Quality Assurance Project Plan (QAPP)
Version 1.3

Water Quality Monitoring for Surface Water On the Crow Indian Reservation, Montana

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For:
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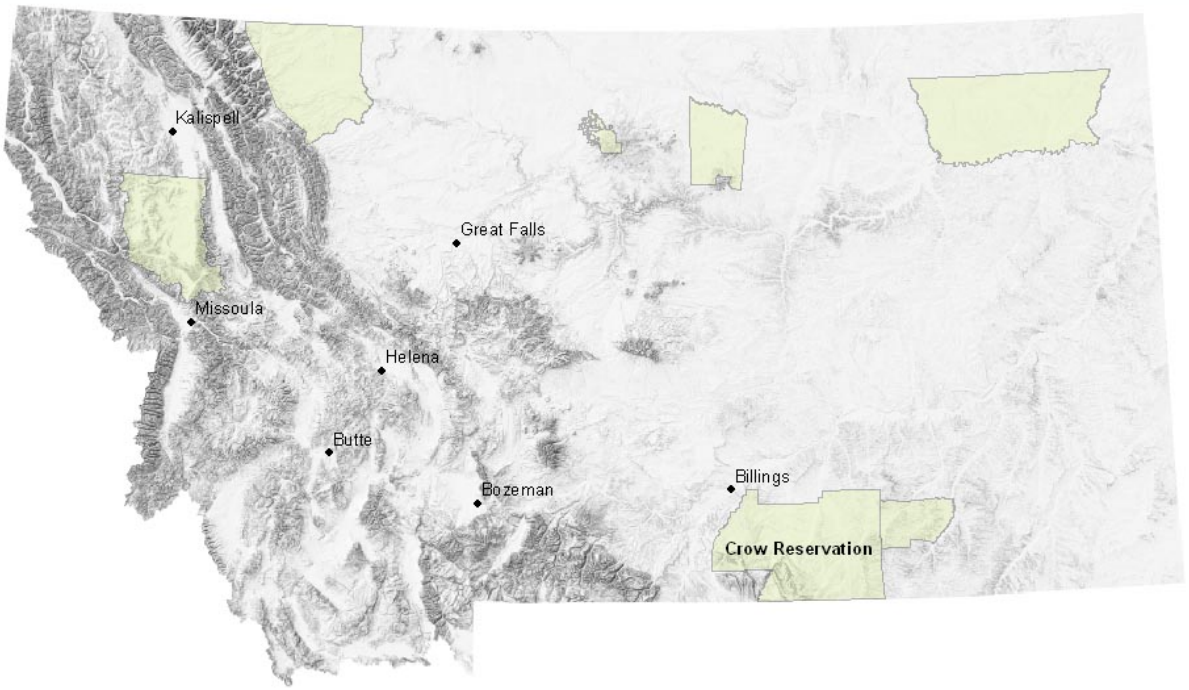
Table of Contents

List of Figures

List of Tables

1) Tribal Structure and Background

Figure 1. Montana Reservation Map



The Crow Indian Reservation is located in south central Montana and encompasses 2.3 million acres of land, of which 455,719 acres are tribal lands and the remaining 1,840,281 acres are either allotted or non-tribal lands. It is the home of the Crow people, or the "Apsaalooke" meaning "Children of the Long Beaked Bird." There are approximately 11,000 tribal members where an estimated 7,900 reside on the Crow Reservation. The seat of government and capital of the Crow Indian Reservation is Crow Agency, Montana.

The climate on the reservation varies from 24 inches of annual precipitation at over 7,000 feet in the Bighorn Mountains to semi-arid with 12 inches of rain around 2,900 feet near Hardin. Vegetation varies from conifer forests to grasslands. Approximately 75% of the precipitation falls from March through July. The frost-free period (growing season) ranges from 115 days in Busby, 123 days in Hardin, 126 days in Wyola, to 135 days in Crow Agency. The last spring frost occurs as late as May 24 and frost may occur as early as September 16th. This portion of Montana enjoys "Indian Summers" which frequently extend into November, including warm sunny days and cool evenings. The mean annual temperature is 45.5 degrees Fahrenheit (f) with a summer high of 110 and a winter low of –48 degrees Fahrenheit (F).

Land use on the Crow Indian Reservation is typical of rural areas in Montana. Land uses include rangeland for livestock grazing, irrigated and dryland crop production, forestland, and developed areas for communities and natural resource production. Of the approximately 1.5 million surface acres in tribal and individual allotted trust ownership, approximately 68% are grazing rangeland, 12% are dry cropland, 3% are irrigated cropland, 15% are forestland, 1% is wild land, and 1% is developed areas.

Most agricultural land on the reservation is leased to non-Indian interests. Agriculture is the primary land use on the Reservation. A small amount of forest management is restricted to the higher elevations of the Pryor Mountains in the southwestern corner of the Reservation and the Wolf Mountains along the eastern border of the Reservation. The Crow Tribe practices multiple use management on most Tribal lands with the exception of the Bighorn Mountains in the south central portion of the Reservation. This area has been designated as a Tribal Primitive Area. (Haire)

There are three major drainage basins on the Crow Reservation: Lower Bighorn River, Little Bighorn River, and Pryor Creek. The Bighorn River and the Little Bighorn River have their headwaters in Wyoming and flow northward into the Crow Indian Reservation, while Pryor Creek originates on the reservation. The Little Bighorn joins the Bighorn River near Hardin, Montana and then flows north off the reservation. Collectively, these drainages are a part of the Yellowstone River basin. There are three additional basins with headwaters on the reservation, including: the Upper Tongue River, Rosebud Creek and Tullock Creek which flows north off of the reservation and joins the Bighorn River near Bighorn, Montana.

Drainage from the western half of the coal producing area on the Crow Indian Reservation flows into the Little Bighorn River. Surface water runoff from the southeastern part of the area eventually reaches the Tongue River. Drainage from the northeastern portion of the area is collected by the Rosebud Creek drainage system. Numerous tributaries on the reservation are the result of bedrock discharge in the form of springs.

The tribe's primary water concerns will have to be formally established through meetings within the tribal organization as well as outside community meetings. This will foster the development of water quality program vision, goals and objectives to eliminate water pollution on the reservation.

The tribe will use the previous water quality monitoring strategy and assessment plan as a template to help identify water quality problems and set program goals and objectives to address these goals. This will initiate the advancement of a functional sampling and analysis plan.

The Apsaalooke Nation is concerned about the effect present land use (e.g., septic systems, livestock, agriculture, etc.) may have on the Little Bighorn River. Since the Little Bighorn River is integral to the Tribe's cultural and economic life, any current or potential future impairment of the river needs to be identified. Surface water monitoring is needed to provide a baseline of the current conditions of Little Bighorn River, as well as to track changes in water quality over time. The longterm use of the surface water monitoring data would be to provide information to help the Tribe establish water quality standards and other tribal regulations and ordinances for the Apsaalooke (Crow) Reservation.

Prior to the 2001 Constitution, the Crow Nation was governed by a 1948 Constitution. The former constitution organized the tribe as a General Council (Tribal Council). The General Council in essence held the executive, legislative, and judicial powers of the government. The General Council was composed of all enrolled members of the Crow Nation, provided that females were 18 years or older and males 21 or older. The General Council was a direct democracy, comparable to that of ancient Athens.

Legislative- 3 reps for each district 6 districts 2yrs, 4 year terms and unlimited opportunity to stay in office upon election

Judicial- 1 chief judge, 2 current associate judges, 4 year terms but unlimited opportunity to stay in office upon election

Executive- 4 officials, maximum of two terms (8 yrs) per position

The Crow Nation, or Crow Tribe of Indians, established a three branch government at a 2001 Council Meeting. The new government is known as the 2001 Constitution. The Executive Branch has four officials; the Chairperson or Chairman, Vice-Chairperson or Vice-Chairman, Secretary, and Vice-Secretary. The Legislative branch is comprised of 18 officials; three representatives for each of the six districts. The judicial branch is not composed of a fixed number of officials. It is typically comprised of a chief judge and one to several associate judges. All officials are elected by the Crow people via anonymous ballots. The 107 council of tribal elders is yet another element if the tribal council. Members of this component are not formally elected but hired on or appointed by the executive branch. The 107 council of tribal elders are regularly consulted before any decisions are finalized. The tribal council approves any decisions regarding water issues on the Crow Reservation. In April 2009, Crow Tribal chairman Carl Vann, passed away before the end of his second term. The Vice Chairman Cedric Black Eagle, was elected into office shortly thereafter and is currently in office.

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3) People Involved in Water Quality Monitoring on the Crow Reservation

Groups involved in water quality work on the Crow Reservation include the tribal water program (106 and 319) employees, LBHC faculty and interns, Environmental Health Steering Committee, EPA Region 8, and the USGS. The roles and contacts within these groups are outlined below.

3.1) Little Big Horn College

Little Big Horn College is a two year tribal college located in Crow Agency, MT. Faculty members at the college work in conjunction with the Crow Environmental Health Steering Committee, a diverse group of community members, and with researchers at MSU-Bozeman to conduct environmental health research. Summer interns are employed each summer who, receive training and help conduct the research. Research efforts have been funded by an INBRE grant through MSU since 2003; primary funding is now provided by the Center for Native Health Partnerships at MSU. A RIMI NIH Program grant to LBHC supports additional student research projects, including related water quality research.

Mari Eggers has been a faculty member at LBHC since 1996, and became a research associate in 2006. Mari has a Master's degree in ecology and a Master's degree in anthropology (social theory). She is currently working on a PhD in environmental health at MSU under the Department of Microbiology. Mari's research is a community based risk assessment of exposure to contaminants through water sources on the Crow Reservation.

Tami Old Coyote works with Mari Eggers to coordinate the well monitoring component of the environmental health project at LBHC. She started after Crescentia left in 2010. Tami has a bachelor's degree in plant science.

Sara Plaggemeyer is a science instructor at LBHC and has directed summer student interns in surface water quality monitoring in the summers of 2008 and 2009. She has her bachelor's degree in biological science and master's degree in education. She is currently working on her PhD in Microbiology at MSU under direction of Dr. Ann Camper on microbial source tracking of fecal bacteria in surface water on the Crow Reservation.

LBHC Summer Interns from LBHC have been hired for summer seasons since 2004 to collect water quality and environmental health data under projects funded by INBRE through MSU Bozeman, Additional interns have been hired in the past couple years through the Center for Native Health Partnerships at MSU, and through LBHC's NIH-RIMI grant.

3.2) Crow Tribe

The Crow Tribe's Water Quality Program is housed under the Natural Resources Department and includes a Clean Water Act (CWA) 106 monitoring coordinator position and a CWA 319 nonpoint source pollution prevention coordinator position. These positions are funded by the federal government through the EPA and are considered continuing environmental programs. They require annual application for funds to maintain the programs. The department head and GAP coordinator both interact directly with personnel in the water program.

Myron Shields is the General Assistance Fund (GAP) coordinator and EPA program director for the Crow Tribe Environmental Program and is the direct supervisor of the CWA 106 and CWA 319 water program coordinators. Myron started with the Crow Tribe in 2009.

Brandon Goodluck has been working as the CWA Section 319 nonpoint source pollution coordinator for the Crow Tribe since May of 2009. He worked as a summer intern at LBHC in the summer of 2007.

Cresentia Cummins has been working as the Crow Tribe CWA 106 coordinator since 2010. Prior to working for the tribe she worked at LBHC on the groundwater component of the environmental health project starting in 2008. She also managed the surface water portion of the LBHC project in the summer of 2008 and was an intern in the fall of 2005. She has a BS degree in Land Resources and Environmental Sciences from MSU.

3.3) US Environmental Protection Agency

The US EPA provides funding through grants to American Indian Tribes under the CWA to conduct water quality monitoring and to make improvements in water quality conditions on reservations.

Jennifer Wintersteen works for the US EPA in Helena, MT and has been the EPA liaison to the Crow Tribe since 2004. She works with the tribe's CWA 106 and 319 program employees to develop their program goals, to write annual funding proposals, and to produce progress reports to ensure movement toward program goals.

3.4) Montana State University

The Crow Tribal and/or the LBHC water quality team collaborates with Montana State University-Bozeman faculty and staff with technical expertise in water quality monitoring project development, quality assurance directives, and data collection and analysis.

Sue Broadaway in the MSU Microbiology Department has provided training for summer interns each spring since 2008. These workshops include basic aseptic microbiology laboratory procedures and lab safety. There is an introduction in use of balances, autoclaves, Rainin pipetters, glass pipettes and different types of bacteriological media. Description of proper maintenance of a laboratory notebook and other laboratory records are included. Hands-on sample collection, serial dilutions and plating as well as filtration techniques are demonstrated.

The instruction incorporates mathematical determination of cell concentrations from plate counts and proper inclusion of bacteriological controls. Fire extinguisher use, safe river sampling, chemical safety and personal protection equipment are also covered.

Dr. Anne Camper is the Associate Dean of the MSU Engineering Department and a professor of civil engineering. Dr. Camper is the principle investigator on the INBRE and RIMI grants to conduct environmental health research on the reservation.

Adam Sigler works for MSU Extension Water Quality (MSUEWQ) in the Land Resources and Environmental Science Department at MSU as a research associate and adjunct instructor. Sigler and other members of MSUEWQ have conducted water quality training workshops for student interns at LBHC since 2006. Workshop topics include fundamentals of watersheds and water quality, water resources on the reservation, QAQC quality data requirements, field sampling techniques, YSI operation and calibration, and basic lab techniques for suspended sediment analysis. Sigler is providing oversight on the creation of this quality assurance document and is working with Brandon Good Luck (the tribes nonpoint source pollution coordinator) on water quality outreach education efforts on the Crow Reservation.

3.5) USGS

The USGS conducts water quantity and quality monitoring and research across the United States. USGS maintains 6 gauging stations on the Crow Reservation with real time discharge data and some water quality data available.

Joanna Thamke is a groundwater scientist with USGS who has conducted water quality monitoring on the Little Big Horn River in collaboration with the Crow Tribe Environmental Department and US EPA since 2009.

Stacy Kinsey is a water resource scientist with the USGS who conducts monitoring at a few of the USGS stations on the Crow Reservation. Stacy initiated work with the Crow Tribe Environmental Department in the summer of 2009 to assess the water quality changes associated with fencing horses out of the Little Big Horn River at the Real Bird property.

4) Problem Definition and Background

4.1) Water and Land Resources on the Reservation

The Crow Indian Reservation in south-central Montana is a large reservation covering 9,307.269 acres (14,542.61 sq mi or 37,665.21 km²) of land area, the fifth-largest Indian reservation in the United States. The reservation is primarily in Big Horn and Yellowstone counties with ceded lands in Rosebud, Carbon, and Treasure Counties. The Crow Indian Reservation's eastern border is the 107th meridian line, except along the border line of the Northern Cheyenne Indian Reservation. The southern border follows the Montana/Wyoming border from the 107th meridian line west to the east bank of the Big Horn River. The border follows the eastern edge of the Bighorn River downstream to Bighorn National Recreation Area and west to the Pryor Mountains and north-easterly to Billings. The northern border travels east and near Hardin, Montana, to the 107th meridian line. The 2000 census reported a total population of 6,894 on reservation lands. Its largest community is Crow Agency. The Crow Reservation is in the head waters of the Missouri with primary watersheds consisting of the Little Big Horn River, the Big Horn River, and Pryor Creek.

In recent years, it is thought that surface waters on the Crow Reservation are contaminated more so than similar rural non-native communities. Tribal members have commented that they used to be able to swim in the rivers without getting sick but now children get diarrhea after swimming and the rivers don't clear up after spring runoff like they used to, they stay cloudy all year. Among the possible reasons for this disparity is that the provisions of the Clean Water Act are not adequately monitored and

enforced on the Crow Reservation. Moreover, subsistence lifestyles of the Crow people, including swimming and the ceremonial practice of the sweat lodge, put them at an increased risk of exposure to surface water contaminants. Approaches to understanding exposure pathways may help to develop culturally appropriate mitigation strategies.

Extensive agriculture is quite possibly the main reason for surface water contamination on the Crow Reservation. Inadequate and/or antiquated sewage treatment facilities are also thought to contribute to contamination. There have been reported occurrences of abandoned un-lined landfills and past oil spills on the Crow Reservation. There is also the coal burning plant in Colstrip, MT., proximal to the Crow Reservation which is thought be the primary contributor to the mercury content in surface waters.

A Nonpoint Source (NPS) Water Pollution Assessment Report was prepared in 2001 as a partial fulfillment of the Environmental Protection Agency EPA requirements under Section 319 of the Federal Clean Water Act (PLl00-4, 1937) by David Haire, a Watershed and Fisheries Scientist of Powell, Wyoming. These requirements specify that individual states and Indian Tribes must prepare both a NPS assessment report and a NPS management plan in order to qualify for funding under CWA Section 319. These documents are utilized in the prioritization of water quality improvement projects on the Reservation. According to EPA guidance, assessment reports must include the following information:

a. identification of navigable waters within the state or reservation which, without additional action to control nonpoint sources of pollution, cannot reasonably be expected to attain or maintain water quality standards or the goals and requirements of the Act;

b. identification of those categories and subcategories of nonpoint sources or, where appropriate, particular nonpoint sources which add significant pollution to each portion of the navigable waters identified under subparagraph (a) in amounts which contribute to such portion not meeting such water quality standards or such goals and requirements;

c. description of the process, including intergovernmental coordination and public participation, for identifying best management practices and measures to control each category and subcategory of nonpoint sources and, where appropriate, particular nonpoint sources identified under subparagraph (b) and to reduce, to the maximum extent practicable, the level of pollution resulting from such category, subcategory, or source; and

d. identification and description of state, tribal, and local programs for controlling pollution added from nonpoint sources to, and improving the quality of, each portion of the navigable waters, including but not limited to those programs which are receiving Federal assistance under subsections (h) and (I) (of the Act).

