

Analysis of densimetric measurements of stream water as a surrogate for suspended-sediment concentration in the Rio Puerco, New Mexico

Regional Water Data Workshop
Kansas City, Missouri
August 08-11, 2014

Jeb Brown
New Mexico Water Science Center



FISP

Federal Interagency Sedimentation Project

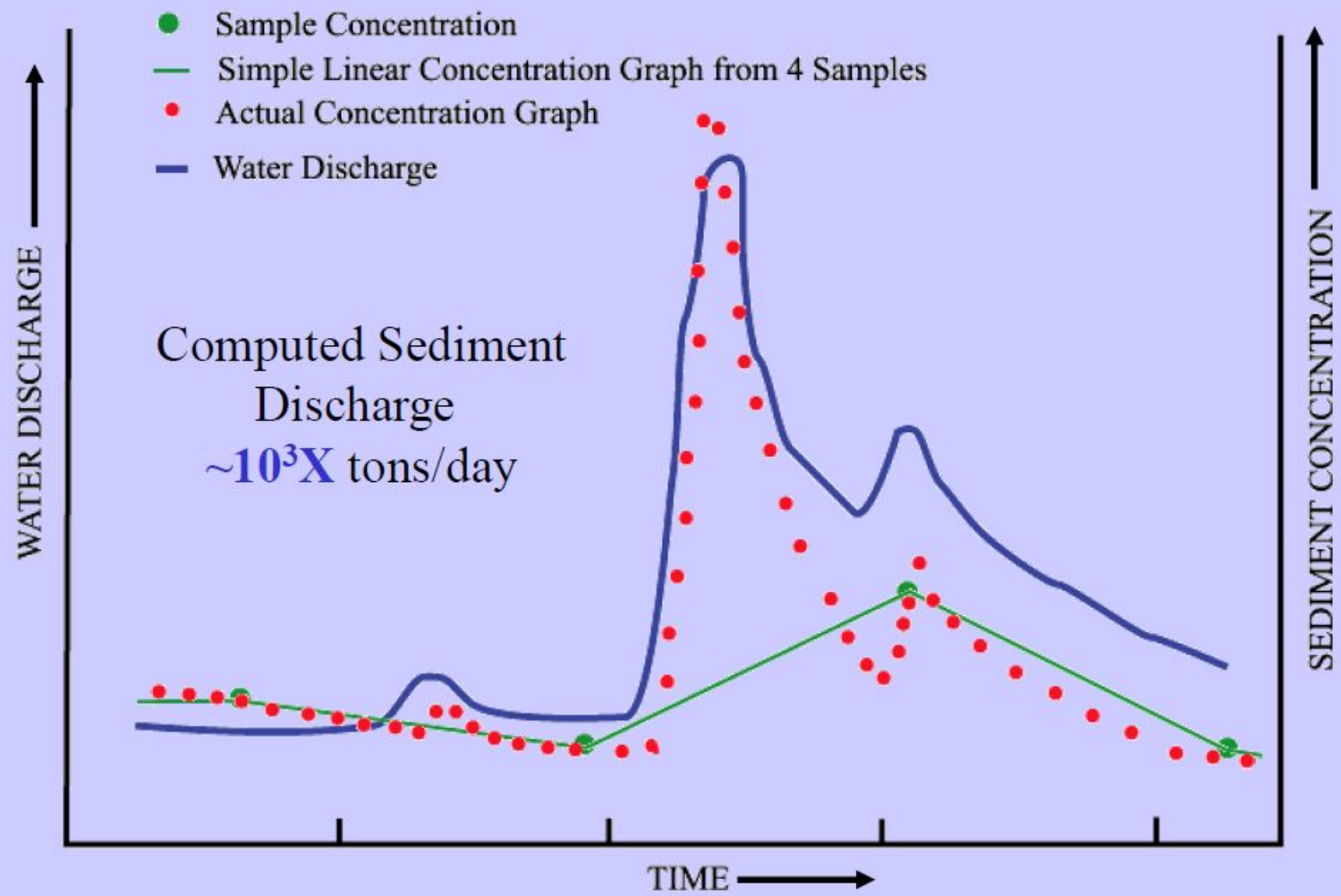
Another surrogate for SSC?

WHY?

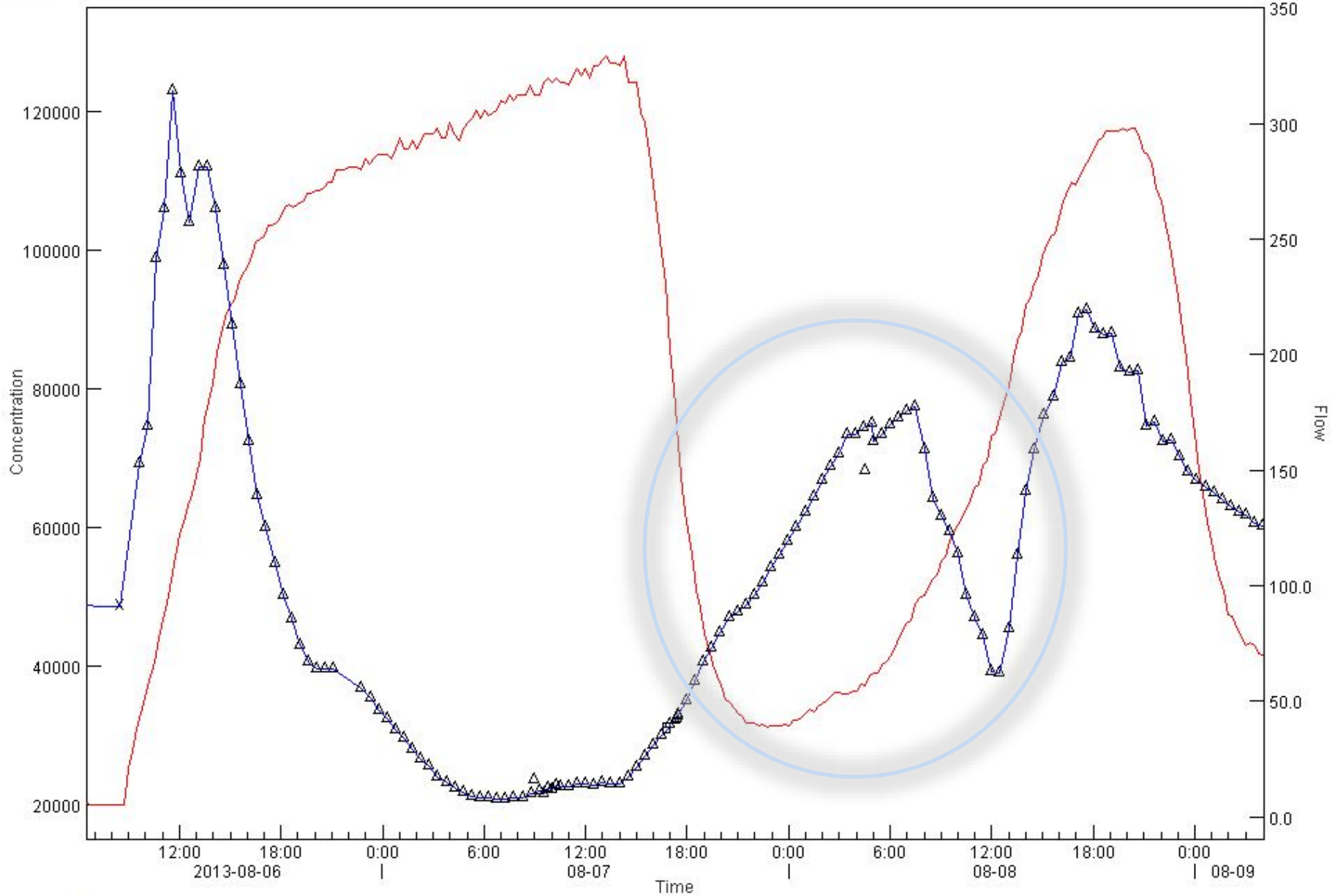


“Too thin to plow, too thick to drink.”

