Assessment of Transport and Deposition of Asbestos-Rich Sediment along Swift Creek and the Sumas River, Whatcom County, Washington: *Year-One Status Report*

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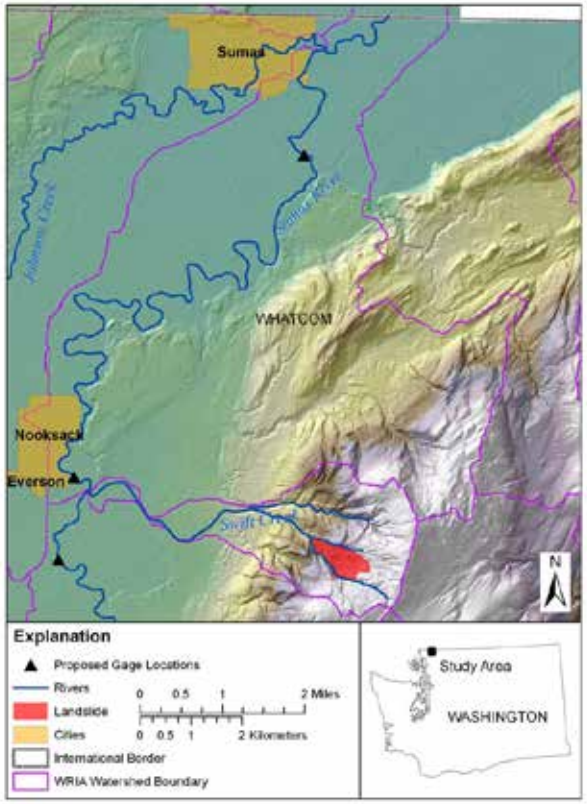
USGS, Washington Water Science Center
Tacoma, Washington

Presented to the Environmental Protection Agency
September 29, 2011

USGS

Original Scope of Work



Calendar Year		2011				2012				2013			
Federal Fiscal Year	FY2011				FY2012				FY2013				
FFY Quarter	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
Tasks													
Task 1A. Continuous streamflow-gaging station operation at 3 Sumas River gages.		x	x	x	x	x	x	x	x	x	x	x	
Task 1B. Continuous sediment monitoring at 3 Sumas River gages.		x	x	x	x	x	x	x	x	x	x	x	
Task 2. Evaluate landslide sediment load into Swift Creek.				x	x	x							
Task 3. Numerical modeling to assess sediment transport and inundation.		x	x	x	x	x	x	x	x	x			
Task 4A. Comprehensive analysis of problem, integrating sediment data, modeling, and geomorphic evaluation.				x	x				x	x	x	x	
Task 4B. Consultation from USGS asbestos and NAWQA experts.	x				x				x				
Task 5A. Year one status report				x									
Task 5B. Prepare and publish Fact Sheet					x								
Task 5C. Prepare and publish USGS-series report or submit USGS-approved manuscript to scientific journal.												x	x

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USGS gaging station #12214350
Sumas River at South Pass Road at Nooksack, WA

USGS gaging station #12214300
Sumas River at Massey Road near Nooksack, WA
USGS

USGS gaging station #12214500
Sumas River near Sumas, WA
(at Telegraph Road)

Gage data are available online on the project page

USGS - Sumas River Sediment Load - Mozilla Firefox

File Edit View History Bookmarks Tools Help

USGS - Sumas River Sediment Load

http://wa.water.usgs.gov/projects/sumas/

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Sumas River Sediment Load

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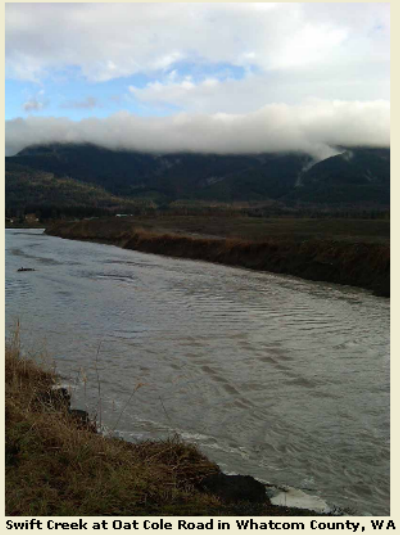

Swift Creek at Oat Cole Road in Whatcom County, WA

The Issue: A large, clay-rich active landslide on the western flank of Sumas Mountain in Whatcom County, Washington, is a significant source of sediment to Swift Creek and the salmon-bearing Sumas River. The landslide contains naturally occurring serpentinite that weathers to chrysotile asbestos and elevated levels of metals. The asbestos load in water as well as deposits along the banks and flood plain of Swift Creek and the Sumas River present human health concerns.

How the USGS will help: The USGS will evaluate sediment load, downstream transport, and spatial extent of sediment being deposited along Swift Creek and the Sumas River. The USGS will characterize input of sediment into the Sumas River from Swift Creek, monitor and quantify the sediment flux down the Sumas River, evaluate the potential for distribution of asbestos, and analyze the geomorphology and hydrology of the Sumas River watershed to assess concentration and transport potential of asbestos downstream to the Canadian border.

Gage sites used for the project:

Site Number	Site Name
12214300	SUMAS RIVER AT MASSEY ROAD NEAR NOOKSACK, WA
12214350	SUMAS RIVER AT SOUTH PASS ROAD AT NOOKSACK, WA
12214500	SUMAS RIVER NEAR SUMAS, WA

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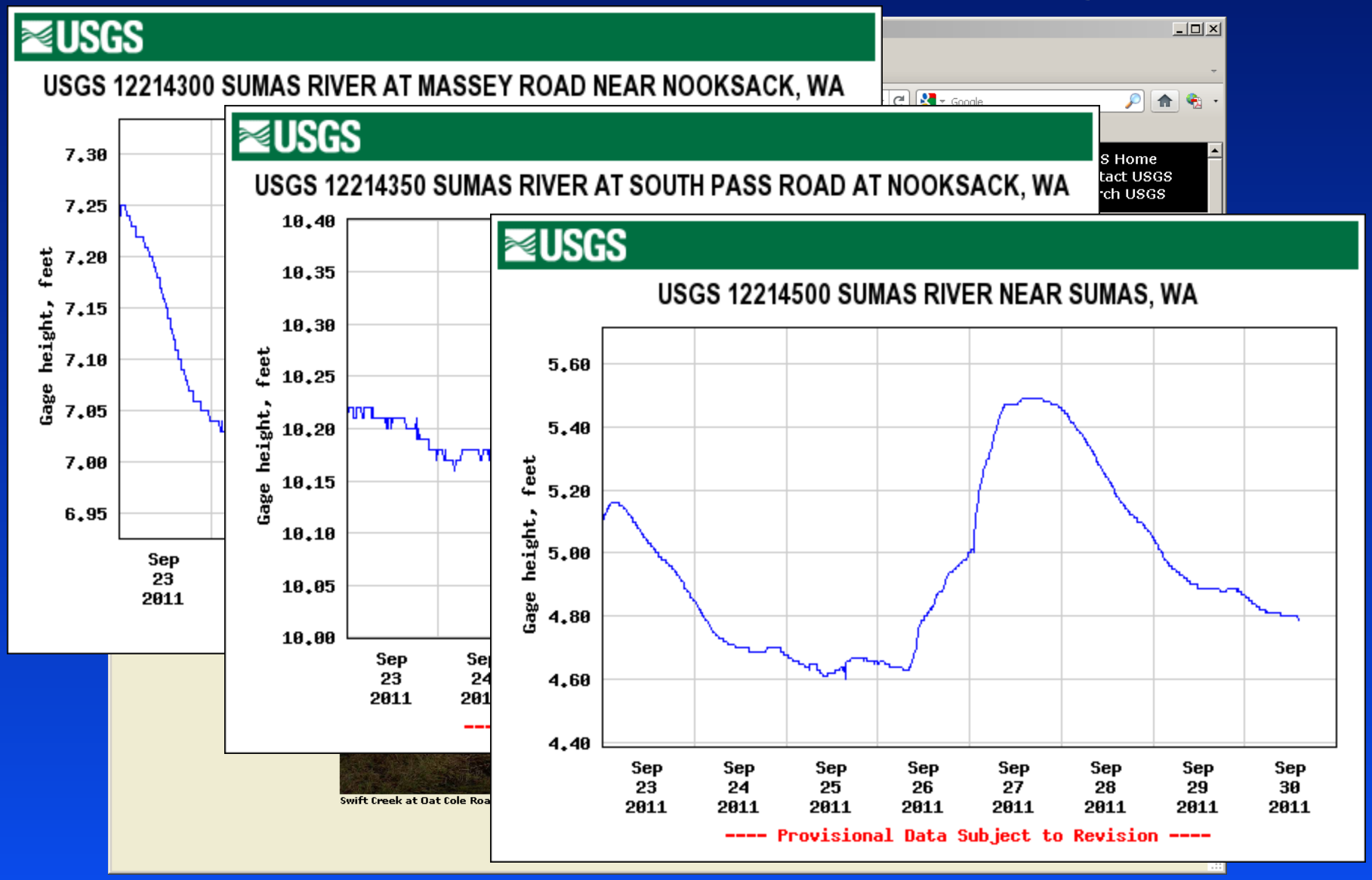
http://wa.water.usgs.gov/projects/sumas/