The objective of CWA Section 319 is to improve water quality and restore impaired uses in waters affected by NPS pollution. To insure consistency among agencies, tribes, and states the EPA has provided the following definition of Nonpoint Source Pollution:

Nonpoint Source (NPS) Pollution is caused by diffuse sources that are not regulated as point sources and normally is associated with agricultural, silvicultural, and urban runoff as well as runoff from construction activities, etc. Such pollution results in human-made or human-induced alteration of the chemical, physical, biological, and radiological integrity of water. NPS pollution does not result from a discharge at a specific, single location such as a single pipe, but generally results from land runoff, precipitation, atmospheric deposition, or percolation. Pollution from NPS occurs when the rate of pollutant materials entering water bodies or groundwater exceeds the natural accumulation rate.

4.2) Little Big Horn River

The Little Big Horn River is the longest and most heavily populated watershed on the Crow Reservation. The mainstem flows for a length of approximately 70 miles from the southern boundary of the Reservation to its mouth near Hardin, MT. The river flows past the towns of Wyola, Lodge Grass, and Crow Agency with landuses in the watershed including irrigated agriculture, livestock grazing, and residential development. Flow modification is prevalent throughout the length of the drainage, as irrigated withdrawals and return flows contribute to both reduced and augmented flows. The drainage elevation range is from about 4,500 ft. where it enters the Reservation to about 3,000 ft. at its mouth. Its headwaters are located in the Big Horn Mountains of Wyoming at elevations approaching 10,000 ft. (Haire) The Little Big Horn River upstream from and including Lodge Grass Creek is classified as a B-1 stream by the Montana DEQ. The Little Big Horn River below Lodge Grass Creek is classified as a B-2 stream by the Montana DEQ. (Administrative Rules of Montana)

4.3) Big Horn River

The Bighorn River begins along the Continental Divide at elevations of almost 14,000 ft. in the Wind River Mountains and Absaroka Range of Wyoming and flows for approximately 461 mi (742 km) before entering the Yellowstone River. The Bighorn River is unique in that it is known as the Wind River in the headwaters and the Bighorn further downstream. The two rivers are sometimes referred to as the Wind/Bighorn. The Wind River officially becomes the Bighorn River at the Wedding of the Waters, on the north side of the Wind River Canyon near the town of Thermopolis, WY. The river flows into Montana within the Bighorn National Recreation Area with the reservation boundary along the eastern side. The river flows into the reservation near St. Xavier and flows for about 25 miles losing about 150 ft of elevation before leaving the reservation near Hardin. The Bighorn is a regulated river, with Boysen Dam controlling its flow above Wind River Canyon in Wyoming and Yellowtail Dam controlling its flow below Bighorn Canyon, upstream from the Crow Indian Reservation. The Big Horn River upstream from Williams Coulee near Hardin is classified by the Montana DEQ as a B-1 stream. (Administrative Rules of Montana) As of October 19th 2009, the Big Horn River from the Reservation boundary to the confluence with the Yellowstone River is listed on the Montana DEQ Clean Water Act Information Center 303d list due to lead and mercury levels not supporting use for drinking water.

4.4) Pryor Creek

The Pryor Creek watershed drains the western quarter of the Crow Indian Reservation. The headwaters of Pryor Creek are located along the northern slopes of Pryor Mountains at the elevations around 7,000 ft. The stream flows directly north for approximately 60 miles and joins the Yellowstone River at a elevation of about 3,000 ft. near the town of Huntley. The east fork of Pryor Creek is located entirely within the Crow Reservation in brushlands/grasslands and does not drain any of the foothills or mountain area like the rest of the watershed. The mainstem of Pryor Creek begins with the confluence of East Pryor Creek and West Pryor Creek about 12 miles below the town of Pryor. (Haire) Pryor Creek upstream from I90 is classified as a B-1 stream by the Montana DEQ. (Administrative Rules of Montana)

4.5) Water Quality Data Collection Background

The Crow Tribe has treatment as state (TAS) for sections 106 and 319 of the CWA. This means the tribe receives federal dollars through the US Environmental Protection Agency (EPA) to conduct these programs on the reservation. Funding is awarded each year based on proposals submitted by tribal employees in the 106 and 319 positions. Section 319 deals with nonpoint source pollution, relying on public education and work with land owners on a voluntary basis to make improvements in landuse practices. Section 106 of the CWA deals with water quality monitoring. While it is the direct job of the

106 tribe employee to conduct water quality monitoring on the reservation, it is also an important part of the 319 program so these two positions should work together on monitoring projects.

The Crow Tribe collected a lot of data between 1994 and 2000 under the direction of Connie Howe. There was a lapse in data collection after that period, so Little Big Horn College picked up the effort in 2006 and has been collecting data since that time. LBHC has contracted the MSU Extension Water Quality (MSUEWQ) program since 2006 to put on water quality trainings for summer interns, faculty and tribal staff. The lab equipment and overall capacity of the LBHC water program has been growing each year since 2006. The desire to ensure the quality of water quality data collected prompted the writing of this document in the summer of 2009.

LBHC student interns will continue to collect water quality samples and conduct monitoring as budgets and schedules allow, however it is the hope of the college that monitoring efforts will be largely taken over by the 106 and 319 programs under the tribe. Collaboration between the 106 and 319 tribe employees and LBHC has been working well during the 2009 season. The tribe does not have water quality monitoring equipment and the college has had limited access to vehicles, so between the two entities they have been able to get out do collect data. The LBHC water lab is equipped to run *E. coli* and suspended sediment samples, so these are analyzed at LBHC. They are also working on molecular genetics methods to conduct sample analysis on fecal contamination sources. Helicobacter Pylori, coliform and *E. coli* samples are sent to the Microbiology Department at MSU-Bozeman for analysis and chemical analysis has been performed by Energy Labs in Billings.

Table 1. Crow Tribe Monitoring Stations

Station Name	Station ID
Black Canyon Youth Camp	CROWNAT101
Rotten Grass 1 - Above Small's res.	CROWNAT102
Lodge Grass 1 - by Yellowtail's res.	CROWNAT103
Little Big Horn 1 - upper brdg, wyola	CROWNAT104
Little Big Horn 2 - Black Brdg.	CROWNAT105
Lodge Grass 2 - Cummins Res.	CROWNAT106
Soap Creek 1 - oil fields	CROWNAT107
Soap Creek 2 - hwy. 313, by ranch	CROWNAT108
Rotton Grass 2 - St. X, bridge	CROWNAT109
Pryor Creek 1 - Pryor Gap	CROWNAT110
Pryor Creek 2 - below lagoons	CROWNAT111
Pryor Creek 3 - Pryor road, by bridge	CROWNAT112
Owl Creek - 40 mile colony, bridge	CROWNAT113
Grey Blanket - to Oil rig on right side	CROWNAT114
Pass Creek 1 - on lil'horn road by BIG res.	CROWNAT115
Little Bighorn 3 - Sarpy road, by bridge	CROWNAT116
Pass Creek 2 - on lil'horn road by Harris	CROWNAT117
LBH - Takes Gun Residence - past LG lagoons	CROWNAT118
Beauvais Creek - county rd #50A	CROWNAT119
Big Horn River - under I-90 bridge	CROWNAT120
Soap Creek 3 - Dropped	CROWNAT121
Lodge Grass 3 - by Clinic	CROWNAT122
LBH - Pickett res. By sweat	CROWNAT123
Little Bighorn 6 - Agri-Systems Dropped 1yr	CROWNAT124
Woody Creek - same rd. as beauvais	CROWNAT125
Little Owl Creek 1 - upper	CROWNAT201
Ash Creek - Upper by forks	CROWNAT202
Little Young's 1 - Upper by forks	CROWNAT203
Little Young's 2 - lower by border/rez.	CROWNAT204
Young's Creek 1 - upper	CROWNAT205
Young's Creek 2 - lower	CROWNAT206
Tanner Creek - mid stream	CROWNAT207
Squirrel Creek 1 - mid stream	CROWNAT208
Squirrel Creek 2 - north fork	CROWNAT209
Canyon - begin of PryorCrk Study	CROWNAT301
Goes Ahead	CROWNAT302
RD by Correl	CROWNAT303
Redstar	CROWNAT304
Catholic Bridge	CROWNAT305
Plenty Coup Park	CROWNAT306
Rock Above	CROWNAT307
Daum Creek	CROWNAT308
Stands Res.	CROWNAT309
Hey Creek	CROWNAT310
Easy Pryor Creek	CROWNAT311

LBHC and the tribal water program employees are represented on the Apsalookee Environmental Health Steering Committee. This group also consists of a diverse range of community members which use a Community Based Participatory Research (CBPR) approach to direct the water quality and environmental health research conducted on the Crow Reservation.

4.6) Data Resources

The Crow Tribe collected water quality data from 1994 to 2000 when Connie Howe was the environmental director for the tribe. Data was collected at approximately 50 different sites and consists of temperature, turbidity, specific conductance, fecal coliforms, and a variety of chemical parameters and is available from the EPA STORET database. If additional water quality data has been collected by the tribe since that time, it was not known to the authors at the time of writing. In December of 2001, David Haire completed a Nonpoint Source Water Pollution Assessment Report on behalf of the tribe. This report included an inventory of landuses potentially contributing to nonpoint source pollution on the reservation.

LBHC started collecting water quality data in the summer of 2006 and has been collecting data each summer since that time. Parameters analyzed include dissolved oxygen, electrical conductivity, pH, total suspended sediment, total dissolved solids, discharge, *E. coli* and coliform bacteria concentrations. Data has been collected at 8 sites on the Little Bighorn River, 6 sites on the Bighorn River, and 4 sites on Pryor Creek. See Table 2 for a list of stations. Methods have evolved since data collection initiated in 2006 and this document is being constructed to standardize data collection between years.

Table 2. LBHC Monitoring Stations

Station Name	Station ID
State Line #1	LBHR-010
Little Horn Ranch Bridge	LBHR-020
Black Bridge	LBHR-030
Wyola	LBHR-040
Spear Sighting	LBHR-060
Westwoods	LBHR-070
Sand Creek	LBHR-050
Reno Creek	LBHR-080
Fort Custer Museum	LBHR-090
Crow Bridge	LBHR-100
LBHC Bridge	LBHR-110
White Clays	LBHR-120
Sarpy Bridge	LBHR-130
After Bay	BHR-010
After Bay Spillway	BHR-020
Big Horn Access	BHR-030
St. Xavier/Pretty Eagle Bridge	BHR-040
Mallard's Landing	BHR-050
Two Leggins	BHR-060
13 Mile	BHR-070
Pryor Gap Site 1	PC-010
Plenty Coup/E Pryor Bridge	PC-020
Pryor Battle Site	PC-030
East of Blue Creek Rd	PC-040

USGS has six active gauging stations and a few other stations within the boundaries of the Crow Reservation. Discharge is measured regularly at the active stations and water quality data has been collected at some of the stations. See Table 3 for a list of USGS stations on the reservation.

National Park Service has monitoring data at the After Bay Spillway Site on the Big Horn River for a variety of chemical parameters staring in about 2005 to present. The data is available in STORET (Sample ID: BICA_BHR1).

Table 3. USGS Monitoring Stations

USGS Site Name	Site ID
Pryor Creek at Pryor MT	06216000
Little Bighorn River at State Line nr Wyola MT	06289000
Little Bighorn River near Hardin MT	06294000
Bighorn Lake near St. Xavier MT	06286400
Bighorn River near St. Xavier, MT	06287000
Birhorn River ab Tullock Cr nr Bighorn MT	06294500
Pass Creek near Wyola MT	06290000
East Pass Creek Near Dayton, WY	06289820
West Pass Creek Near Parkman, WY	06289600
Lodge Grass Cr ab Willow Cr diversion, nr Wyola MT	06291500

5) Project Tasks Overview

LBHC works throughout the school year to recruit summer interns for the water quality monitoring crew, and these interns are hired in the spring. A field crew leader is chosen every year based on experience and academic background. Interns are trained in the spring at a series of workshops. MSUEWQ conducts a water quality monitoring workshop in May where students learn about watershed concepts, water quality, and water quality monitoring and analysis protocols. Field sampling and analysis begins in June and winds down in August but additional monitoring will be conducted year round as schedules and budgets permit. During the summer sampling season, interns will spend one day each week conducting sampling. One watershed will be targeted each week and interns will rotate through the three watersheds. *E. coli* and sediment samples are processed at LBHC and chemical samples are delivered to Energy Laboratories, Inc. in Billings, MT for analysis, Helicobacter Pylori, coliform and *E. coli* samples have been delivered or shipped to the Microbiology Department at MSU-Bozeman for analysis.

6) Trainings

Water quality monitoring and laboratory workshops have been conducted for LBHC interns since the spring of 2006. These workshops provide interns with the working knowledge they need to conduct sampling and analysis. MSUEWQ conducts a water quality monitoring workshop and Sue Broadaway with the MSU Microbiology Department conducts a laboratory methods workshop. See the MSU portion of Section 3 in this document for further description of these workshops.

7) Documentation and Records

Field data sheets must be completed on-site at the time sampling occurs including date, time, sample number and designated field site location name. The field crew leader is responsible for returning original completed field sheets to the water quality coordinator and making copies for science lab backup documentation. A binder for the data sheets is maintained at LBHC.

8) Sampling and Process Design

The list of top priority sample sites for each river has been selected so that all sites in a watershed can be sampled in one day. Field crew members will make every effort to get to all of the top priority sample sites for the designated watershed each week. Sampling should be scheduled during the first half of the week to allow for the bacteria samples to be processed before the weekend. The scheduled rotation through the watersheds will be arranged in advance by the Field Crew and Water Quality Coordinator. If any Field Crew member cannot conduct the scheduled sampling, they should notify the Field Crew Leader and Water Quality Coordinator as soon as possible so alternative monitoring duties can be discussed and carried out.

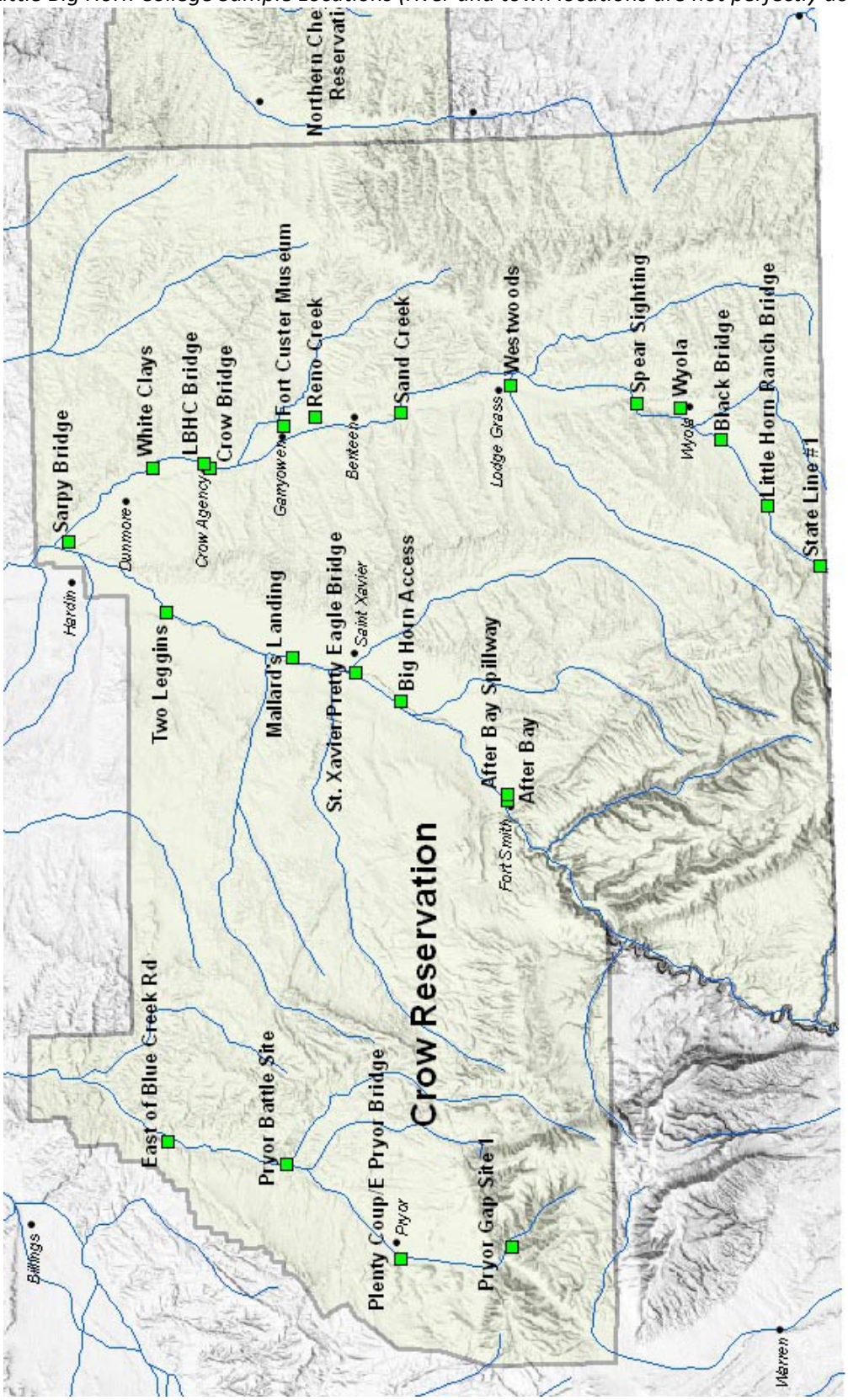
Width and depth integrated sampling is being implemented with the writing of this QAPP. The handheld DH-81 and the rope suspended DH-95 will be used to collect water samples. These samplers have interchangeable bottles and nozzles. A sufficient number of nozzles and bottles will be acid washed and sterilized for each sample trip so that a fresh set can be used at each sample location. The Little Big Horn River has 7 top priority sample sites which is greater than the number for the other two rivers. E. coli and chemical samples will be collected directly from the depth integrated sampler from a single vertical sample at the center of the stream. Suspended sediment will be collected from a churn bucket with water collected from 10 verticals across the stream width. There is only one churn bucket which will be shared between the sites and rinsed between uses.