07/23/2013 14:09



Sample Time vs. Adj Susp. sed.



t2013 /08 /06 10 :07 :00 mg/L:74500

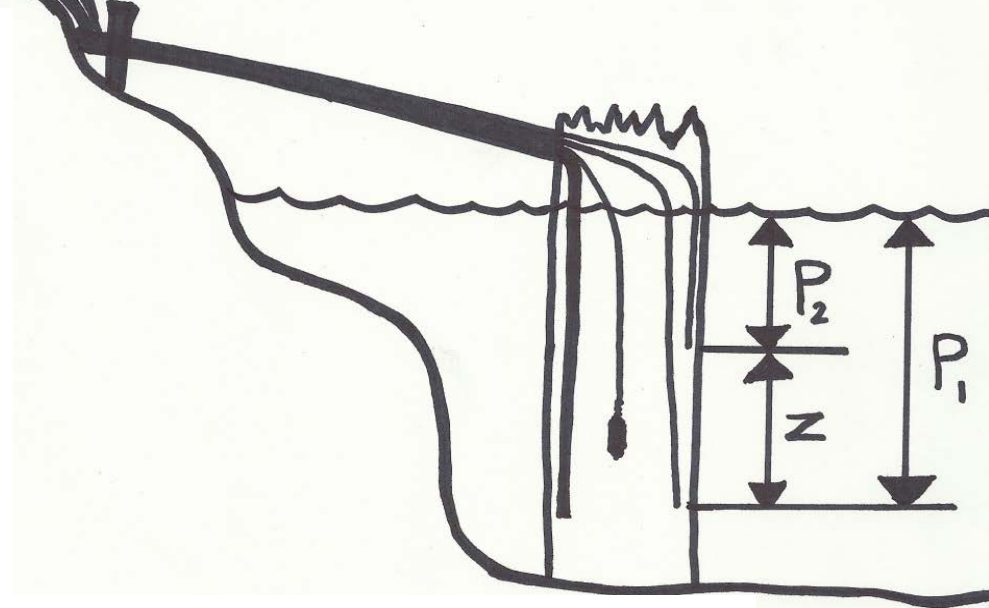
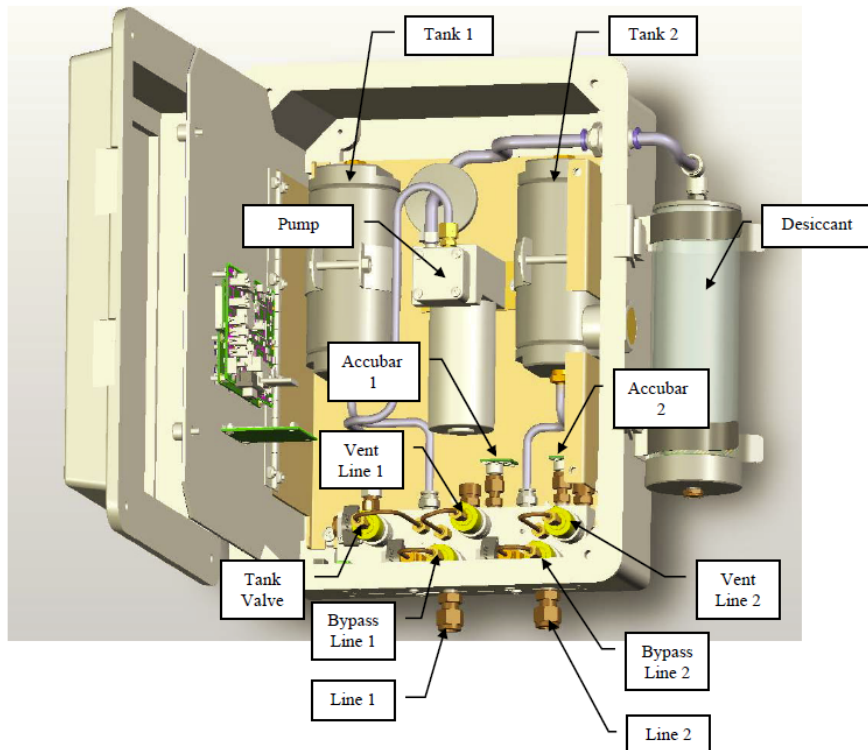
Dual orifice bubbler surrogate gage



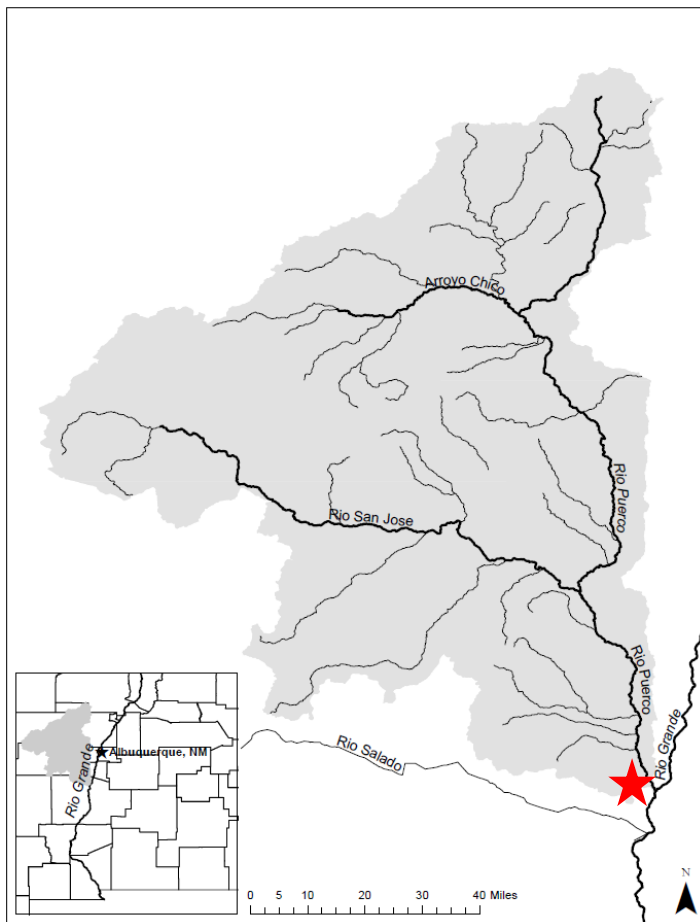
$$\rho_{sw} = \frac{P_1 - P_2}{Z * 2.0367}$$

