

Water Resources Task Group Update: Surface Water



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BLM – MT – Miles City

May 9, 2007

Water Tasks

- 1. Implement the surface water monitoring plan, evaluate the data, and modify the plan as needed.**
2. Implement the groundwater monitoring plan, evaluate the data, and modify the plan as needed.
3. Prepare an ongoing list of studies being conducted, and provide recommendations on additional studies that are needed.
4. Develop a consistent approach for dealing with water management (impoundments, irrigation...)

General Sampling Strategy proposed in the Water Task Group's Surface Water Monitoring Plan for the Powder River Basin

<u>Stream Type</u>	<u>Constituent Class</u>	<u>Sampling Frequency</u>
Mainstem	Streamflow	Continuous
	Field Measurements	12 times per year
	Major Ions	12 times per year
	Suspended sediment	12 times per year
	Primary Metals	12 times per year
	Secondary Metals	2 times per year
	Nutrients	2 times per year
Tributary	Streamflow	Continuous
	Field Measurements	6 times per year
	Major Ions	6 times per year
	Suspended sediment	6 times per year
	Nutrients	2 times per year

Status of Surface Water Monitoring relative to the IWA Surface Water Monitoring Plan, April, 2007

Conducted = ●; Partially Conducted = ⊙; Not Conducted = ○)

	Site	Stream Type	Assigned Priority	Continu-ous Stream-flow	Field measure-ments	Major Ions
Rosebud	Rosebud Creek at reservation boundary, near Kirby	Mainstem	High	●	●	●
	Rosebud Creek, near Colstrip	Mainstem	Low	○	○	○
	Rosebud Creek at mouth, near Rosebud	Mainstem	Med	○	○	○
Tongue	Tongue River, at Monarch	Mainstem	Med	●	●	●
	Goose Creek, near Acme	Tributary	Med	●	●	●
	Prairie Dog Creek, near Acme	Tributary	Med	●	●	●
	Tongue River at State Line, near Decker	Mainstem	High	●	●	●
	Tongue River at Dam, near Decker	Mainstem	Med	●	●	●
	Hanging Woman Creek near Birney	Tributary	Med	●	●	●
	Tongue River at Birney Day School Bridge, near Birney	Mainstem	High	●	●	●
	Otter Creek at Ashland	Tributary	Med	●	●	●
	Tongue River below Brandenburg Bridge, near Ashland	Mainstem	Med	●	●	●
	Pumpkin Creek, near Miles City	Tributary	Med	●	●	●
	Tongue River, at Miles City	Mainstem	Med	●	●	●
	Tongue River above T&Y div. dam, near Miles City	Mainstem	NA	●	●	●

	Site	Stream Type	Assigned Priority	Continuous	Field	Major
				Stream-flow	measurements	ions
Powder	Powder River, at Sussex	Mainstem	Med	●	●	●
	Powder River below Burger Draw, near Buffalo	Mainstem	Med	○	●	●
	Crazy Woman at Upper Station, near Arvada	Tributary	Med	●	●	●
	Powder River, at Arvada	Mainstem	Med	●	●	●
	Clear Creek, near Arvada	Tributary	Med	●	●	●
	Powder River, at Moorhead	Mainstem	High	●	●	●
	Little Powder River above Dry Creek, near Weston	Tributary	Med	●	●	●
	Little Powder River, near Broadus	Tributary	Low	○	●	●
	Powder River, near Powderville	Mainstem	Med	○	○	○
	Mizpah Creek, near Mizpah	Tributary	Low	○	○	○
Powder River, near Locate	Mainstem	Med	●	●	●	
Cheyenne	Porcupine Creek, near Teckla	Tributary	Med	○	○	○
	Antelope Creek, near Teckla	Tributary	High	○	●	●
	Cheyenne River, near Dull Center	Mainstem	High	●	●	●
	Little Thunder Creek, near Hampshire	Tributary	Med	○	●	●
	Black Thunder Creek, near Hampshire	Tributary	Med	○	●	●
	Cheyenne River, near Spencer	Mainstem	High	●	●	●
Belle Fourche	Belle Fourche River below Rattlesnake Creek, near Piney	Mainstem	High	○	●	●
	Caballo Creek, near Gillette	Tributary	Med	○	○	○
	Caballo Creek at mouth, near Piney	Tributary	High	○	●	●
	Donkey Creek, near Moorcroft	Tributary	High	○	●	●
	Belle Fourche River, below Moorcroft	Mainstem	Med	●	●	●
	Belle Fourche River, below Hulett	Mainstem	Med	○	●	●
	Belle Fourche River at WY-SD State Line	Mainstem	High	●	○	○

Powder River Basin Regional Surface Water Monitoring Network

Use USGS to Monitor at USGS
stations

BLM, USGS, MDEQ, WDEQ,
WSEO, MDNRC, Northern
Cheyenne Tribe, EPA, and
industry.

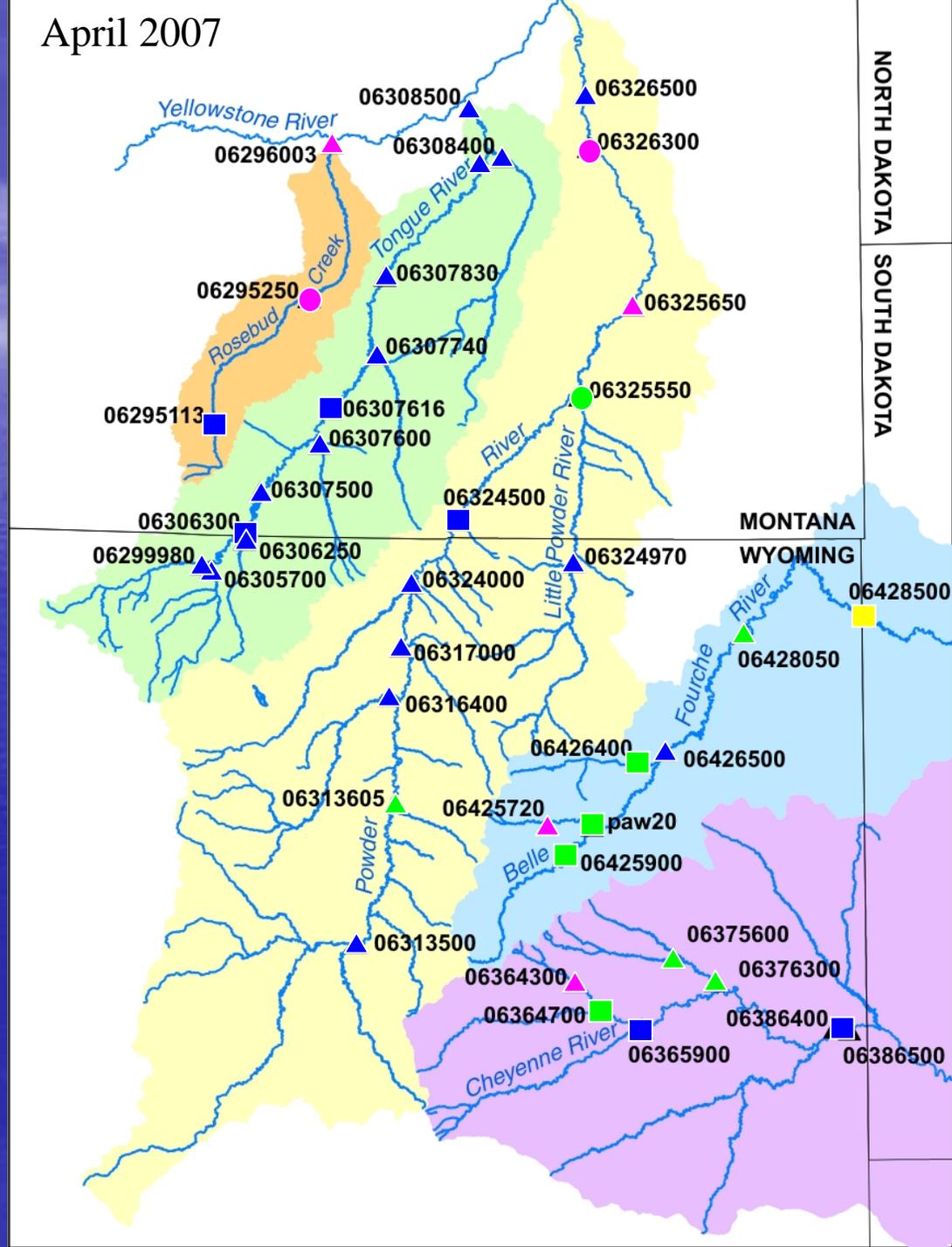
Priority

- High
- ▲ Medium
- Low

Status

- ▲ Cont. Flow and WQ
- ▲ Inst. Flow and WQ
- ▲ Flow Only
- ▲ Not Monitored

April 2007



PRB Surface Water Quality Data Analysis/Interpretations

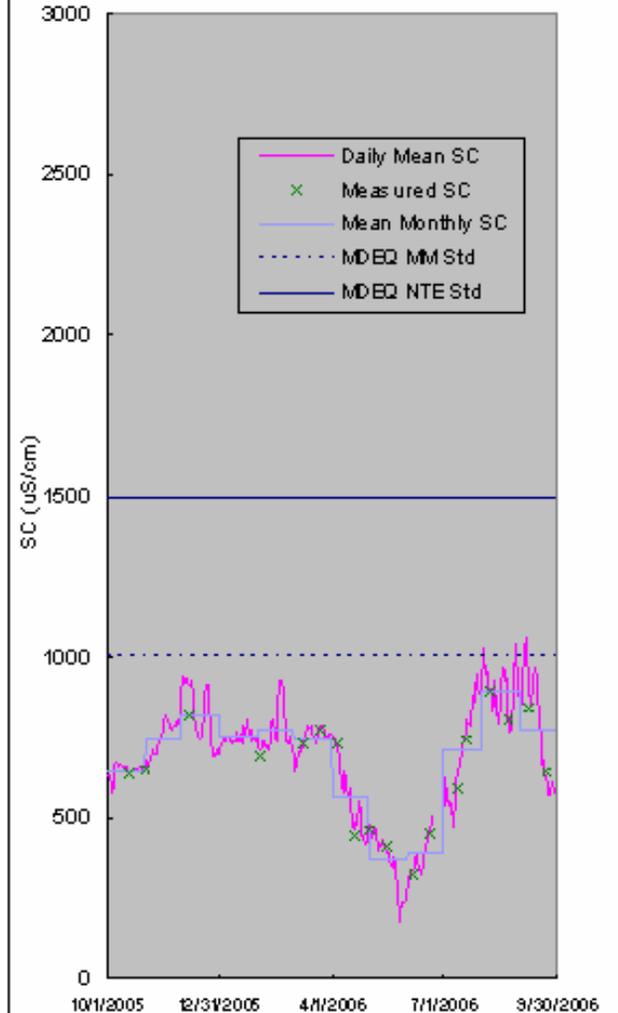
- Andy Bobst – BLM, Miles City
- Helen Dawson – EPA, Denver
- Melanie Clark – USGS, Cheyenne

BLM Analysis

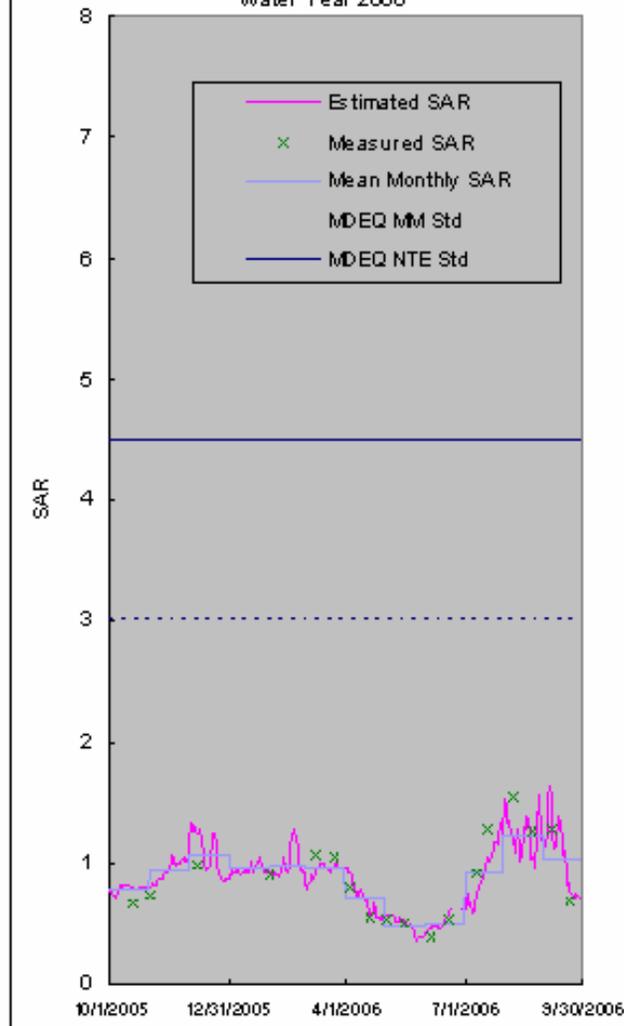
- Unadjusted values of flow, SC, SAR for Tongue and Powder
- Flow-corrected analysis on Tongue River

Tongue River at State Line

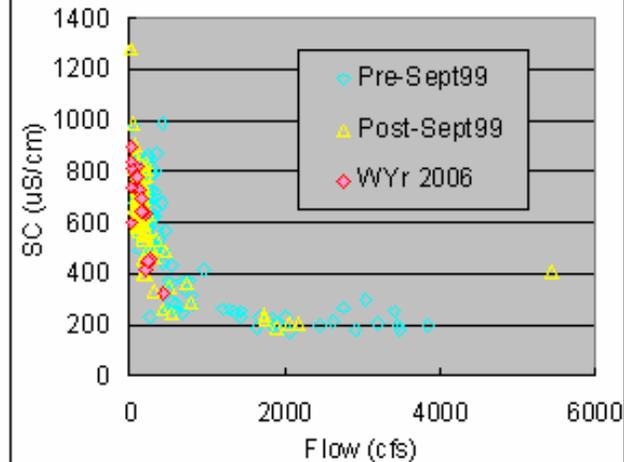
Daily Mean and Measured SC Values
Tongue River at State Line
Water Year 2006



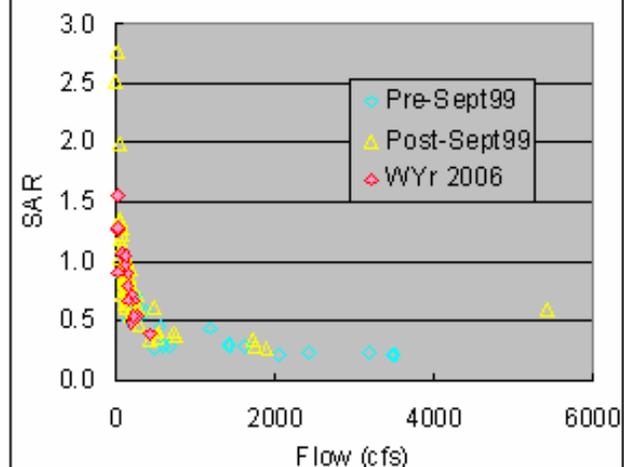
Estimated and Measured SAR Values
Tongue River at State Line
Water Year 2006