In addition to the field sampling and measurements conducted during the field season (June-August) chemical parameters will be sampled 4 times a year at the most upstream and downstream sites of each river. The four sample events should be conducted to get samples before spring runoff, during spring runoff, after spring runoff, and during a precipitation event if possible. This sampling of the most upstream and downstream sites will provide a screening of where potential issues may exist and will guide future chemical sampling plans. Scheduling of these sample events will be determined by observing runoff at the USGS gauges on the USGS website to determine when spring runoff is occurring, and when the rivers have returned to baseflow conditions in mid-summer. The Water Quality Coordinator will arrange to get bottles from Energy Lab and schedule these sampling events. One set of quality control samples including a duplicate and a blank sample will be collected for each river on at least one of the sampling trips. The list of chemical parameters were determined by examining previously collected data, and through conversations between Mari Eggers and Adam Sigler.

Table 4. High Priority LBHC Sample Sites and Justification

Station Name	Station ID	Lat	Long	Top Priority	Access Type	Justification Note
Little Bighorn River						
State Line #1	LBHR-010	45.00695	-107.61548	X	wadeable after high flow, bridge at high flow	Water entering reservation
Little Horn Ranch Bridge	LBHR-020	45.05664	-107.53156		usually wadeable	Don't expect big change from stateline
Black Bridge	LBHR-030	45.10108	-107.44048		bridge	Alternate for Wyola with slower traffic than Spear Sighting
Wyola	LBHR-040	45.13927	-107.39586	X	bridge	Nice straight site downstream from feedlot, but floods out in spring, Black Bridge is the alternate site
Spear Sighting	LBHR-050	45.18078	-107.38806		bridge	Bridge on angle and fast traffic
Westwoods	LBHR-060	45.30339	-107.35915	X	bridge	Upstream from Lodge Grass Lagoons
Sand Creek	LBHR-070	45.41026	-107.39227	X	bridge	Downstream from Lodge Grass Lagoons
Reno Creek	LBHR-080	45.49411	-107.39359		bridge	Could be priority if it represents the top of the 319 effort
Fort Custer Museum	LBHR-090	45.52443	-107.40507		wadeable after high flow	Side channel and ownership issues
Crow Bridge	LBHR-100	45.59737	-107.46031		bridge	Fast traffic
LBHC Bridge	LBHR-110	45.60291	-107.45367	X	bridge	Upstream from Crow Lagoons
White Clays	LBHR-120	45.65213	-107.45831	X	wadeable after high flow	Downstream from Crow Lagoons
Sarpy Bridge	LBHR-130	45.73565	-107.55789	X	bridge	Water leaving reservation
Big Horn River						
After Bay	BHR-010	45.31567	-107.92752	X	grab sample from dock	Always sampled before
After Bay Spillway	BHR-020	45.31606	-107.92020	X	grab sample from bank	Always sampled before
Big Horn Access	BHR-030	45.41648	-107.78938	X	grab sample from bank	Always sampled before
St. Xavier/Pretty Eagle Bridge	BHR-040	45.46076	-107.74772	X	bridge	Always sampled before
Mallard's Landing	BHR-050	45.52162	-107.72601	X	grab sample from bank	Always sampled before
Two Leggins	BHR-060	45.64285	-107.65811	X	bridge	Always sampled before
13 Mile	BHR-070	NO DATA	NO DATA		NO DATA	Couldn't find site
Pryor Creek						
Pryor Gap Site 1	PC-010	45.31783	-108.54144	X	wadeable	Always sampled before
Plenty Coup/E Pryor Bridge	PC-020	45.4262	-108.55613	X	wadeable	Always sampled before
Pryor Battle Site	PC-030	45.53632	-108.42493	X	wadeable after high flow, bridge at high flow	Always sampled before
East of Blue Creek Rd	PC-040	45.65041	-108.39142	X	grab sample from bank	Always sampled before

Figure 2. Little Big Horn College Sample Locations (river and town locations are not perfectly accurate)



8.1) Nutrients

Nitrate plus nitrite and ortho phosphate were selected to address interest in pollution contributing to eutrophication. Soluble forms were selected due to lower cost than for total nutrient analysis and because soluble forms of nutrients are those more readily available to aquatic vegetation and hence more directly correlated to eutrophication risk. Data collected between 1994 and 2000 came back with values for a number of sample locations with concentrations above 0.5 mg/l nitrate plus nitrite as N, which is much higher than what would be expected naturally in the Northwestern Glaciated Plains. Ortho phosphate data collected during the same period also came up with a handful of values above 0.1 mg/l as P which is above what would be expected naturally here. The MTDEQ proposed water quality standards for nitrate as N and total phosphorus as P are 0.076 and 0.124 mg/l respectively for the Northwestern Great Plains Ecoregion.

8.2) Arsenic

Arsenic was selected because Mari Eggers indicated that it has been detected in at least one drinking water well on the reservation. Arsenic was also detected above the detection limit in surface water samples collected between 1994 and 2000 in Pryor Creek (0.053 mg/l), Woody Creek (0.015 mg/l), Soap Creeks (value dropped), and Owl Creek (0.006 mg/l). The drinking water standard for arsenic is 0.01 mg/l.

8.3) Lead

Samples from the Big Horn River are being sampled for lead because Mari Eggers has been told that historic uranium mining in the Pryor Mountains drains down Dry Head Creek into Big Horn Lake. Radioactive lead is the last element in the decay series for uranium. As of October 19th 2009, the Big Horn River from the Reservation boundary to the confluence with the Yellowstone River is listed on the Montana DEQ Clean Water Act Information Center 303d list due to lead and mercury levels not supporting use for drinking water. Pryor Creek samples are being tested for lead because a few samples collected between 1994 and 2000 came back above detection limit for lead. In October of 1997 one sample at Pryor Road near the bridge came back at 0.34 mg/l for lead. The drinking water standard for lead is 0.015 mg/l. Hardness is necessary for calculating soluble metal toxicity to aquatic life.

8.4) Chemical Oxygen Demand (COD)

COD was selected to quantify biological waste loading to the Little Big Horn River. Low dissolved oxygen values have been measured by both the tribe and the LBHC student interns in the Little Bighorn River, which is indicative of possible organic loading. Additionally, Mari Eggers was told that leasions which have been observed on Catfish in the river could be caused by excessively high biological material in the river.

8.5) Chromium, Cadmium, Selenium (if funding allows)

Cadmium will be tested for if funding allows. It was found above detection levels between 1994 and 2000 in 8 of approximately 130 samples. Two of these samples were above the drinking water standard of 0.005 mg/l at 0.006 and 0.01 in Pryor Creek and Soap Creek respectively.

Chromium will be tested for if funding allows. It was found above detection levels between 1994 and 2000 in 5 of approximately 120 samples. One of these samples was above the drinking water standard of 0.1 mg/l at 0.11 in Pryor Creek. Hardness is necessary for calculating soluble metal toxicity to aquatic life.

Selenium will be tested for if funding allows. It was found above detection levels between 1994 and 2000 in 4 of approximately 120 samples. One of these samples was above the drinking water standard of 0.05 mg/l at 0.117 in Rotten Grass Creek.

8.6) Iron

Iron will be tested to better understand iron movement in the watersheds. This is simply to improve the understanding of iron dynamics in the watersheds because problems with iron staining are so widespread in the area. Iron does not pose health concerns in drinking water. Iron concentrations in Lodge Grass Creek, Pass Creek, Owl Creek, Soap Creek, Rotten Grass Creek, Pryor Creek, the Little Bighorn River, Beauvais Creek, and Woody Creek all came up above 1.0 mg/l for iron in one or more samples.

8.7) Sodium, Calcium and Magnesium (Calculated Sodium Adsorption Ratio and Hardness)

Sodium, calcium and magnesium will be tested in the samples to facilitate calculation of the sodium adsorption ration (SAR) and hardness of the water. SAR is an important water quality parameter for irrigation suitability and is potentially affected by coal bed methane (CBM) development. Collecting baseline SAR data will be beneficial if CBM product water discharge becomes a concern in the future. Calcium and magnesium can also be used to calculate hardness which is necessary to calculate the toxicity of soluble metals to aquatic life. Calcium and magnesium data does not appear to have been collected between 1994 and 2000 but sodium values ranged up to 287 mg/l.

8.8) Barium, Copper, Fluoride, Mercury (not analyzing for)

Barium will not be tested for because only 2 samples between 1994 and 2000 came back above detection and none of them were over the 2 mg/l drinking water standard. Copper will not be tested for because only 8 samples between 1994 and 2000 came back above detection and none of these approached the 1.3 mg/l drinking water standard. Fluoride will not be tested for because all but one value between 1994 and 2000 came back below 1.0 mg/l which is far below 2 mg/l where some problems might start to arise with dental fluorosis. Mercury is not being tested for because it is rarely present in detectable concentrations in the water column and was not found above detection in any samples between 1994 and 2000.

8.9) *E. coli* bacteria

E. coli will be sampled for on every site visit. Previous sampling had detected *E. coli* concentrations ranging from below detection to greater than an estimated 12,000 CFU per 100ml based on the Easygel screening method. Work conducted by the Microbiology Department at Montana State University has detected highly pathogenic forms of *E. coli* which has prompted continued interest in determining source and nature of *E. coli* in the watersheds. In the table, reference is made to the basic Montana DEQ threshold of 126 CFU per 100 ml for water used for recreation during the swimming season. Below are standards used by the Northern Cheyenne and the Chippewa Cree Tribes for general and pristine waters.

E. coli standard for all waters borrowed from Northern Cheyenne standards

E. coli 126 cfu per 100 ml when calculated as a geometric mean

235 cfu per 100 ml for single sample not to exceed value for full body contact

406 cfu per 100 ml for single sample not to exceed value for incidental contact recreation

E. coli standard for the most pristine waters borrowed from the Chippewa Cree

The geometric mean number of Escherichia coli bacteria may not exceed 32 colony forming units per 100 milliliters and 10% of the samples may not exceed 64 colony forming units per 100 milliliters during any 30-day period if resulting from domestic sewage. A single instantaneous sample may not exceed a maximum of 126 E. coli organisms per 100 milliliters.

Table 5. Parameters Previously Detected Values, MT WQ Standards, and Reporting Limits

Parameter	Previously Detected Values	MT Standard	Reporting Limit	Analytical Method	Cost per Sample
pH	7.5 – 8.5 In the three rivers	6.5-8.5 (secondary drinking) [1]; No induced change over 0.5 units [3]	+/- 0.2 units	YSI	NA
Temperature	5 to 25 degrees C	No induced change of more than a few degrees from natural and 19.5 C is a noted threshold [3]	+/- 0.15 C	YSI	NA
Dissolved Oxygen	2.5 mg/l up to saturation depending on location	1 day minimum for early life stages of fish is 8.0 mg/l [2]	+/- 0.2 mg/l	YSI	NA
Specific Conductance	0.2 to 0.9 mS/cm	USDA Irrigation Threshold = 3 mS/cm	+/- 0.5% of reading	YSI	NA
Nitrate plus Nitrite as N	Up to 0.5 mg/l	10 mg/l (drinking) [1]; 0.076 mg/l (aquatic life) [4]	0.01 mg/l	E353.2	$15.00
Ortho Phosphate	Up to over 0.1 mg/l	No standard Total P standard is 0.124 mg/l(aquatic life) [4]	0.001 mg/l	E365.1	$15.00
Arsenic (total recoverable)	Up to 0.053 mg/l	0.01 mg/l (drinking) [1] 0.34 mg/l (aquatic life acute) [2] 0.15 mg/l (aquatic life chronic) [2]	0.003	E200.7/8	Package Dependent
Arsenic (dissolved)	No Data	Same as above [5]	0.003	E200.7/8	Package Dependent
Cadmium (total recoverable)	Up to 0.01 mg/l	0.005mg/l (drinking) [1] 0.000097 to 0.00052 mg/l depending on hardness of water (aquatic life) [2]	0.00008 mg/l	E200.7/8	Package Dependent
Cadmium (dissolved)	No Data	0.002 mg/l (aquatic life acute) [5] 0.00025 mg/l(aquatic life chronic) [5]	0.00008 mg/l	E200.7/8	Package Dependent
Chromium (total recoverable)	Up to 0.11 mg/l	0.1 mg/l (drinking) [1] aquatic standards are specific chromium form [2]	0.01 mg/l	E200.7/8	Package Dependent
Chromium (dissolved)	No Data	0.011 to 0.57 mg/l depending on chromium form [5]	0.01 mg/l	E200.7/8	Package Dependent
Lead (total recoverable)	Up to 0.34 mg/l	0.015 mg/l (drinking) [1]; 0.000545 to 0.01398 mg/l depending on hardness of water (aquatic life) [2]	0.01 mg/l	E200.7/8	Package Dependent
Lead (dissolved)	No Data	0.065 mg/l (aquatic life acute) [5] 0.0025 mg/l (aquatic life chronic) [5]	0.01 mg/l	E200.7/8	Package Dependent
Iron (total recoverable)	Up to 1 mg/l	0.3 mg/l (secondary drinking) [1]	0.03 mg/l	E200.7/8	Package Dependent
Iron (dissolved)	No Data	1 mg/l chronic nonpriority [5]	0.03 mg/l	E200.7/8	Package Dependent
Chemical Oxygen Demand	No Data	No Information	1 mg/l	E410.4	$25.00
Calcium, Magnesium, Sodium Sodium Adsorption Ratio and Hardness (Calculated)	No data for Ca or Mg; Na up to 287 mg/l No data for SAR	No standard USDA SAR guideline is 12	Ca 1.0 mg/l Mg 1.0 mg/l Na 1.0 mg/l	E200.7/8	Package Dependent
Suspended Sediment Concentration	No Data	Specific to Natural Conditions in the Waterbody	10 mg/l	See Appendix	About $1.00
E. coli (Easygel)	No detection up to about 12,000 CFU per 100 ml	126 CFU per 100 ml during months recreation takes place [3]	Easygel = 33 per 100 ml	See Appendix	$2.00/plate
E. coli (M-ColiBlue)	No Data	126 CFU per 100 ml during months recreation takes place [3]	depends on amount filtered which is limited by turbidity	See Appendix	About $5.50 per dilution depending on ability to order in bulk

[1] - Drinking water standards are from the EPA MCL list.
[2] - Montana DEQ surface water standards from the DEQ-7 document.
[3] - From Montana DEQ water quality standards document (Administrative Rules of Montana)
[4] - From proposed MT DEQ numeric nutrients standards for the Wadeable Streams in the Northern Great Plains Ecoregion.
[5] - EPA recommended criteria assuming 100 mg/l hardness http://www.epa.gov/waterscience/criteria/wqctable/#appendxa

8.9) Safety

Field crew members are instructed to work in a team of at least two in wading streams for safety precautions and to wear lifejackets at all times when sampling. The USGS rule of 10 is a basic guideline to determine if a stream is wadeable. This means that if the depth of the stream times the speed of the water (in feet per second) is more than 10, the stream is not wadeable. For example, 3 x 3 = 9 so if the water is more than 3 feet deep and moving more than 3 feet per second, it is too deep and fast to wade safely. Don't take chances!

8.10) Site Access Permission

Permission to access each of the stream sampling sites is obtained from all private property owners. As a courtesy, these owners are notified at least 24 hours in advance of plans to conduct monitoring activities on the site

9) Sampling Methods

Sampling methods depend on wadability and presence of bridges for water access at individual sites. Specific instructions for sampling under different access conditions are included in the SOP in Appendix C. USGS discharge gauging stations are available in each of the watersheds and will be used for determining flow where present. USGS discharge data will also be used to estimate flow at sites where flow measurements are not possible due to non-wadability.

Each sample site falls into one of the following categories.