Figure from the Sutron dual orifice bubbler manual, pg. 8

Pneumatic Features Dual Orifice Bubbler



$$\rho_{ssc} = \rho_{sw} - \rho_{pw}$$

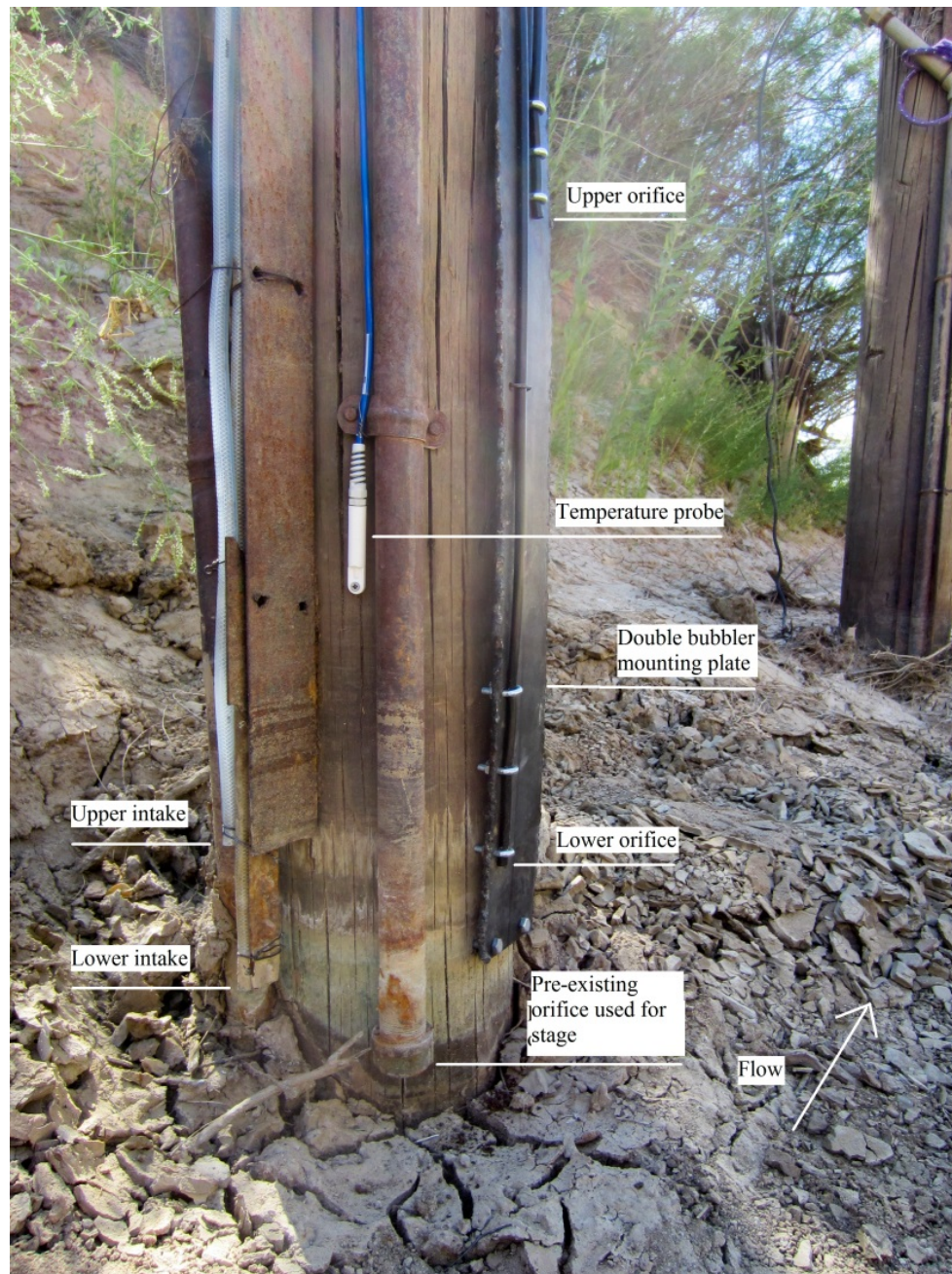


- Daily suspended-sediment sampling since 1947
- Basin: 6,080 square miles
- Ephemeral, monsoon driven flow
- Unlimited supply of fine sediments
- SSC's historically as much as 400,000 mg/L, Beverage and Culbertson, 1964



Assumptions:

1. Uniform sediment concentration between both orifices (well mixed)
2. P1 and P2 sense the same water surface (low turbulence at water surface)
3. Free from salinity based issues
4. High SSC's required (minimum SSC likely depends on water surface turbulence and orifice spacing)



1. Well mixed SSC?

Box coefficients

2008: 1.00 1.07 0.98 0.84 1.02 0.97 1.00 0.99 1.03

2009: 0.76 0.97 0.96 1.00 1.02

2010: 1.07 0.99 1.06 1.07 1.06

2011: 0.93 0.99 1.03 1.02

2012: 0.98 1.00 0.99 1.00 1.03 1.00 0.97 0.82

2013: 0.99 1.03 0.99 1.02 1.00 1.03 1.03 1.03 0.99

2. Simultaneous, accurate measurement of water surface? →

Not perfect, yet better than some sites. This is likely the greatest source of noise in the data.

3. Salinity?

Specific conductance:

Minimum: 71 $\mu\text{S}/\text{cm}$ (0.04 PPT)

Median: 1,680 $\mu\text{S}/\text{cm}$ (0.90 PPT)

Maximum: 11,200 $\mu\text{S}/\text{cm}$ (6.80 PPT)

4. Sufficient SSC's?

Minimum: 6,730 mg/L

Median: 29,800 mg/L

Maximum: 195,000 mg/L

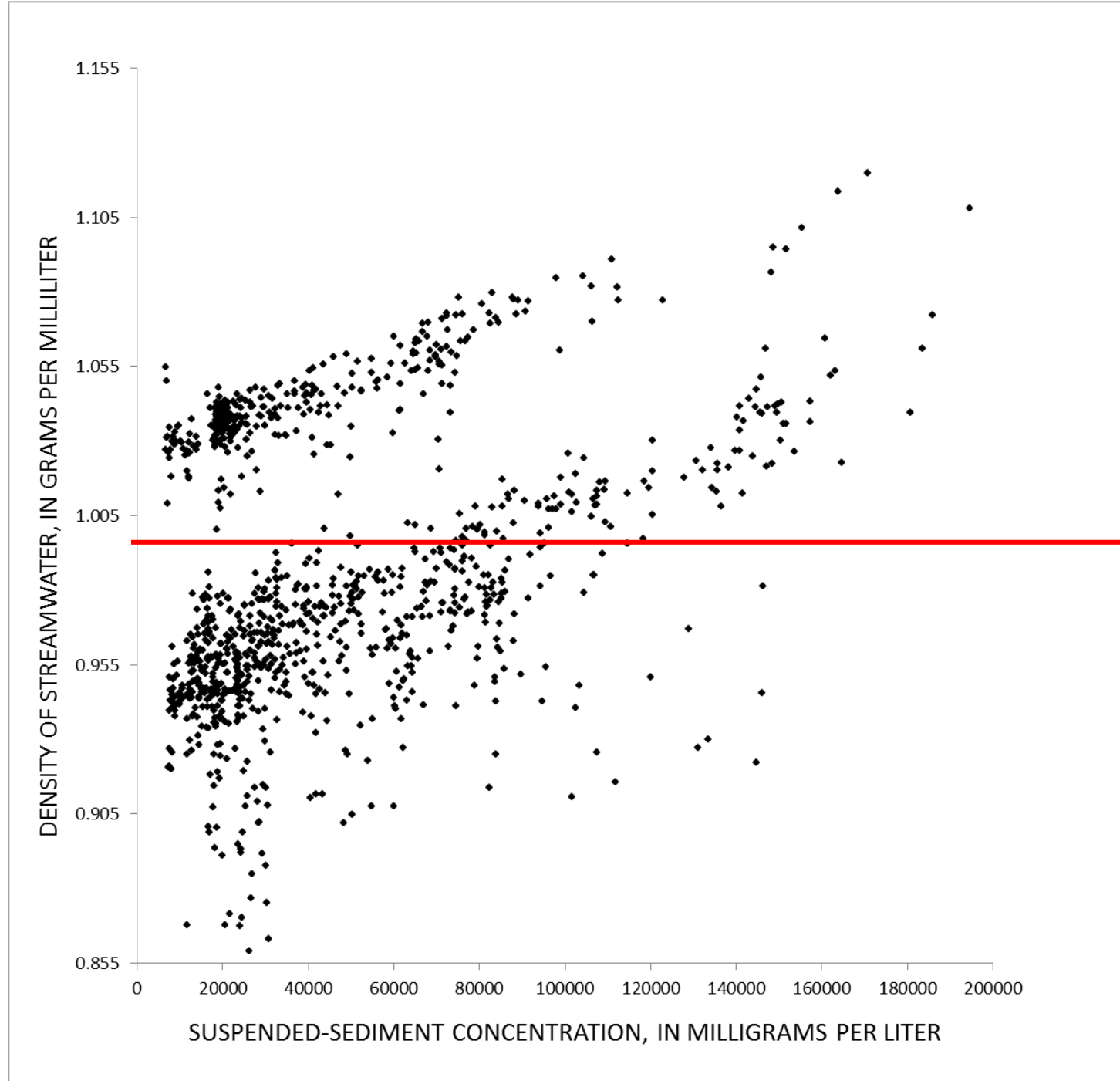
Assumptions at the Rio Puerco:

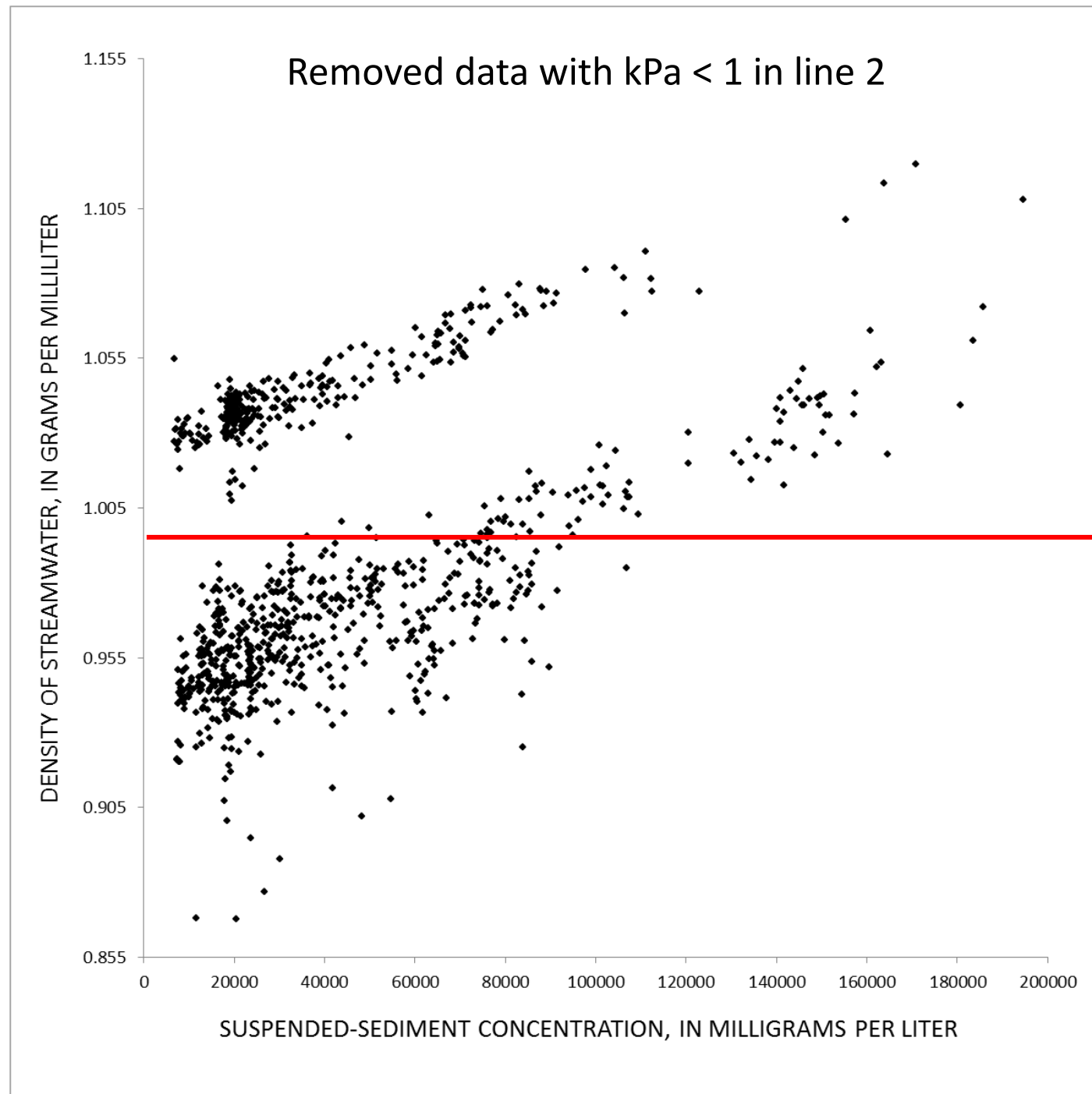


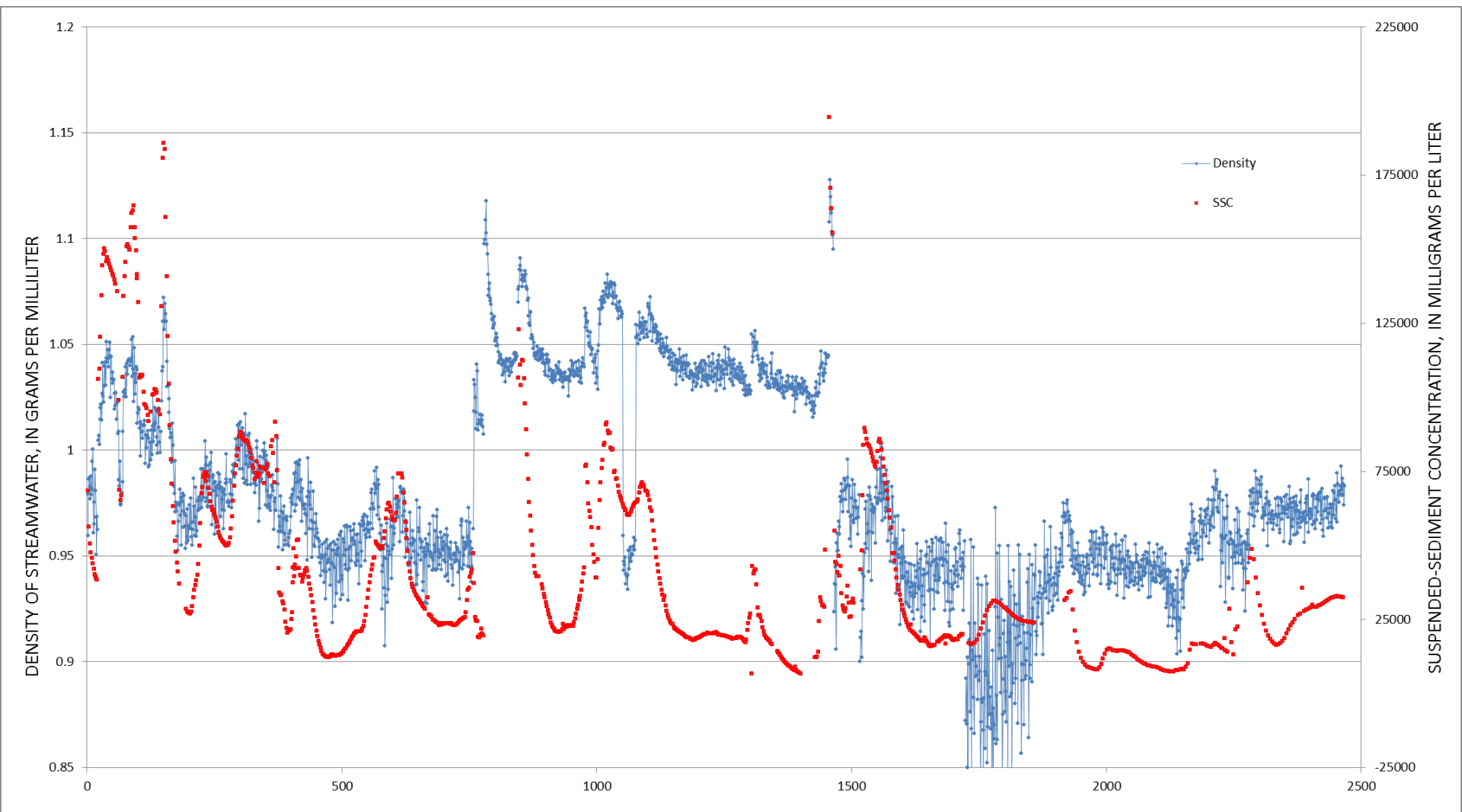


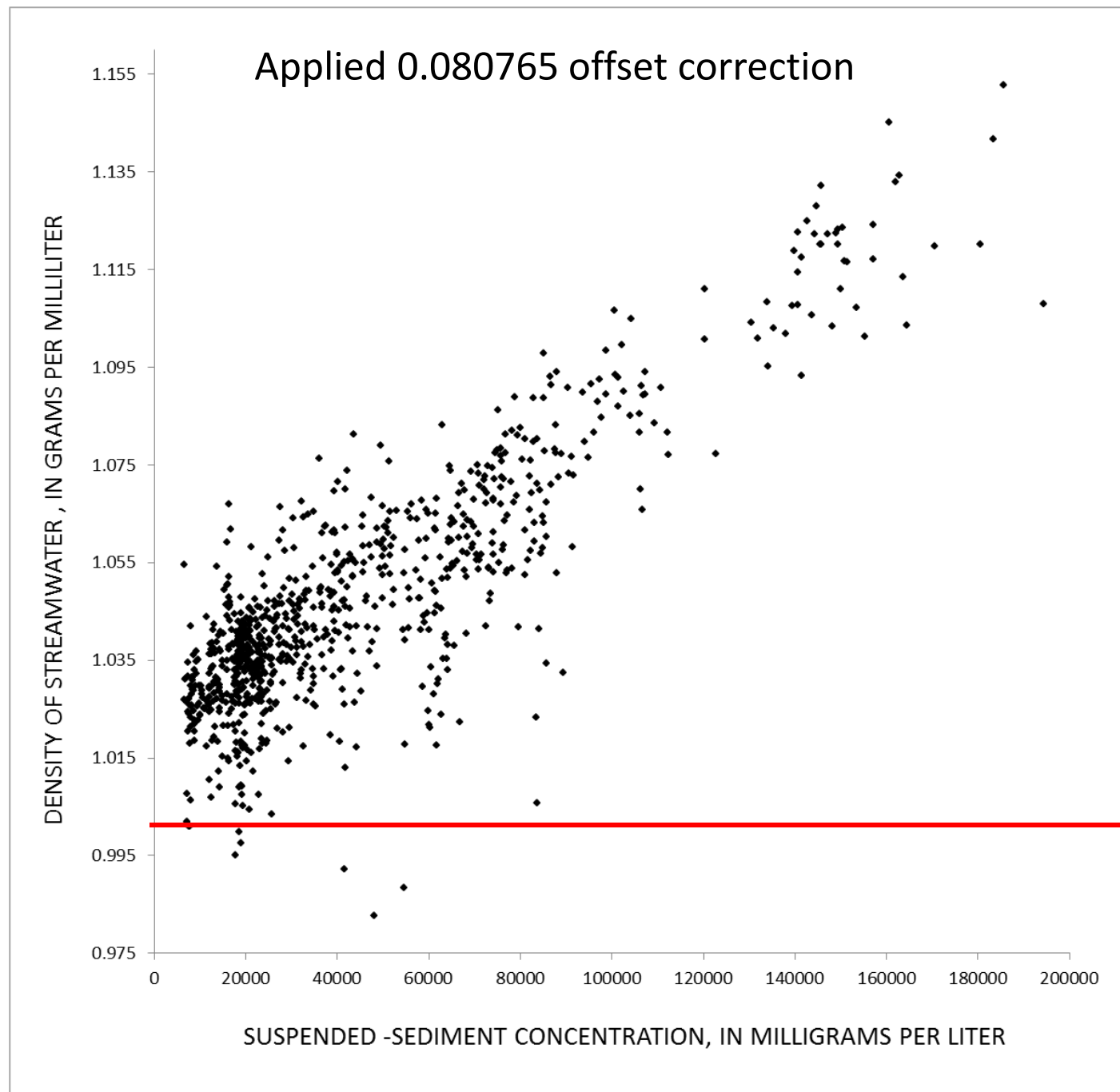
Data collected:

- Suspended-sediment concentration (both point and EWI)
- Density (Sutron dual orifice bubbler)
- Water temperature (FTS digitemp)