Available online on the project page



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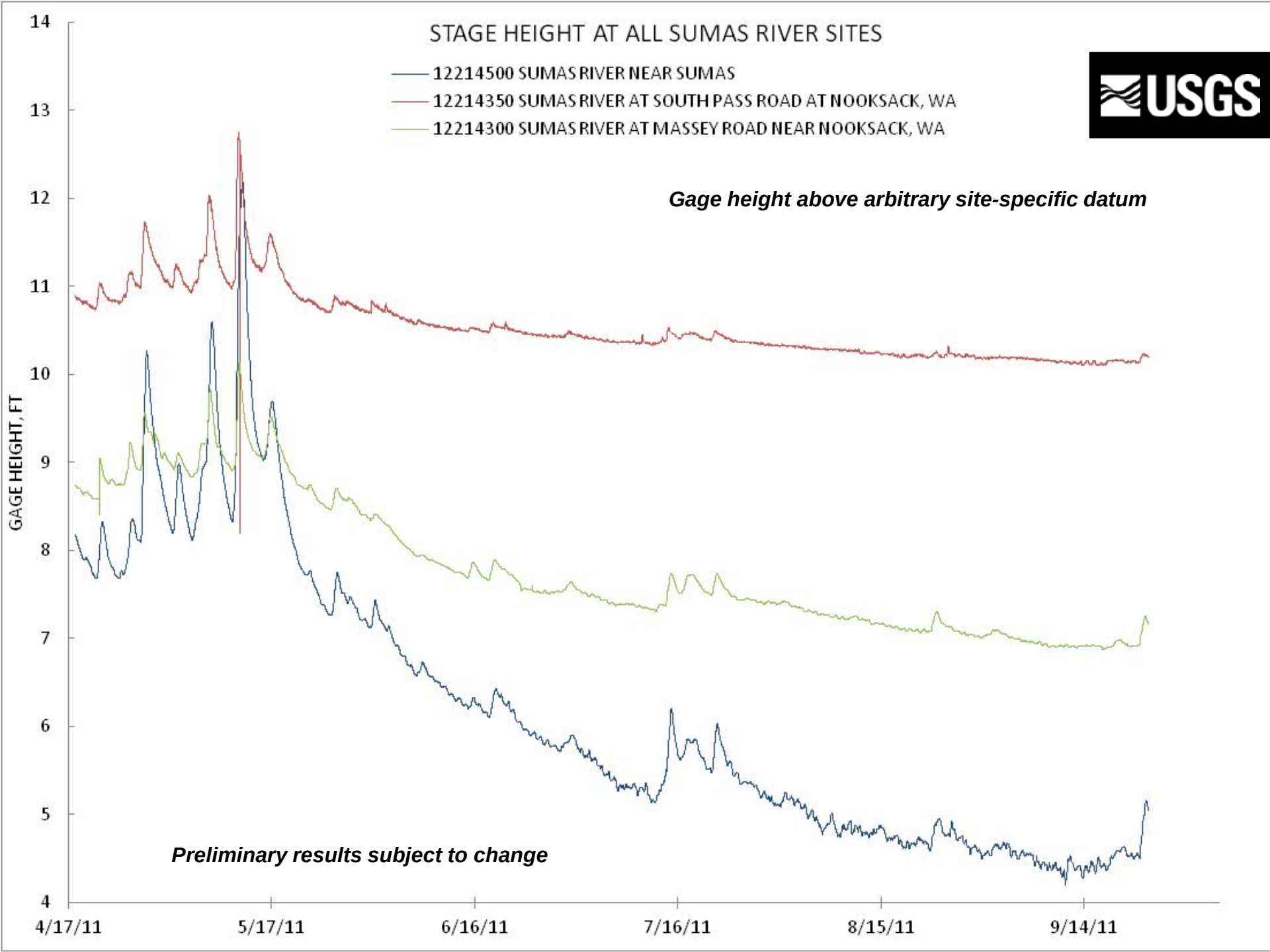
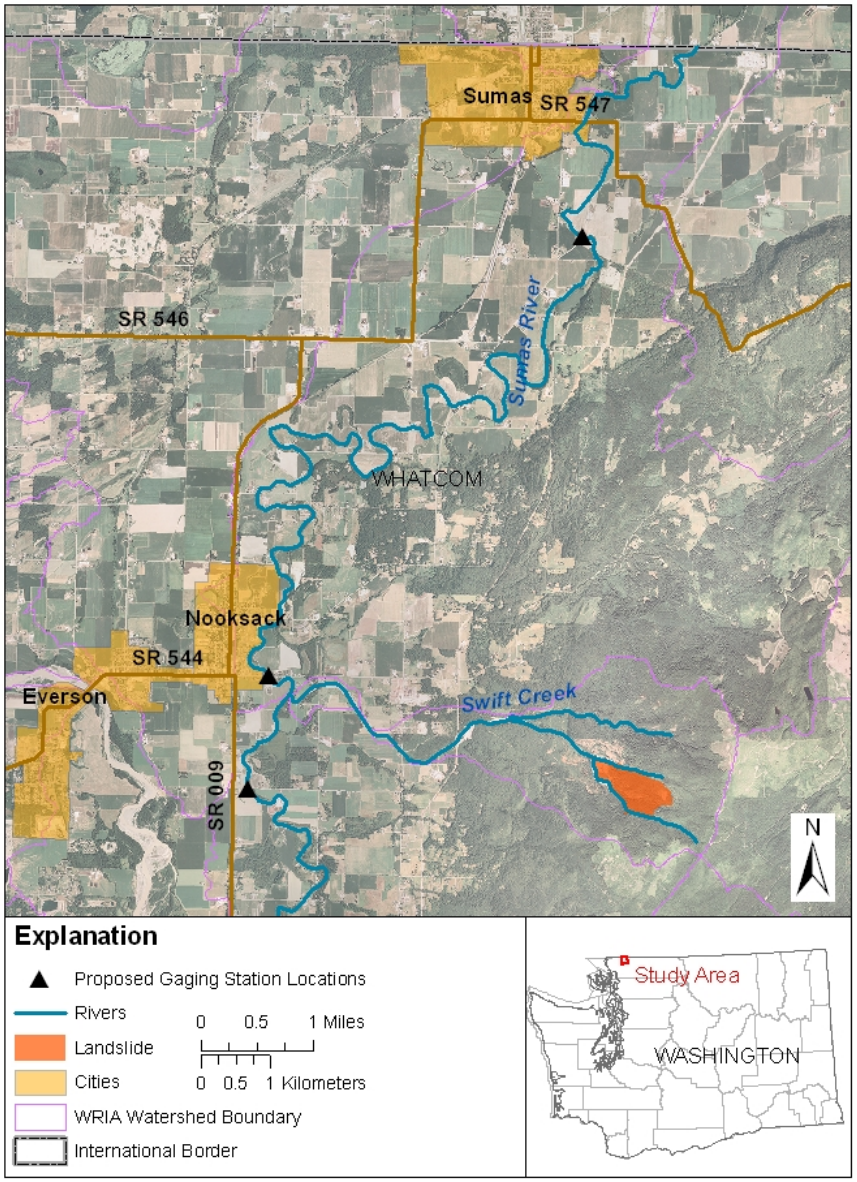
http://wa.water.usgs.gov/projects/sumas/

Preliminary results subject to change


STAGE HEIGHT AT ALL SUMAS RIVER SITES
12214500 SUMAS RIVER NEAR SUMAS
12214350 SUMAS RIVER AT SOUTH PASS ROAD AT NOOKSACK, WA
12214300 SUMAS RIVER AT MASSEY ROAD NEAR NOOKSACK, WA
USGS
Gage height above arbitrary site-specific datum
Preliminary results subject to change
GAGE HEIGHT, FT
14
13
12
11
10
9
8
7
6
5
4
4/17/11
5/17/11
6/16/11
7/16/11
8/15/11
9/14/11

Project Status: Task 1A



- All streamflow gages are installed and operational
- Started collecting data in April 2011
- Stage reported real-time on Internet
- Discharge will be back-calculated for the full record once stage-discharge relation established.