- Wadeable
    - Shallow and slow enough to wade entire width
        - YSI measurements taken in center
        - Suspended sediment samples collected across width and depth with DH-81
        - Chemical and *E. coli* samples collected across depth at center point with DH-81
- Non-wadeable with Bridge
    - Not shallow and slow enough to wade entire width with bridge present
        - YSI measurements take from bridge if possible or from shore
        - Suspended sediment samples collected across width and depth with DH-95
        - Chemical and *E. coli* samples collected across depth at center point with DH-95
- Non-wadeable without Bridge
    - Not shallow and slow enough to wade entire width with no bridge present
        - YSI measurements from bank or close to bank
        - Water samples are grab samples from bank or close to bank

9.1) Field Parameters with the YSI

For wadeable streams field parameters will be measured with the YSI in the center or thalweg of the channel at mid depth. Similarly, at bridge sites where the bridge is low enough for the YSI cord to reach the water, field measurements will be taken in the center or thalweg of the channel. At non-wadeable sites without bridges or with high bridges, field parameters will be measured from shore or a safe wading depth.

9.2) Water Samples

Water samples that are integrated across the width and depth of the stream are an important aspect of collecting representative suspended sediment samples. We are also taking the stance that collecting depth integrated samples for *E. coli* will help to reduce the variability in bacteria concentration that is naturally present in the stream and will provide for a more representative number. In the case of dissolved parameters such as metals and nutrients, integrated sampling is not considered to be as important. However, because a depth integrated sampler will be in use, chemical samples will be collected from a single depth integrated vertical at the center of the rivers in the same way that *E. coli* will be sampled.

Table 6. Parameters, sampling equipment and handling

Parameter	Sampling Equipment	Volume	Preservative	Hold Time
pH	YSI 556 Meter	instream	n/a	n/a
Temperature	YSI 556 Meter	instream	n/a	n/a
Dissolved Oxygen	YSI 556 Meter	instream	n/a	n/a
Specific Conductance	YSI 556 Meter	instream	n/a	n/a
Nitrate plus Nitrite as N	Depth Integrated Sampler or Grab Sample	500 ml Energy Bottle	H_2SO_4 Refrigerated	28 days
Chemical Oxygen Demand	Depth Integrated Sampler or Grab Sample	500 ml Energy Bottle	H_2SO_4 Refrigerated	28 days
Ortho Phosphate as P dissolved	Depth Integrated Sampler or Grab Sample	250 ml Energy Bottle	Unpreserved Refrigerated	48 hours
Dissolved Metals (arsenic, cadmium, chromium, lead*, iron, calcium, magnesium, sodium)	Depth Integrated Sampler or Grab Sample	250 ml Energy Bottle	Filtered HNO_3 Refrigerated	180 days
Suspended Sediment Concentration	Depth Integrated Sampler or Grab Sample	Quart Mason Jars	Refrigerated	7 days
E. coli	Depth Integrated Sampler or Grab Sample	Easygel Bottles or Sterile Bottles	Refrigerated	24 hours
Discharge	Marsh McBirney, Tape Measure, Stakes	instream	n/a	n/a
Lat/Long	GPS	n/a	n/a	n/a
Photos	Digital Camera	n/a	n/a	n/a

*lead is only to be sampled in Big Horn and Pryor Watersheds

Parameters grouped by shading are collected in the same bottle (i.e. nitrate and COD).

10) Sample Handling

Samples will be labeled in the field at the sample location. Minimum information on the identification labels will include:

Sample Site Name
Date and Time
Indication if the sample is a duplicate or a blank
Sampler's last name and first initial
Preservative added if any

E. coli samples are kept on ice and processed back at LBHC the same day (see analytical method in Appendix G). Suspended Sediment Concentration samples are transported on ice, refrigerated and processed at LBHC within 7 days of collection (see analytical method in Appendix F) Chemistry samples are kept on ice, a chain of custody form is filled out for Energy Laboratories, Inc. in Billings, MT. Samples are transferred to the lab by personal delivery, Fed Ex or UPS within the specified holding times and processed accordingly. See sample holding times in Table 4 in section 9.
NOTE: HOLD TIME FOR PHOSPHATE IS 48 HOURS, HOLD TIME FOR BACTERIA IS 24 HOURS

11) Quality Objectives and Criteria for Measurement Data

It is essential that the quality of data collected is sufficient to meet the intended use of the data. It is important that the sample locations and timing provide a representative picture of water quality in the river. It is also important that the quality of the data is checked by running blank and duplicate samples so you can have confidence that the final test results are a true representation of the quality of the water at the time of sampling.

11.1) Representativeness

In Space: Sampling sites were selected along each stream moving from headwaters downstream considering different land uses in the watersheds with significant consideration given to accessibility of the sites.

In the Water Column: In order to increase the degree that samples collected represent the water quality at the site at the time of sampling, width and depth integrated sampling has been incorporated.

In Time: In routine sampling efforts, rotation through the watersheds on a weekly basis functions to spread sampling out over the summer to represent changes over the course of the summer. Scheduling of chemical sampling before, during and after spring runoff will help to capture different water quality conditions on the different limbs of the hydrograph.

11.2) Precision and Accuracy

Precision refers to the degree of agreement among repeated measurements of the same characteristic and is addressed here with duplicate samples. Accuracy refers to how close the result is to the actual value and is partially addressed here with blank samples. A general guideline is that a duplicate and a field blank sample are run for 10 percent of samples collected.

Suspended sediment concentration (SSC) field blanks are prepared by taking distilled water into the field and filling a sample bottle with distilled water at one of the study sites. SSC method blanks are also run by passing distilled water through a glass fiber filter and handling the drying and weighing process along with the water samples. This process is described in the protocol in the appendix. Blanks typically do not vary from zero by more than a few mg and should never vary by more than 10 mg or the detection limit referenced in table 4 should be adjusted up accordingly.

Duplicate sediment samples are collected at every sampling location. By collecting duplicate samples, allowance is made for broken mason jars as well as for assessment of suspended sediment method precision. Precision can be assessed by comparing results for the duplicate samples. Relative percent difference (RPD) between the results can be calculated with the following formula:

$$\text{RPD as \%} = ((D1-D2)/((D1+D2)/2))x100$$

Where:

D1 is the first replicate
D2 is the second replicate

Relative percent difference will be higher when the amount of sediment in the samples is lower. The difference between results should not be more than 10 mg/L for results lower than 50 mg/l (5 times the reporting limit) and should not exceed 10% RPD for results over 50 mg/l. These are arbitrary guidelines based on MSUEWQ's experience using this method in the past.

E. coli samples using Coliscan are can be assessed for precision with the same formula by comparing the highest and lowest value for each set of triplicate samples. However, a high degree of variability in *E. coli* concentration is expected and the triplicate samples are typically averaged and treated as a single sample to get a more representative number. If possible, autoclaved distilled water should be carried to the field to run a field blank. The field blank should be prepared from the sterile water source and will help to determine if any contamination is taking place during the field sampling process.

Chemical: One set of blank and duplicate samples should be collected for the each of the 4 chemical sampling events during the year. Duplicate results can be compared with the same RPD formula listed above for SSC. RPD should not exceed 25% for duplicates with results more than 5 times the reporting limit.

11.3) Comparability

Efforts to increase the comparability of data to other data collection efforts have been made through aligning methods with those of USGS to the degree possible and through consideration of the parameters previously tested by the tribe's water program. Comparability of data is also increased through use of an EPA certified YSI 556 meter and use of a certified laboratory for chemical analysis of water samples.

11.4) Completeness

There are no legal or compliance uses anticipated for the water quality program data. In addition, there is no fraction of the planned data that must be collected in order to fulfill a statistical criteria. It is expected that samples will be collected from all sites unless unanticipated weather conditions prevent sampling.

12) Equipment Maintenance and Calibration

12.1) YSI Maintenance and Calibration

The YSI 556 meter will be maintained by the field crew and stored with ½ inch of tap water in the calibration/storage cup when not in use. The field crew leader will calibrate the meter once every week prior to sampling. If possible, the meter should be calibrated the morning of sampling. If necessary, the meter can be calibrated the day before sampling. Calibration procedures are outlined in Appendix B.

Calibration solutions are ordered from Northwest Scientific in Billings, MT (406-252-3269) and LBHC's account number is 421472. Conductivity solution is usually not in stock and must be ordered at least a week in advance. For pH solutions it is important to ask for the non-toxic type of solution. It is important to ensure solutions are not expired and that the cap is in good shape and the bottle is not leaking. Cost of solution is approximately 15 to 20 dollars for the 500 ml bottles and 75 to 100 dollars for the 2.5 liter bottles.

Solutions:

Conductivity: 500 ml of 1000us/cm (part # 2243-16)

pH: 4 (500 ml part # 1501-16), 7 (500 ml part # 1551-16), 10 (500 ml part # 1601-16)

12.2) Flow Meter Maintenance

The Marsh McBirney flow meter will also be maintained by the field crew and will be the responsibility of the field crew leader to ensure that it is calibrated once a week prior to any discharge measurements; this entails checking the zero velocity reading periodically and watching for chaotic readings when measuring discharge.

13) Data Management and Reports

13.1) Data Management

Field data sheets are inspected by the Field Crew Leader before leaving the site to ensure they are completely filled out. Data sheets should be placed in the designated datasheet binder on return to LBHC.

13.2) Reports

A power point presentation is conducted near the end of the summer to report on the data collected for the field season. This is an opportunity for field crew members to share data and communicate the Crow Reservation surface water contamination levels with local agencies, Crow Tribal officials, and the general public.

14) References

- Administrative Rules of Montana (ARM), title 17, Chapter 30 – Water Quality, Sub-Chapter 6 – surface Water Quality Standards.
- Montana Numeric Water Quality Standards Circular DEQ-7.
- Scientific and Technical Basis of the Numeric Nutrient Criteria for Montana's Wadeable Streams and Rivers. Prepared by Michael Suplee - Montana Department of Environmental Quality; Vicki Watson - University of Montana; Arun Varghese and Josh Cleland – ICF International. November 2008.
- Haire, David H. Crow Indian Reservation Nonpoint Source Water Pollution Assessment Report. December, 2001. Presented to EPA Region VIII Headquarters Denver, Colorado, for the: Crow Water Pollution Control Program, Crow Tribal Environmental Protection Program.

APPENDIX A
SAMPLE SITES
DESCRIPTIONS, COORDINATES, PICTURES, DRIVING DIRECTIONS

Little Bighorn - Stateline #1 Site (LBHR-010)

Lat/Long: 45.00695 , -107.61548 NAD83

Alternative Site Names: USGS 06289000

Driving Directions: Drive time from LBHC is approximately 1 hour. Drive south on I-90 to Garryowen and get on right frontage road toward Lodge Grass. Turn right on the 2nd railroad crossing just south of Wyola. Keep straight, pavement ends, take a right where the road forks and sample site is about 0.25 mile further at a bridge.

Site Description: The sample site is near a bridge over the Little Big Horn River. There is a USGS gauging station just downstream from the bridge. The sample site is about 150 feet upstream from the bridge and is wadable after spring runoff. When the site is unwadable, sample from the bridge.

Previous Sample Locations: Prior to this document, the sample location was approximately half a mile upstream from the bridge.

Upstream Landuse Notes: Primary landuse around the sample site is range and no notable irrigation. The headwaters were not scouted for landuse.

Stateline Bridge

Stateline Wading Site

Stateline Bridge Looking Upstream

Stateline Looking Downstream

Stateline USGS Gauge House

Little Bighorn - Little Horn Ranch Bridge Site (LBHR-020)

Lat/Long: 45. 05664, -107.53156 NAD83

Alternative Site Names: none

Driving Directions: You'll pass this site traveling to Stateline just before the pavement ends. From Stateline, go back the way you came on gravel road. Keep straight and shortly after pavement begins, it is the first bridge you will encounter.

Site Description: The sample site is just upstream from a bridge (~200 feet) over the Little Big Horn River. There is an irrigation-ditch that empties into the river just upstream from the bridge; make sure to sample upstream from bridge and river/irrigation-ditch confluence. This site should be wadable year-round but if not, the bridge is there. **Previous Sample Locations:** none

Upstream Landuse Notes: Agricultural practices are apparent; flood and sprinkler irrigation is evident as is hay production and corn production under a pivot. Herbicides and pesticides may pose as a concern.

Little Horn Ranch Sign

Little Horn Ranch Wading Site

Little Horn Ranch Looking Upstream

Little Horn Ranch Looking Downstream

Little Bighorn - Black Bridge Site (LBHR-030)

Lat/Long: 45.10108, -107.44048 NAD83

Alternative Site Names: none

Driving Directions: Continue on road from Little Big Horn Ranch, take a left heading North toward Wyola at the T sign just south of Wyola. Just down this road about 0.25 miles is the bridge site.

Site Description: This site is at a bridge over the Little Big Horn River. This site is non-wadable; site will be specific to bridge sampling. Just upstream the river is braided with most of the flow occurring in the right-most channel.

Previous Sample Locations: Upstream (~150 feet) from the bridge in the right-most channel. It was designated historically as a grab sample site.

Upstream Landuse Notes: Agricultural practices are evident; livestock and flood/sprinkler irrigation is evident. There are houses near the Little Big Horn River proximal to this site; straight piping may be possible and could pose as a concern.

Black Bridge

Black Bridge Looking Downstream

Black Bridge Looking Upstream Left

Black Bridge Looking Upstream Right

Little Bighorn - Wyola Bridge Site (LBHR-040)

Lat/Long: 45.13927, -107.39586 NAD83

Alternative Site Names: none

Driving Directions: From Black Bridge, get back on paved road and continue North toward Wyola. Take a left into town west of railroad tracks. Drive through town and continue on gravel road. The road will curve left and just ahead will be the bridge site.

Site Description: This site is at a bridge over the Little Big Horn River. This site is non-wadable; site will be specific to bridge sampling.

Previous Sample Locations: Just upstream (~15 feet) from the bridge on the right bank; it was designated historically as a grab sample site.

Upstream Landuse Notes: Agricultural practices are evident. Flood irrigation is evident; an irrigation canal drains back into the Little Big Horn River on the left bank just upstream from the bridge. There are houses near the Little Big Horn River proximal to this site; straight piping may be possible and could pose as a concern.

Wyola Bridge

Wyola Bridge Looking Upstream

Wyola Bridge Looking Downstream

Little Bighorn - Spear Sighting Site (LBHR-050)

Lat/Long: 45.18078, -107.38806 NAD83

Alternative Site Names: previously this SiteID was LBHR-070 but that number placed it after Westwoods and Sand Creek which incorrectly indicated it was downstream from those two sites. During writing of this QAPP the SiteID was changed to LBHR-050 and the other two site names were changed accordingly as well.

Driving Directions: Drive back the way you came, through town taking a left across the railroad tracks. Make a left on frontage road and continue North until the next bridge.

Site Description: This site is at a bridge over the Little Big Horn River. This site is non-wadable; site will be specific to bridge sampling. Macrophite growth is evident down-stream of the bridge proximal to the right bank.

Previous Sample Locations: Historically, this has been a grab sample site but the exact locality is not known.

Upstream Landuse Notes: There are houses near the Little Big Horn River proximal to this site; straight piping may be possible and could pose as a concern.

Spear Sighting Bridge

Spear Sighting Bridge Looking

Spear Sighting Bridge Looking Downstream

Little Bighorn - Westwoods Site (LBHR-060)

Lat/Long: 45.30339, -107.35915 NAD83

Alternative Site Names: previously this SiteID was LBHR-050 but was changed to LBHR-060 because Spear Sighting was incorrectly named, see explanation in Spear Sighting description.

Driving Directions: Continue North on frontage road until just before Lodge Grass. Take a right at West Woods sign directly across the railroad crossing to the left.

Site Description: This site is at a bridge over the Little Big Horn River. This site is non-wadable; site will be specific to bridge sampling. Macrophite growth and shallow bar conditions are evident just downstream from the bridge.

Previous Sample Locations: Just upstream from the bridge (~200 feet) on the left bank.

Upstream Landuse Notes: Private property; the river may be damned just upstream. The permission of the landowners may need to be attained before sampling. Flood irrigation is prevalent. This site is upstream from the Lodge Grass sewage lagoons.

West Woods Sign on Frontage Rd.

West Woods Bridge Site

West Woods Bridge Looking Upstream

West Woods Bridge Looking Downstream

Little Bighorn - Sand Creek Site (LBHR-070)

Lat/Long: 45.41026, -107. 39227 NAD83

Alternative Site Names: previously this SiteID was LBHR-060 but was changed to LBHR-070 because Spear Sighting was incorrectly named, see explanation in Spear Sighting description.

Driving Directions: Continue North on Frontage road past Lodge Grass until the next Bridge. It is located between mile markers 8 and 9.

Site Description: This site is at a bridge over the Little Big Horn River. This site is non-wadable; site will be specific to bridge sampling. Macrophite growth and shallow bar conditions are evident just downstream from the bridge.

Previous Sample Locations: Historically, this site was designated a grab sample site upstream (~200 feet) from the bridge; sampling was done by wading the river as close to the center as possible from the right bank.

Upstream Landuse Notes: Primary landuse around the sample site is range and no notable irrigation. This is the site downstream from the Lodge Grass sewage lagoons.