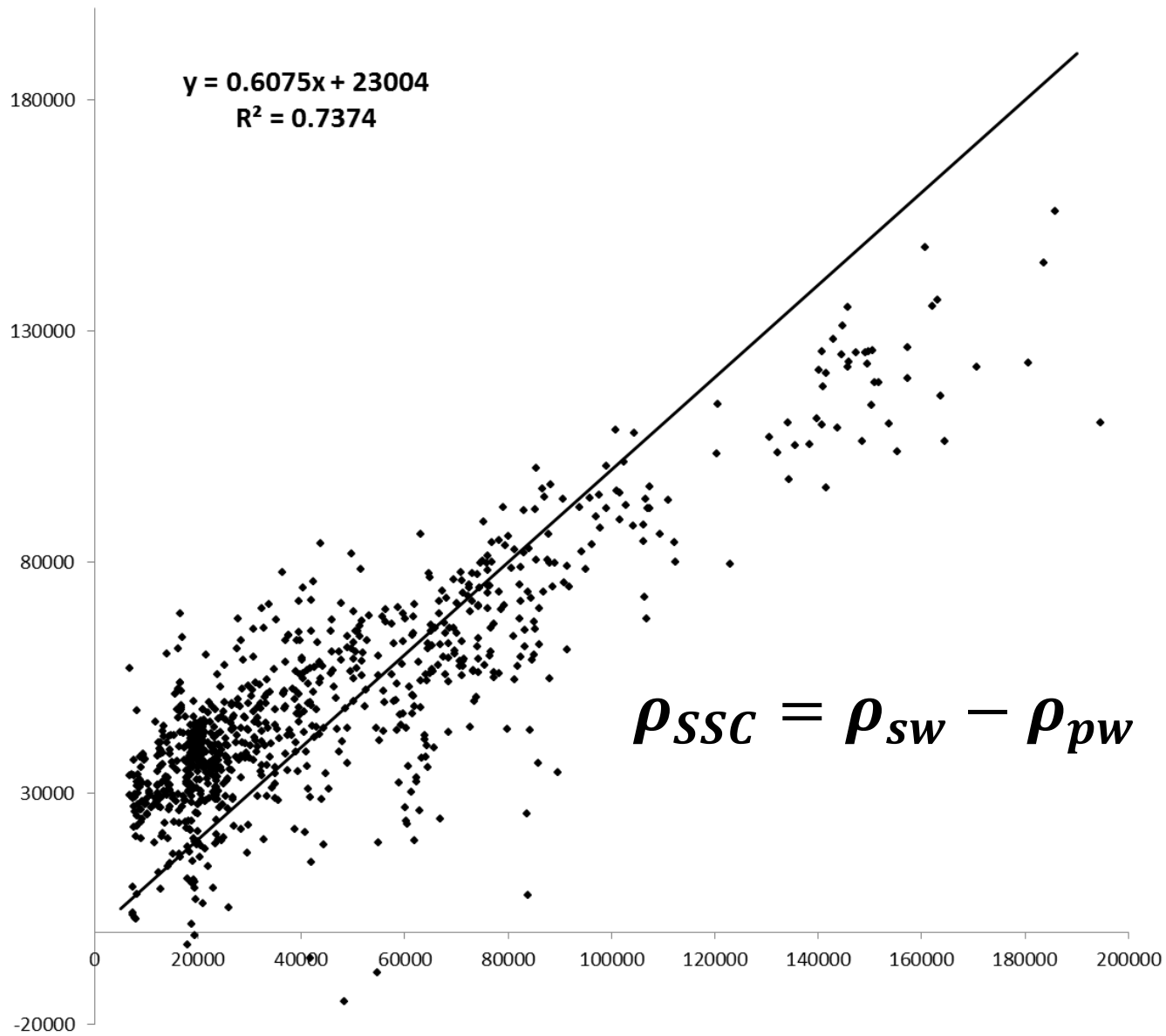




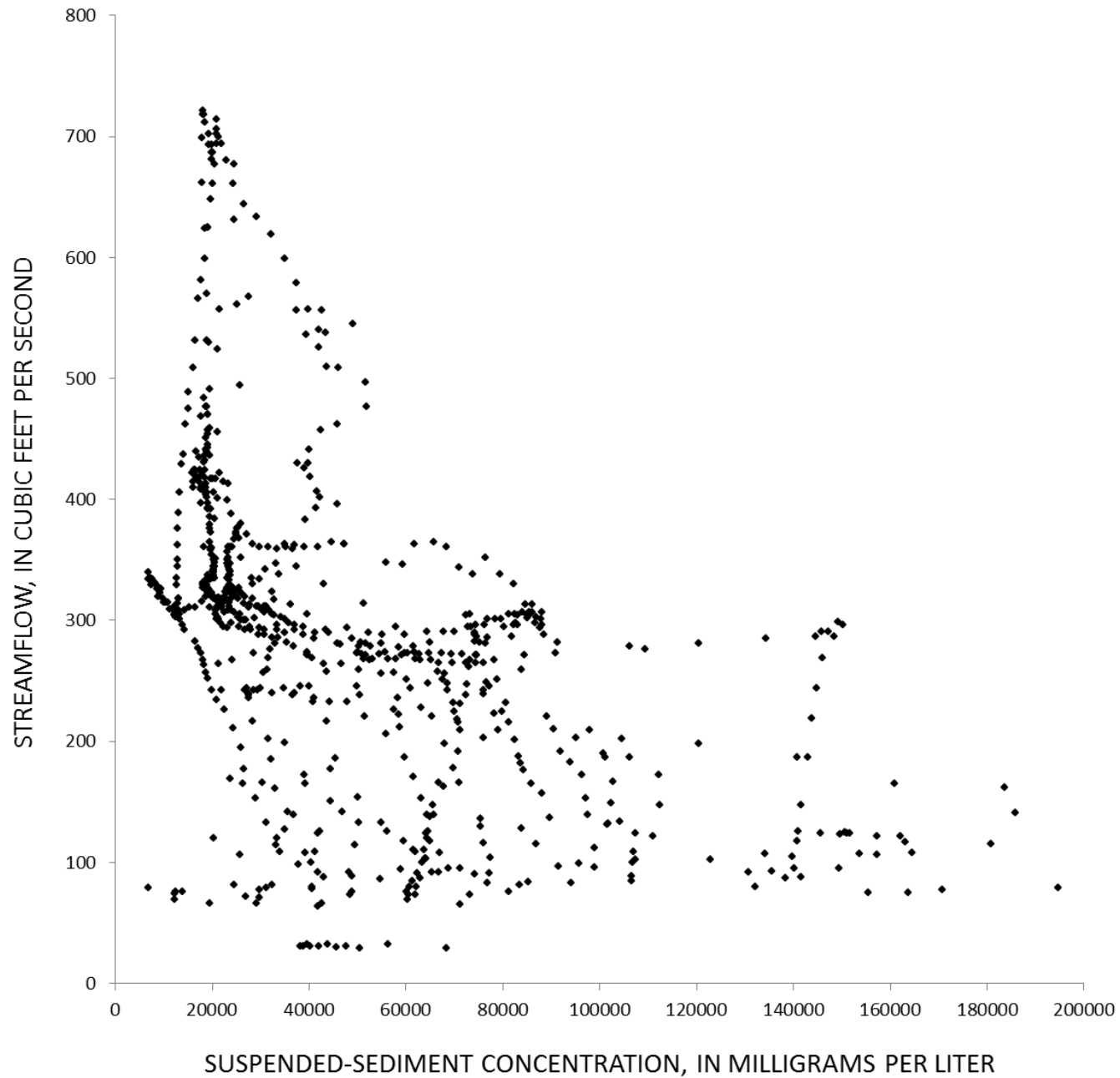


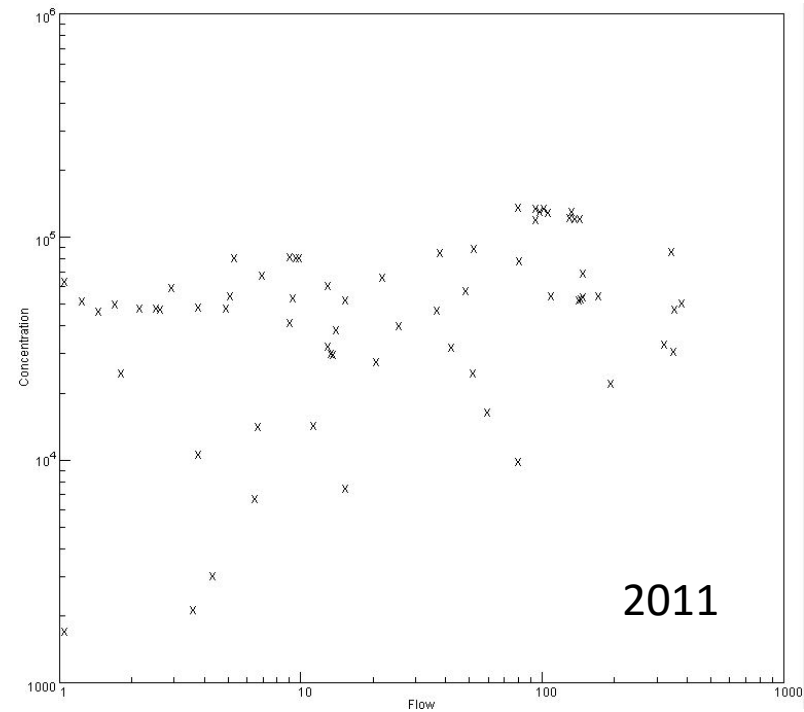
