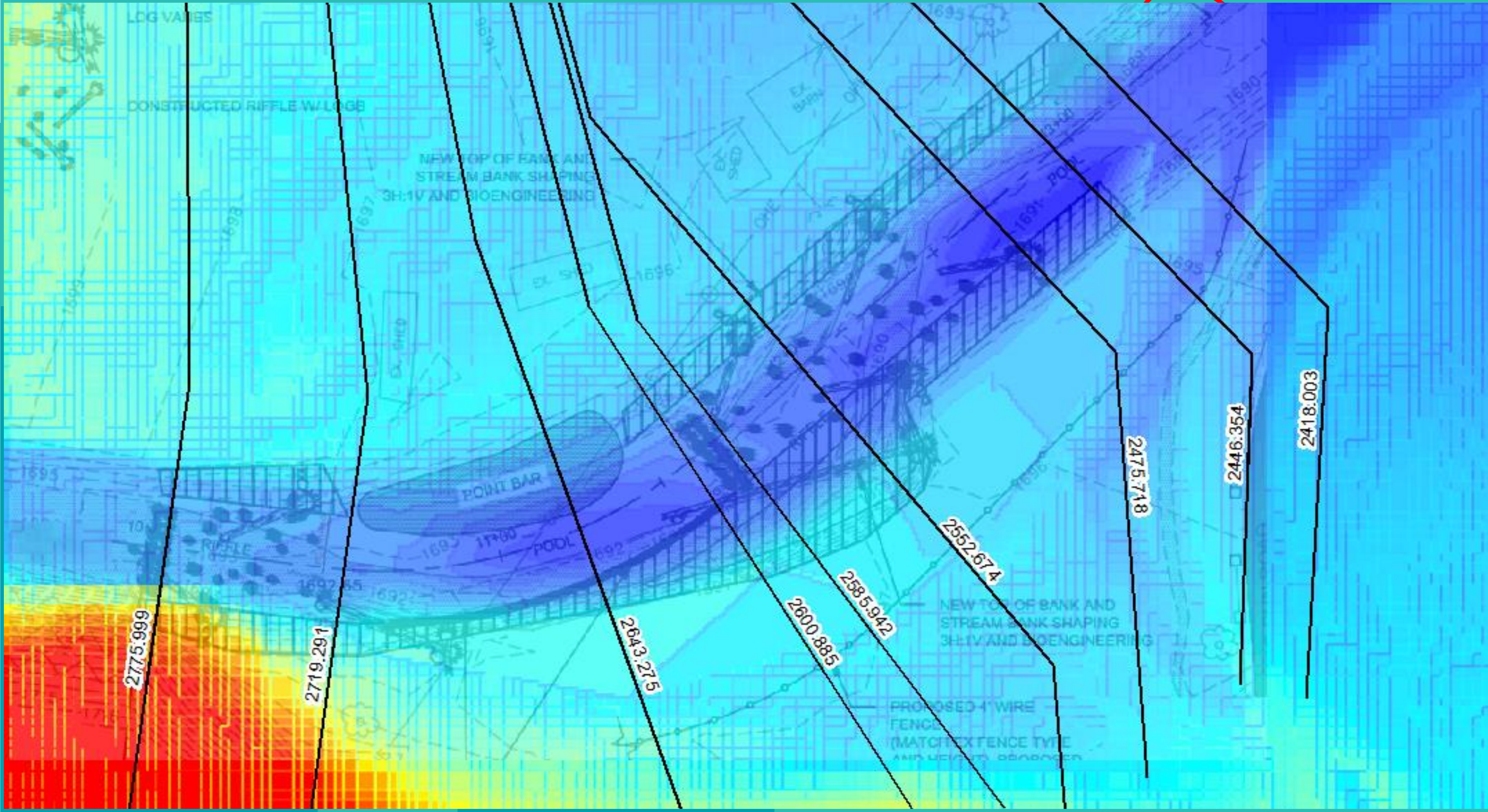
Questions, Answered

- Could a 1D model adequately predict the extent of the washout/deposition?
- How well does a 2D model perform?
- What kind of flows were needed to produce such a significant change in the bed?
- Which is the “best value” approach?

Thank you!

Your questions?

kristine.mosuela@woodplc.com



LOG VANES
CONSTRUCTED RIFFLE W/ LOGS
NEW TOP OF BANK AND
STREAM BANK SHAPING
3H:1V AND BIOENGINEERING
POINT BAR
POOL
RIFFLE
POOL
NEW TOP OF BANK AND
STREAM BANK SHAPING
3H:1V AND BIOENGINEERING
PROPOSED 4' WIRE
FENCE
(MATCH EX FENCE TYPE
2775.999
2719.291
2643.275
2600.885
2585.942
2552.674
2475.718
2446.354
2418.003