Sand Creek Bridge Site

Sand Creek Bridge Looking Upstream

Sand Creek Bridge Looking Downstream

Sand Creek Bridge Turtle

Little Bighorn - Reno Creek Bridge Site (LBHR-080)

Lat/Long: 45.49411, -107.39359 NAD83

Alternative Site Names: none

Driving Directions: Continue North on the Frontage road. It is the bridge just past the Reno Creek right turn under the overpass.

Site Description: This site is at a bridge over the Little Big Horn River. This site is non-wadable at high flow, wadable at low flow.

Previous Sample Locations: Historically, this has never been a sample site. This has is a USGS bridge sample site.

Upstream Landuse Notes: Primary landuse around the sample site is range and no notable irrigation.

Reno Creek Bridge

Reno Creek Bridge Looking Upstream

Rock Creek Bridge Looking Downstream

Little Bighorn - Fort Custer Museum Site (LBHR-090)

Lat/Long: 45.52443, -107.40507 NAD83

Alternative Site Names: Pitch Ranch, Garryowen

Driving Directions: Continue North on the Frontage road until Garryowen. Take a right under the Interstate overpass. Take another right on the frontage road on East side of the Interstate toward Gas Station/Subway. Drive South (~1 mile) and turn left just after Fort Custer Museum. Drive east on gravel road (~0.5 miles) until silver grainery storage unit and take a left toward abandoned white house just down the road.

Site Description: This has been designated a grab sample site wadable at low flow. Sand bar conditions divert some the the river flow to a left channel with most of the flow occurring in the right channel. Grab sampling will occur (~200-300 yards) down-stream of sand bar and Pitch house/corrals.

Previous Sample Locations: Historically, a grab sample was taken from the left bank of the right channel.

Upstream Landuse Notes: There is cattle usually in the area. This site may be hazardous when bulls are with cows. Flood irrigation is evident; irrigation canals run parallel on the side of the gravel road. Permission to sample needs to be done with the current owner of the property, Cris Cortlander. He owns the Garryowen Building.

Fort Custer Turn on Highway

Fort Custer Turn into Driveway

Fort Custer Sample Site

Fort Custer Site Looking Upstream

Fort Custer Site Looking Downstream

Little Bighorn – Second Bridge (LBHR-09-5)

Lat/Long: 45.56771, -107. 45348 NAD83
Alternative Site Names: ???
Driving Directions: ???

Site Description: Site used in the USGS study in 2009-2010. Sampling can be conducted from the frontage road bridge during high flow or just downstream during low flow.
Previous Sample Locations: none.
Upstream Landuse Notes: ???

Second Bridge Wading Site
Looking Downstream

Second Bridge Wading Site
Looking Upstream

Second Bridge Wading Site
Cross Section

Second Bridge Looking Downstream
From Frontage Bridge

Little Bighorn - Crow Bridge (LBHR-100)

Lat/Long: 45.59737, -107. 46031 NAD83

Alternative Site Names: First Bridge, Veterans Park Bridge

Driving Directions: From LBHC, drive west to the four-way stop and take a left. Keep straight for ~0.25 miles until the bridge.

Site Description: This site is wadable upstream from the bridge at low flow, however this is currently a USGS bridge site and will be designated as a bridge site if this site is used. Note: this is a USGS site not sampled in previous years. Cones and traffic direction would be necessary in the event of bridge sampling.

Previous Sample Locations: none.

Upstream Landuse Notes: There are houses near the Little Big Horn River proximal to this site; straight piping may be possible and could pose as a concern. The water treatment plant/dam is located ~1 mile upstream. Macrophite growth is abundant.

Crow Bridge Site

Crow Bridge Site Looking Upstream

Crow Bridge Site Looking Downstream

Little Bighorn - Little Big Horn Bridge Site (LBHR-110)

Lat/Long: 45.60291, -107.45367 NAD83

Alternative Site Names: none

Driving Directions: Just East of LBHC.

Site Description: This site is at a bridge over the Little Big Horn River. This site is non-wadable; site will be specific to bridge sampling. This is the site upstream from the Crow Agency sewage lagoons.

Previous Sample Locations: Historically, sampling occurred (~200-300 yards) upstream from the right bank at a popular swimming area.

Upstream Landuse Notes: There are houses near the Little Big Horn River proximal to this site; straight piping may be possible and could pose as a concern

LBH Bridge Site

LBH Bridge Looking Upstream

LBH Bridge Looking Downstream

LBH Bridge Old Sample Site Upstream

Little Bighorn – Donald Pitch Site (LBHR-11-5)

Lat/Long: 45.615995, -107.45108 NAD83
Alternative Site Names: none
Driving Directions: Just East of LBHC.
Site Description: This site is wadable at most discharge levels???
Previous Sample Locations:

Upstream Landuse Notes:

Donald Pitch Site Looking Upstream

Donald Pitch Site Looking Downstream

Donald Pitch Site Cross Section

Little Bighorn - White Clays Site (LBHR-12-0)

Lat/Long: 45.65213, -107.45831 NAD83

Alternative Site Names: none

Driving Directions: From LBHC, drive through town northward to get on the road beginning directly across from the BIA building. Drive continue North past the Police station and sewage lagoons. The pavement will end. Keep straight on the gravel road for ~3 miles and turn right into the White Clay ranch. Keep straight on road past the house heading East for (~.25 miles) to the river.

Site Description: This site is wadable after spring runoff. There is livestock in the area; leave gates the way they were (opened/closed) upon crossing.

Previous Sample Locations: none

Upstream Landuse Notes: Primary landuse around the sample site is range and no notable irrigation. There are houses near the Little Big Horn River proximal to this site; straight piping may be possible and could pose as a concern. This site is also the site downstream from the sewage lagoons.

White Clays Site

White Clays Looking Upstream

White Clays Looking Downstream

Little Bighorn – Black Lodge Hall Community Center Site (LBHR-12-5)

Lat/Long: 45.71303, -107.53233 NAD83
Alternative Site Names: none
Driving Directions: ???

Site Description:

Previous Sample Locations: none
Upstream Landuse Notes:

Black Lodge Hall Site Looking Upstream

Black Lodge Hall Site Looking Downstream

Black Lodge Hall Site Cross Section

Little Bighorn – Sarpy Bridge (LBHR-130) new site

Lat/Long: 45.73565, 107.55789 NAD83

Alternative Site Names: USGS: 06294000 Little Bighorn River near Hardin MT

Driving Directions: Heading from Crow Agency to Hardin, take the first freeway exit. Go under the freeway and turn left back to the south on the frontage road. Take a left under the freeway on Sarpy River Road and travel about half a mile to the bridge where Sarpy River Road crosses the Little Bighorn River.

Site Description: Sample from the bridge.

Previous Sample Locations: none, new site for LBHC with the writing of this QAPP

Upstream Landuse Notes: Primarily farmland with some scattered homes along the river.

Sarpy Bridge

Sarpy Bridge USGS Guage

Sarpy Bridge Looking Upstream

Sarpy Bridge Looking Downstream

Big Horn - After Bay Site (BHR-010)

Lat/Long: 45.31567, -107.92752 NAD83

Alternative Site Names: none

Driving Directions: Drive west on the road from LBHC past the railroad tracks. Keep straight; the road will wind right and wind left uphill past a water tower to the right. Keep West bound for ~9 miles. Take a left at the T sign and continue South bound (~20 miles) till you arrive at St. Xavier. Take a left at the 313 sign toward Fort Smith. Continue for about 20 miles driving past town and take a right at the Big Horn Canyon National Recreation sign past the visitor center. Drive over the dam/bridge and take the 2nd left~0.25 miles down the road. The road will go directly to the sample site dock.

Site Description: This site is non-wadable and is designated as a grab sample site from the dock.

Previous Sample Locations: none.

Upstream Landuse Notes: Primary landuse around the sample site is range and no notable irrigation.

Afterbay Site

Afterbay Looking Upstream

Afterbay Looking Downstream

Big Horn - After Bay Spillway Site (BHR-020)

Lat/Long: 45.31606, -107.92020 NAD83

Alternative Site Names: none

Driving Directions: From the After Bay sample site, drive back on the road you came and take the left just after the bridge/dam down the river side.

Site Description: This site in non-wadable and is designated as a grab sample site.

Previous Sample Locations: none. Note: historically, this was not a sample site. Stay down stream of the cable when wading and/or grab sampling from the right bank

Upstream Landuse Notes: Primary landuse around the sample site is range and no notable irrigation.

Yellowtail Dam Sign

Afterbay Spillway Site

Afterbay Spillway Looking Upstream

Afterbay Spillway Looking Downstream

Big Horn - Big Horn Fishing Access Site (BHR-030)

Lat/Long: 45. 41648, -107.78938 NAD83

Alternative Site Names: none

Driving Directions: Drive back out on the road in which you came continuing north from Fort Smith. Continue for ~8 miles and take a left in the Big Horn Fishing Access. Take a left at the fork in the gravel road.

Site Description: This site is designated a grab sample site. There is a sand bar creating two channels at the sample site.

Previous Sample Locations: none

Upstream Landuse Notes: Flood irrigation is evident. An irrigation canal empties into the Big Horn river from the right bank just upstream from the loading dock area. There are houses near the Big Horn River proximal to this site; straight piping may be possible and could pose as a concern

Big Horn Fishing Access Sign

Big Horn Fishing Access Site

Big Horn Fishing Access Looking Upstream

Big Horn Fishing Access Looking Downstream

Big Horn Fishing Access Irrigation Diversion

Big Horn - St. Xavier Bridge Site (BHR-040)

Lat/Long: 45.46076, -107.74772 NAD83

Alternative Site Names: none

Driving Direction: Get back on paved road and continue north for ~6 miles till you arrive at St. Xavier. Take a left at the stop sign onto the road going west. Keep straight on road for ~0.3 miles to the bridge.

Site Description: This site is at a bridge over the Big Horn River. This site is non-wadable; site will be specific to bridge sampling.

Previous Sample Locations: Just upstream (~150 feet) from the bridge. Grab sampling was done from the right bank.

Upstream Landuse Notes: Flood irrigation is evident. There are houses near the Big Horn River proximal to this site; straight piping may be possible and could pose as a concern

St. Xavier Site

St. Xavier Site Looking Upstream

St. Xavier Site Looking Downstream

Big Horn - Mallard's Landing Site (BHR-050)

Lat/Long: 45.52162, -107.72601 NAD83

Alternative Site Names: none

Driving Directions: Go back east the way you came to stop sign at the intersection. Keep straight on the road for ~10 miles and turn left after Mallards Landing sign just after house and corrals. Keep straight on gravel road for ~2 miles and take a right at Mallards Landing sign.

Site Description: This sight is non-wadable and is designated as a grab sample site from the right bank.

Previous Sample Locations: none

Upstream Landuse Notes: Flood irrigation and cattle grazing is evident in the area. Irrigation canals can be seen paralleling the gravel road. There are houses near the Big Horn River proximal to this site; straight piping may be possible and could pose as a concern.

Mallard's Landing Site

Mallard's Landing Site Looking

Mallard's Landing Site Looking Downstream

Big Horn - Two Leggins Bridge Site (BHR-060)

Lat/Long: 45.64285, -107.65811 NAD83

Alternative Site Names: none

Driving Directions: Get back to paved road and continue north past the T sign toward Hardin ~10 miles to the bridge.

Site Description: This site is at a bridge over the Big Horn River. This site is non-wadable; site will be specific to bridge sampling. The bridge is located just downstream of the confluence of the multiple channels of the Big Horn river; The river behaves as a braided stream just upstream of the bridge.

Previous Sample Locations: Just upstream ~200 yards on the left bank of the left-most channel.

Upstream Landuse Notes: Flood irrigation and cattle grazing is evident in the area. There are houses near the Big Horn River proximal to this site; straight piping may be possible and could pose as a concern.

Two Leggins Site

Two Leggins Site Looking Upstream

Two Leggins Site Looking Upstream Right

Two Leggins Site Looking Downstream

Big Horn – 13 Mile (sample site ID)

Lat/Long: NO DATA

Alternative Site Names: NO DATA

Driving Directions: this site was not sampled when Jonah was working and we did not locate it.

Site Description: NO DATA

Previous Sample Locations: NO DATA

Upstream Landuse Notes: NO DATA

Pryor - Pryor Gap Site (PC-010)

Lat/Long: 45.31783, -108.54144 NAD83

Alternative Site Names: none

Driving Directions: Drive west on the road from LBHC past the railroad tracks. Keep straight; the road will wind right and wind left uphill past a water tower to the right. Keep West bound for ~9 miles. Take a left at the T sign and continue South bound. Keep straight past St. Xavier; road will go to Pryor after an hour's drive. Keep straight and take a left just after pavement ends. Continue on unpaved road for ~5 miles. Drive through stream if possible. Site is ~50 feet upstream from stream crossing. The commute takes ~2 hours from LBHC.

Site Description: This site is wadable year round.

Previous Sample Locations: Down-stream ~200-300 yards; this was only a grab sample site.

Upstream Landuse Notes: Flood irrigation and livestock is evident. Irrigation canals parallel the unpaved road.

Pryor Gap Site

Pryor Gap Site Looking Upstream

Pryor Gap Site Looking Downstream

Two Leggins Site Looking Downstream

Pryor - Plenty Coups Bridge Site (PC-020)

Lat/Long: 45.4262, -108.55613 NAD83

Alternative Site Names: none

Driving Directions: Go back the way you came and continue onto the paved road for ~8 miles. Take a left at Edgar sign/Plenty Coups State Park sign and keep straight for <1 mile to bridge.

Site Description: This site is located on a bridge over Pryor Creek. This site is wad-able year round. There is abundant macrophite growth.

Previous Sample Locations: Just upstream from the bridge and wire fence.

Upstream Landuse Notes: Flood irrigation and cattle grazing evident. A dam is located ~100 feet upstream. There are houses near the Pryor Creek and proximal to this site; straight piping may be possible and could pose as a concern.

Plenty Coup Site

Plenty Coup Site Looking Upstream

Plenty Coup Site Looking Downstream

Pryor - Battle Site (PC-030)

Lat/Long: 45.53632, -108.42493 NAD83

Alternative Site Names: none

Driving Directions: Go back to the road that will take you to Pryor. At Pryor, take a left and head north through town and continue for ~10 miles to historic site sign.

Site Description: This site is located at a bridge but is wad-able at low flow.

Previous Sample Locations: Just upstream from bridge ~50 feet.

Upstream Landuse Notes: Flood irrigation is evident. There are houses near the Big Horn River proximal to this site; straight piping may be possible and could pose as a concern.

Pryor Battle Site Sample Site

Pryor Battle Site Sample Site Looking Upstream

Pryor Battle Site Sample Site Looking Downstream

Pryor - Blue Creek Site (PC-040)

Lat/Long: 45.65041, -108.39142 NAD83

Alternative Site Names: none

Driving Directions: Continue north on frontage road for ~8 miles to a bridge.

Site Description: This is a grab sample site. Site is not wad-able. The bridge is over an irrigation canal that empties into Pryor Creek.

Previous Sample Locations: none

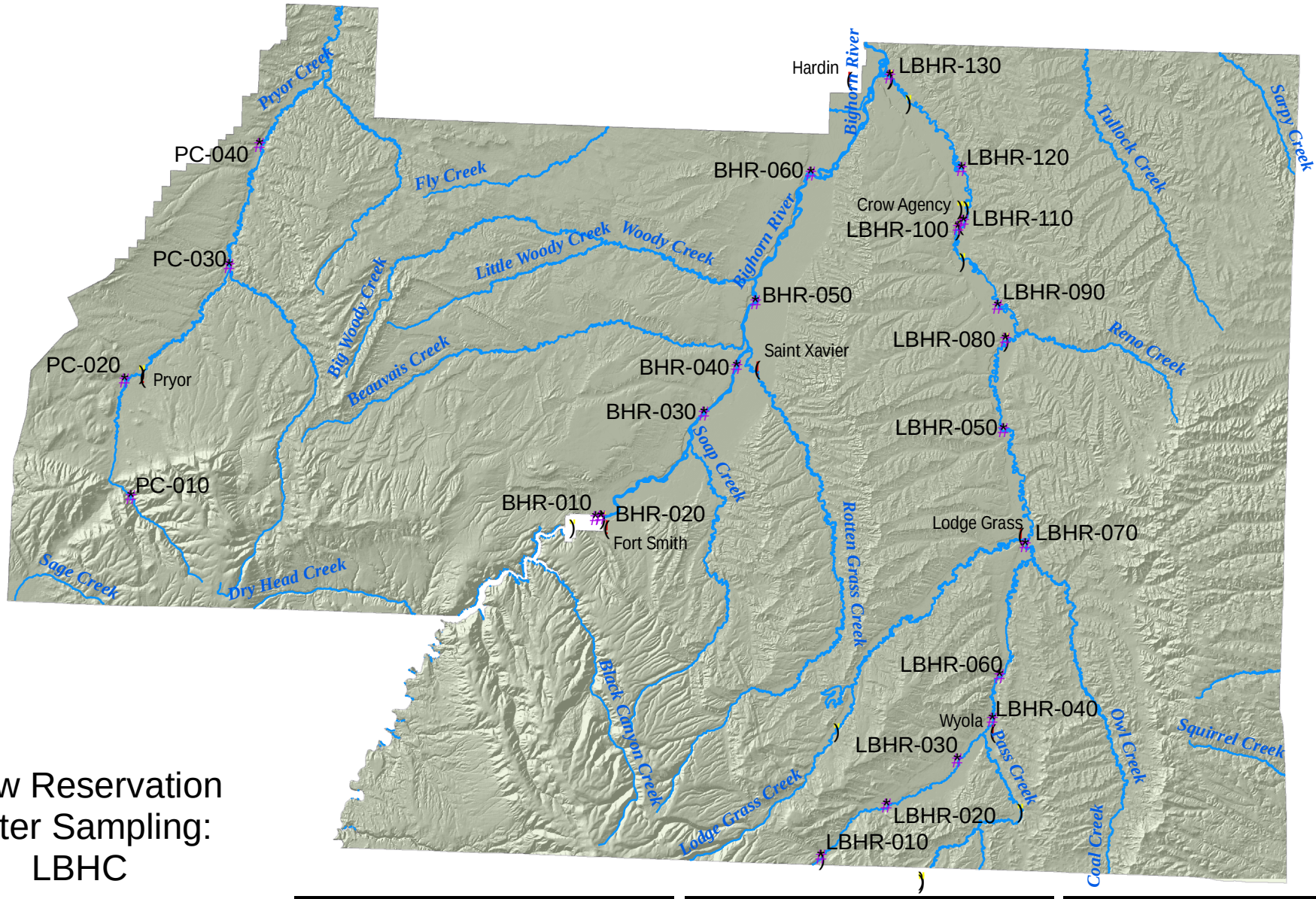
Upstream Landuse Notes: Flood irrigation is evident as is livestock grazing. Note: it would fastest to return to LBHC. Continue north until the T sign and take a right toward Hardin.