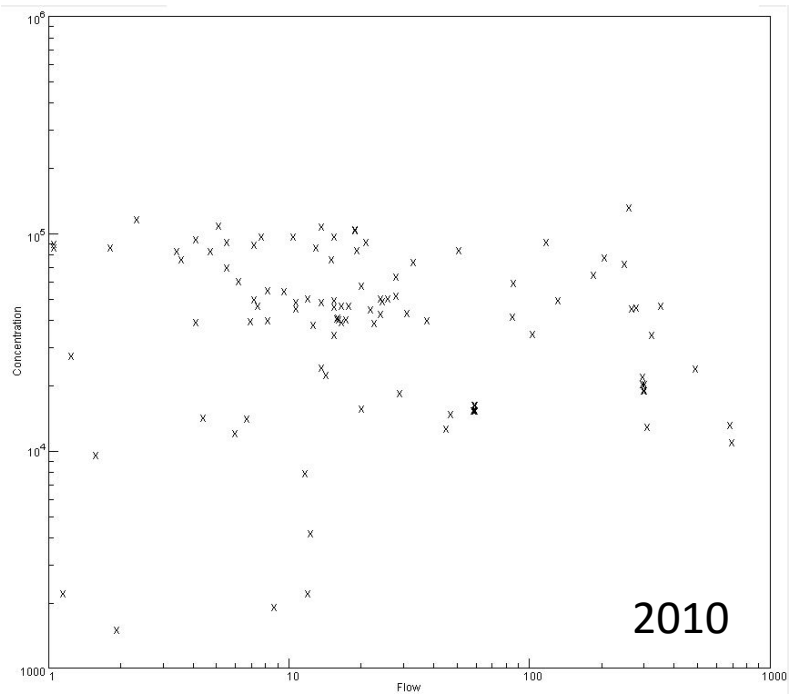
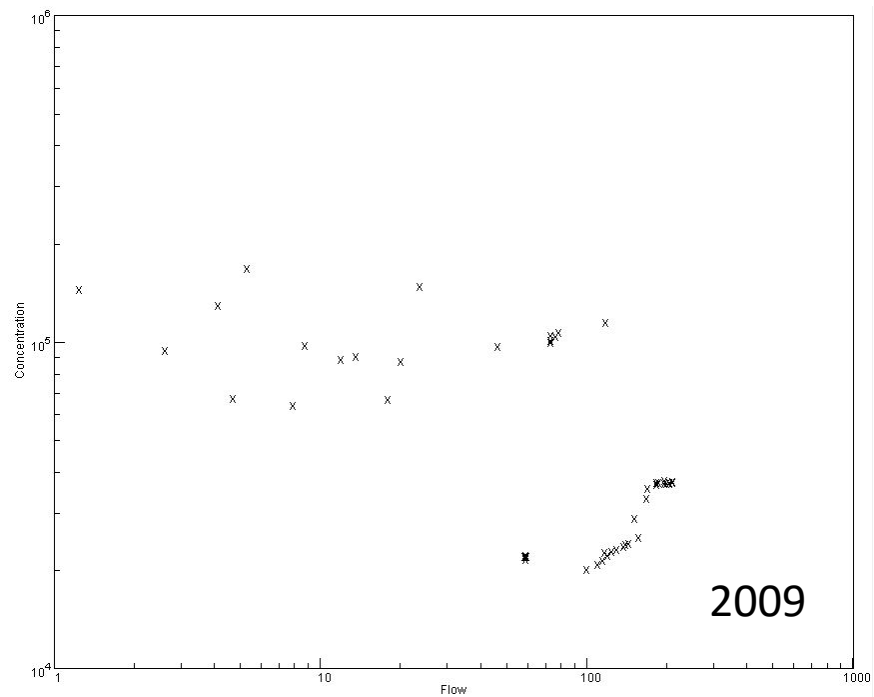
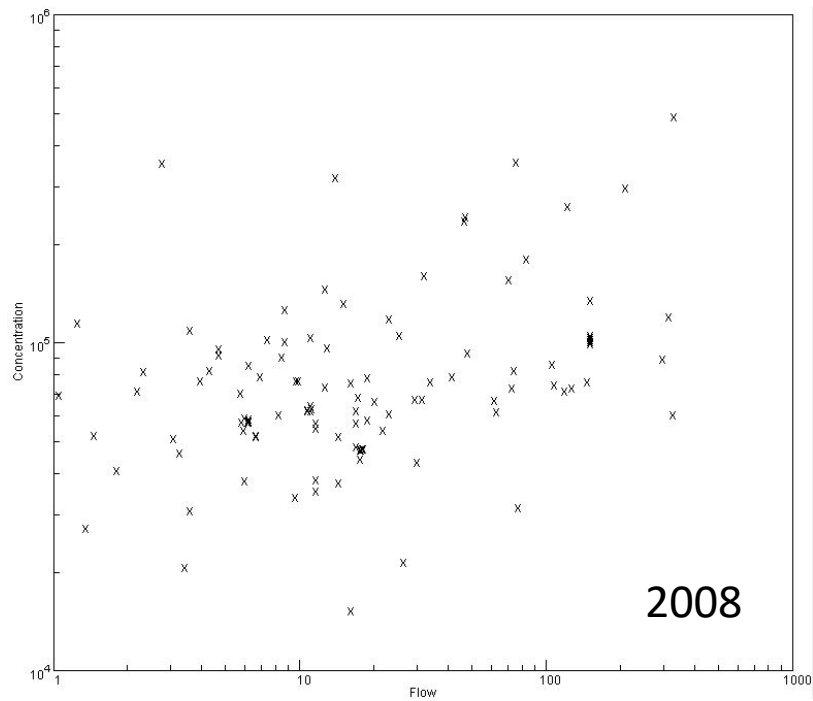