Analytical SC vs. Flow
Tongue River at State Line

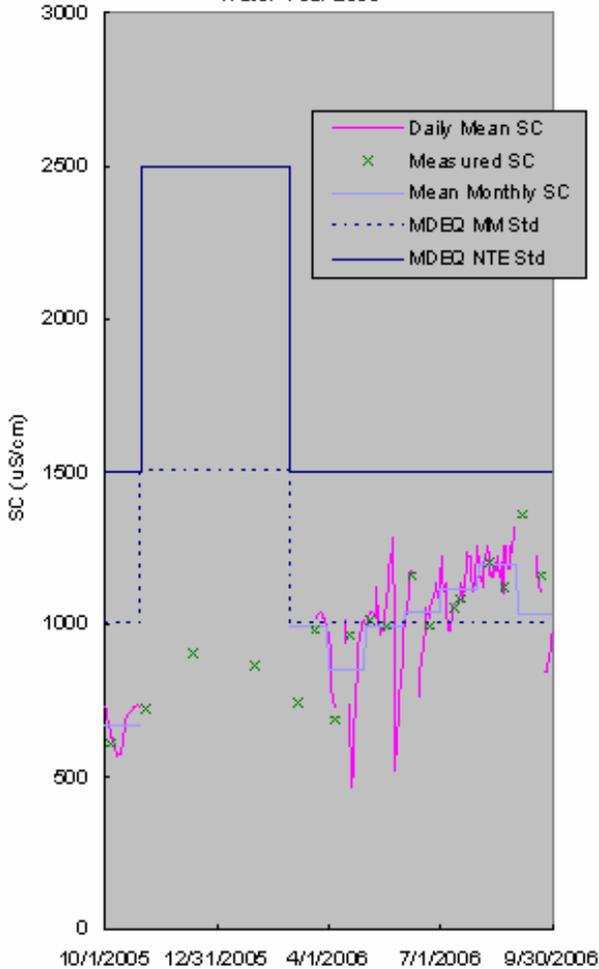


Analytical SAR vs. Flow
Tongue River at State Line

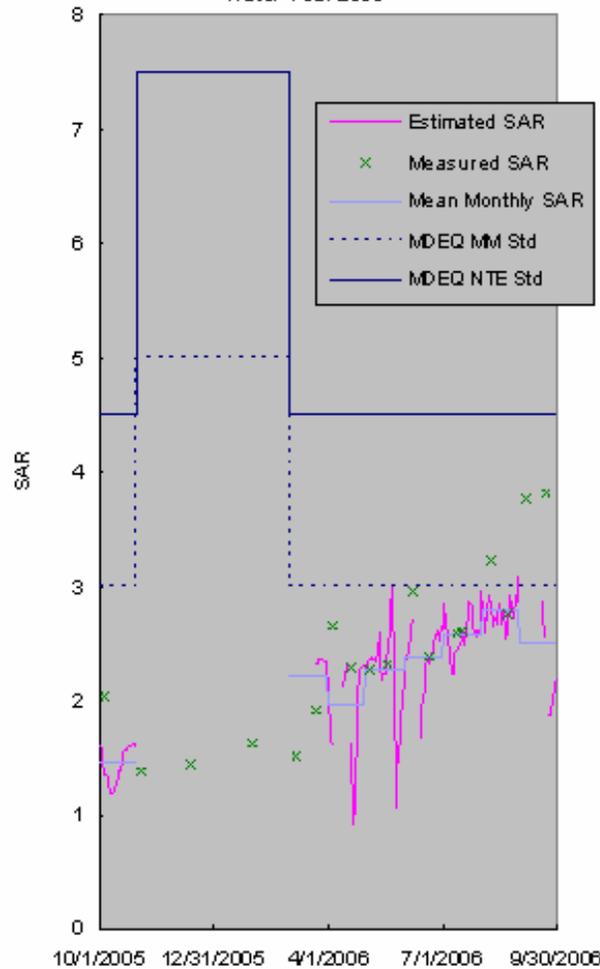


Tongue River at Miles City (mouth)

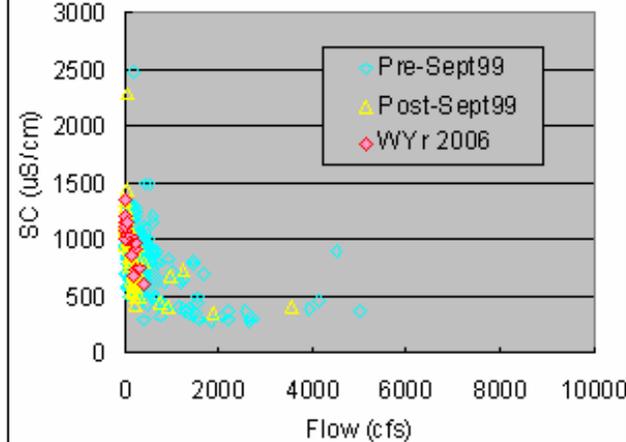
Daily Mean and Measured SC Values
Tongue River at Miles City
Water Year 2006



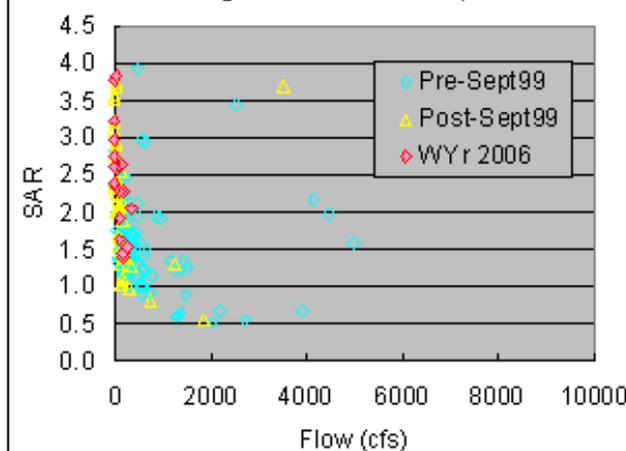
Estimated and Measured SAR Values
Tongue River at Miles City
Water Year 2006



Analytical SC vs. Flow
Tongue River at Miles City



Analytical SAR vs. Flow
Tongue River at Miles City

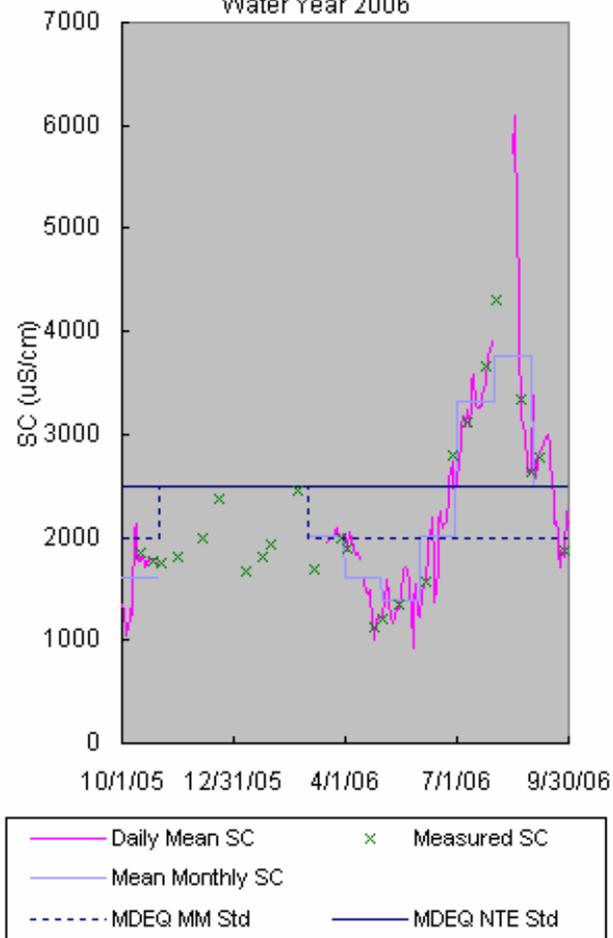


Surface Water Monitoring "Data Results" Water Year 2006 – Tongue River

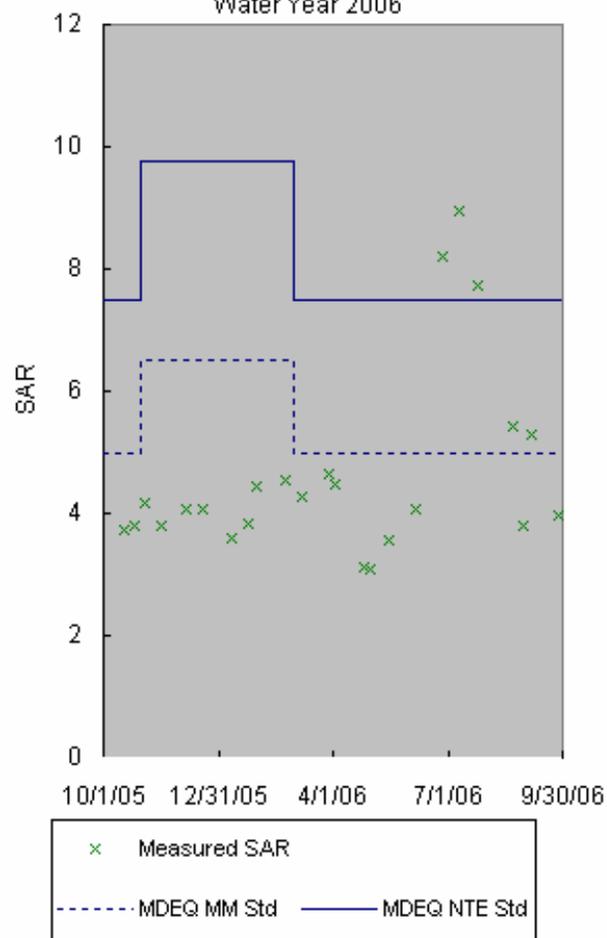
- Decker (state line)
 - Observed values for EC and SAR were not in excess of the MDEQ Standards.
- Miles City (mouth)
 - Mean monthly EC values were above the MDEQ Standard, while SAR values were not in excess of the MDEQ Standard.

Powder River at Moorhead (State Line)

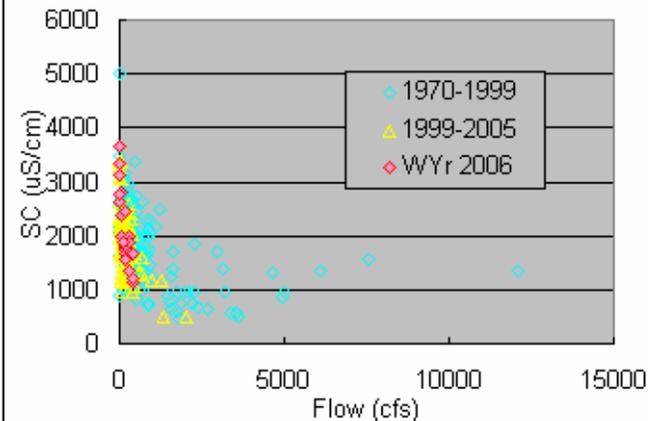
Daily Mean and Analytical SC Values
Powder River at Moorhead
Water Year 2006



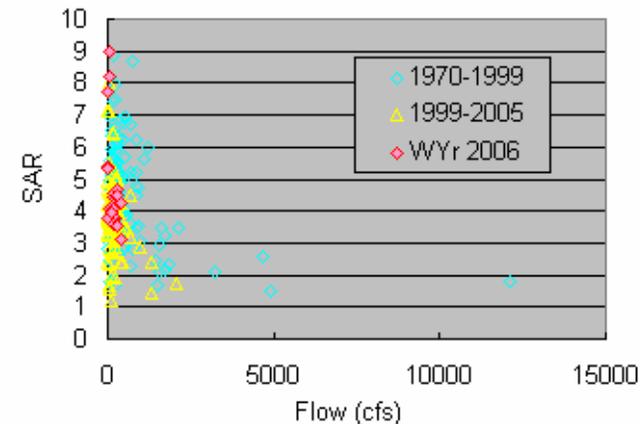
Analytical SAR Values
Powder River at Moorhead
Water Year 2006



Analytical SC vs. Flow
Powder River at Moorhead

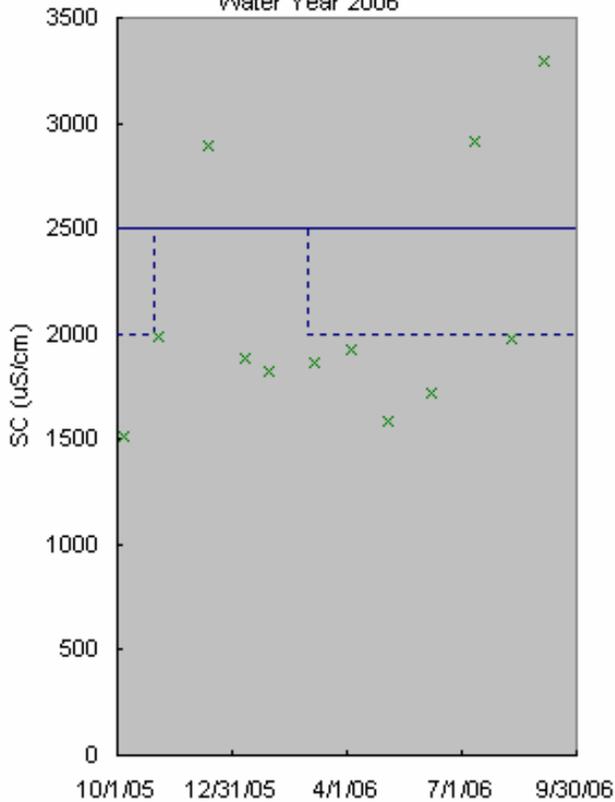


Analytical SAR vs. Flow
Powder River at Moorhead



Powder River at Locate (mouth)

Analytical SC Values
Powder River at Locate
Water Year 2006

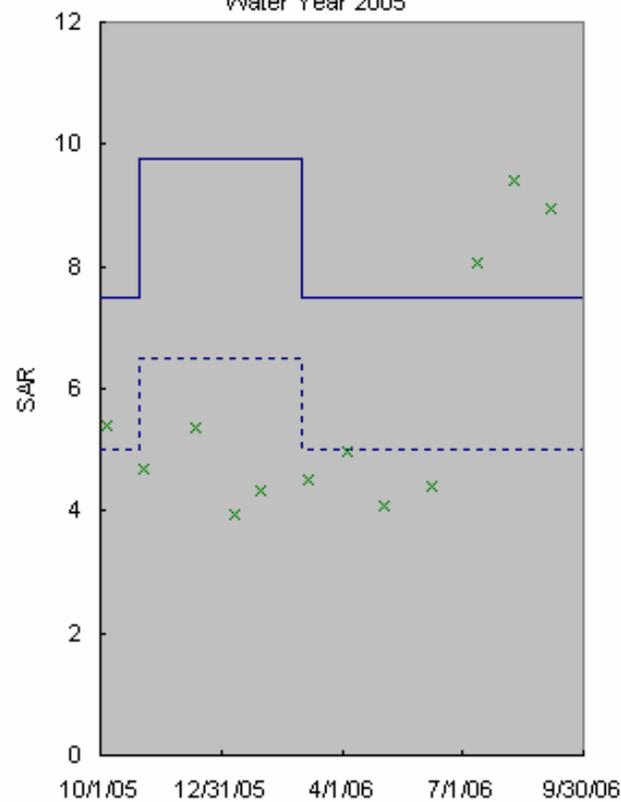


x Measured SC

----- MDEQ MM Std

———— MDEQ NTE Std

Analytical SAR Values
Powder River at Locate
Water Year 2005

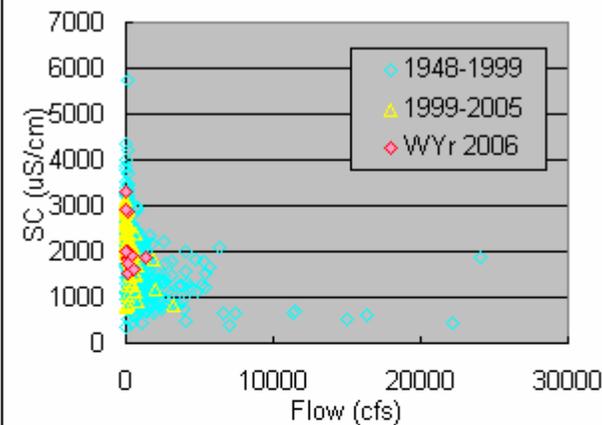


x Measured SAR

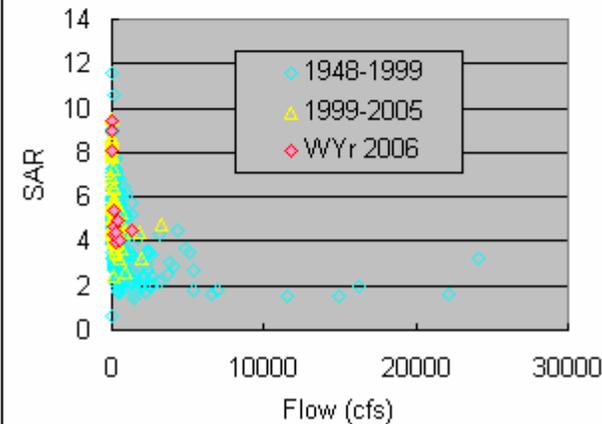
----- MDEQ MM Std

———— MDEQ NTE Std

Analytical SC vs. Flow
Powder River at Locate



Analytical SAR vs. Flow
Powder River at Locate



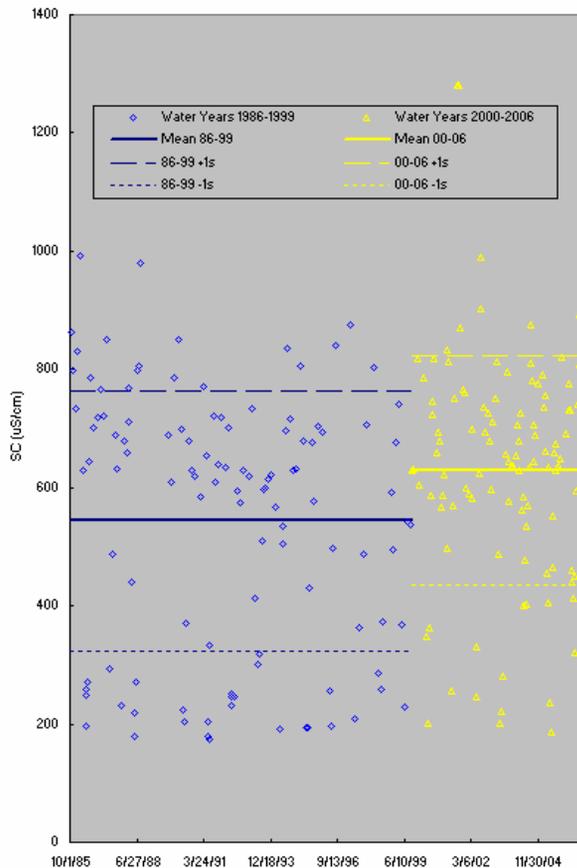
Surface Water Monitoring "Data Results" Water Year 2006 – Powder River

- Moorhead (state line)
 - EC values in excess of both the mean monthly and instantaneous MDEQ Standards were recorded.
 - SAR values in excess of the instantaneous MDEQ Standard were recorded. Insufficient data was available to assess the mean monthly standard.
- Locate (mouth)
 - EC and SAR values in excess of their respective instantaneous standards were recorded. Insufficient data was available to assess the mean monthly standards.