Blue Creek Road Site

Blue Creek Road Site Looking Upstream

Blue Creek Road Site Looking Downstream

Blue Creek Road Site Irrigation Diversion



Crow Reservation Water Sampling: LBHC

Map Attributes:

- LBHC
- USGS
- Towns

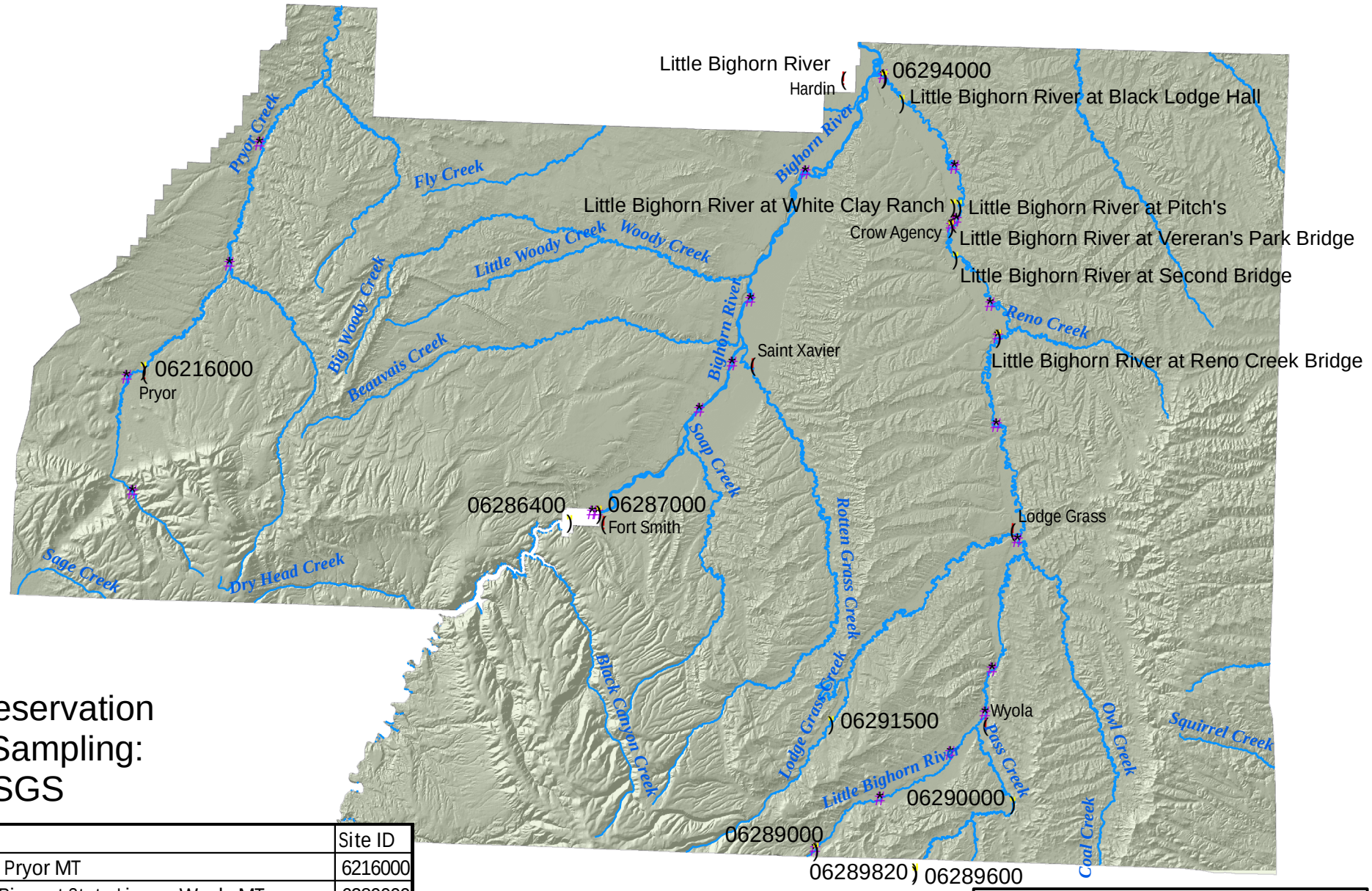
0 5 10 20 Miles

Station Name	Station ID
Crow Bridge	LBHR-100
LBHC Bridge	LBHR-110
White Clays	LBHR-120
Sarpy Bridge	LBHR-130
After Bay	BHR-010
After Bay Spillway	BHR-020
Big Horn Access	BHR-030
St. Xavier/Pretty Eagle Bridge	BHR-040
Mallard's Landing	BHR-050

Station Name	Station ID
State Line #1	LBHR-010
Little Horn Ranch Bridge	LBHR-020
Black Bridge	LBHR-030
Wyola	LBHR-040
Spear Sighting	LBHR-060
Westwoods	LBHR-070
Sand Creek	LBHR-050
Reno Creek	LBHR-080
Fort Custer Museum	LBHR-090

Station Name	Station ID
Two Leggins	BHR-060
13 Mile	BHR-070
Pryor Gap Site 1	PC-010
Plenty Coup/E Pryor Bridge	PC-020
Pryor Battle Site	PC-030
East of Blue Creek Rd	PC-040

MSU Water Quality Extension
Michael Jensen
Sources: NRIS, USGS,



Crow Reservation Water Sampling: USGS

USGS Site	Site ID
Pryor Creek at Pryor MT	6216000
Little Bighorn River at State Line nr Wyola MT	6289000
Little Bighorn River near Hardin MT	6294000
Bighorn Lake near St. Xavier MT	6286400
Bighorn River near St. Xavier, MT	6287000
Birhorn River ab Tullock Cr nr Bighorn MT	6294500
Pass Creek near Wyola MT	6290000
East Pass Creek Near Dayton, WY	6289820
West Pass Creek Near Parkman, WY	6289600
Lodge Grass Cr ab Willow Cr diversion, nr Wyola MT	6291500

***** 2009 USGS Sites are labeled without a Site ID.**

Map Attributes:

- USGS
- LBHC
- Towns

0 5 10 20 Miles

MSU Water Quality Extension
Michael Jensen
Sources: NRIS, USGS,

APPENDIX B
FIELD PREPARATION
YSI CALIBRATION, EQUIPMENT STERILIZATION, MARSH MCBIRNEY ZERO CHECK

B.1 YSI CALIBRATION & CARE

(Adapted from a QAPP for the Gallatin Volunteer Monitoring Program written by Tammy Crone)

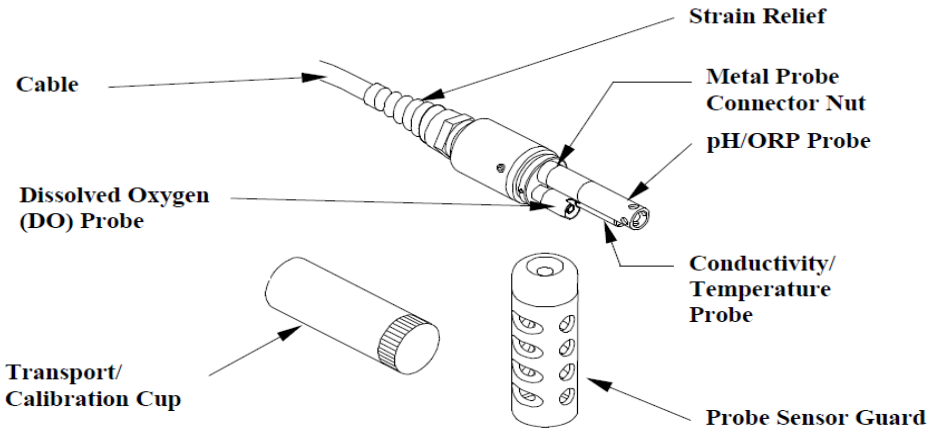


Figure 1: Probe Module from the YSI 556 Manual

B.1. YSI 556 CARE

- Before calibrating the YSI, check the condition of all of the probes
  - The pH glass bulb at the end of the probe should be clear. If it is starting to get cloudy or if you notice the pH taking a long time (> 5min) to calibrate then consider replacing the pH probe
  - Inspect the membrane on the dissolved oxygen probe. The membrane should be clear and not cloudy/dirty or scratched. There should not be bubbles under the membrane.
  - Check all probes to make sure they are free of sediment or buildup that may have accumulated since the last time it was used.

B.1.1 CALIBRATION TIPS & HINTS

- Calibration solutions should ideally be stored at room temperature and calibration should be performed at room temperature.
- The transport/calibration cup that comes with the probe serves as a calibration chamber for all calibrations and minimizes the volume of calibration solutions required.
- Ensure all sensors are immersed in the calibration solution. Many of the calibrations factor in readings from other sensors (e.g., temperature sensor). The top vent hole of the conductivity sensor must also be immersed during some calibrations.
- Make sure to loosen the seal of the transport/calibration cup prior to the DO calibration to allow pressure equilibration.
- For maximum accuracy, use a small amount of previously used calibration solution to pre-rinse the probe. You may wish to save old calibration standards for this purpose (Figure 1).
- Put some deionized (DI) water at ambient temperature to rinse the probe between calibration solutions.
- Have several clean, absorbent paper towels or Kim-wipes available to dry the probe between rinses and calibration solutions. Shake excess rinse water off the probe. Dry off the outside of the probe and sensor guard. (Making sure the probe module is dry reduces carry-over contamination of calibration solutions and increases the accuracy of the calibration.

Figure 1. Bottles of used solution for each calibration solution for rinsing.

B.1.2 PROBE INSPECTION

- Ensure the o-ring is installed in the o-ring groove of the transport/calibration cup and that the bottom cap is securely tightened. **NOTE:** Do not overtighten!
- Remove the probe sensor guard, if installed.
- Remove the o-ring, if installed, from the probe and inspect for defects. Replace with extra o-ring if defects found.

B.1.3 PROBE STORAGE

- Store the probe with about half an inch of tap water in the storage cup.

B.1.4 ACCESSING THE CALIBRATION SCREEN

1. Press the **On/Off** key to display the **Run** screen.
2. Press the **Escape** key to display the main menu screen (figure 2).
3. Use the arrow keys to highlight **Calibrate** (figure 3).
4. Press **Enter** key. **Calibrate** screen is displayed. Conductivity will automatically be highlighted on this screen.

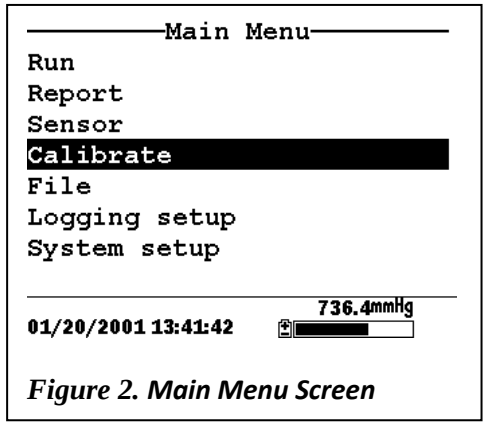


Figure 2. Main Menu Screen

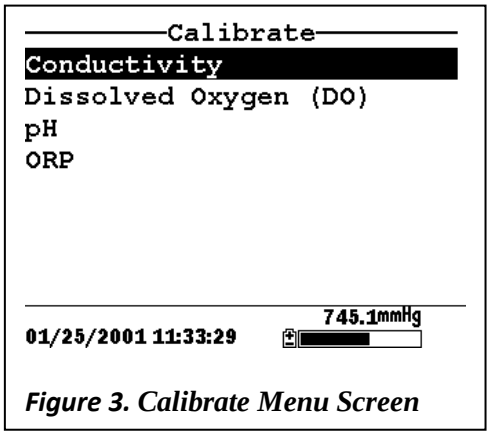


Figure 3. Calibrate Menu Screen

B.1.5 CONDUCTIVITY CALIBRATION

1. Go to **Calibrate screen** as described above. **Conductivity** should already be highlighted.
2. Press **Enter**. The **Conductivity Calibration** Screen is displayed.
3. Press **Enter** again. **Specific Conductance** parameter will automatically be highlighted.
4. Remove the clear plastic **transport/calibration cup (picture 1)**.
5. Pre-rinse the conductivity sensor with **1413 standard conductivity calibration solution** from the rinse bottle (used during previous calibrations). Discard used rinse solution.
6. Pour enough new **1413 standard** into the **transport/calibration cup** to entirely cover the sensors (~55ml). Tap the probe gently to remove air bubbles. **(picture 2)**
8. With screen showing a highlighted **Specific Conductance** parameter, press **arrow key** to highlight **Conductivity**, press **Enter** key. The **Enter Cond Screen mS/cm** is displayed.

Picture 1

Picture 2

9. Use the keypad to enter the **calibration value** of the standard that is being used. The **1413 uS/cm Standard Solution** should be entered as**: 1.413**
10. Press **Enter** key. The **Cond Calibration Menu** Screen will be displayed.

    Note: *the YSI is set-up for "temperature compensation". Always use the value for the calibration standard at* ***25°C****.*

11. Allow at least one minute for **instrument temperature** to stabilize. The current values of enabled sensors will appear on the screen and will change with time as they stabilize.
12. Observe the reading under **Conductivity (uS/cm)**. When the reading shows no significant change for **30 seconds**, press **Enter** key.
13. **Record values** in the **YSI Calibration Log: -Date-Time-Barometric Pressure-Instrument Temperature-Conductivity-RECORD VALUE**.
14. Press **Enter** key again, screen will indicate calibration has been accepted.
15. Press **Enter** key again, to return to the **Conductivity Calibration Selection Screen**.
16. Press **Escape** to return to the **Calibrate Menu Screen**.
17. Pour used solution into the rinse bottle for rinsing next time.
18. **Rinse** the probe and sensors with **DI water** and wipe dry with a **Kim-wipe**.

B.1.6 DISSOLVED OXYGEN CALIBRATION in % SATURATION

1. In the **Calibration Screen**, use the **arrow keys** to highlight **DO 2 mil PE (Blue)**.
2. Press **Enter** key. The **DO %** will automatically be highlighted.
3. Press **Enter** key again. The **Enter Baro mmHG screen** will be displayed. **Do not enter the barometric pressure.** (This meter has an internal barometer.)
4. Pour approximately 1/8 inch of water (indicated by arrow 2) in bottom of **transport/calibration cup**.
   *** Do Not** immerse the temperature sensor in the water.
5. Screw the **transport/calibration cup** onto the probe using only 1 or 2 threads, so it is just hanging on (arrow 1).
6. Press **Enter** key. The **DOsat Calibration Menu Screen** will be displayed.
7. Allow 10 minutes for the **DO probe** to stabilize (and for the temperature to stabilize).
8. When the **DO %** reading is stable for 30 seconds, press **Enter** key to accept the reading.
9. **Record values** in the **YSI Calibration Log: -Date-Time-Barometric Pressure-Instrument**
   Temperature-Dissolved Oxygen % Saturation-RECORD VALUE
10. Press **Enter** key again. This returns you to the **DO Calibration Menu Screen**.
11. Press **Escape** key, to return to the **Calibrate Menu Screen**.

