SOURCE WATER QUALITY MONITORING IN THE BIG THOMPSON RIVER WATERSHED

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Purpose of the Loveland Water Quality Monitoring Program:

Collect, analyze, and interpret water quality data that are of interest with regard to drinking water, wastewater, recreation, and aquatic ecosystems
Currently, the Loveland Water Quality Monitoring Program has two components

1. Loveland Water and Power Source Water Monitoring
2. Cooperative monitoring with the USGS
LW&P SURFACE WATER MONITORING

• Big Thompson River and CB-T system
  • 9 years
  • 22 parameters were collected monthly or bi-weekly
  • 15 core sites within the watershed

• Water Quality Data
  • In-house analysis for rapid results
  • Location and parameter flexibility for special projects or in response to an event
USGS-LW&P COOPERATIVE MONITORING

- Continuation of the Big Thompson River data set
  - 20+ years
  - 40+ parameters were collected monthly
  - 9+ core sites within the watershed.

- Water Quality Data
  - Standardized with robust QA/QC
  - Easily available through NWIS or WQP

- USGS Database
  - Data entry and database maintenance completed by USGS
  - Servers are very secure
USGS SAMPLING LOCATIONS
USGS AND LOVELAND SAMPLING LOCATIONS
WHY COLLECT ALL THAT INFORMATION?

- Precision and accuracy

- Data mining
WHY COLLECT ALL THAT INFORMATION?

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Slope = 0.002, p = 0.24
WHY COLLECT ALL THAT INFORMATION?

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Slope = 0.02, p = 0.03
WHY COLLECT ALL THAT INFORMATION?

-Precision and accuracy

Slope = 0.006, p = 0.003
Example of data mining: Wildfire effects on water quality

Common - “The effects of fire on hydrological systems at the catchment scale are not well known, largely because site specific data from both before and after wildfire are rare.” Siebert et al. (2010)

Big Thompson - “Pre-fire water quality was well characterized because the sites (in the Big Thompson River) has been monitored at least monthly since the early 2000s.” Mast et al. (2016)
Potential Water Quality Impacts of Wildfire:

- **Nutrients** – Nitrate, Total Phosphorus, Organic Nitrogen
- **Metals** – Total Copper, Total Arsenic, Total Lead, Total Manganese, Dissolved Aluminum
- **General** – Flow, Turbidity, Total and Dissolved Organic Carbon, pH
WHY COLLECT ALL THAT INFORMATION?

Potential Water Quality Impacts of Wildfire:

• Nutrients – Nitrate ✔, Total Phosphorus ✔, Organic Nitrogen ✔

• Metals – Total Copper ✔, Total Arsenic ✔, Total Lead ✔, Total Manganese ✔, Dissolved Aluminum ✔

• General – Flow ✔, Turbidity ✔, Total and Dissolved Organic Carbon ✔, pH ✔
BENEFITS OF LONG TERM MONITORING

Opportunities to:

• Develop appropriate site specific standards (e.g. Copper, Upper Thompson Sanitation District 2015)
• Quantitatively evaluate long term trends (e.g. Stevens 2003),
• Investigate potential causes of changes in water quality (e.g. Fayram et al. 2019, Voelz et al. 2005)
• Be included in broad-scale investigations that may be of local utility (e.g. Spahr et al. 2010)
• Characterize changes to water quality in response to management actions or natural events (e.g. Mast et al. 2016)
ACCOMPLISHMENTS

• Develop appropriate site specific standards
• Quantitatively evaluate long term trends
• Quantify changes in water quality and identify causes
• Collaboration
DEVELOP APPROPRIATE SITE SPECIFIC STANDARDS

- Site specific standards possible utilizing the biotic ligand model (BLM)
  - BLM requires lots of data (Temp, pH, Cu, DOC, Ca, Mg, Na, K, SO4, Cl, Alkalinity)
  - Long time series of those data thanks to USGS source water sampling
  - Upper Thompson Sanitation District obtained a change in the copper standard for their outfall using these data and a BLM
  - Loveland BLM results suggest the current outfall limit is appropriate
ACCOMPLISHMENTS

- Develop appropriate site specific standards
- **Quantitatively evaluate long term trends**
- Quantify changes in water quality and identify causes
- Collaboration
QUANTITATIVELY EVALUATE LONG TERM TRENDS

• Provides advance notice of potential future water quality issues and management successes.

• Hydros Consulting 5 year Big Thompson River Summary Report (via Big Thompson Watershed Forum)
  • Significant downward trend in phosphorus below water reclamation facility outfall thanks to updated biological nutrient removal process
ACCOMPLISHMENTS

- Develop appropriate site specific standards
- Quantitatively evaluate long term trends
- **Quantify changes in water quality and identify causes**
- Collaboration
QUANTIFY CHANGES IN WATER QUALITY AND IDENTIFY CAUSES

- Fire effects on water quality in North Fork Big Thompson River

Cameron Peak Fire = 208,913 ac
Big T Watershed = 532,347 ac
Big T Watershed Burned = 65,275 ac
Percent of Fire in Big T Watershed = 31%
Percent of Big T Watershed Burned = 12%
QUANTIFY CHANGES IN WATER QUALITY AND IDENTIFY CAUSES

• Fire effects on water quality in North Fork Big Thompson River
QUANTIFY CHANGES IN WATER QUALITY AND IDENTIFY CAUSES

- Fire effects on water quality in North Fork Big Thompson River
QUANTIFY CHANGES IN WATER QUALITY AND IDENTIFY CAUSES

• Fire effects on water quality in North Fork Big Thompson River
  - USGS, City of Greeley, BTWC, City of Loveland
  - Establish regression models for parameters of interest in North Fork Big Thompson and Buckhorn with data prior to the fire
  - Examine post-fire data for departures from these models as an indication
COLLABORATION

• Fire Effects on Water Quality Monitoring
  • BTWC, Loveland, Greeley, USGS

• Expansion of baseline monitoring of macroinvertebrates
  • Colorado Parks and Wildlife, Pisces Molecular
CONCLUSIONS

- Robust monitoring programs allow
  - More accurate characterization of current conditions
  - Better understanding of relative status (both temporally and spatially)
  - Ability to respond to unanticipated challenges
  - Organizations with diverse missions to utilize the data for the betterment of the watershed

- We hope to continue to improve our program as we learn and discover new challenges.
- We welcome collaboration!
THANK YOU