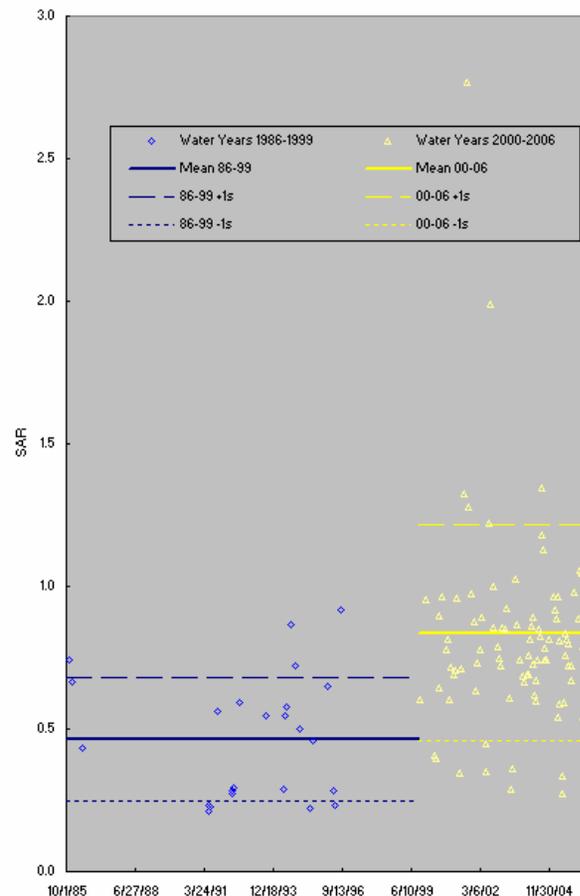
Bobst, 2007, Water Year 2006 Overview of Surface Water Monitoring Data for SC, SAR, and Flow in the Tongue River Watershed

- Tongue River at the State Line

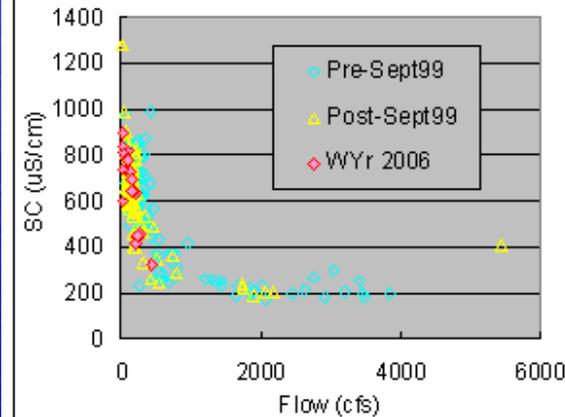
SC vs. Time
Tongue River at State Line



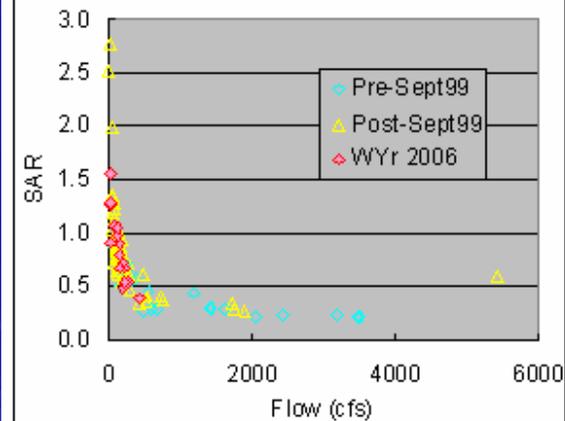
SAR vs. Time
Tongue River at State Line



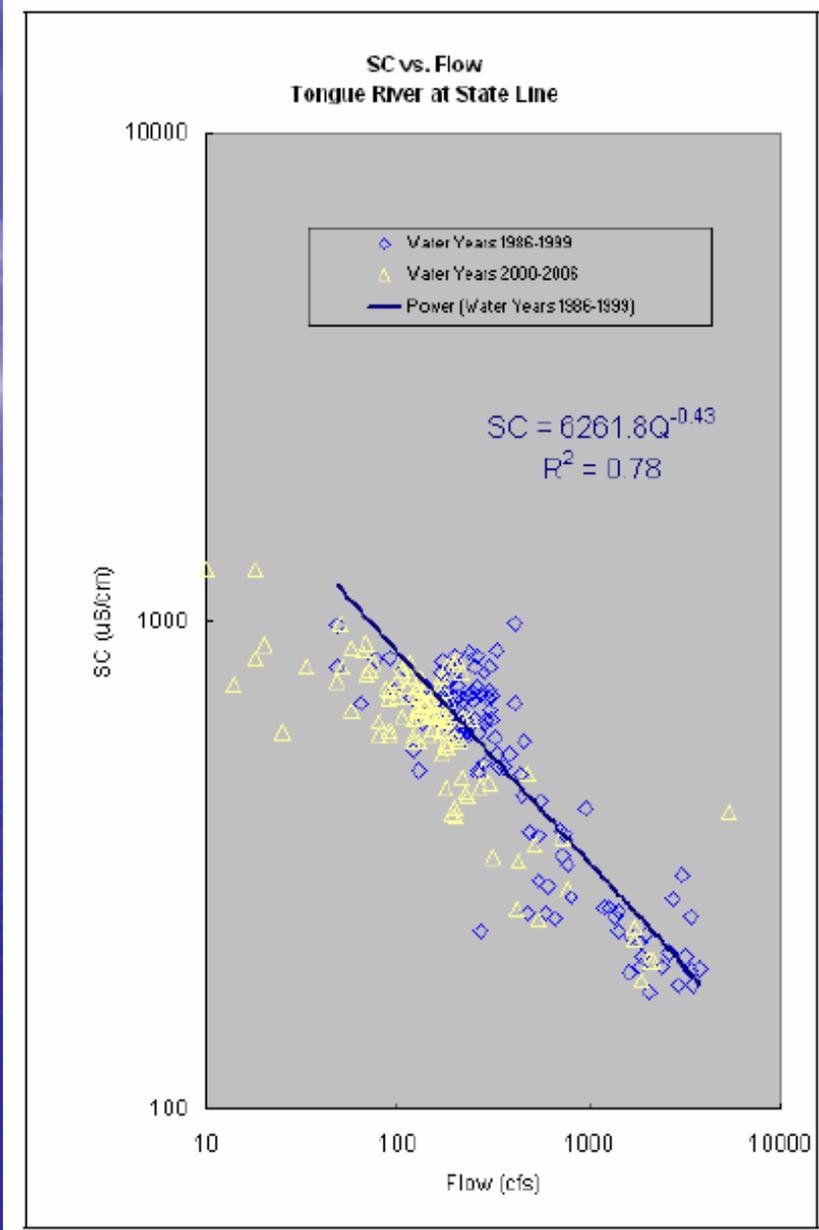
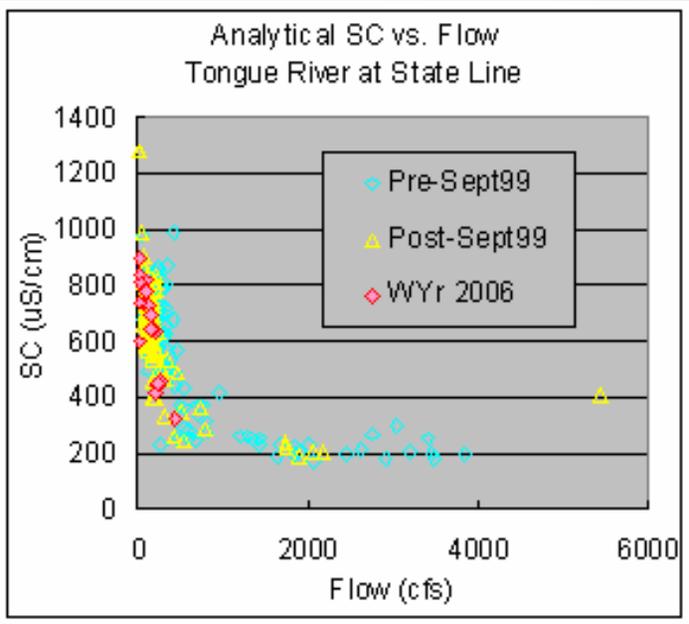
Analytical SC vs. Flow
Tongue River at State Line