Picture 3

B.1.7 pH CALIBRATION

1. In the **Calibration Screen**, use the **arrow keys** to highlight **pH**.
2. Press **Enter** key. The **pH Calibration Screen** will be displayed.
3. Use **arrow keys** to highlight **2-point** option to calibrate the pH sensor.
4. Press the **Enter** key, the **pH Entry Screen** will be displayed.
5. **Record values** on **YSI Calibration Log: -Date-Time-Barometric Pressure-Instrument Temperature**.
6. **Enter value** of **pH standard** being used.
   NOTE: Always calibrate in **7 buffer** first.
7. **Rinse** the **pH sensor** with **7.00 buffer** from the rinse bottle and discard.
8. **Pour** enough **7.00 buffer** into the **transport/calibration cup** to completely cover all sensors making sure there are no air bubbles in the solution **(picture 4)**.
10. Use the keypad to enter the **calibration value** of the **pH standard** being used.
11. Press **Enter**. The **pH Calibration Screen** will be displayed.
12. Allow **1 minute** for temperature to stabilize. **Observe pH reading**. If **no significant change** in **30 seconds**, press **Enter** key. The screen will indicate **calibration accepted.**
13. **Record value** on the **YSI Calibration Log**
14. Pour used solution into the pH 7 rinse bottle for rinsing next time.
15. Press **Enter** key to return to **pH Calibration Screen**, continue with the **second point** of calibration for **pH 10.00** (**repeat steps 5-13).**
16. **Rinse** the probe and sensors with **DI water** and wipe dry with a **Kimwipe**.
17. Press **Enter** to return to the **pH Calibration Screen**.
18. Press **Escape** twice to return to the data logging menu.


Picture 4

B.2 *E. coli* sample collection preparation

Concept

E. coli is a bacteria which is an indicator organism for fecal contamination of water. The amount of *E. coli* present in the water is used to estimate the risk of pathogens being present in the water which can cause disease. Using sterile methods during *E. coli* sampling is important to get reliable results. Sample bottles and DH81 nozzles must be autoclaved between uses and transported in autoclave bags under sterile conditions until use.

Procedure

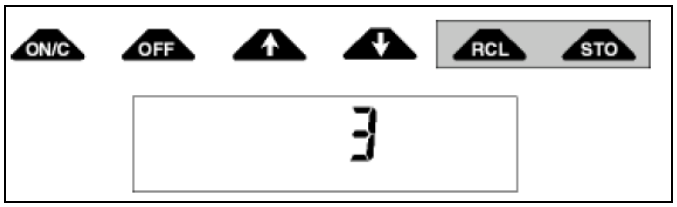
1. Collect enough DH-81 nozzles and sample bottles for all of the sample sites you will be visiting and 2 additional sets for a duplicate and a blank sample. Wash the bottles and nozzles with liquinox soap and attach the nozzles to the bottles.
2. Place each bottle in an individual autoclave bag. Roll the bag up around the bottle and tape it closed with autoclave tape.
3. Place the bagged bottles into the autoclave and start the machine. It should reach 121 degrees C under pressure for at least 15 minutes.
4. When the cycle is complete, carefully remove the hot bags and place them in a relatively clean tub or bag for transport to the field.
5. Preparation of water for a blank sample: Autoclave approximately 200 mL of bottled drinking water to use for a blank sample.
    a. Do not use tap water because it could contain chlorine that may affect the bacteria.
    b. Do not use distilled water because it may affect bacteria differently than river water.
6. Sterilize enough sample bottles for each site as well as 2 additional bottles for a blank and a duplicate. You may also want to sterilize 2 extra bottles in case a bottle is contaminated in the field.
7. Transport the sterile water and bottles to the field for *E. coli* sampling.

B.3 Marsh McBirney Zero Check

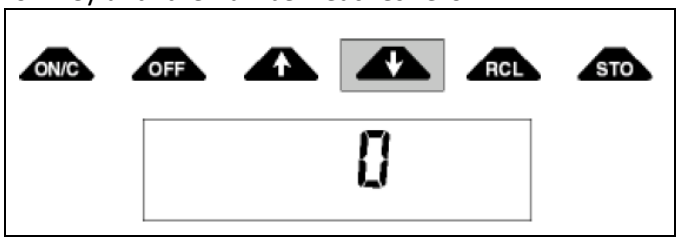
(Instructions from the Marsh McBirney manual)

Once a week, a zero check should be performed on the Marsh McBirney to ensure that the meter is reading accurately

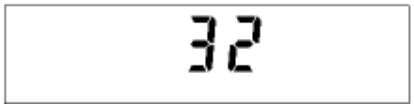
1. First gently clean the sensor with soapy water because oil film buildup on the sensor bulb can cause noisy readings
2. Fill a 5 gallon bucket with water
3. Attach the bulb to a top setting rod and place the bulb 3 inches from the bottom of the top setting rod.
4. Place the sensor in the bucket of water making sure to keep the sensor at least 3 inches away from all sides of the bucket.
5. Wait 10-15 minutes and make sure the water is not moving. If the meter reads zero, it is in good shape. If it does not read zero, continue to step 6.
6. To start the zeroing sequence, press the STO and RCL keys at the same time. You will see a number 3 on the display.



7. Push the down arrow key until the number reaches zero



8. The number 32 should be displayed



9. The unit will decrement itself to zero and turn off. The unit is now zeroed

Note:
Once a year or at least every few years the Marsh McBirney should be checked against a known velocity. This can be done by using the meter in a flume where you know the exact velocity (i.e. hydrology lab at MSU), sending the meter into Marsh McBirney to be calibrated, or comparing the readings against a different meter that you know is accurately recording velocity.

APPENDIX C
STANDARD OPERATING PROCEDURES - FIELD

C.1 Photo Monitoring Methods

Concept

Photographs can provide an extremely valuable record of site conditions over time. Photographs can qualitatively illustrate condition of riparian vegetation, degree of algae growth in the channel, bank conditions and overall site appearance. Photographs taken at a site can also document abnormal conditions and trigger memories from sample events which can help to explain unusual water quality results.

Procedure

1. Pick a specific photo location that can be used at the site on each visit which provides a good view up and down the channel. Use a permanent feature at the site to help mark the location.
2. GPS this location and record the coordinates on the photo data sheet.
3. From this location take photograph looking upstream and downstream and a picture of each bank.
4. Take a photograph down into the channel to depict the amount of algae growth in the channel.
5. Take a few rocks from the channel and photograph them to document algae growth. Place a pencil or hand in the image for scale.
6. Fill out the following information on the photo section of the field visit form:
    a. What the photograph is (i.e. upstream, left bank, algae in channel, etc.)
    b. Jpeg number
    c. Latitude and Longitude
    d. Compass bearing the photo is taken on

C. 2 Discharge Measurement

Concept

Discharge (flow) is the volume of water moving past a point in a stream in a given amount of time. The most common unit for discharge is cubic feet per second (CFS) or cubic meters per second. If you know the discharge in a stream and the concentration of a pollutant in the stream, you can calculate the total amount of the pollutant moving downstream. Discharge is also important for understanding behavior of parameters like temperature in a stream.

Discharge readings are usually taken after chemistry samples are taken because the bottom of the channel is disturbed when measuring discharge which can affect water quality.

Procedure

Select a good cross section by looking for the following:

A relatively straight portion of channel (not on a bend)
Water is as smooth as possible (not turbulent)
Water is moving downstream across the entire width (no backwater areas)
Avoid undercut banks or section with obstacles (such as large rocks or debris)
Make sure you are capturing all of the flow (there are no side channels)
It is ideal to select a location with no islands. However, a discharge can be taken where an island exists, if the tape is stretched over the island and measurements are taken on both sides of the island.

Finding a good cross section may require altering the stream by removing debris, rocks, or algae. If you do alter the channel, make sure you do it before starting the measurement.

- Stretch a measuring tape across channel perpendicular to the flow with the zero end of the tape at the left bank. The left bank is on the left side when looking downstream.
  - Secure the tape with stakes or objects on the bank. Make sure the tape is taut and does not sag in the middle.
  - Record the measurement on the tape at the left and right edges of water. Use these numbers to determine the wetted width of the channel.
- Based on the wetted width of the channel, determine the distance between measurement increments.
  - Select a length that will give you at least 20 measurements across the width. An easy way to do this is to divide the wetted width by 20 and round down to a convenient number.
- Start at the left wetted edge of the channel and record zero depth and zero velocity on the discharge datasheet for that location.
- Move over with the top setting rod one length increment away from the left bank to make the first measurement. Make sure you are standing downstream and away from the rod to avoid your legs altering the flow and affecting the measurement.

- Measure and record the depth. The increments on the rod are in tenths of feet.
- Adjust the top setting rod so the measurement bulb is at the correct depth and is facing upstream. If the stream is less than 2 feet deep the measurement is taken at 60% depth (60% of the way down from the surface). If the water is more than 2 feet deep, two measurements are taken and averaged, one at 20% and one at 80% depth.
    - Depth less than 2 ft example: if the water is 1.8 feet deep, align the 1 on the sliding rod with the 8 on the handle of the rod. This will place the bulb at 60% of the 1.8 ft depth.
    - Depth more than 2 ft example: if the water is 2.6 ft deep, the rod is set at half and then twice the depth for the two readings. Two times 2.6 is 5.2 so you align the 5 on the slider with the 2 on the handle which places the bulb at 20% of the depth. Half of 2.6 is 1.3 so you align the 1 on the slider with the 3 on the handle which puts the bulb at 80% of the depth.
- Once you have positioned the bulb, press the "On/c" button to start the velocity measurement and hold the rod stationary for 30 seconds. You should see a bar move across the screen as the meter averages the velocity over the 30 second period. Record the velocity on the datasheet.
- Repeat the depth and velocity measurement for each increment across the channel.

Figure E.4.1 – Channel Divided into Cross Sections

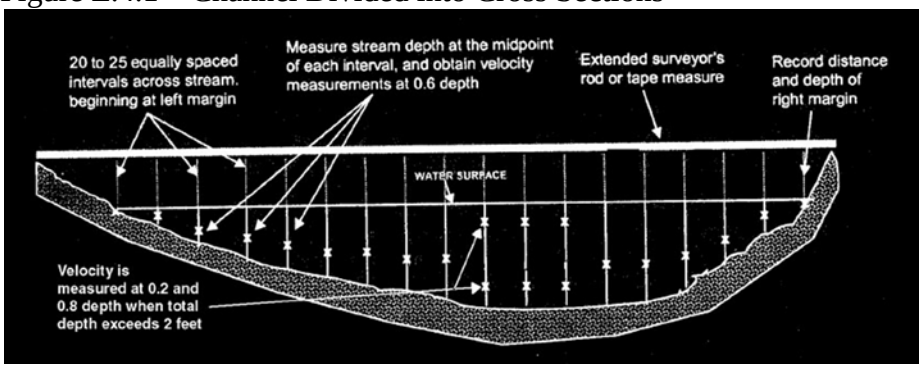
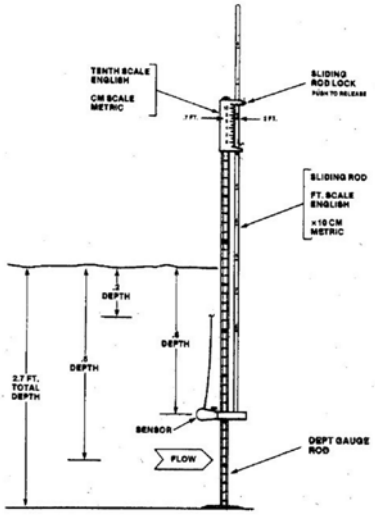


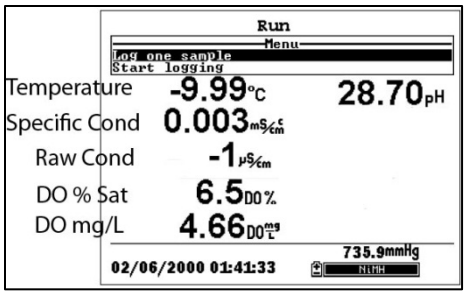
Figure E.4.2 – Top Setting Rod



C.3 Wadable Site: Sample Collection and Field Parameter Measurement

Do not wade at a sample site if it does not seem safe. Always wear a life jacket and work in pairs.

Field Measurements (YSI)



Gently place the YSI probe far enough into the stream that it is in actively moving water. The probe is delicate and should never be thrown into the water. The probe should be left to equilibrate for at least 5 minutes. Once numbers have stabilized, record Temperature, pH, Specific Conductance, Conductivity, Dissolved Oxygen mg/l, Dissolved oxygen percent saturation, and barometric pressure on the field visit form. After measurements are completed, rinse the probe and replace the storage cup with half an inch of tap water to keep the probes moist.

Place a handheld thermometer in the shade to determine air temperature and record this value on the field visit form.

Water Sample Collection

E. coli Samples

- Put on a clean pair of disposable nitrile gloves.
- Attach a sterile sample bottle and nozzle to the DH-81 sampler.
- Wade to the center or thalweg of the channel with the DH-81 sampler. Rinse the sampler 3 times with river water. Raise and lower the sampler from the top of the water all the way to the bottom until the bottle is full. Return to shore with the sampler.
    - For Easygel samples, mix the sample in the DH-81, remove the lid and pipette samples directly from the DH-81 into the Easygel sample bottles.
    - For m-coli blue or other methods, pour off the required sample volume into a sterile sample bottle.
- Duplicates and Blanks.
    - One set of duplicate samples should be collected for each day that *E. coli* samples are collected. These samples are collected in an identical manner to that described above and are labeled according to the method outlined below.
    - One set of field blank samples should be collected for each day that *E. coli* samples are collected. These samples are collected by placing an fresh sterile DH-81 sample bottle set to the sampling rod and pouring sterilized water through into the sampler. Water is then poured from the DH-81 into a sample bottle and labeled as a blank according to the method outlined below.

Chemistry Samples

- Rinse the sample bottles with river water three times before starting.
- With water remaining in the DH-81 after *E. coli* sample bottles are filled, fill the 500 ml bottle for nitrate and chemical oxygen demand analysis and preserve it with sulfuric acid provided by the lab.

- Fill the 250 ml bottle for phosphorus analysis.
- Filter 250 ml of water into the 250 ml bottle and preserve with HNO_3 provided by the lab for dissolved metals analysis.
- If you run out of water before all of the bottles are filled, return to the thalweg of the stream and repeat step 2 to collect more water.
- Duplicates and Blanks.
    - One set of duplicate samples should be collected for each day that chemical samples are collected. These samples are collected in an identical manner to that described above and are labeled according to the method outlined below.
    - One set of field blank samples should be collected for each day that chemical samples are collected. These samples are collected by pouring distilled water into the nitrate and COD bottle and preserving with sulfuric acid provided by the lab. Pouring distilled water into the 250 ml phosphorus bottle. Pouring DI water into a 1 liter bottle which was washed for metal collection and filtering enough water to fill a 250 ml metals bottle, then preserving the sample with nitric acid provided by the lab. Blank samples are labeled according to the method outlined below.

<u>Suspended Sediment</u>

- Go to the center or thalweg of the stream with the DH-81. Point the nozzle upstream, hold the bar vertically with the nozzle just above the surface and then begin lowering the sampler at a consistent rate until the back of the bottle just touches the bottom. Do not pause at the bottom and come back to the surface at the same rate. You should not hold the sampler steady at any point in the depth of the stream because it will take in more water from that depth making the sample uneven.
- Triple rinse the two sample bottles for suspended sediment using water from the DH-81, this will also rinse the DH-81.
- After rinsing, repeat the lowering and raising process until the DH-81 is full, then pour the water off into the churn bucket. You can fill the DH-81 as many times as necessary in order to get enough water for your samples. Once you have enough water in the churn bucket for all of your samples, return to the bank.
- While operating the churn to mix the sample, fill the two sample bottles from the spicket on the churn bucket.
    - Two suspended sediment samples (duplicates) are always collected. If the water is very turbid, collect a smaller volume of sample so the entire sample can be filtered without clogging the filter. Duplicate samples should be labeled according to the method outlined below.
    - For each sample day, at one sample site a field blank should be prepared by pouring distilled water into a sample bottle and labeling it according to the method outlined below.

<u>Turbidity Measurement</u>

- Carefully remove a cuvette (sample bottle) from the Hach turbidity meter case. Be cautious not to scratch, damage the cuvette, or get it dirty. While operating the churn so the sample is well mixed, triple rinse the cuvette with water from the churn and then fill it to the line near the top and cap the bottle.

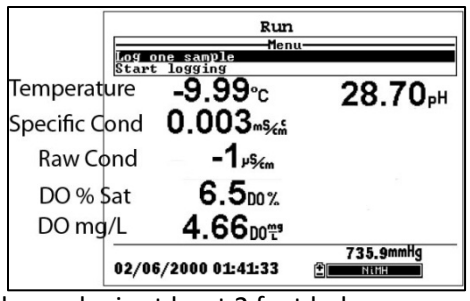
- Clean the cuvette using a clean Kim wipe. Remove all water and fingerprints from the cuvette so it is clear. Hold the cuvette to the light to ensure that it does not have any water streaks or finger prints on it.
- Turn on the turbidity meter.
- Gently invert the cuvette multiple times so it is well mixed. Do not shake it because this will introduce air bubbles. Immediately after mixing, place the cuvette in the turbidity meter with the arrow on the cuvette aligned with the arrow on the meter. Close the cap that covers the cuvette.
- Press the read button.
- Write the turbidity value on the field datasheet.
- Repeat the steps above a second time to produce a duplicate sample.
- Rinse the churn bucket with tap water after sampling is complete.