PREDICTED SUSPENDED-SEDIMENT CONCENTRATION , IN MILLIGRAMS PER LITER



OBSERVED SUSPENDED-SEDIMENT CONCENTRATION, IN MILLIGRAMS PER LITER



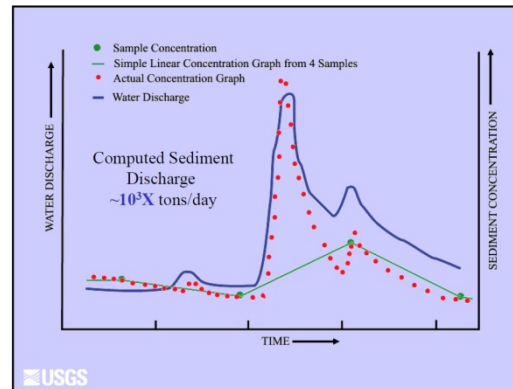


Unanswered questions:

- Is there a way to reduce noise further?
- What is the minimum orifice spacing + SSC?
- What is with the change in slope in the regression as compared with perfect fit line?
- What questions about sediment transport does this data resolution allow us to ask?
- What rivers would benefit from this technology?

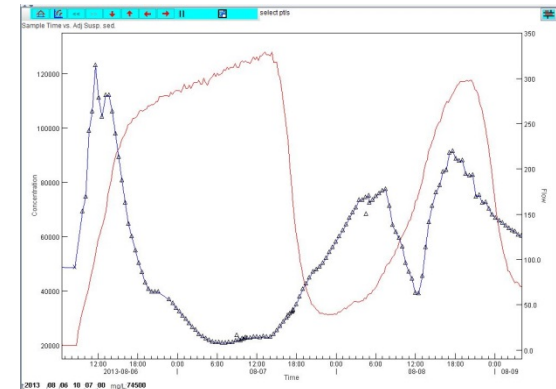
The good:

- Finally a surrogate for high SSC rivers.
- Cheap
- Robust
- Readily available
- Data resolution!
- Data accuracy!
- Data timeliness!



The bad:

- Application likely limited (high SSC's needed, requires deep water, 'calm' water surface, etc)



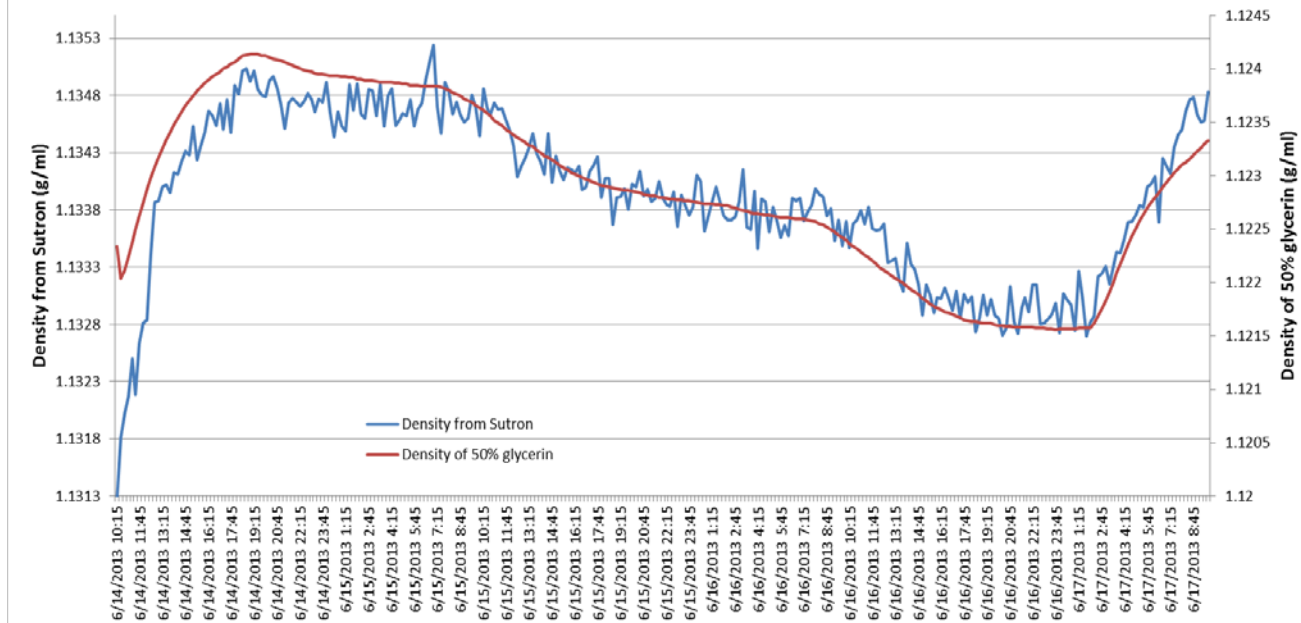


The Ugly.

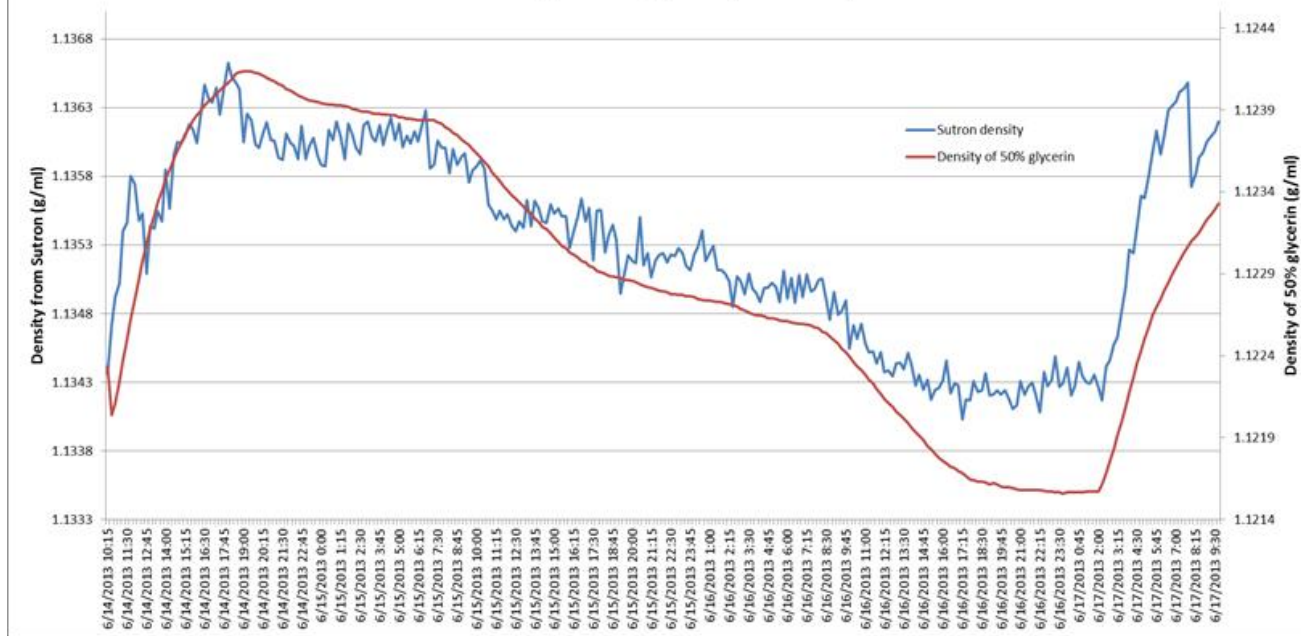
(The end)