Analytical SAR vs. Flow
Tongue River at State Line



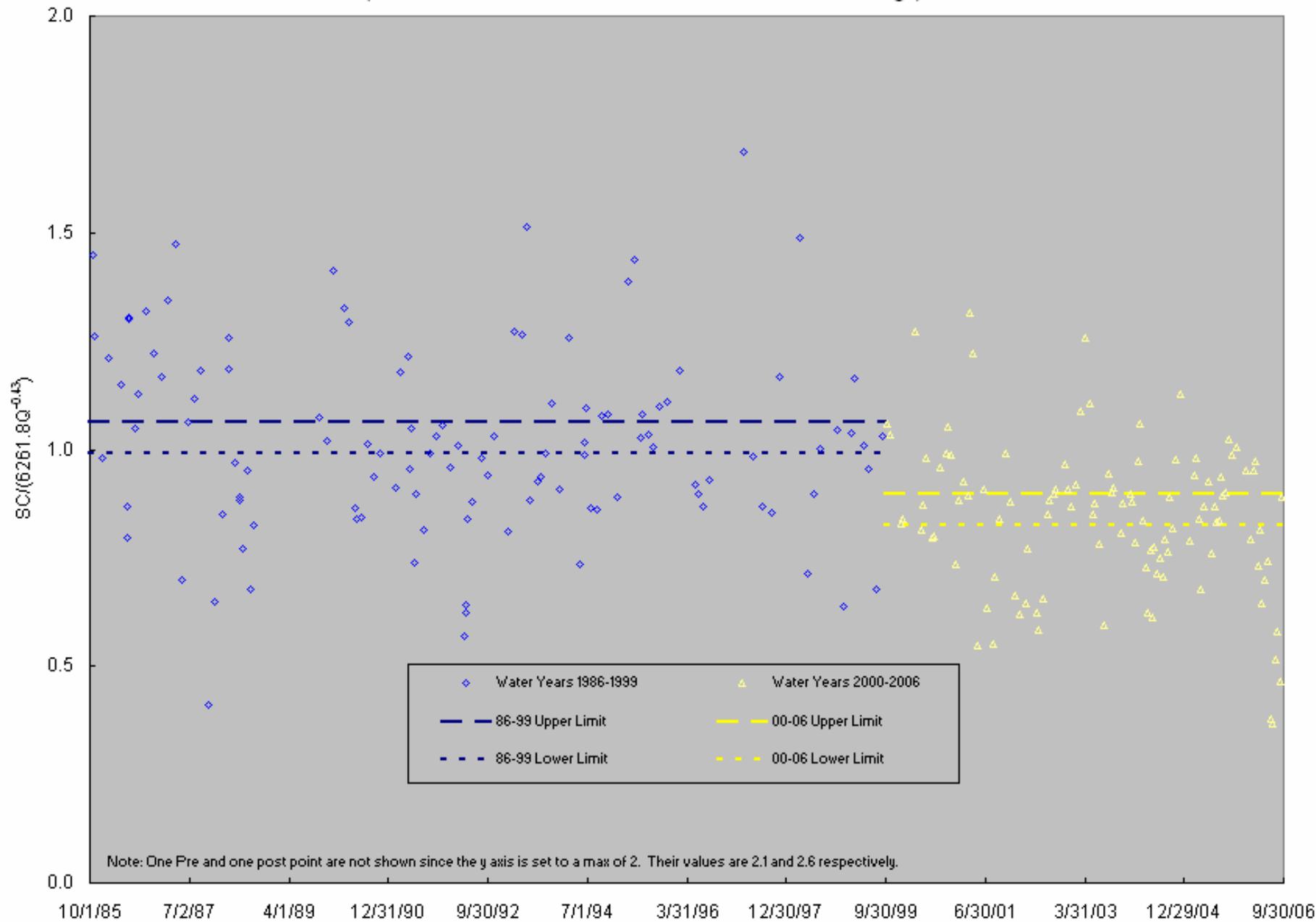
Flow Correction



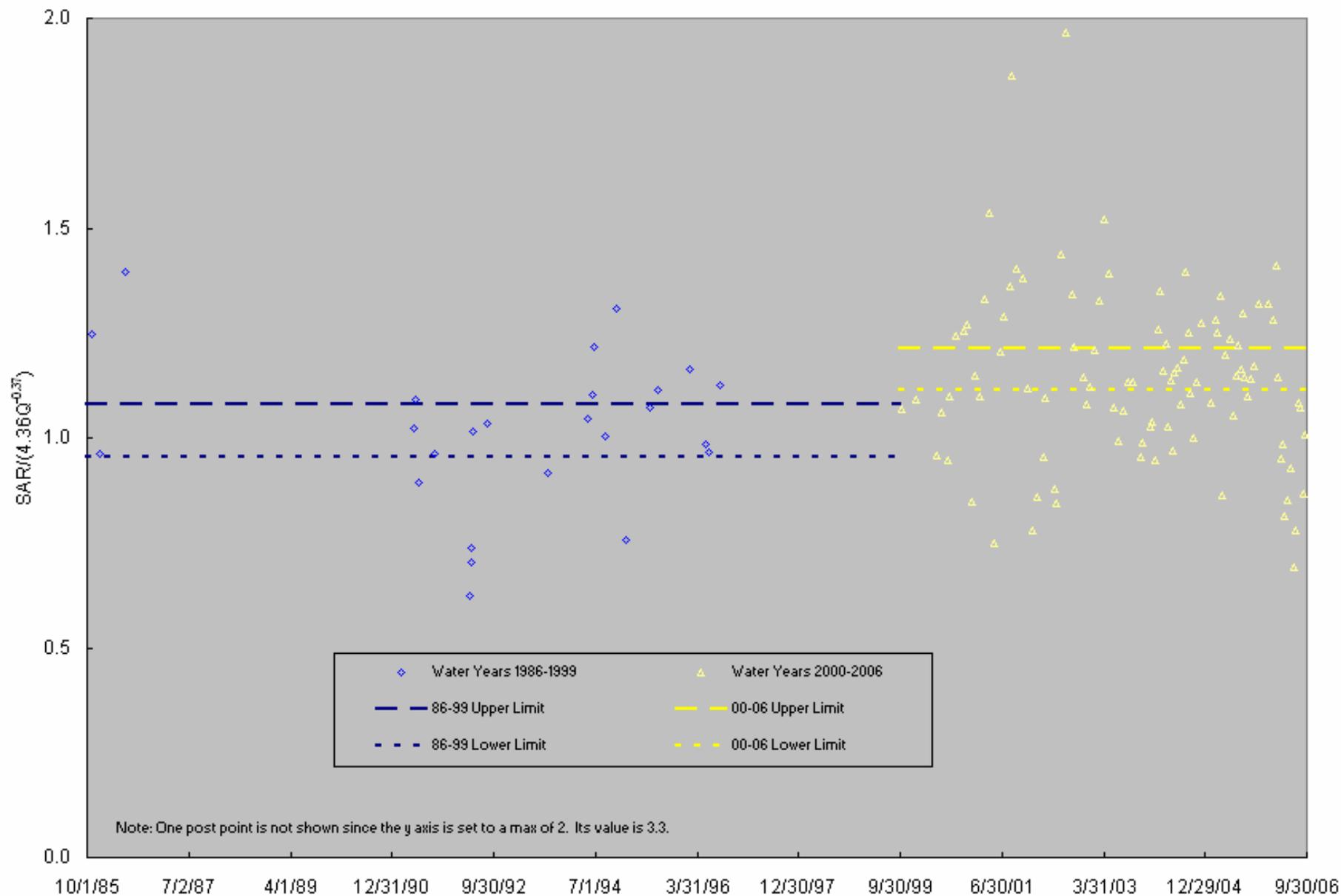
$$SC = 6261.8Q^{-0.4296}$$

$$\frac{SC}{6261.8Q^{-0.4296}} = 1$$

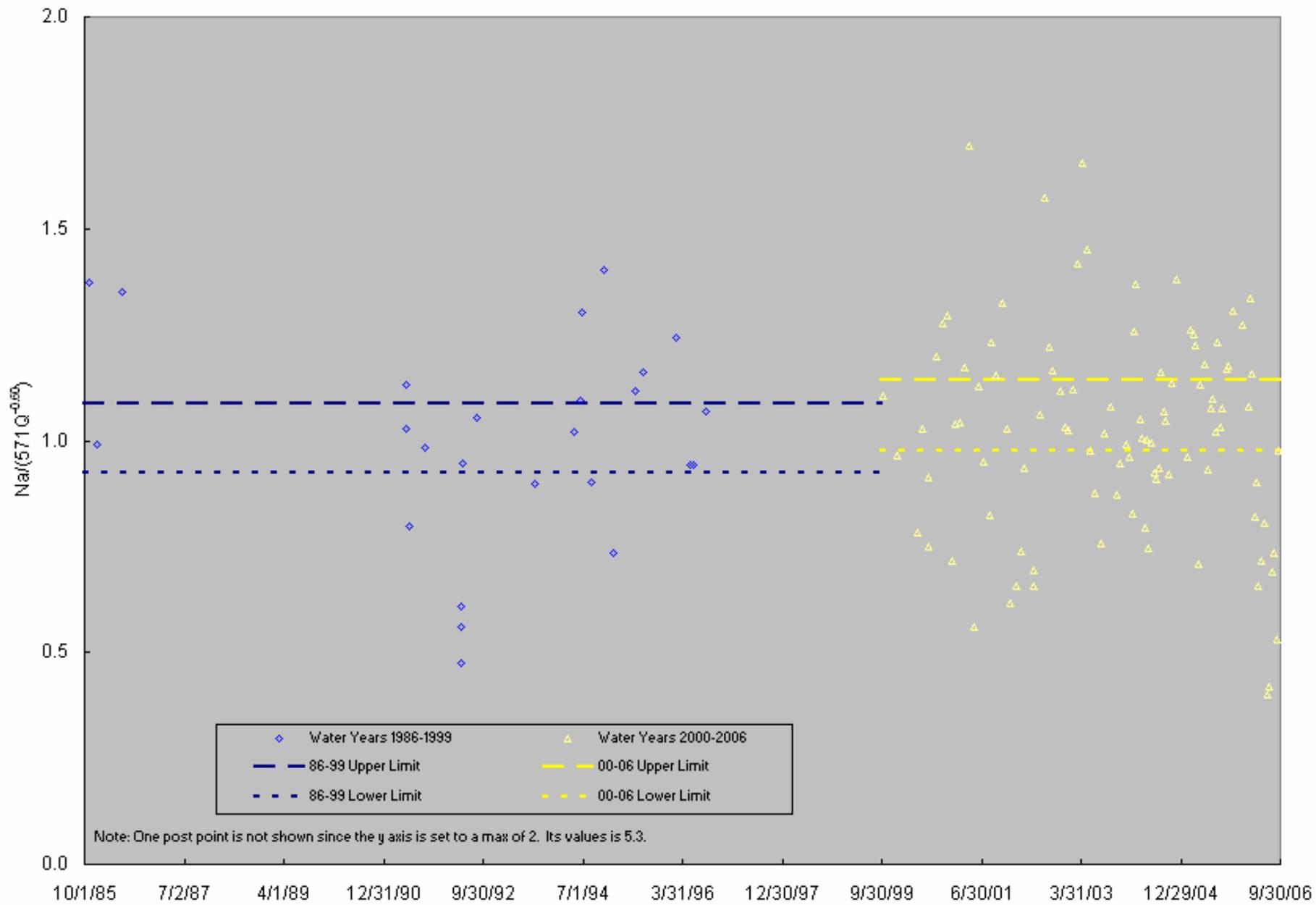
Flow Corrected SC vs. Time
Tongue River at State Line
90% Confidence Intervals
(90% Confident that the true mean is within the identified range)



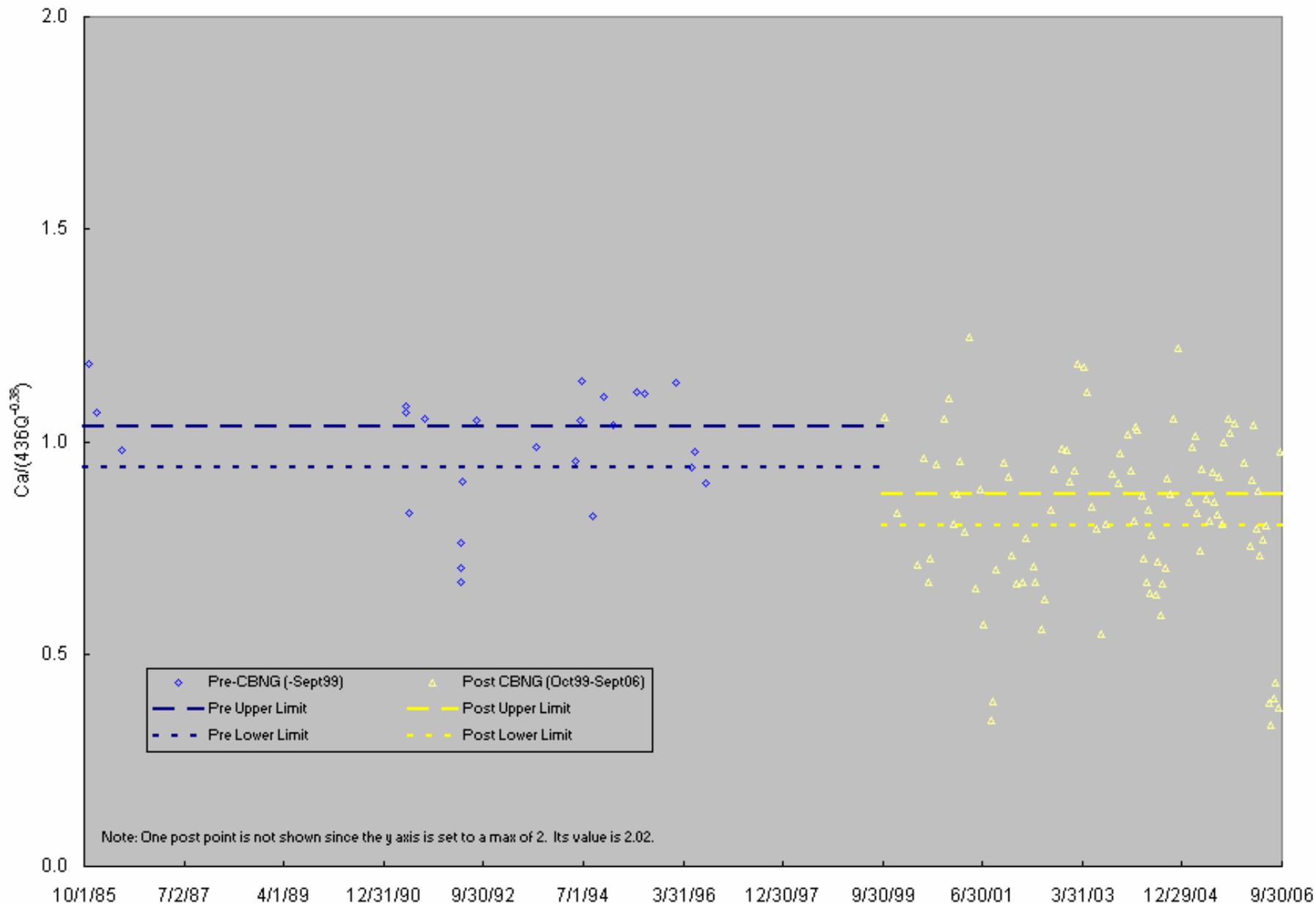
**Flow Corrected SAR vs. Time
Tongue River at State Line
90% Confidence Intervals
(90% Confident that the true mean is within the identified range)**



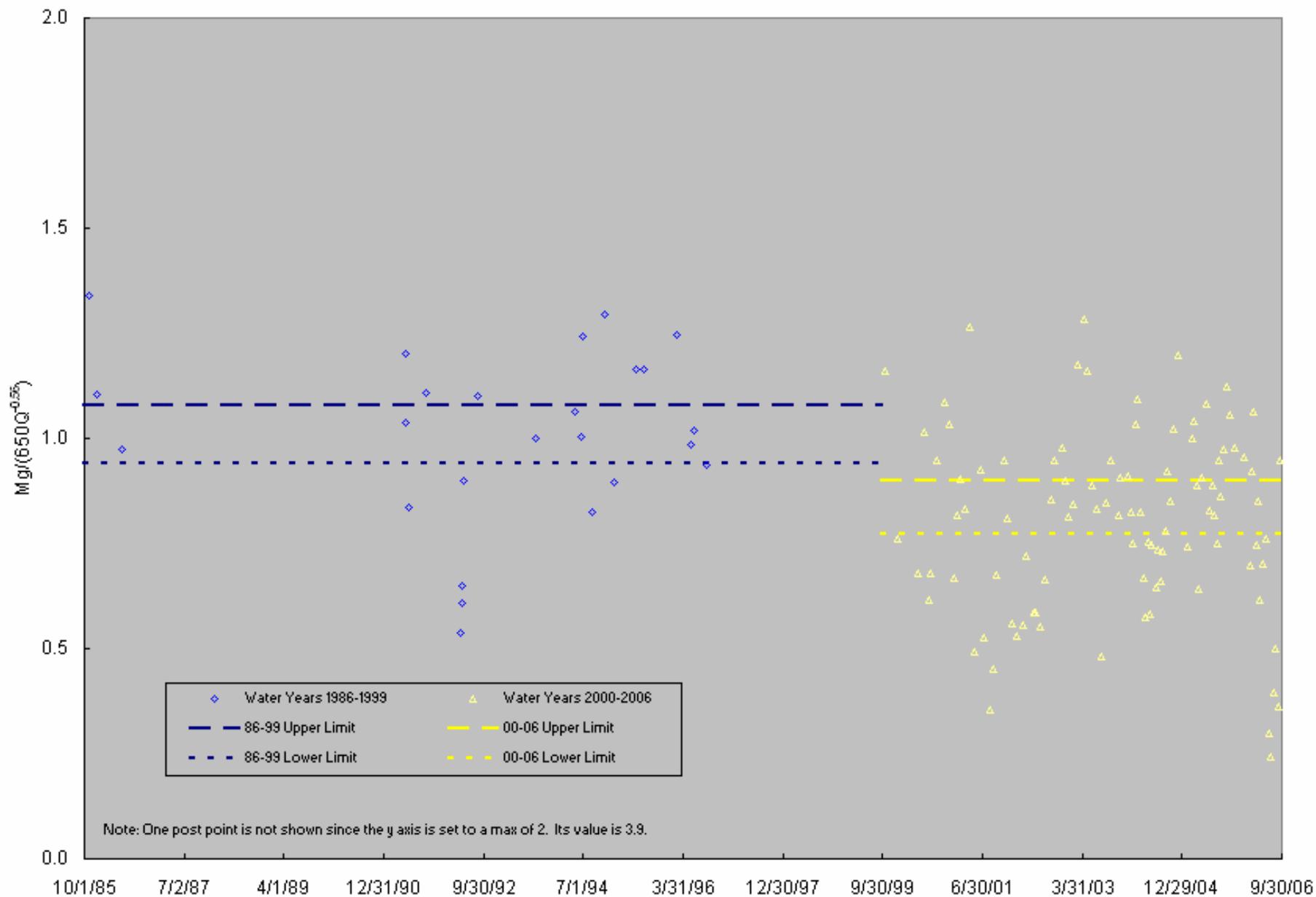
Flow Corrected Na vs. Time
Tongue River at State Line
90% Confidence Intervals
(90% Confident that the true mean is within the identified range)



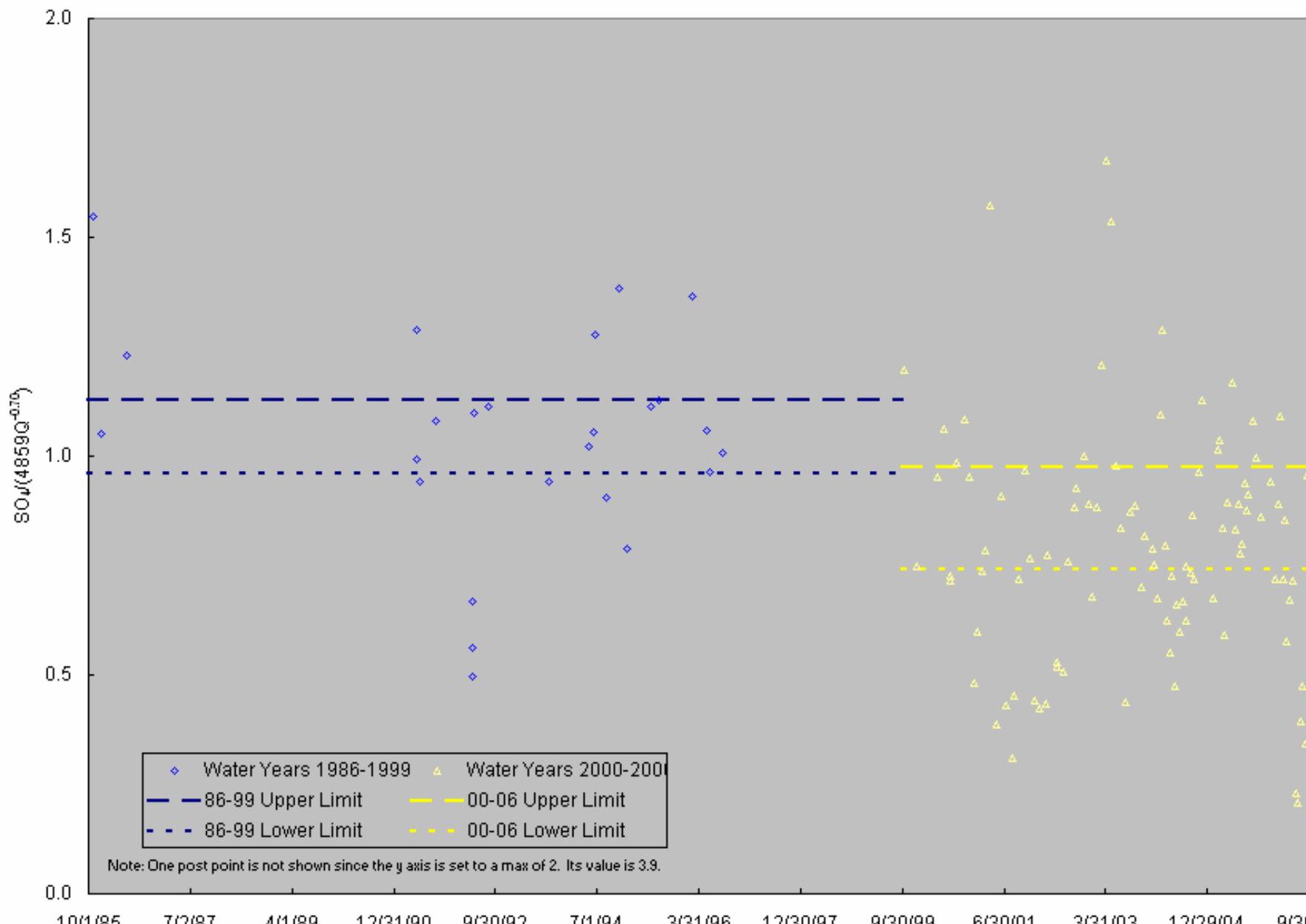
**Flow Corrected Ca vs. Time
Tongue River at State Line
90% Confidence Intervals
(90% Confident that the true mean is within the identified range)**