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Instruments used to monitor sediment

- Turbidity (DTS-12 and Analite 180)
- ISCO 6712 Automated Sampler
- Hydroacoustics (Sontek Argonaut SW—3 MHz)

DTS-12

Analite 180

ISCO Sampler

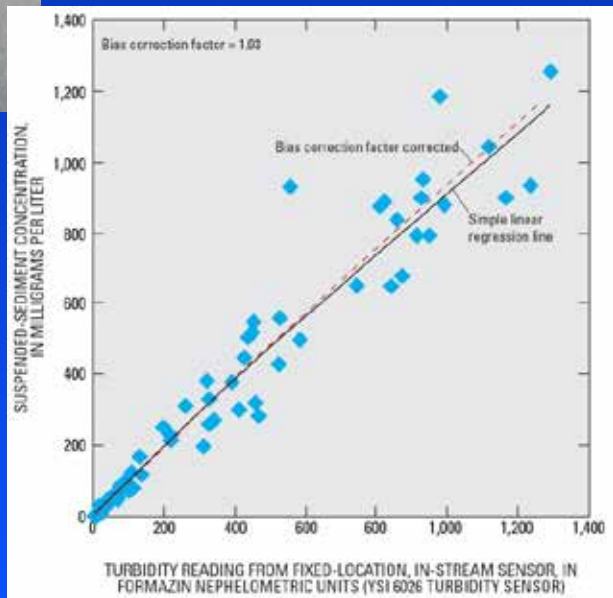
Sontek Argonaut SW

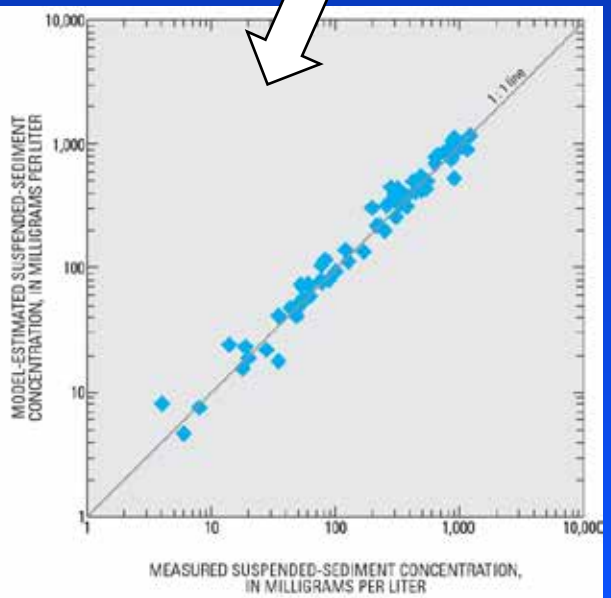
USGS

The use of brand names is for identification purposes only and does not constitute endorsement by the USGS

Correlation of surrogate data with manual suspended-sediment concentration (SSC) samples enables the calculation of total sediment flux or total sediment load

See Rasmussen et al., (2009)





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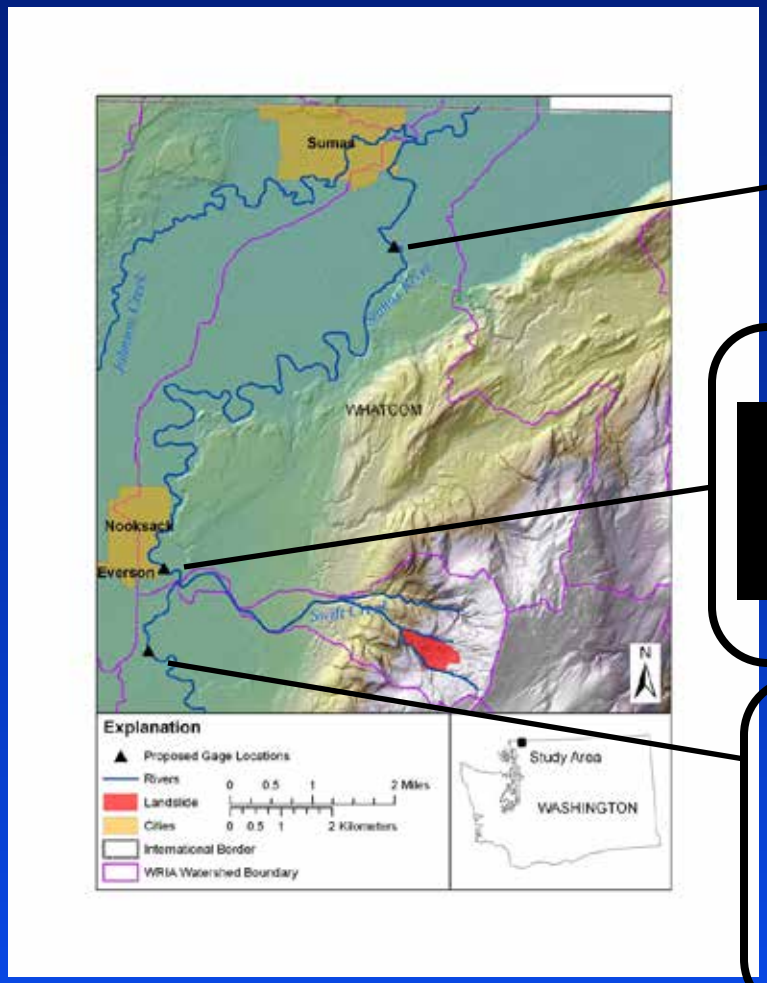
Sediment Monitoring with Surrogate Sediment Instruments



[Telegraph Road]

[South Pass Road]

[Massey Road]

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Preliminary results subject to change

DTS-12 mounting assembly

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Instrument deployment at Telegraph Road

Instrument deployment at Telegraph Road

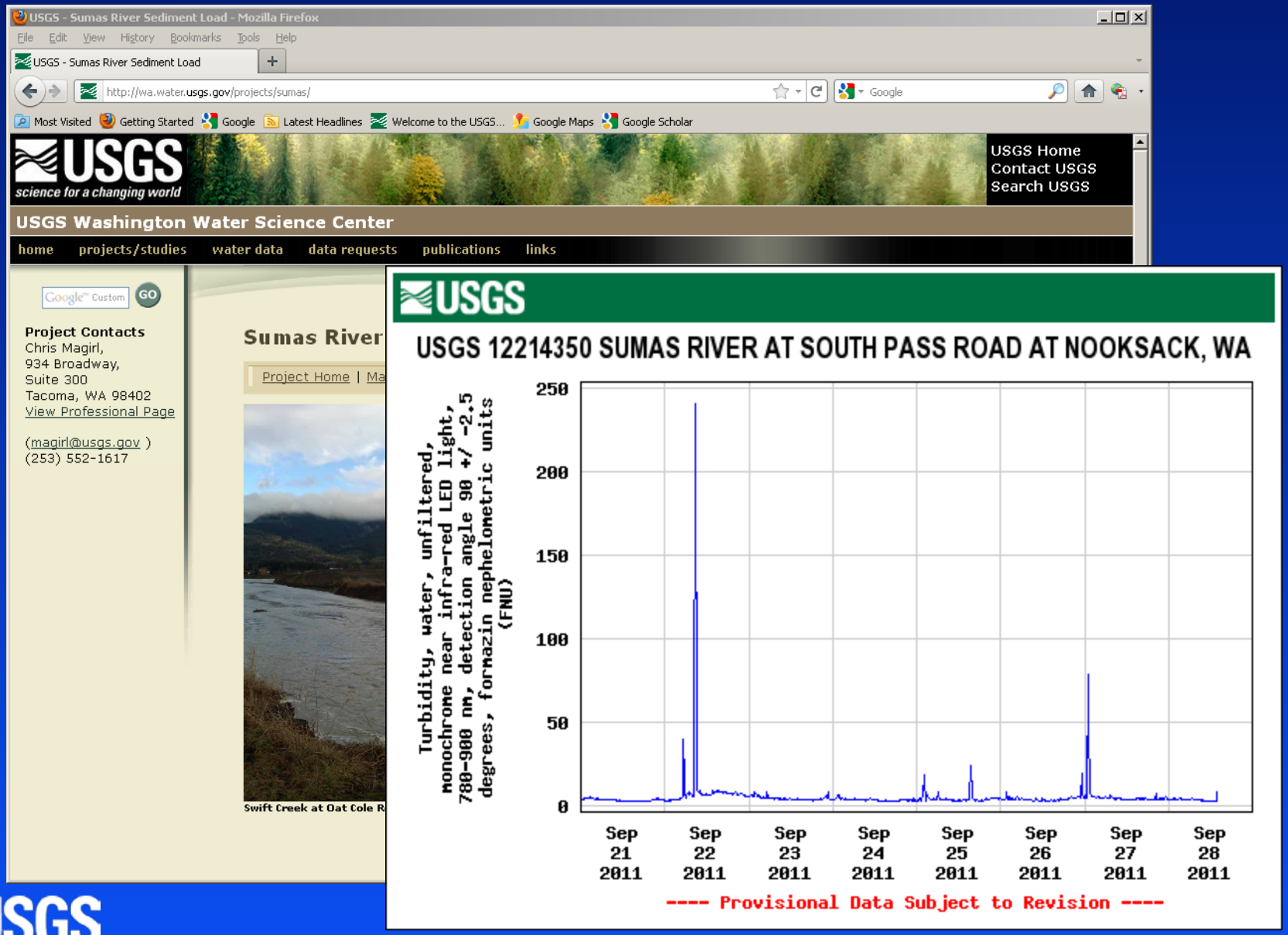
Instrument deployment at South Pass Road