Density of 50% glycerin (DOBOLD)



Density of 50% glycerin (DOBNEW)



WY 2008

Date	Time	Types	STREAMFLOW	Susp. sed.	Coeff.
02/22/2008	12:20:00	Point	18	46500	1.00
02/22/2008	12:30:00	Point	18	46400	1.07
05/28/2008	15:40:00	Point	5.9	53100	0.98
05/28/2008	16:00:00	Point	6.0	57900	0.84
07/11/2008	12:00:00	Point	151	99100	1.02
07/11/2008	12:30:00	Point	151	100000	0.97
07/18/2008	11:55:00	Point	9.7	74900	1.00
07/31/2008	14:30:00	Point	11	61100	0.99
07/31/2008	15:00:00	Point	11	61400	1.03

WY 2009

Date	Time	Types	STREAMFLOW	Susp. sed.	Coeff.
05/26/2009	14:40:00	Point	18	65700	0.76
06/29/2009	15:00:00	Point	73	99600	0.97
06/29/2009	15:15:00	Point	73	97900	0.96
09/21/2009	11:00:00	Point	60	21700	1.00
09/21/2009	11:10:00	Point	59	21700	1.02

WY 2010

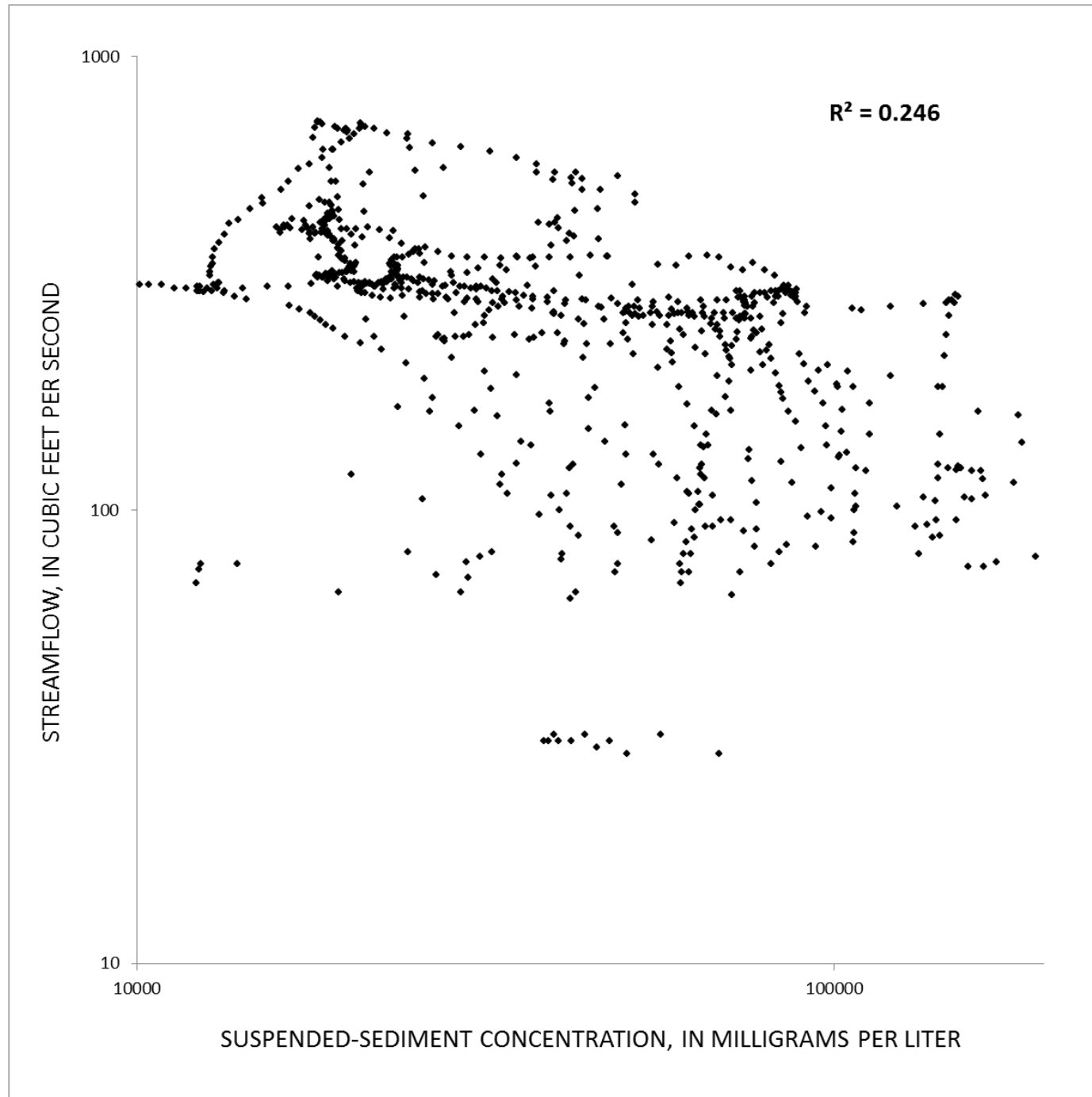
Date	Time	Types	STREAMFLOW	Susp. sed.	Coeff.
12/15/2009	12:30:00	Point	0.01	151	0.59
03/13/2010	14:00:00	Point	19	101000	1.07
04/29/2010	10:00:00	Point	16	39200	0.99
07/30/2010	11:30:00	Point	298	19800	1.06
07/30/2010	11:35:00	Point	301	19800	1.07
08/12/2010	14:30:00	Point	60	15900	1.06
08/12/2010	14:35:00	Point	59	15900	1.06

WY 2011

Date	Time	Types	STREAMFLOW	Susp. sed.	Coeff.
04/15/2011	14:30:00	Point	0.09	277	0.54
04/26/2011	9:15:00	Point	0.09	22	0.07
08/09/2011	12:10:00	Point	13	29300	0.93
09/07/2011	11:45:00	Point	2.6	46000	0.99
09/09/2011	9:30:00	Point	94	131000	1.03
09/19/2011	13:30:00	Point	148	52200	1.02

WY 2008

Date	Time	Types	STREAMFLOW	Susp. sed.	Coeff.
10/15/2012	8:37:30	Point	138	72100	0.99
10/15/2012	11:37:30	Point	76	69500	0.99
07/11/2013	13:02:30	Point	4.6	91900	1.03
07/11/2013	15:52:30	Point	3.1	146000	1.03
07/14/2013	11:52:30	Point	288	145000	0.99
07/15/2013	13:25:00	Point	6.1	60900	1.02
07/16/2013	13:25:00	Point	110	165000	1.00
07/23/2013	14:07:30	Point	274	61700	1.03
07/29/2013	11:42:30	Point	289	54400	1.03
07/30/2013	11:42:30	Point	289	54400	1.03
08/01/2013	11:55:00	Point	12	41800	0.99





"Sediment gnome goes fishing"