**Flow Corrected Mg vs. Time
Tongue River at State Line
90% Confidence Intervals
(90% Confident that the true mean is within the identified range)**



Flow Corrected SO₄ vs. Time
Tongue River at State Line
90% Confidence Intervals
(90% Confident that the true mean is within the identified range)





Powder River Watershed Questions

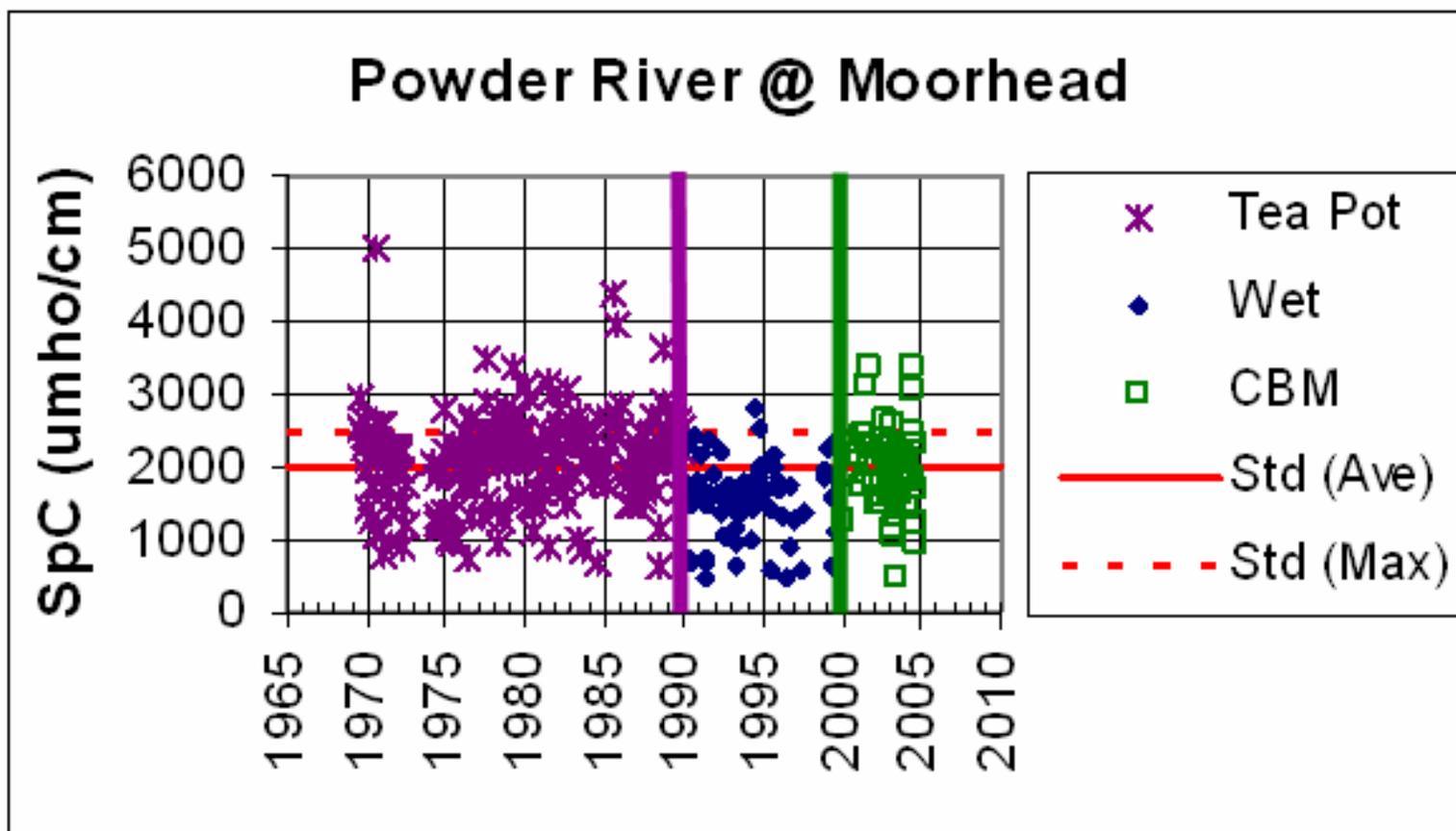
1. What is the water quality of the permitted CBM discharge?
2. What is the ambient stream water quality?
3. What has been the impact of CBM discharge on stream water quality?

SpC

Powder River at Moorhead



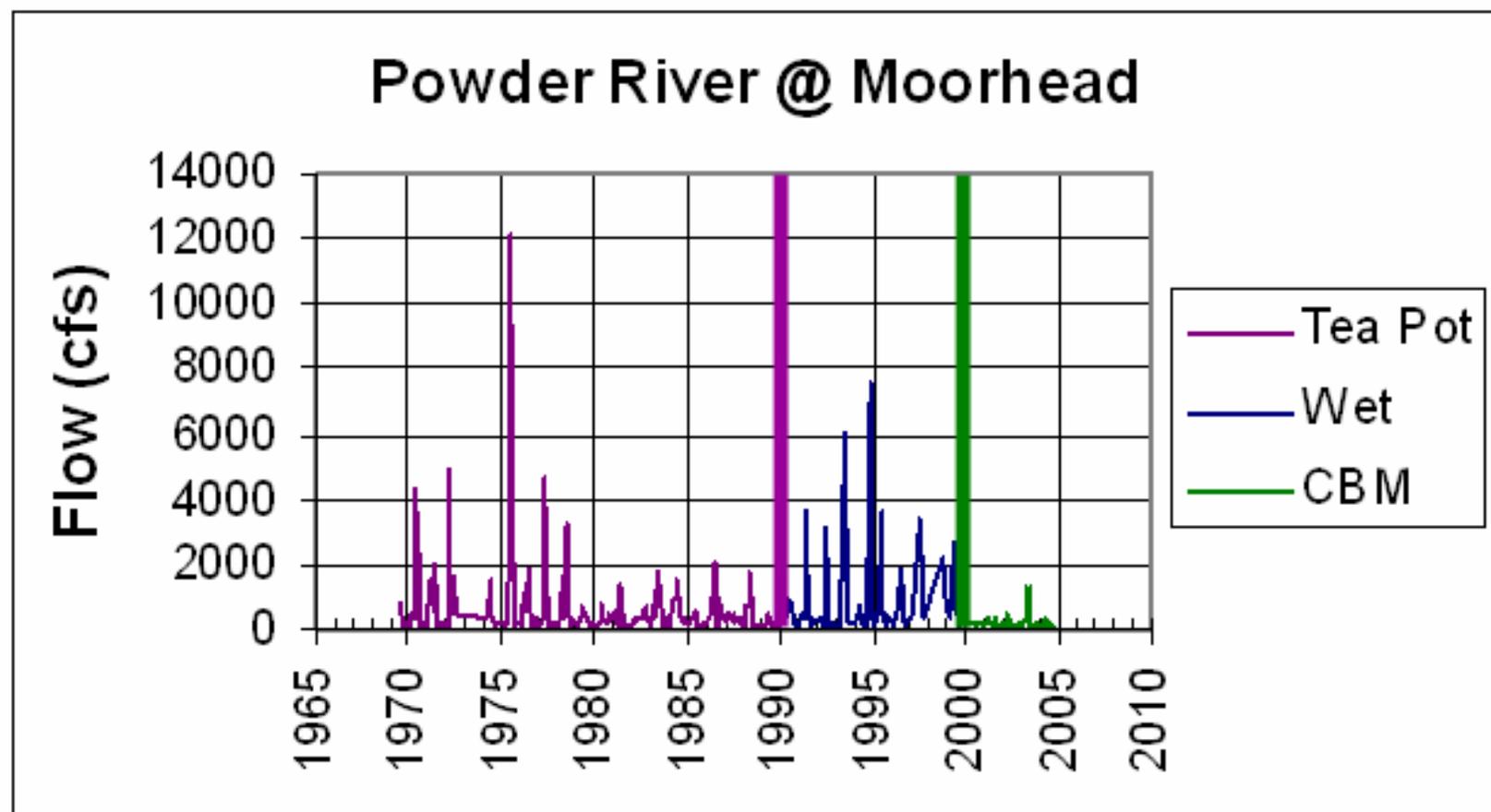
- What is the time period that represents “natural” background?





Flow Powder River at Moorhead

- What impact has the drought had on water quality?

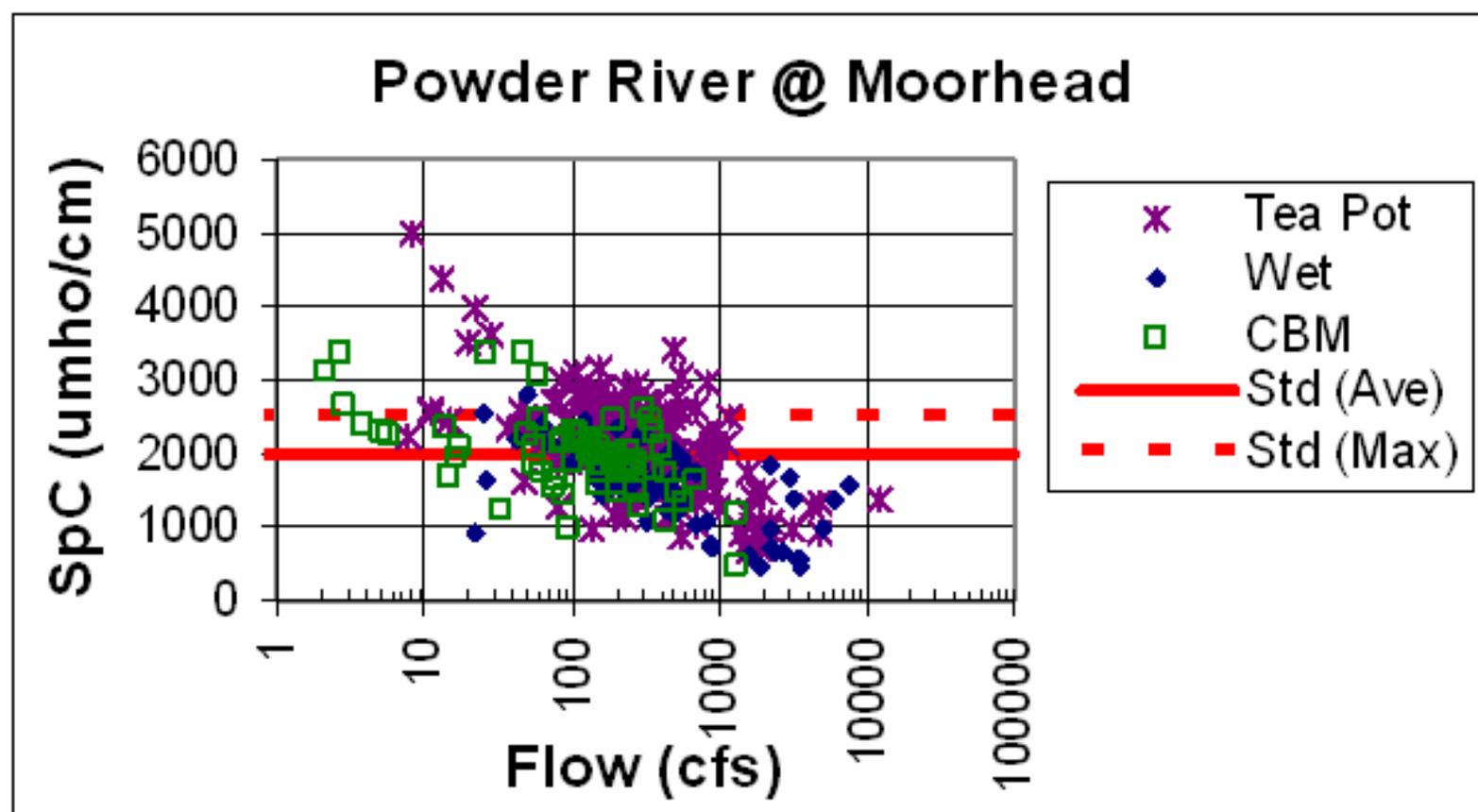


Flow vs SpC

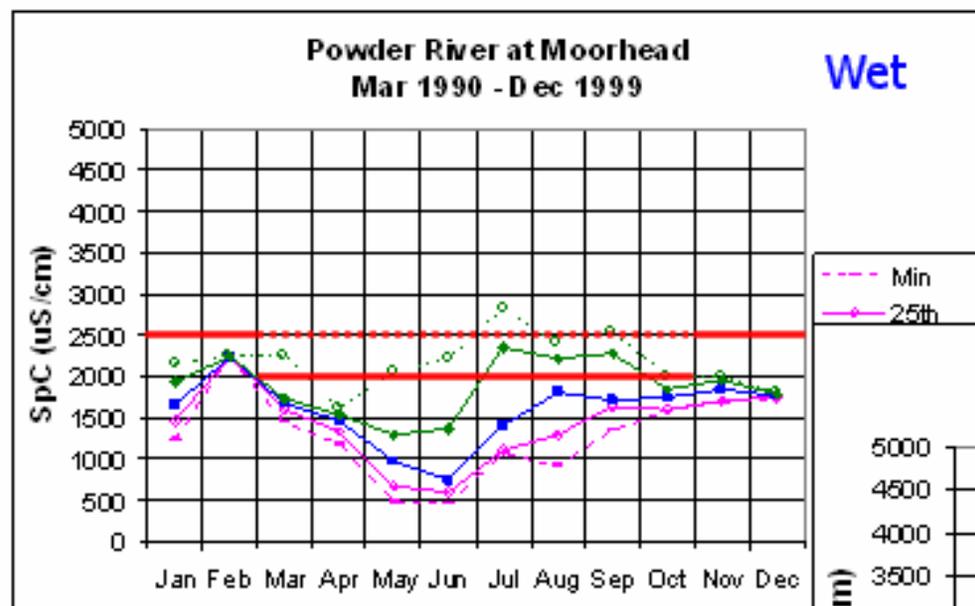
Powder River at Moorhead



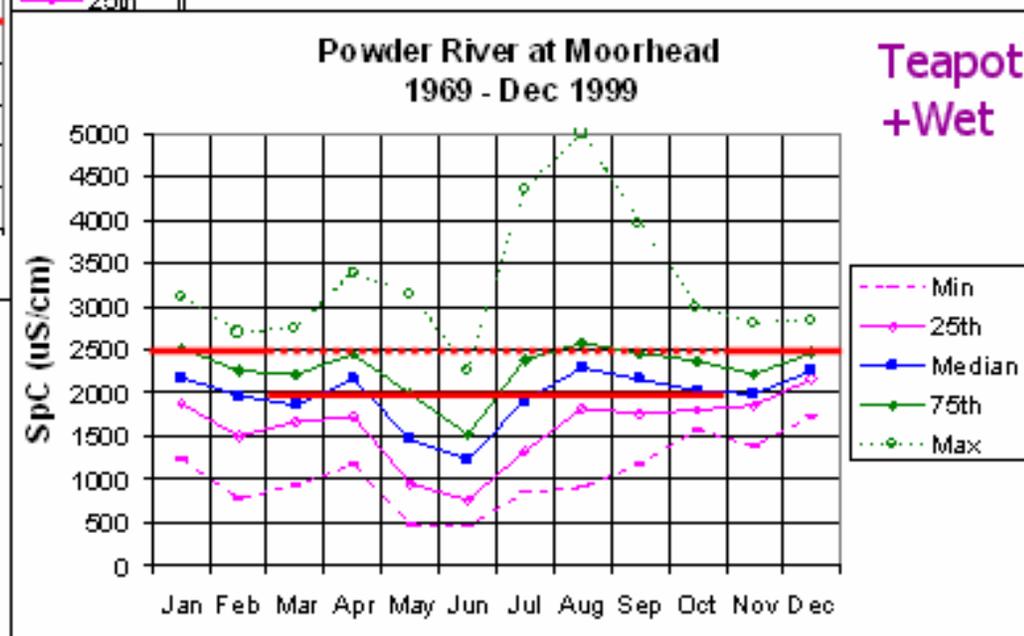
- What are the relationships between flow and water quality?