Exposed instrumentation at Telegraph Road during summer base flow

USGS

Instrumentation at Telegraph Road after redeployment during summer base flow

Available online on the project page



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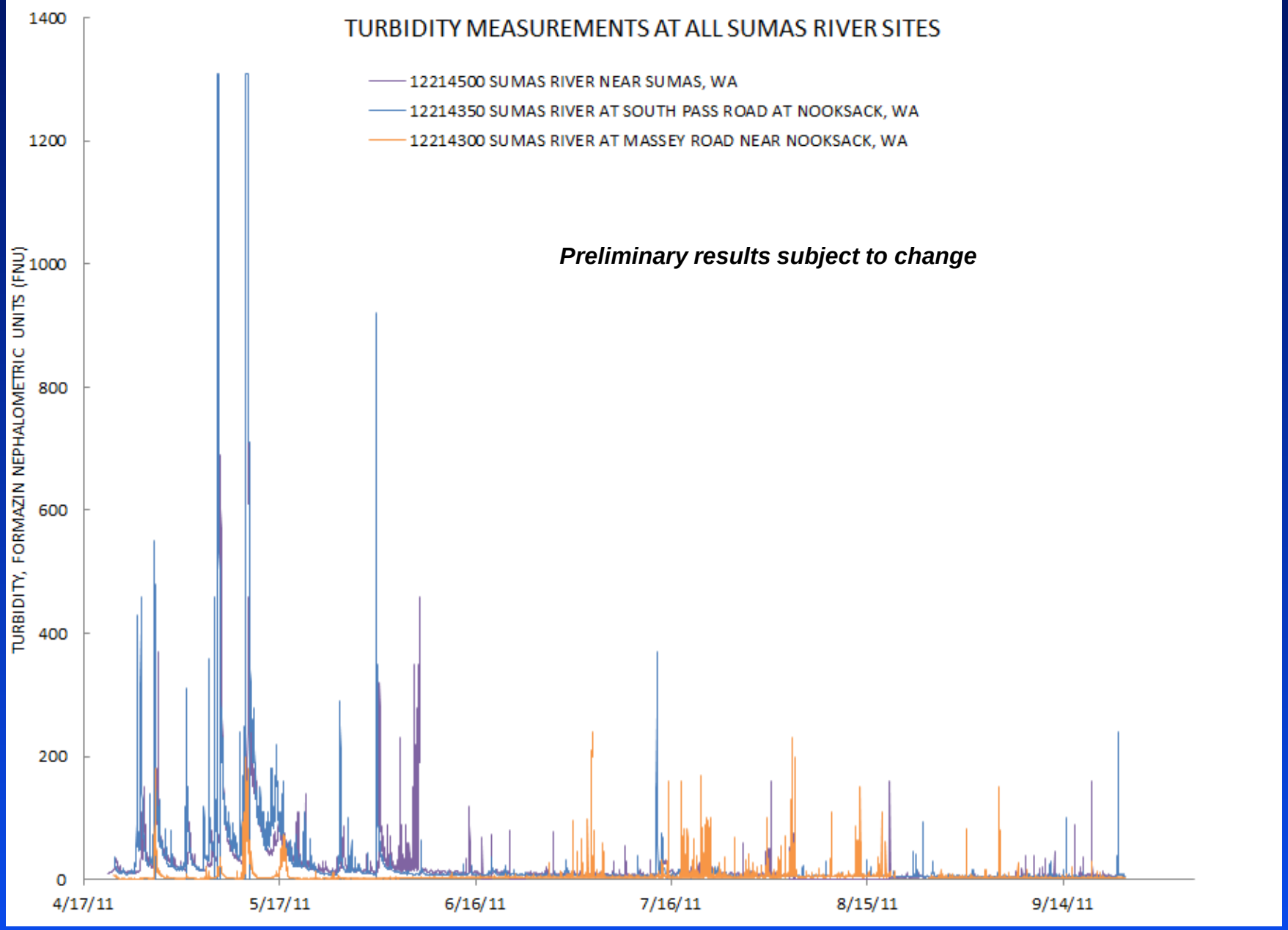
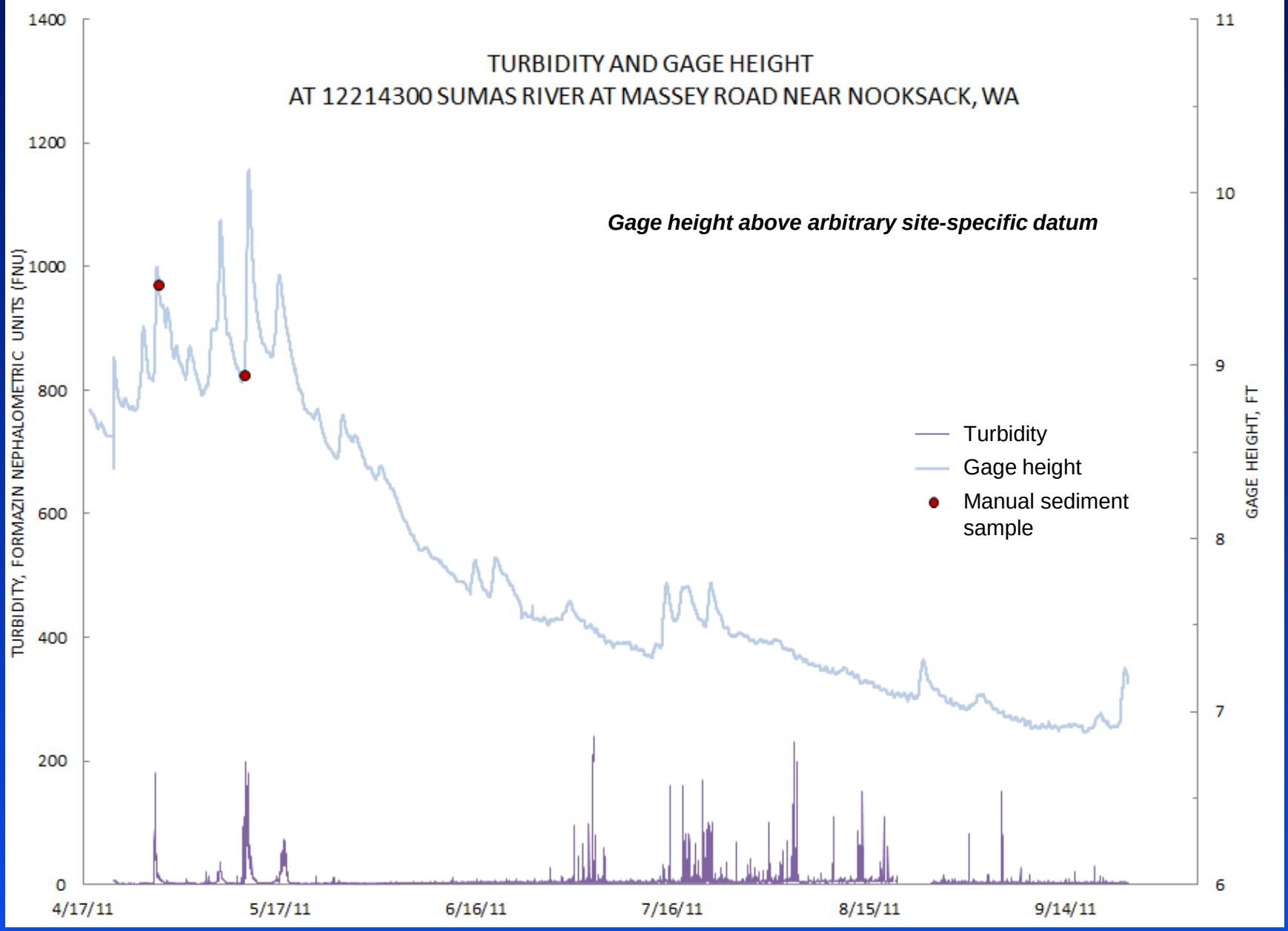