Powder River at Moorhead SpC Statistics by Month



— MT Ave Std
- - - - - MT Max Std



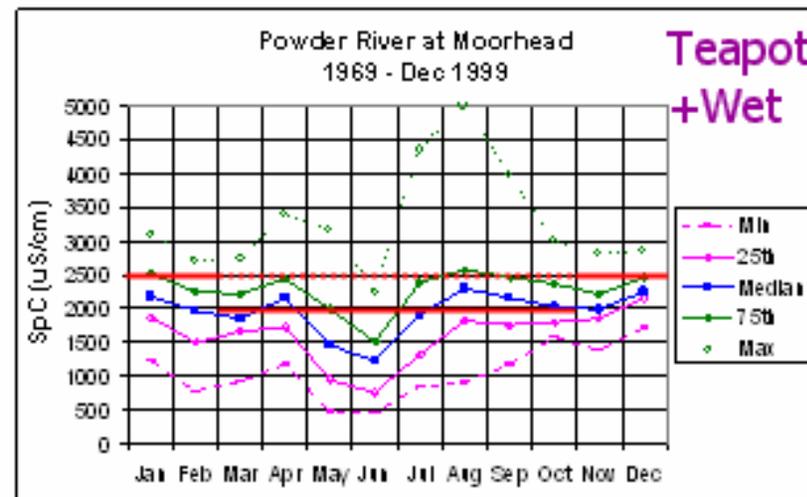
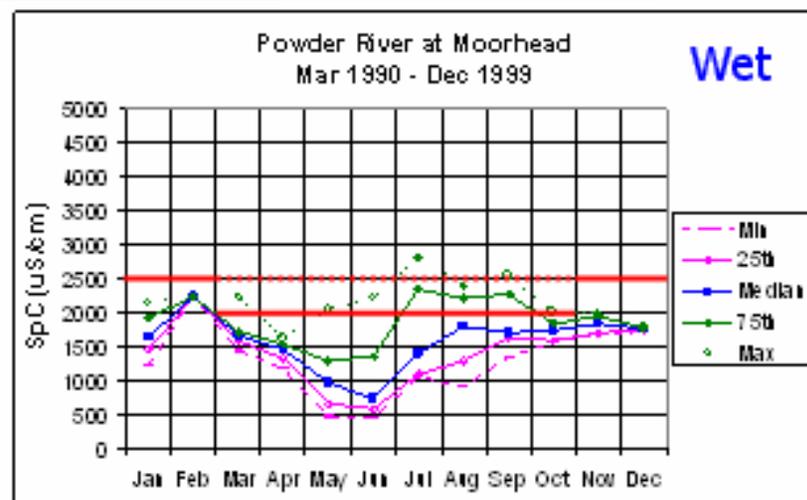
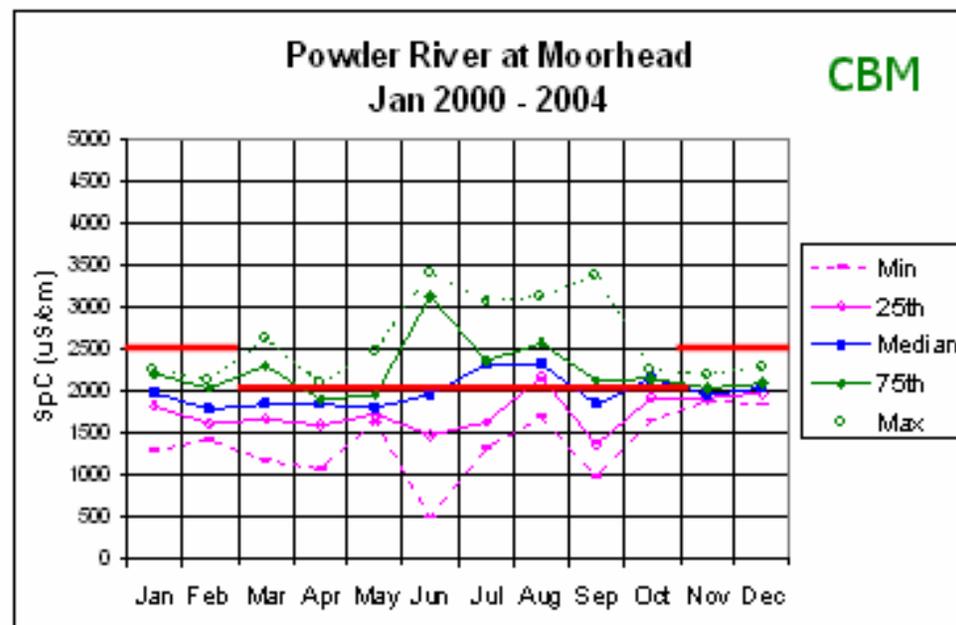


Powder River Watershed Questions

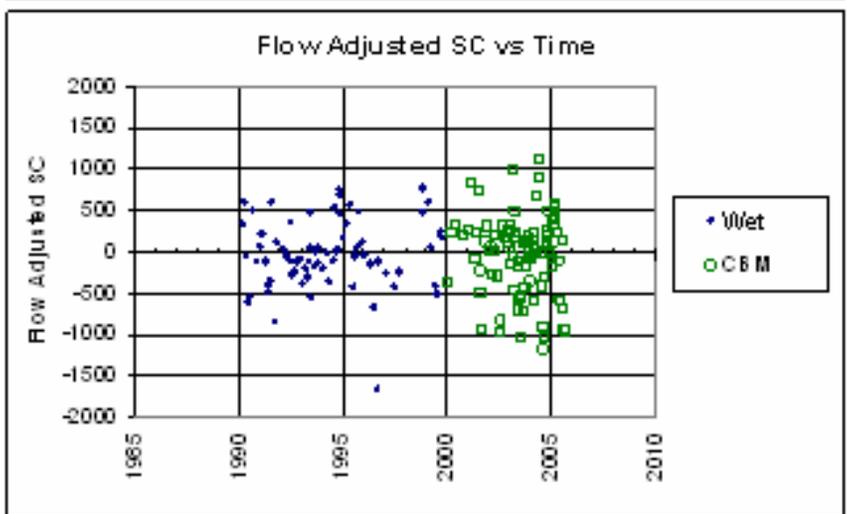
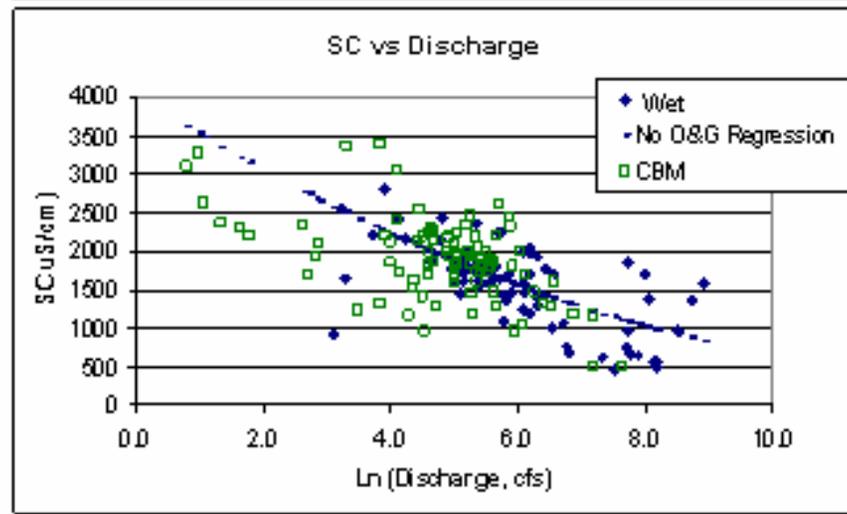
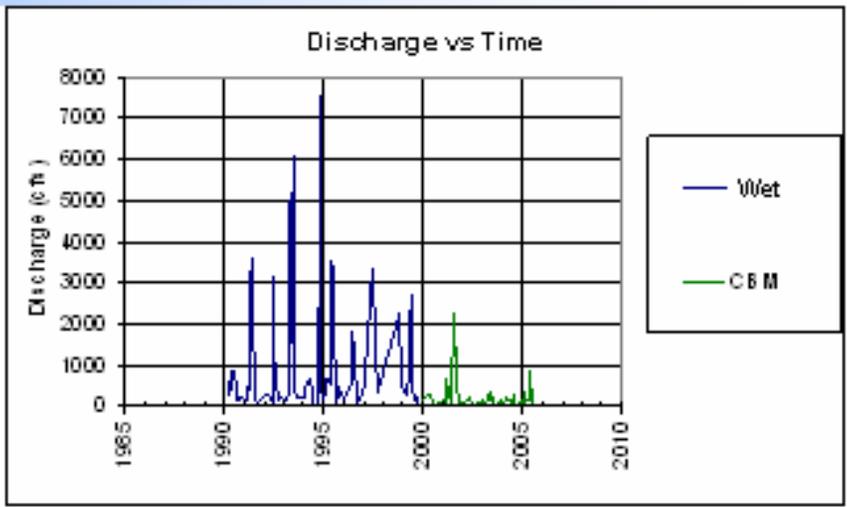
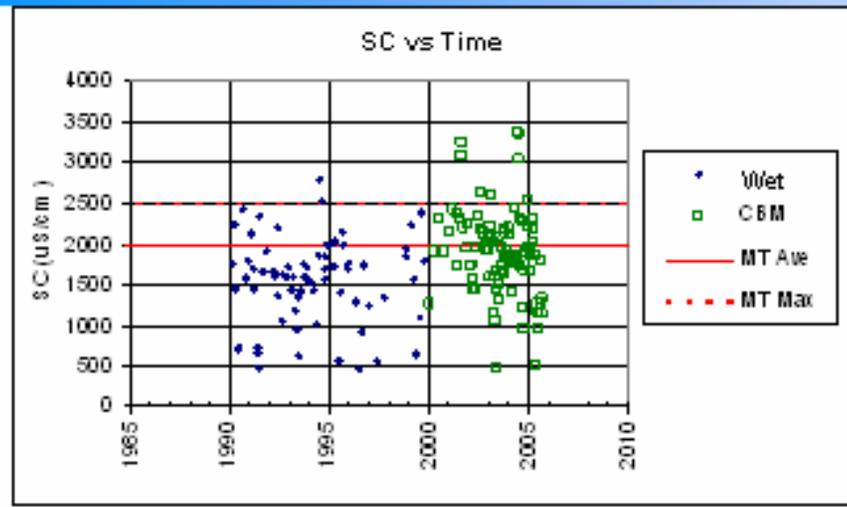
1. What is the water quality of the permitted CBM discharge?
2. What is the ambient stream water quality?
3. What has been the impact of CBM discharge on stream water quality?



Powder River at Moorhead SpC Statistics by Month

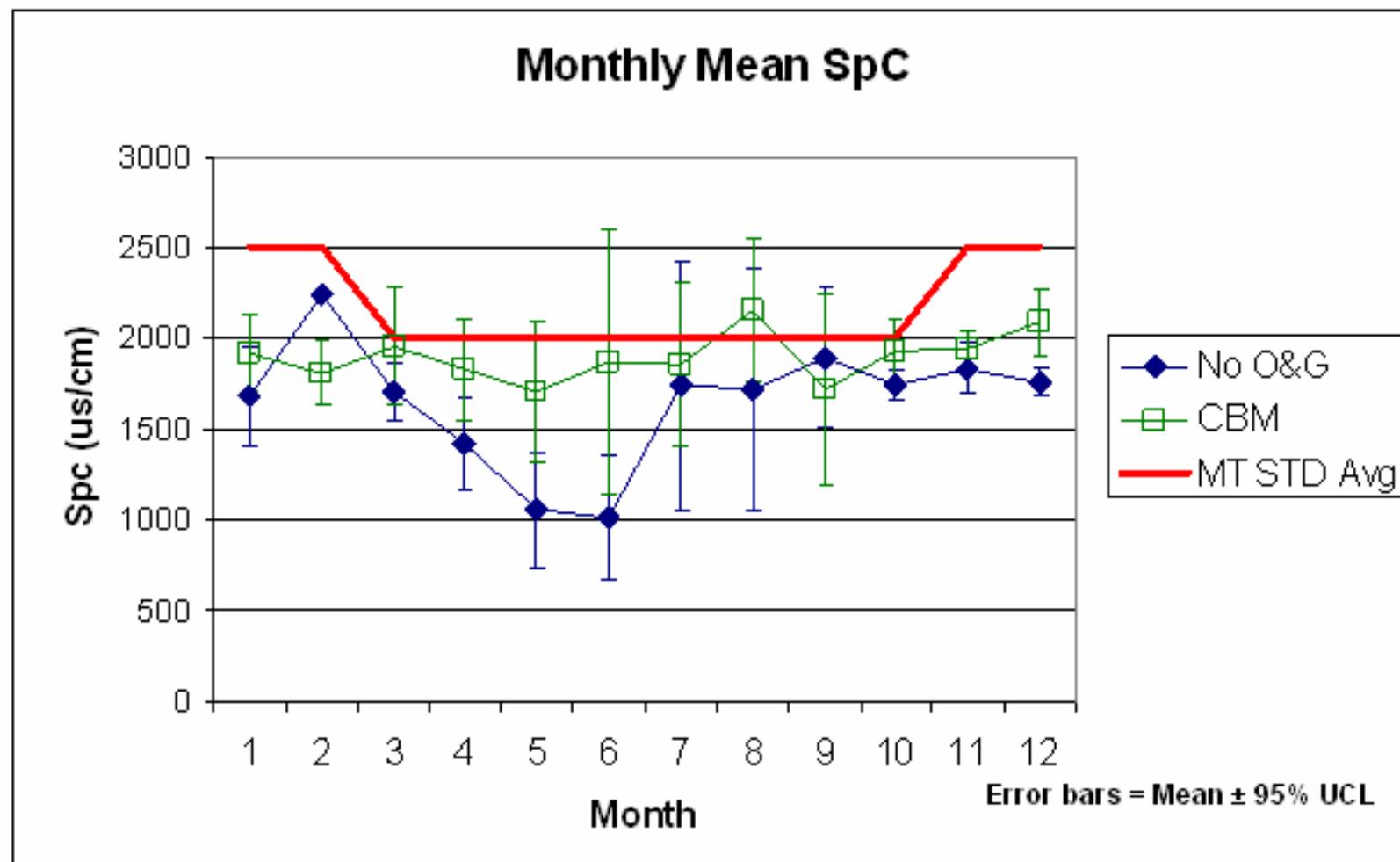


Flow Adjusted SpC Powder River at Moorhead



Powder River at Moorhead

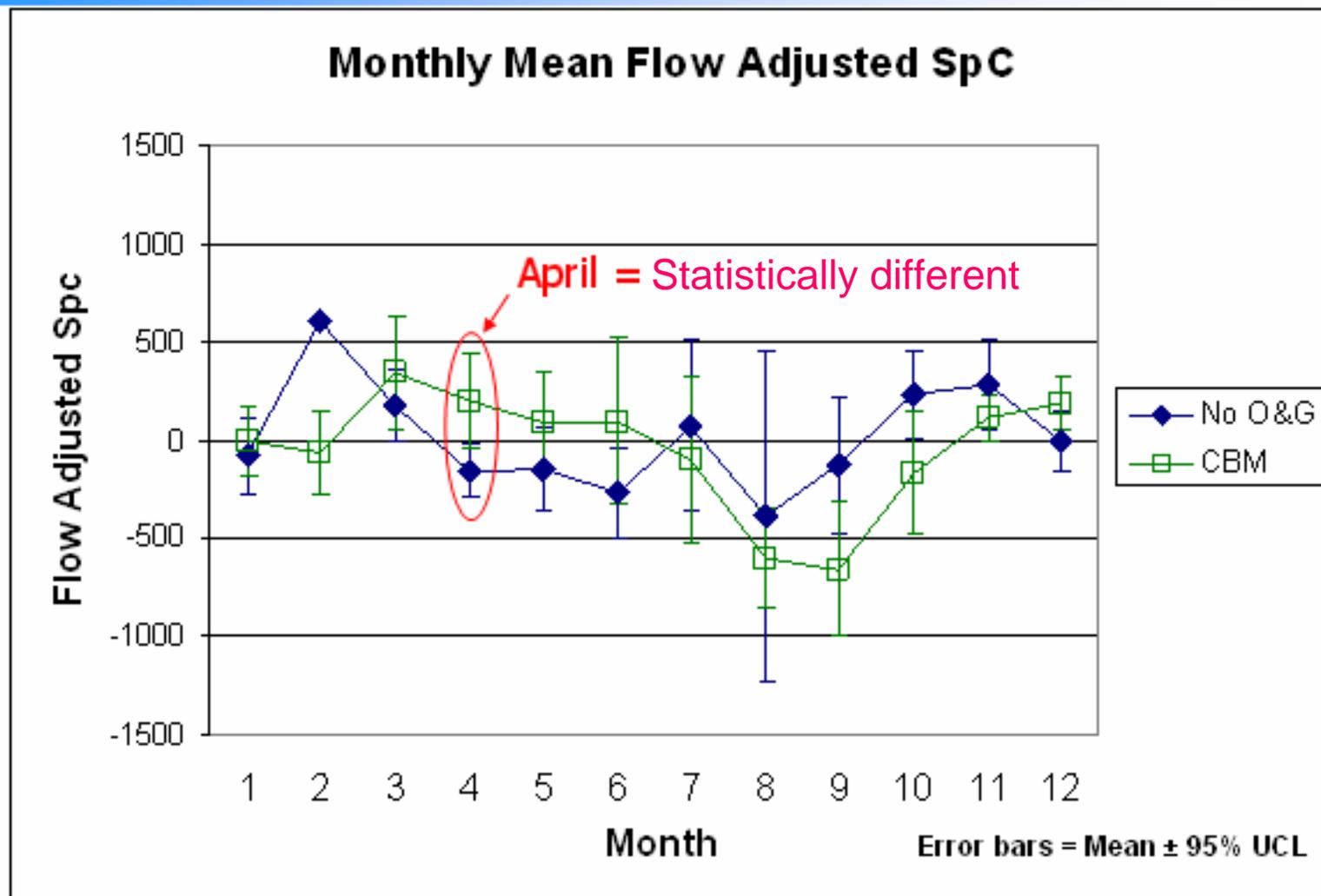
Monthly Mean SpC





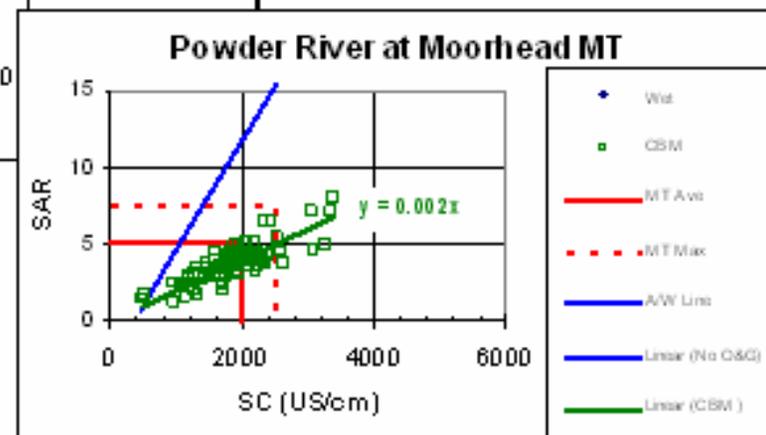
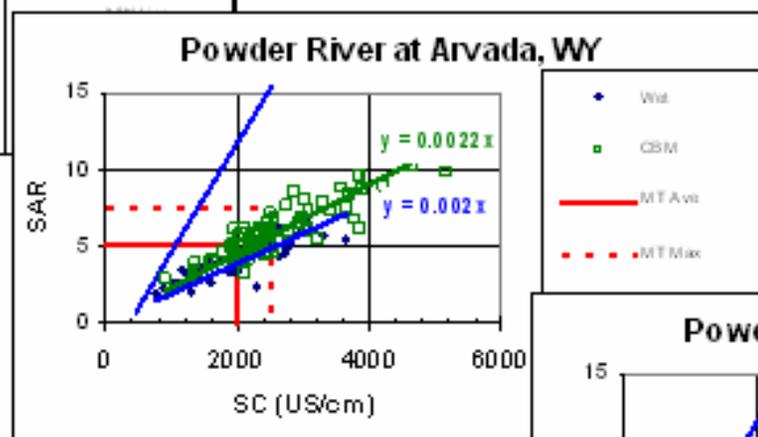
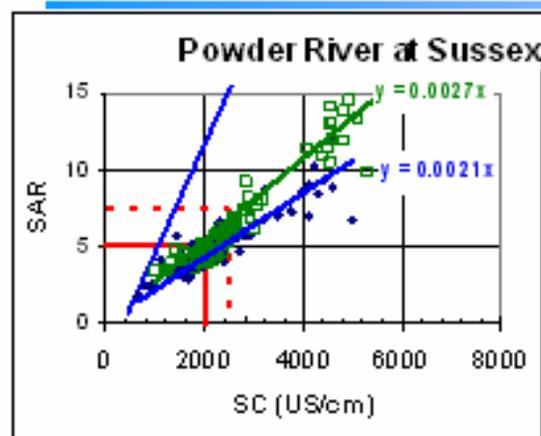
Powder River at Moorhead

Monthly Mean Flow Adjusted SpC



SAR?

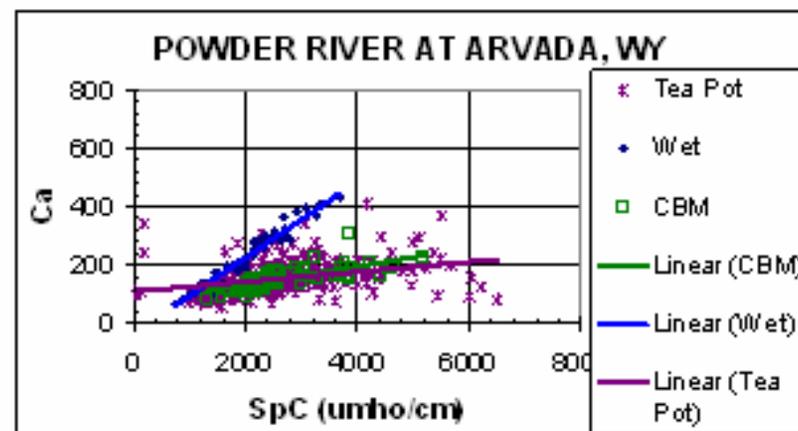
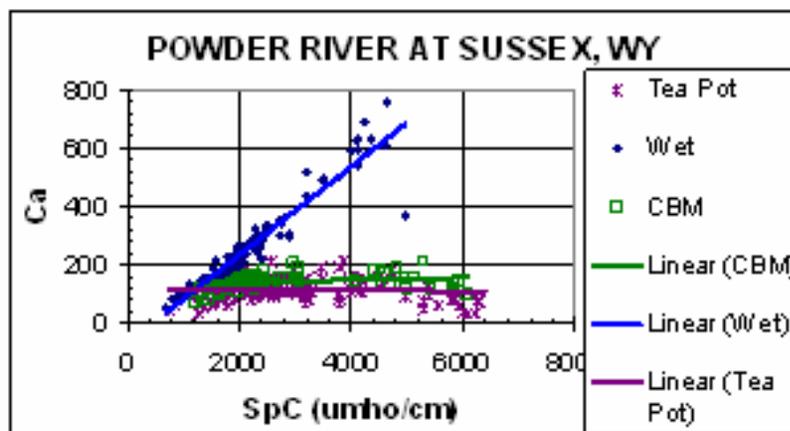
(Not analyzed 1990-99 at Powder River at Moorhead)



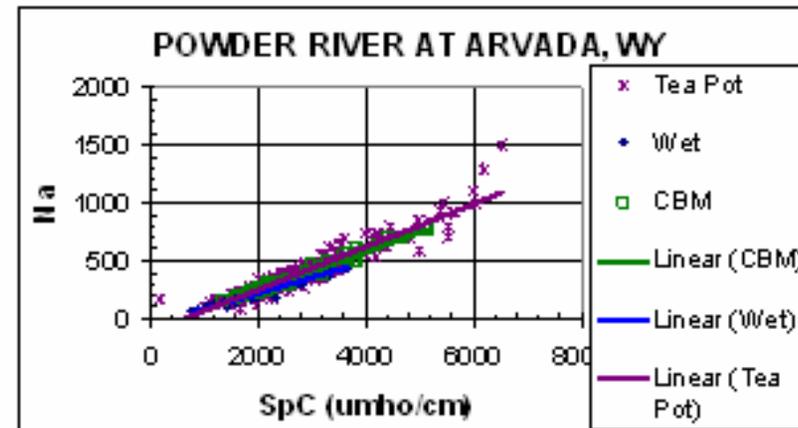
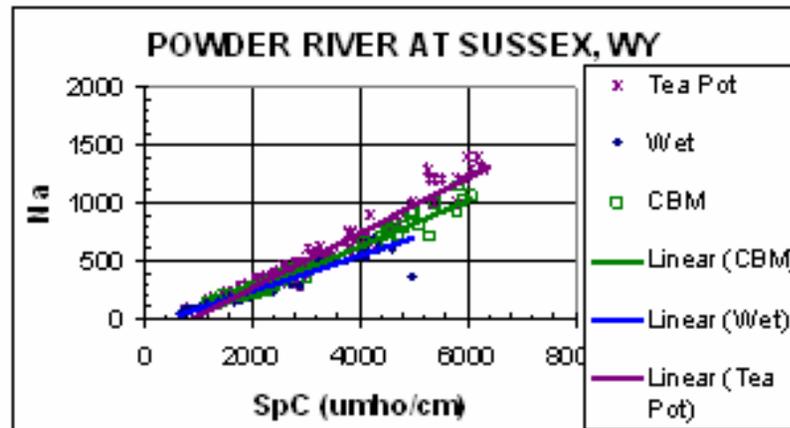


SpC vs Calcium & Sodium Powder River at Sussex & Arvada

CALCIUM



SODIUM





Technical Summary

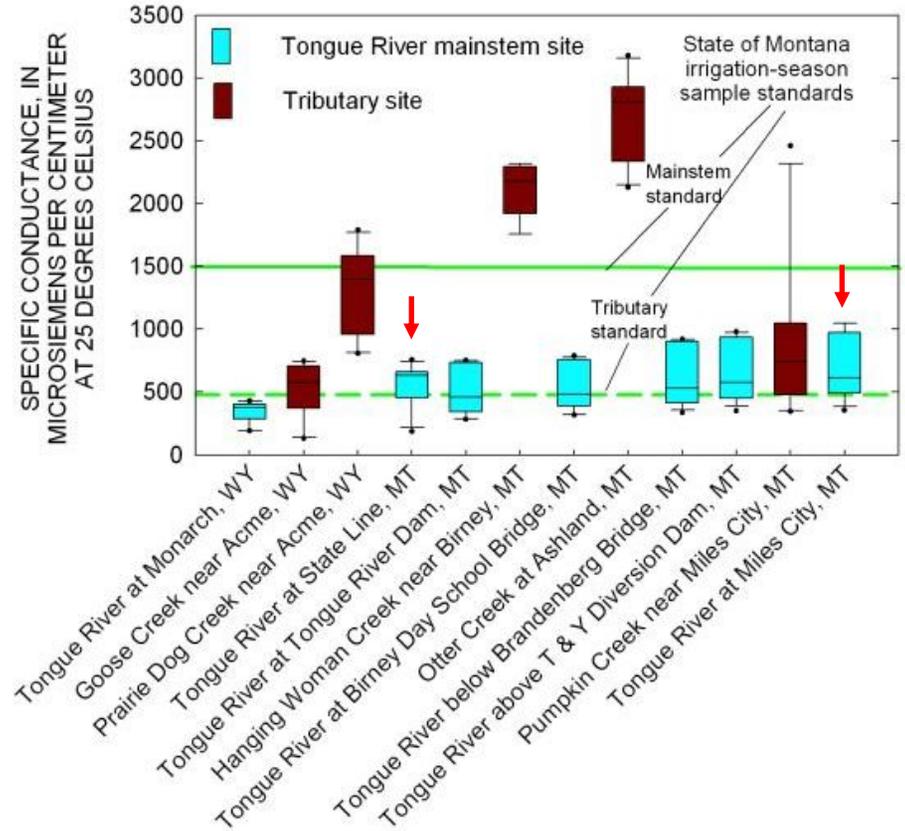
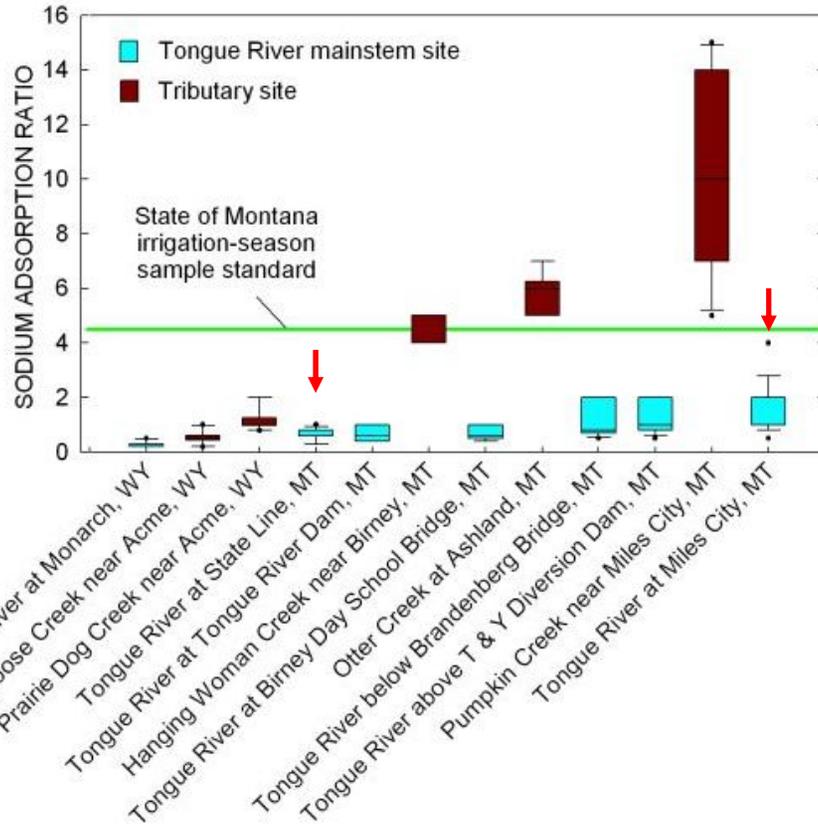
- Because of varying climate conditions and historical oil and gas operations in the basin, the available data do not allow an unambiguous determination of the impacts of CBM discharge on SpC and SAR in the Powder River at Moorhead.
- When the data are considered in aggregate, existing discharge and SpC relationships appear to suggest that there has been no statistically significant impact from CBM operations on SpC in the Powder River at Moorhead.
- Also, when the data are considered in aggregate, existing SAR and SpC relationships appear to suggest there has been no significant impact from CBM operations on SAR in the Powder River at Moorhead.
- When monthly flow adjusted SpC statistics for the Powder River at Moorhead are considered, most months show no statistically significant impact from CBM operations. The exception is April, where flow adjusted SpC since CBM operations commenced is statistically greater than that of the period 1990-1999 when there was no discharge due to oil & gas operations.
- The quality of discharge from CBM activities in the Powder River may deteriorate as development moves west and north, due to increased salinity in groundwater, and therefore may impact stream water quality in the future.