TURBIDITY MEASUREMENTS AT ALL SUMAS RIVER SITES
12214500 SUMAS RIVER NEAR SUMAS, WA
12214350 SUMAS RIVER AT SOUTH PASS ROAD AT NOOKSACK, WA
12214300 SUMAS RIVER AT MASSEY ROAD NEAR NOOKSACK, WA
Preliminary results subject to change
TURBIDITY, FORMAZIN NEPHALOMETRIC UNITS (FNU)
1400
1200
1000
800
600
400
200
0
4/17/11
5/17/11
6/16/11
7/16/11
8/15/11
9/14/11

USGS



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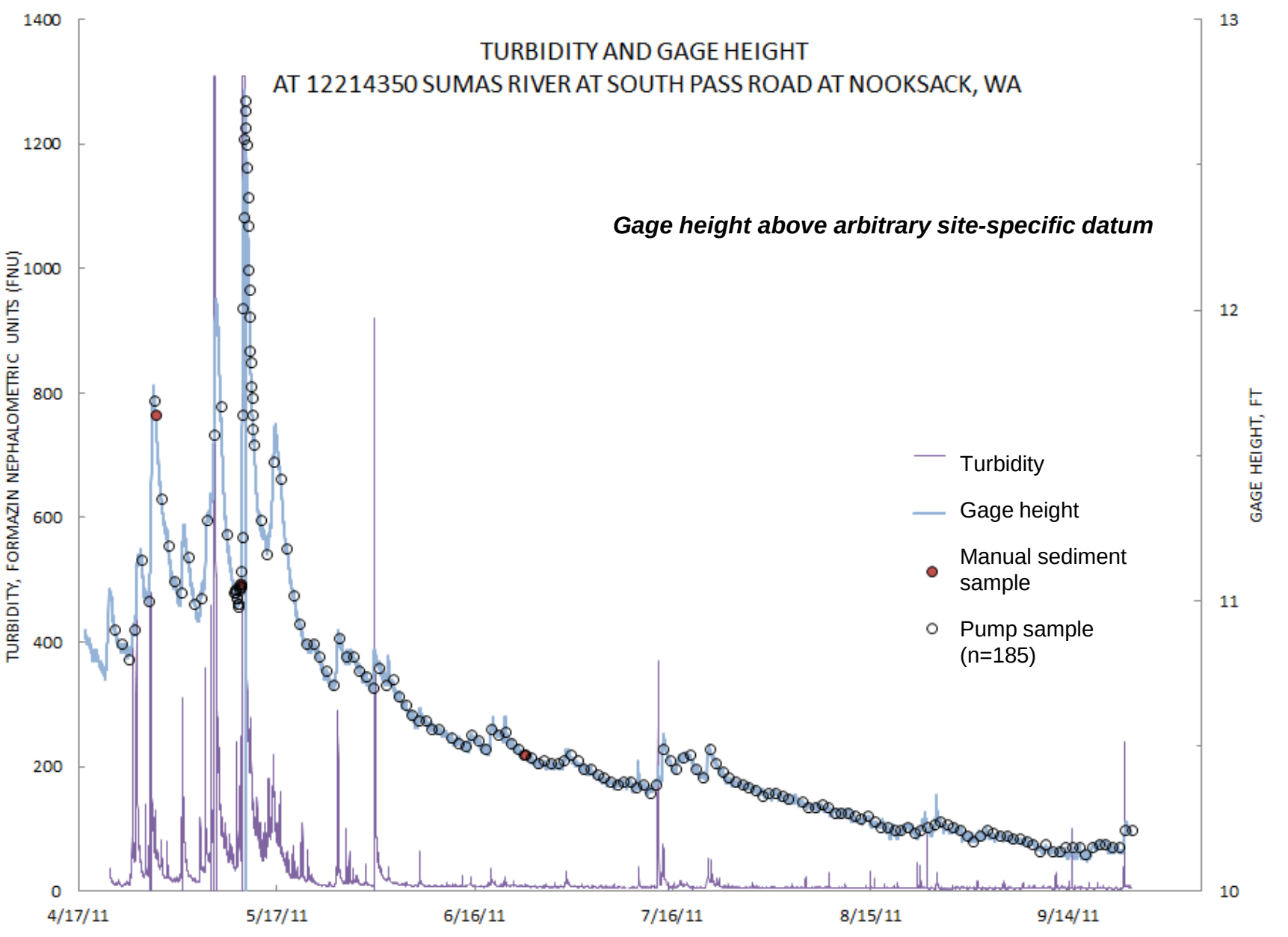
Preliminary results subject to change



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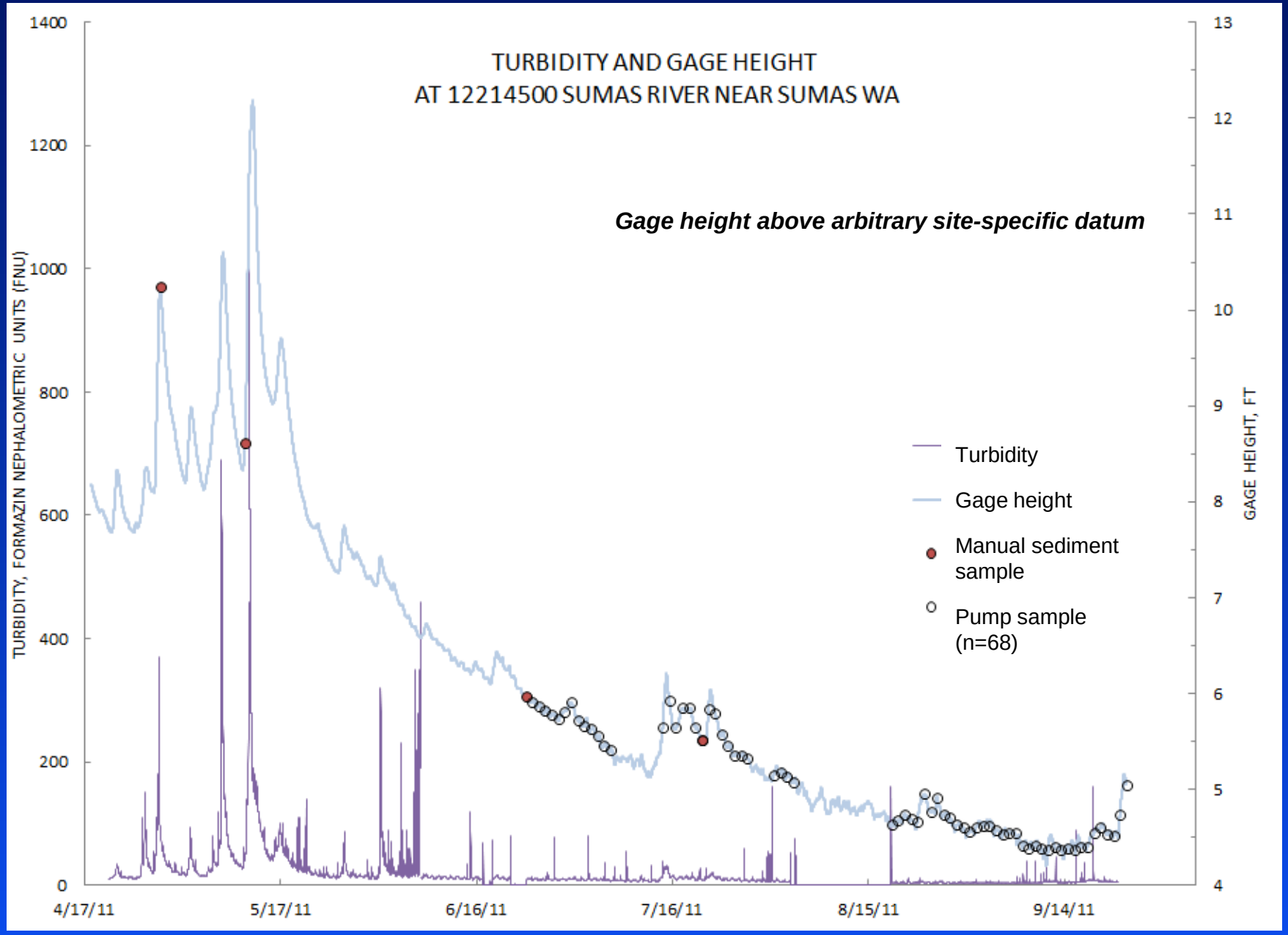
Preliminary results subject to change