USGS Analysis

Tongue River Surface-Water-Quality Monitoring Network

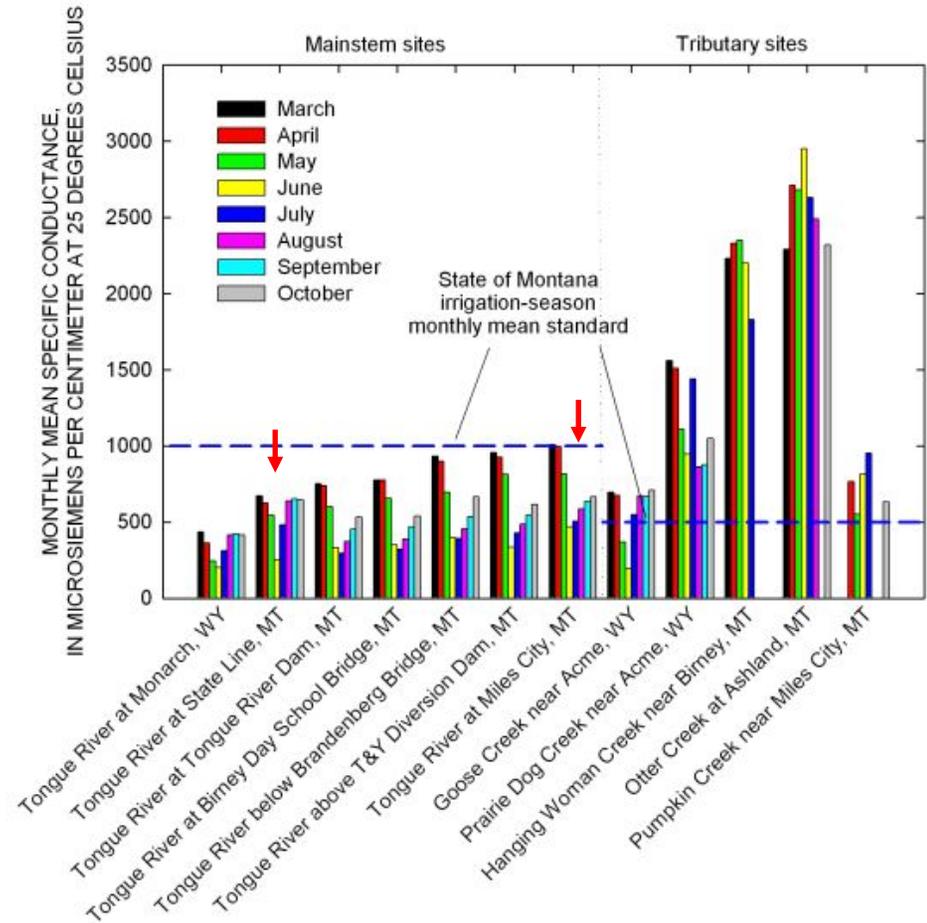
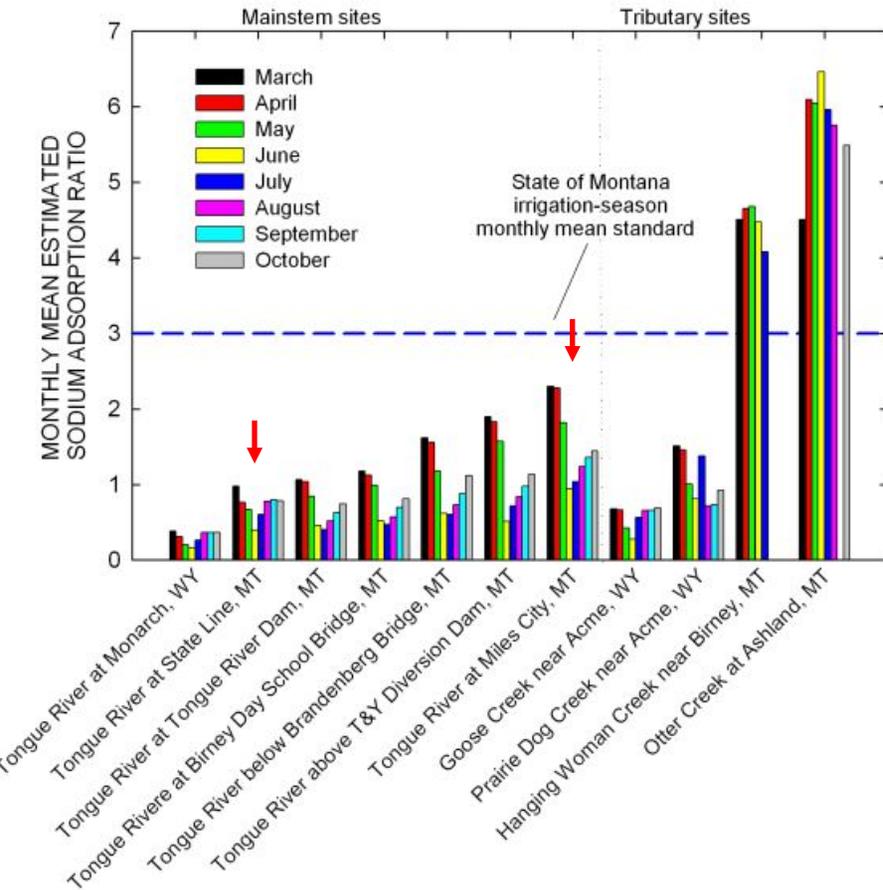
- Findings available at URL <http://tonguerivermonitoring.cr.usgs.gov/>
- Estimating SAR in realtime for 11 sites in the Tongue River basin
- 2004 and 2005 data summary
- Reconnaissance of specific conductance on Tongue River during September 2005

Comparison of 2005 Data to MDEQ Instantaneous Standards



From USGS 2005 Data Summary

Comparison of 2005 Data to MDEQ Mean Monthly



From USGS 2005 Data Summary

USGS Analysis—continued

In cooperation with WDEQ:

- Estimating SAR in realtime for 4 sites in the Powder River drainage basin
Report available at URL:
<http://pubs.water.usgs.gov/sir2006-5113>
- Scientific Investigations Report Clark and Mason, in review:
Describes water quality at 22 sites in the Tongue, Powder, Cheyenne, and Belle Fourche River drainage basins

USGS Analysis—continued

Report characterizes water quality at 20 sites in WY and 2 sites in MT, including:

- a description of general hydrology;
- summaries of water-quality characteristics for water years 2001-2005;
- an analysis of specific conductance and SAR for water years 2001-2005 that includes relations with streamflow and seasonal variations; and
- temporal pattern in selected long-term water-quality data, including trend analysis of selected sites and constituents for water years 1991-2005.

USGS Analysis—continued

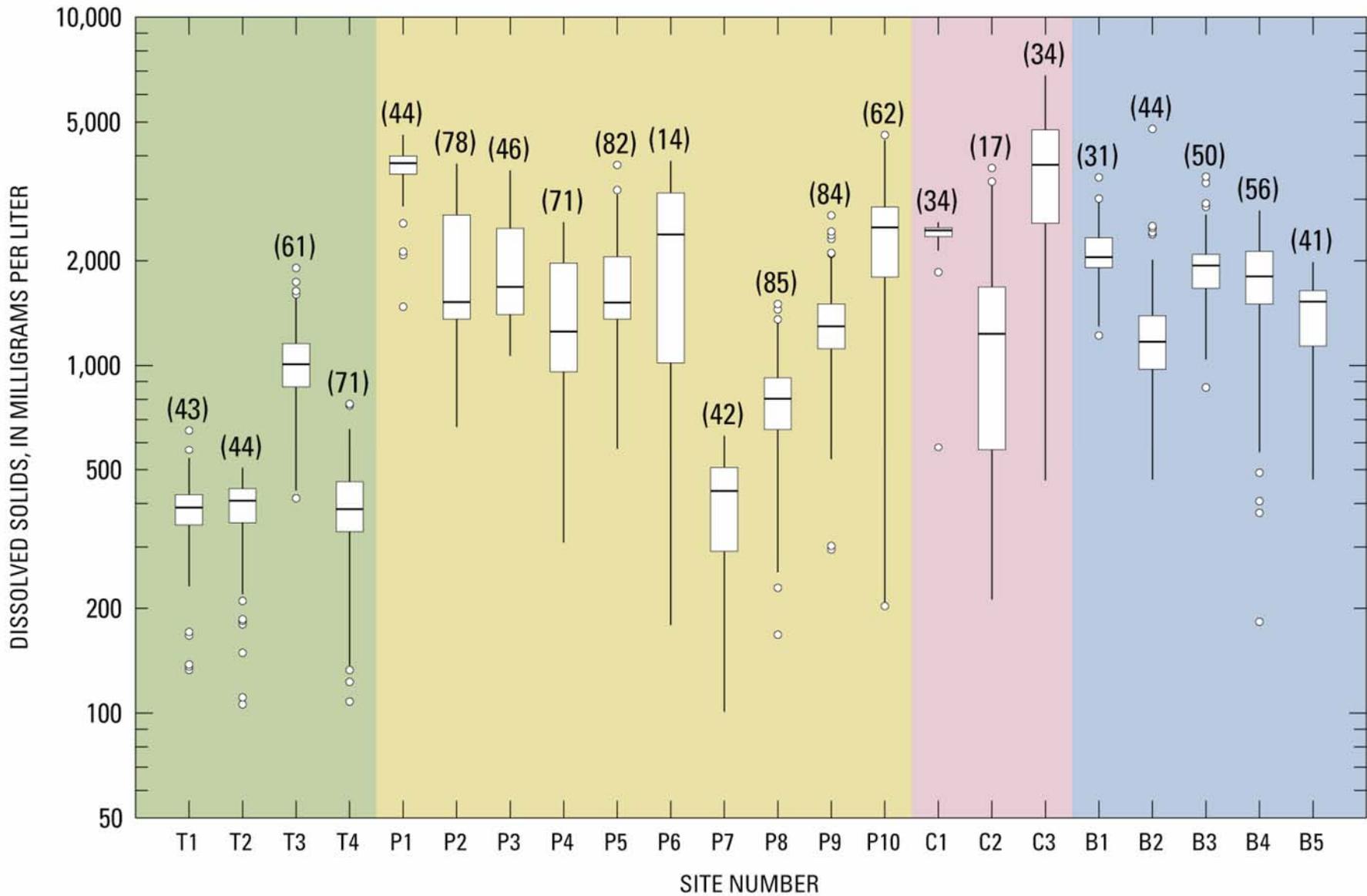
General hydrology

- Annual streamflows in all major river basins were substantially less than average during water years 2001-2005 because of drought
- Lowest runoff in 45 years of record on Tongue River and second lowest in 74 years of record on Powder River
- Samples for the study period may not represent long-term average water-quality conditions

USGS Analysis—continued

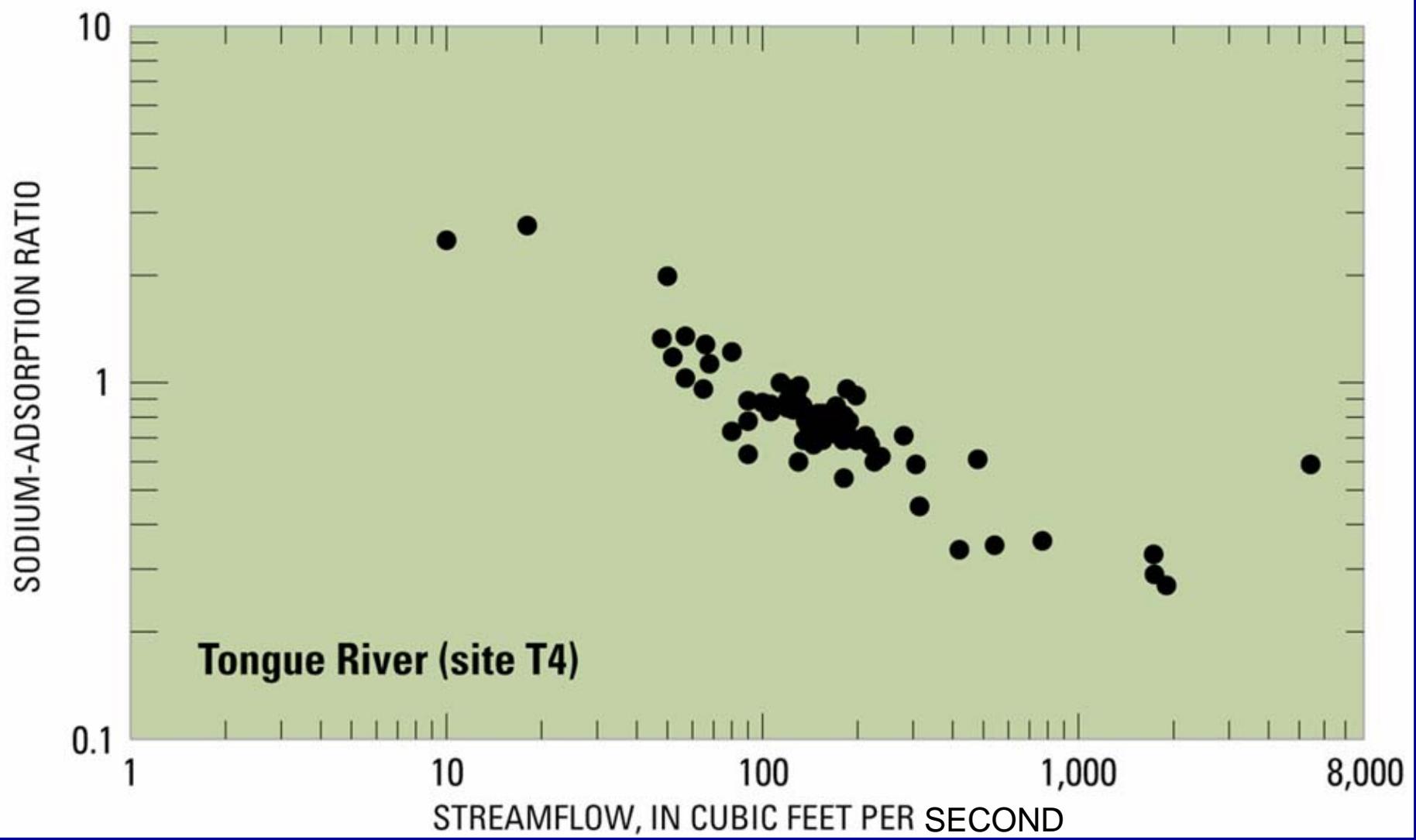
Water-quality characteristics for water years 2001-2005

- Water chemistry in streams with headwaters in mountainous areas were dominated by calcium, magnesium, sulfate and bicarbonate
- Plains streams were dominated by sodium and sulfate
- Chloride, total aluminum, and dissolved manganese were the constituents that most often observed in concentrations higher than WY water-quality criteria
- Dissolved-solids concentrations generally were lowest in the Tongue River basin and were highly variable in the Powder, Cheyenne and Belle Fourche basins



USGS Analysis—continued

- Specific conductance and SAR correlations with streamflow in streams with headwaters in mountainous areas generally were strong
- Specific conductance and SAR correlations with streamflow in streams with headwaters in plains areas were less consistent
- Seasonal variations generally were observed on the mainstems, but not necessarily on smaller tributaries



USGS Analysis—continued

Trends for specific conductance were tested at 8 sites in the Tongue, Powder, and Belle Fourche basins for water years 1991-2005:

- Upward trends in unadjusted values were significant (p -value < 0.10) at 2 sites in Tongue River basin and 2 sites in the Powder River basin
- Less than average streamflow during later part of trend period likely the cause of trends in unadjusted values
- Flow-adjusted values were not significant (p -value > 0.10) at any of the sites

USGS Analysis—continued

Trends for SAR were tested at 4 sites in the Powder River basin:

- Upward trends in unadjusted SAR values were significant (p-value < 0.10) at a site on Salt Creek and two sites on the Powder River
- Trend in Salt Creek likely controlling the trends at the Powder River sites

USGS Analysis—continued

Trends for SAR were tested at 4 sites in the Powder River basin—continued:

- Upward trend in flow-adjusted values were significant (p-value <0.10) at a site on Salt Creek and two sites on the Powder River
- A downward trend in flow-adjusted values was significant (p-value <0.10) at a site on the Little Powder River
- Causes of the flow-adjusted trends were not determined because of influence of Salt Creek and multiple land-use changes in the basins

Conclusions

- There is not an apparent CBNG signal at this time.
- As more data is collected, more discriminating methods can be used for data analysis.
- Flow adjusted SC values appear to be similar to or somewhat less than historical.
- Flow adjusted SAR values appear to be somewhat elevated compared to historical.
 - Flow adjusted Na is similar to historic; therefore the increase in SAR appears to be due to decreases in Ca and Mg. As such, it may be due to drought conditions and changes in land management practices rather than CBNG discharges.
- Impacts are less than identified in the programmatic EISs; the impact analysis appears to be somewhat conservative

Other Surface Water Issues

- MDEQ and WDEQ are discussing the MT-BER's determination that EC and SAR are harmful parameters
 - DEQs along with EPA negotiator are having weekly conference calls
 - DEQs, EPA negotiator, and Northern Cheyenne Tribe are having monthly face to face meetings.
 - Hope to come to an agreement on standards by the end of summer
- TMDL Modeling and Assessment Reports
 - Powder, Tongue, Rosebud
 - EPA (Ron Steg) hopes to have out by end of June

A wide, calm river flows through a landscape under a vast, blue sky filled with wispy, white clouds. In the foreground, several large, smooth, light-colored rocks are partially submerged in the water. The riverbanks are lined with green trees and shrubs. The overall scene is serene and natural.

Questions/Discussion