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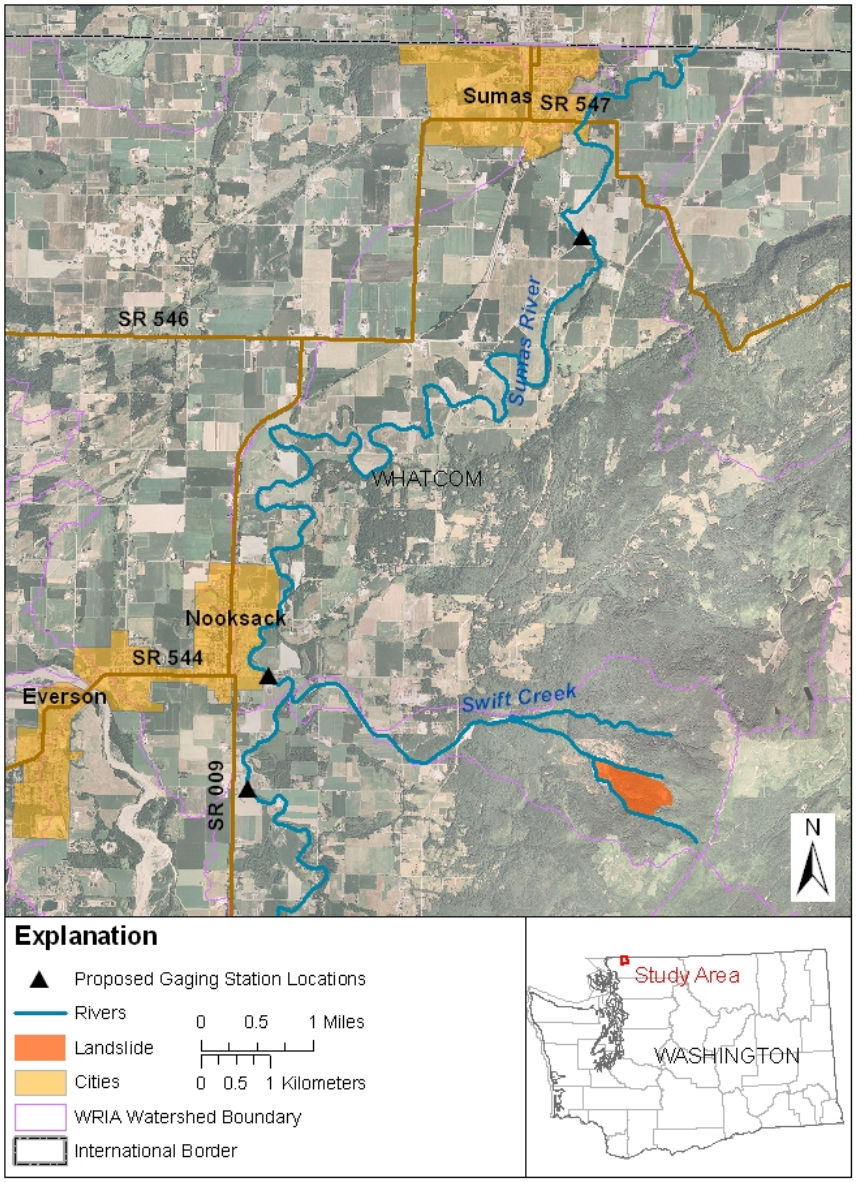
Preliminary results subject to change

Project Status: Task 1B



- All surrogate sediment instruments except the Analite 180 are in the river—Analite 180 will be installed in October 2011.
- Collecting and recording data every 15 minutes.

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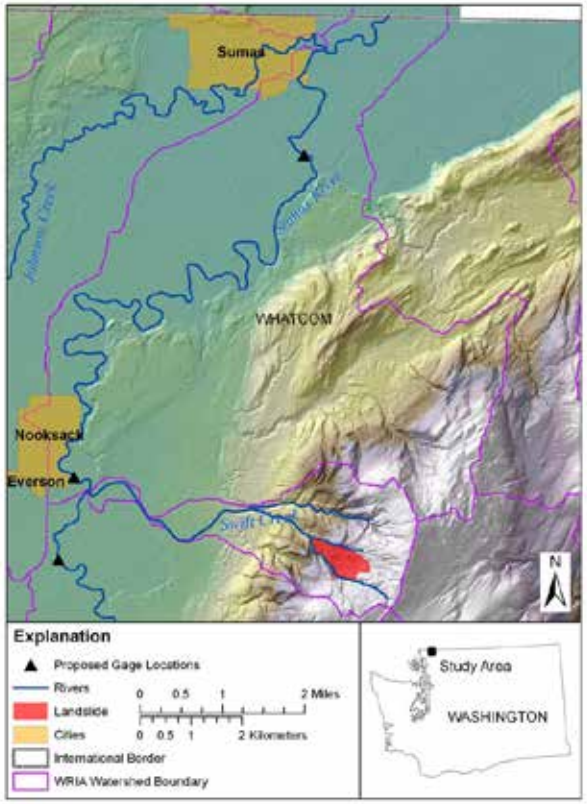
Preliminary results subject to change

Modified Scope of Work as of July 2011



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Task 1B. Continuous sediment monitoring at 3 Sumas River gages.		x	x	x	x	x	x	x	x	x	x	x	
Task 2. Evaluate landslide ~~sediment load into Swift~~ Creek.				x	x	x							
Task 3. Numerical modeling ~~to assess sediment transport~~ and inundation.		x	x	x	x	x	x	x	x	x			
Task 4A. Comprehensive analysis of problem, integrating sediment data, modeling, and geomorphic evaluation.				x	x				x	x	x	x	
Task 4B. Consultation from USGS asbestos and NAWQA experts.	x				x				x				
Task 5A. Year one status report				x									
~~Task 5B. Prepare and~~ publish Fact Sheet					x								
Task 5C. Prepare and publish USGS-series report or submit USGS-approved manuscript to scientific journal.												x	x

Due to reduced FY2012 funding, Task 2 and Task 5B will not be completed; Task 3 was reduced in scope such that no numerical model will be constructed.

Activities for FY2012

- Continue collecting discharge, suspended-sediment concentration (SSC), and surrogate sediment data
- Develop correlations between SSC and turbidity, acoustic data, and discharge
- Measure asbestos concentration in water at gages
- Attempt a correlation between sediment load and asbestos
- Determine settling velocity of asbestos fibers

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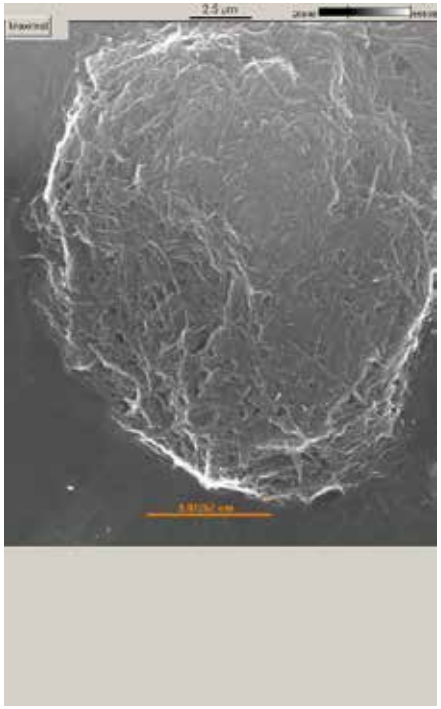
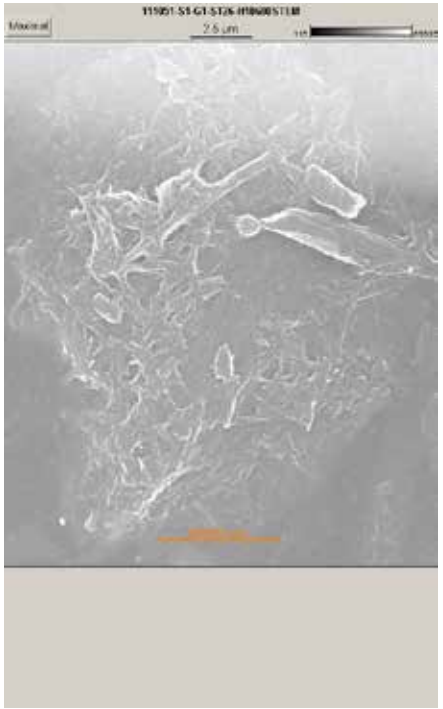
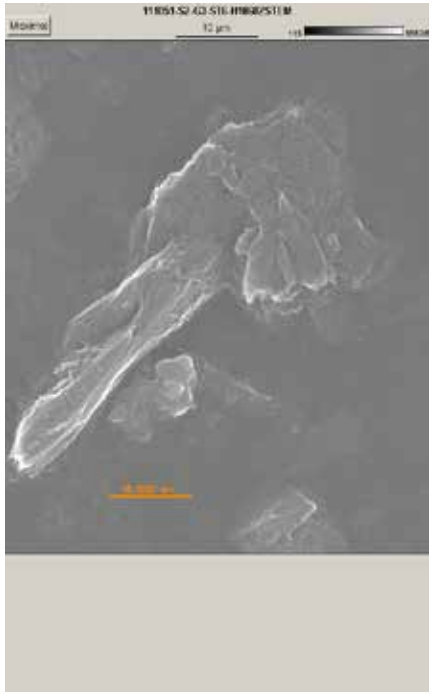
Quantification of asbestos fraction of suspended-sediment samples from the Sumas River







Preliminary results subject to change

- Suspended-sediment samples to be processed and analyzed following the California Air Resources Board (CARB) method 435 using scanning and transmission electron microscopy (STEM)
- Samples prepared from 2-4 grams of suspended sediment recovered from gravimetric analysis of suspended-sediment concentration.
- Sample composited from verticals of EDI/EWI (Edwards and Glysson, 1999) or from multiple daily pumped samples collected over uniform hydrologic conditions.

Preliminary results subject to change

- Analytical variability (precision) determined from analysis of split, triplicate samples
- Bias determined from inter-laboratory comparison of results between sample splits with USGS lab.
- 30 to 45 samples analyzed per year, 60% storm-related samples, 30% non-storm related samples; 10% quality-assurance samples

Preliminary results subject to change

Results from preliminary samples

Lab/Cor Sample No. : S1
Client Sample No. : 1 - Sample 1, Ground fines, Swift Creek sediment
GRR : 1
Dilution : 0.001
Dilution Factor : 1 **Final Dilution:** 0.001
Ws : 5.171E-05
w : 0.1
µ : 6.0083E-14 **µ length :** 3 **µ width :** 0.1

As Received Weight (g) : 2.44
Lab Filter Area (mm2) : 193
Grid Openings Analyzed : 1
Average Grid Opening Area (mm2) : 0.010484
Area Analyzed (mm2) : 0.010484
Analytical Sens. (Weight Percent) : 2.14E-05
Analytical Sens. (struc/g) : 3.56E+08
Detection Limit. (struc/g) : 1.06E+09

Analyst(s)	Analysis Date	Microscope	Magnification
JH	5/15/2011	H-7000	20000

Structure Type	Weight Percent (%)	Concentration (struc/g)	Struct Count[1] Primary/Total		Wa
Total Chrysotile Structures	3.68E+01	1.78E+09		5	1.90E-05

Lab/Cor Sample No. : S2
Client Sample No. : 2 - Sample 2, Ground fines and other grains, Swift Creek sediment
GRR : 1
Dilution : 0.01
Dilution Factor : 1 **Final Dilution:** 0.01
Ws : 0.001074800
w : 0.1
µ : 6.0083E-14 **µ length :** 3 **µ width :** 0.1

As Received Weight (g) : 2.24
Lab Filter Area (mm2) : 193
Grid Openings Analyzed : 1
Average Grid Opening Area (mm2) : 0.010484
Area Analyzed (mm2) : 0.010484
Analytical Sens. (Weight Percent) : 1.03E-06
Analytical Sens. (struc/g) : 1.71E+07
Detection Limit. (struc/g) : 5.12E+07

Analyst(s)	Analysis Date	Microscope	Magnification
JH	5/15/2011	H-7000	20000

Structure Type	Weight Percent (%)	Concentration (struc/g)	Struct Count[1] Primary/Total		Wa
Total Chrysotile Structures	5.89E+01	5.14E+07		3	6.33E-04

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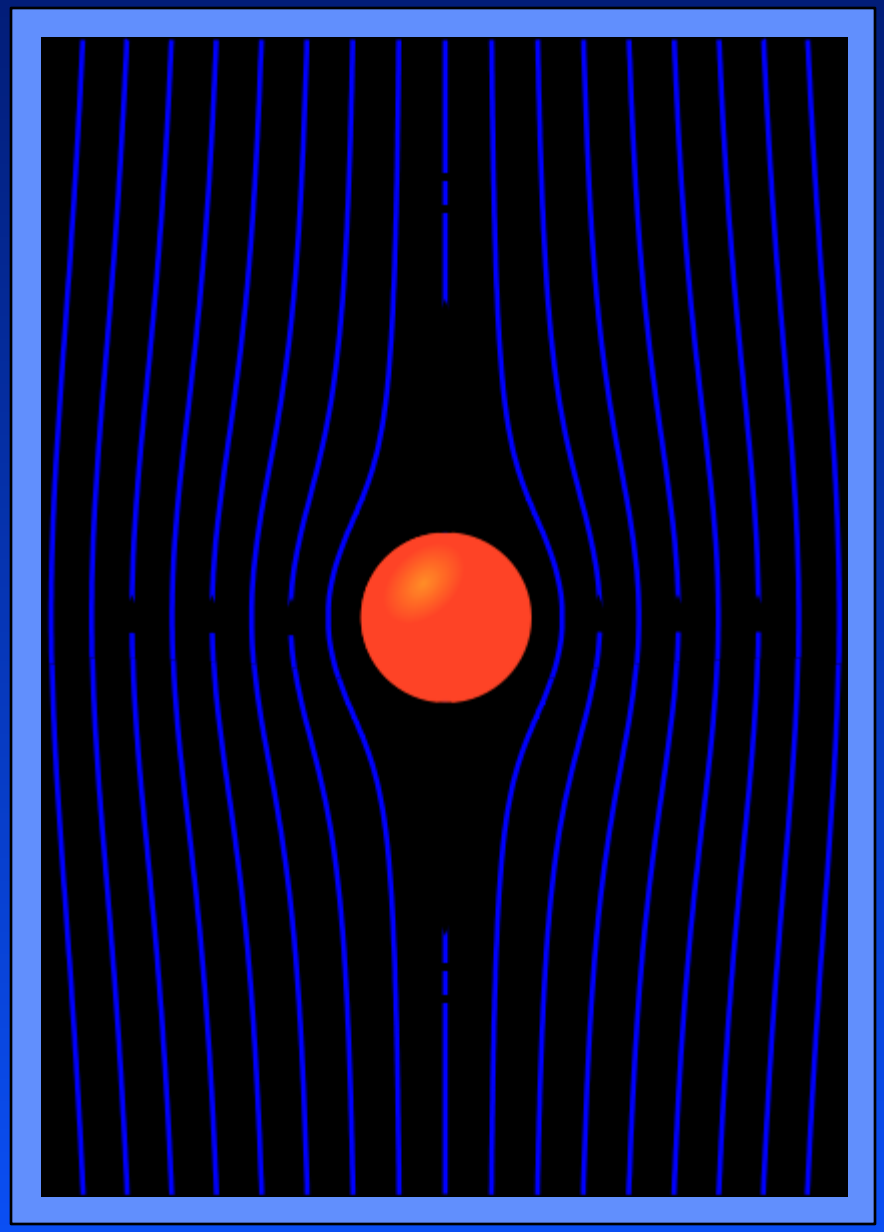
Preliminary results subject to change

Stoke's Law for settling velocity



Using first principles of fluid mechanics

$$v_s = \frac{2}{9}\frac{(\rho_p - \rho_f)}{\mu} g\, R^2$$

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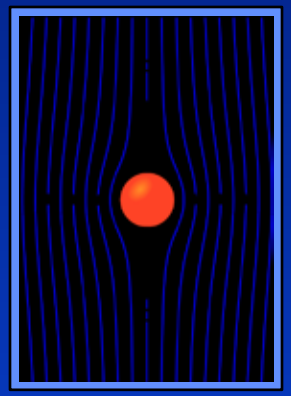
Settling velocity of asbestos/ Transport potential of asbestos fibers

First principles



Desk-top experiments

Field data from the Sumas River

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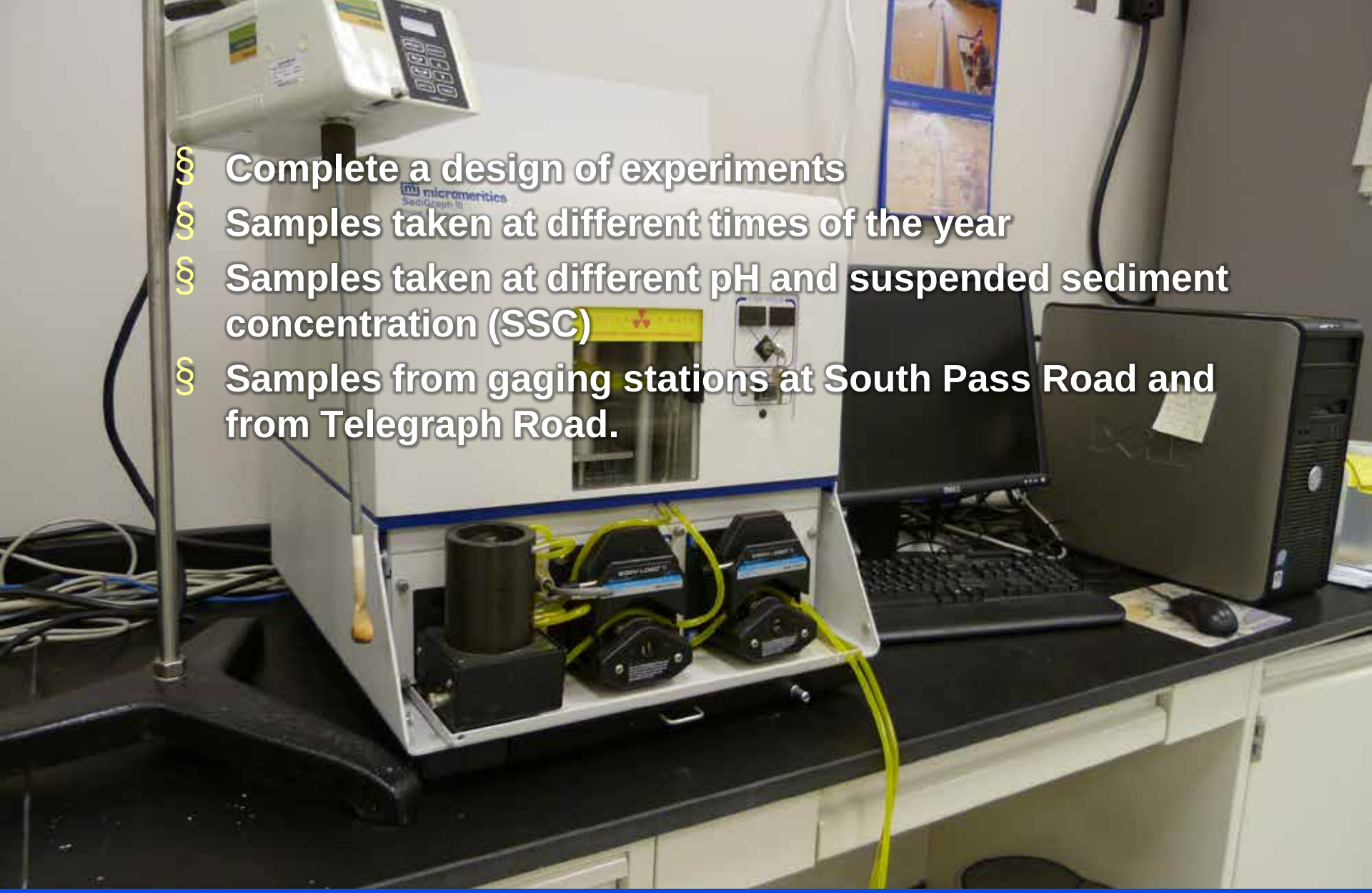

- Complete a design of experiments
- Samples taken at different times of the year
- Samples taken at different pH and suspended sediment concentration (SSC)
- Samples from gaging stations at South Pass Road and from Telegraph Road.

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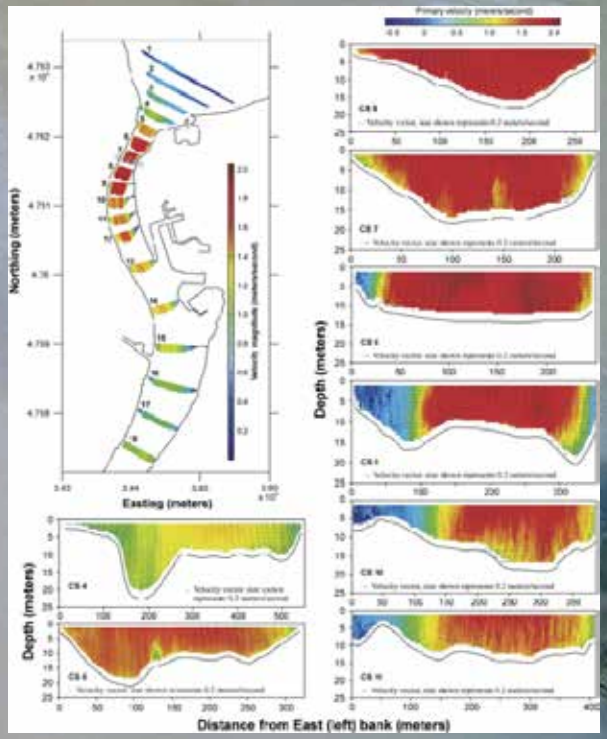
SediGraph at USGS Cascades Volcano Observatory

Field data from the Sumas River

- Manual samples taken from South Pass Road and Telegraph Road will be used to infer asbestos concentration and sediment-transport potential

- Velocity measurements from the river at varying flows are used to determine turbulent kinetic energy and flow velocity that transports asbestos downstream



from Czuba et al. (2011)
doi:10.1016/j.jglr.2011.05.011

USGS

Key Accomplishments in FY2011

- Installation and operation of all planned streamflow gages (3) by April 2011
- Installation of turbidity sensors at all gages by April 2011
- Installation of acoustic Doppler velocity meter (ADVM) at South Pass Road
- Installation of Isco Samplers at South Pass and Telegraph Roads
- Received consultation from USGS asbestos expert, Brad Van Gosen
- Participated in the *Swift-Sumas Sediment Science Summit*, held on May 27, 2011

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Goals for FY 2012

- Continued operation of the three streamflow-gaging stations; construction of a stage-discharge relation to enable the reporting of discharge
- Collect suspended-sediment samples at all three gaging sites
- Analyze suspended-sediment concentration for collected samples from the Sumas River
- Estimate suspended-sediment load in the river at the gaging stations
- Analyze water samples for asbestos concentration and attempt to correlate with suspended-sediment concentration
- Install pH sensor and collect pH data during the year (not continuously)
- Complete a study to determine the settling velocity of asbestos fibers in water

USGS

Summary

- Study is on track with the key tasks of the revised Scope of Work
- Provisional sediment load data to be calculated in FY2012
- Settling velocity study to be completed in FY2012
- Full geomorphic assessment, with sediment–load estimates to be completed in FY2013

USGS