Sample Bottle Labeling

- Sample Site Name and ID
  Site names and IDs are in Table 4 of the QAPP
  Example: State Line #1, LBHR-010
- Date and Time
  If you don't use military time, indicate AM or PM
  Example: 10/19/2009 14:25
- Indication if the sample is a duplicate or a blank
  For duplicate samples, after the sample ID put a D1 on the first sample and a D2 after the second sample. For field blanks, put a B1 after the sample ID.
  Example: State Line #1, LBHR-010, D1
  State Line #1, LBHR-010, D2
  State Line #1, LBHR-010, B1
- Sampler's last name and first initial
  Example: B Goodluck
- Preservative added if any
  Sulfuric acid (H_2SO_4) is used to preserve nitrate samples and nitric acid (HNO_3) is used to preserve metal samples.
  Example: H_2SO_4 or HNO_3

C.4 Non-wadable with Bridge Site: Sample Collection and Field Parameter Measurement

If the site is not wadable, but there is a bridge, sampling may be done from the bridge to get a representative sample. Wear a life jacket when sampling at these sites and work in pairs.



Field Measurements (YSI)

If the cord on the YSI is long enough to reach at least 2 feet into the water, the measurements can be taken in the middle of the channel from the bridge. Use the wrist strap and extreme caution not to drop the YSI into the water or to fall into the water when taking these readings. Lower the probe into the water supporting it by the cord, so the pressure is not on the connection between the cord and the unit. Ensure the probe is at least 2 feet below the surface, wait for the numbers to stabilize, and record Temperature, pH, Specific Conductance, Conductivity, Dissolved Oxygen mg/l, Dissolved Oxygen Percent Saturation, and Barametric Pressure on the field visit form. After measurements are completed, rinse the probe and replace the storage cup with half an inch of tap water to keep the probes moist.

If the YSI cord will not reach 2 feet into the water, collect the sample from the bank as outlined in the next section (E.7).

Place a handheld thermometer in the shade to determine air temperature and record this value on the field visit form.

Water Sample Collection

E. coli Samples

- Put on a clean pair of disposable nitrile gloves.
- Attach a sterile sample bottle and nozzle to the DH-95 sampler and attach the rope to the sampler.
- Set up cones on the bridge to slow traffic if necessary.
- Walk to the center or thalweg of the channel with the DH-95 sampler.
- Lower the sampler to the bottom of the channel and raise it again. Do this fast enough that the bottle is not quite full when you pull it out. If it is full when you pull it out, you will need to raise and lower it at a faster rate. Rinse the sampler 3 times while determining the appropriate rate to raise and lower it.
- Lower and raise the sampler at the rate determined in the previous step to collect a sample.
    - For IDEXX (Quanti Tray) samples, mix the sample in the bottle and pour 100 mL into a sterile sample bottle through the nozzle.
    - For Easygel samples, mix the sample in the bottle, remove the lid and pipette samples directly from the sample bottle into the Easygel sample bottles.
    - For m-coli blue or other methods, pour off the required sample volume into a sterile sample bottle.
- Duplicates and Blanks.

- One set of duplicate samples should be collected for each day that *E. coli* samples are collected. These samples are collected in an identical manner to that described above and are labeled according to the method outlined below.
- One set of field blank samples should be collected for each day that *E. coli* samples are collected. These samples are collected by placing a fresh sterile DH-81 sample bottle set to the sampling rod and pouring sterilized water through into the sampler. Water is then poured from the DH-81 into a sample bottle and labeled as a blank according to the method outlined below.

Chemistry Samples

- Rinse the sample bottles with river water three times before starting.
- With water remaining in the DH-95 after *E. coli* sample bottles are filled, fill the 500 ml bottle for nitrate and chemical oxygen demand analysis and preserve with sulfuric acid provided by the lab.
- Fill the 250 ml bottle for phosphorus analysis.
- Filter 250 ml of water into the 250 ml bottle and preserve with nitric acid provided by the lab for dissolved metals analysis.
- If you run out of water before all of the bottles are filled, lower and raise the sampler again to collect another batch of water.
- Duplicates and Blanks.
  - One set of duplicate samples should be collected for each day that chemical samples are collected. These samples are collected in an identical manner to that described above and are labeled according to the method outlined below.
  - One set of field blank samples should be collected for each day that chemical samples are collected. These samples are collected by pouring distilled water into the nitrate and COD bottle and preserving with sulfuric acid provided by the lab. Pouring distilled water into the 250 ml phosphorus bottle. Pouring DI water into a 1 liter bottle which was washed for metal collection and filtering enough water to fill a 250 ml metals bottle, then preserving the sample with nitric acid provided by the lab. Blank samples are labeled according to the method outlined below.

Suspended Sediment

- Walk on the bridge to the center or thalweg of the river with the DH-95. Lower the sampler into the water at a consistent rate until you feel it hit the bottom of the channel, then bring it back up at the same rate. Do not pause at the bottom or any place in the water because it will take in more water from that depth making the sample uneven. The DH-95 should be lowered and raised at a rate so that it is not quite full when it comes back to the surface.
- Triple rinse the two sample bottles for suspended sediment using water from the DH-95, this will also rinse the DH-95.
- After rinsing, repeat the lowering and raising process and pour the water off into the churn bucket. You can fill the DH-95 as many times as necessary in order to get enough

water for your samples. Once you have enough water in the churn bucket for all of your samples, return to the vehicle or another convenient place to complete sampling.

- While operating the churn to mix the sample, fill the two sample bottles from the spicket on the churn bucket.
    - Two suspended sediment samples (duplicates) are always collected. If the water is very turbid, collect a smaller volume of sample so the entire sample can be filtered without clogging the filter. Duplicate samples should be labeled according to the method outlined below.
    - For each sample day, at one sample site a field blank should be prepared by pouring distilled water into a sample bottle and labeling it according to the method outlined below.

Turbidity Measurement

- Carefully remove a cuvette (sample bottle) from the Hach turbidity meter case. Be cautious not to scratch, damage the cuvette, or get it dirty. While operating the churn so the sample is well mixed, triple rinse the cuvette with water from the churn and then fill it to the line near the top and cap the bottle.
- Clean the cuvette using a clean Kim wipe. Remove all water and fingerprints from the cuvette so it is clear. Hold the cuvette to the light to ensure that it does not have any water streaks or finger prints on it.
- Turn on the turbidity meter.
- Gently invert the cuvette multiple times so it is well mixed. Do not shake it because this will introduce air bubbles. Immediately after mixing, place the cuvette in the turbidity meter with the arrow on the cuvette aligned with the arrow on the meter. Close the cap that covers the cuvette.
- Press the read button.
- Write the turbidity value on the field datasheet.
- Repeat the steps above a second time to produce a duplicate sample.
- Rinse the churn bucket with tap water after sampling is complete.

Sample Bottle Labeling

Sample Site Name and ID

Site names and IDs are in Table 4 of the QAPP

Example: State Line #1, LBHR-010

Date and Time

If you don't use military time, indicate AM or PM

Example: 10/19/2009 14:25

Indication if the sample is a duplicate or a blank

For duplicate samples, after the sample ID put a D1 on the first sample and a D2 after the second sample. For field blanks, put a B1 after the sample ID.

Example: State Line #1, LBHR-010, D1
State Line #1, LBHR-010, D2
State Line #1, LBHR-010, B1

Sampler's last name and first initial

Example: B Goodluck

Preservative added if any

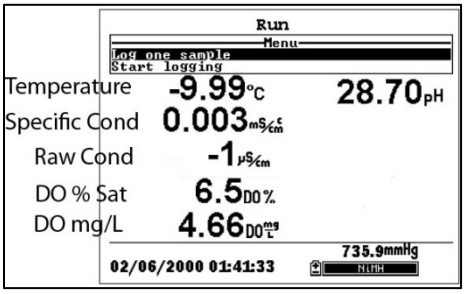
Sulfuric acid (H_2SO_4) is used to preserve nitrate samples and nitric acid (HNO_3) is used to preserve metal samples.

Example: H_2SO_4 or HNO_3

C.5 Non-wadable without Bridge Site: Sample Collection and Field Parameter Measurement (Grab Sample)

If the site is not wadable and there is not a bridge, the samples will be collected from the bank or close to the bank. Wear a life jacket when sampling at these sites and work in pairs.

Field Measurements (YSI)



Gently place the YSI probe far enough into the stream that it is in actively moving water. The probe is delicate and should never be thrown into the water. The probe should be left to equilibrate for at least 5 minutes. Once numbers have stabilized, record Temperature, pH, Specific Conductance, Conductivity, Dissolved Oxygen mg/l, Dissolved Oxygen Percent Saturation, and Barometric Pressure on the field visit form. After measurements are completed, rinse the probe and replace the storage cup with half an inch of tap water to keep the probes moist.

Place a handheld thermometer in the shade to determine air temperature and record this value on the field visit form.

Water Sample Collection

E. coli Samples

- Put on a clean pair of disposable nitrile gloves.
- Wade into the channel as far as you feel comfortable or sample from the bank.
    - For IDEXX samples, fill a sterile bottle to the 100 mL line directly from the stream.
    - For Easygel samples, pipette directly from the stream into the Easygel sample bottles.
    - For m-coli blue or other methods, fill sample bottles directly from the stream. Plunge the sample bottle into the water upside down and to a depth at least a foot below the surface and turn the bottle upright as you bring it to the surface.
    - For each sample day, at one sample site, a field blank should be prepared by pouring sterile water into a sample bottle and marking it as a field blank.

Sediment Samples

- Rinse each of the sample bottles three times with river water before filling them.
- Plunge the glass mason jar into the water upside down to a depth of at least one foot below the surface and turn the bottle upright as you bring it to the surface.
- Two suspended sediment samples (duplicates) are always collected. If the water is very turbid, collect a smaller volume of sample so the entire sample can be filtered without clogging the filter.
- For each sample day, at one sample site, a field blank should be prepared by pouring distilled water into a sample bottle and marking it as a field blank.

Turbidity Measurement

- Carefully remove a cuvette (sample bottle) from the Hach turbidity meter case. Be cautious not to scratch, damage the cuvette, or get it dirty.
- Triple rinse the cuvette by dipping it in the river and then fill it to the line near the top and cap the bottle.
- Clean the cuvette using a clean Kim wipe. Remove all water and fingerprints from the cuvette so it is clear. Hold the cuvette to the light to ensure that it does not have any water streaks or finger prints on it.
- Turn on the turbidity meter.
- Gently invert the cuvette multiple times so it is well mixed. Do not shake it because this will introduce air bubbles. Immediately after mixing, place the cuvette in the turbidity meter with the arrow on the cuvette aligned with the arrow on the meter. Close the cap that covers the cuvette.
- Press the read button.
- Write the turbidity value on the field datasheet.
- Repeat the steps above a second time to produce a duplicate sample.
- Rinse the churn bucket with tap water after sampling is complete.

Chemical Samples

- Rinse each of the sample bottles three times with river water before filling them.
- Fill the 500 ml bottle for nitrate and chemical oxygen demand analysis and preserve with sulfuric acid provided by the lab.
- Fill the 250 ml bottle for phosphorus analysis.
- Fill a one liter bottle washed for metal collection. From this bottle, filter 250 ml of water into the 250 ml bottle and preserve with nitric acid provided by the lab for dissolved metals analysis.
- Duplicate and Blanks
    - One set of duplicate samples should be collected for each day that chemical samples are collected. These samples are collected in an identical manner to that described above and are labeled according to the method outlined below.
    - One set of field blank samples should be collected for each day that chemical samples are collected. These samples are collected by pouring distilled water into the nitrate and COD bottle and preserving with sulfuric acid provided by the lab. Pouring distilled water into the 250 ml phosphorus bottle. Pouring DI water into a 1 liter bottle which was washed for metal collection and filtering enough water to fill a 250 ml metals bottle, then preserving the sample with nitric acid provided by the lab. Blank samples are labeled according to the method outlined below.

Sample Bottle Labeling

Sample Site Name and ID

Site names and IDs are in Table 4 of the QAPP

Example: State Line #1, LBHR-010

Date and Time

If you don't use military time, indicate AM or PM

Example: 10/19/2009 14:25

Indication if the sample is a duplicate or a blank

For duplicate samples, after the sample ID put a D1 on the first sample and a D2 after the second sample. For field blanks, put a B1 after the sample ID.

Example: State Line #1, LBHR-010, D1
State Line #1, LBHR-010, D2
State Line #1, LBHR-010, B1

Sampler's last name and first initial

Example: B Goodluck

Preservative added if any

Sulfuric acid (H_2SO_4) is used to preserve nitrate samples and nitric acid (HNO_3) is used to preserve metal samples.

Example: H_2SO_4 or HNO_3

APPENDIX D

TRUTRACK INSTALLATION

CONTINUOUS STAGE AND TEMPARATURE MONITORING

D.1 TRUTRACK INSTALLATION

Trutracks are instruments which can be installed in stream to log water depth, water temperature, and air temperature at a selected interval. If at least 3 discharge measurements are taken over the course of a season in the stream next to a trutrack, a rating curve can be created so continuous discharge can be estimated for the site.

Materials needed

- Steel post
- 1 inch PVC 5 feet long
- PVC cap for pipe
- Cordless Drill
- 3/8 inch bolt 2 inches long with a nylon nut
- Light weight wire or nylon string
- 1.5 inch diameter hose clamps (3)
- Calibrated Trutrack
- Laptop with up-to-date Omnilog software
- Trutrack download cable

Selecting a location for a stilling well to house a trutrack

Finding a good location for a stilling well will help to protect the equipment and make it possible to get a more reliable relationship between water depth and discharge. Look for the following characteristics for a stilling well location:

- A relatively straight channel reach
- A relatively narrow channel reach
- A reach that appears stable without debris that will be modifying flow
- A reach without excessively high velocities
- A reach away from confluences or side channels
- A location in the channel where the stilling well is less likely to be knocked over by debris moving down the channel
- A location where the trutrack will not be out of the water during low flow or submerged during high flow (trutracks are available in half meter , meter, and longer lengths)

Installing a stilling well and trutrack

- A trutrack is housed inside a piece of pipe which acts as a stilling well. Steel pipes have been used in many cases, but PVC fixed to a steal post seems to work pretty well and is much cheaper and easier to manage.
- Based on suggestions above, locate the place where the stilling well will be located and drive the steel post into the channel substrate far enough to make it stable. Ensure that the post is vertical.

- Line the pvc pipe up on the post and determine where you want the bottom of the trutrack, mark this depth on the pipe.
- Move to shore and drill a hole in the pipe at the depth marked for the bottom of the trutrack. Run the bolt through the hole and secure it with the nylon nut.
- Drill a few more holes in the pipe above the bolt hole to allow water into the pipe (stilling well).
- Secure the pipe to the steel post with hose clamps and ensure that it is stable.
- Start the trutrack with the Omnilog software. Set it to collect data on whatever time interval you are interested in. If you expect the water level to be fairly stable, you may only log every few hours. If you expect the water level to be highly variable due to irrigation or other factors, you may want to log as often as every 10 minutes.
- Secure a piece of wire or string on the top of the trutrack that is long enough to reach out the top of the pipe when the trutrack is resting on the bolt at the bottom of the pipe.
- Lower the trutrack into the pvc pipe.
- Remember that every time you remove the trutrack to read it, it is critical that it is replaced so that it is sitting at the exact same depth in the pipe. If the pipe does not move and the trutrack is always sitting on the bolt in the pipe, this should be accomplished.
- Check the trutrack again within a week or so to ensure that it is collecting data as you intended it to.
- Download the trutrack every month or so to ensure data is not lost in case of malfunction.

APPENDIX E
STANDARD OPERATING PROCEDURES - LAB

E.1 Suspended Sediment Concentration (SSC)

Concept:
Suspended sediment is the amount of particulate in suspension in a water sample. Some amount of suspended sediment is normal in most streams especially during spring runoff. However, too much sediment can lead to problems with fisheries and siltation of reservoirs downstream. The amount of suspended sediment in the water can be determined by filtering a sample through 2 micron filter measuring how much the weight of the filter changes with the sediment. Holding time for the samples is 7 days, so they need to be filtered within 7 days of being collected.

Materials:

- Vacuum Pump
- Scale that reads to mg (leveled on the counter for accuracy)
- Warming oven
- Vacuum Flasks (2)
- Filter Apparatuses (2)
- Glass Fiber Filters (Whatman Cat. no. 1827 090)
- Forceps
- DI Spray Bottle
- Permanent Marker
- Sharpie
- Aluminum Trays (Fisher Cat. no. 08-732-110)
- Graduated Cylinder
- Brown Trays (2 for every 8 samples)
- Samples
- Datasheets

Procedure:

1. Turn the oven on to 103 degrees C. If other people may be using the oven, put a note on the door indicating when you will be finished with it.
2. Confirm numbering of a sufficient number of aluminum trays for the # samples to be filtered plus one extra for a blank. The blank should be tray number 1 and should be labeled on the datasheet as “blank.”
3. Put on a clean pair of nitrile gloves.
4. Using forceps, place a 90mm glass filter on each aluminum tray to be used
5. Place the aluminum/filter combos in the oven and cook them for 30 minutes.
6. Use a fine point permanent marker to mark the water line precisely at the bottom of the meniscus on each sample bottle. (this will allow you to refill the bottle after filtering to determine sample volume)

7. Remove the aluminum/filter combos from the oven one at a time closing the door to keep the other aluminum/filter combos hot. Place them directly on the scale and read the value as soon as it stabilizes. This is typically within 30 seconds and the "g" on the scale typically lights up when the number is stable. **Record aluminum/filter combo weights in the proper row on the datasheet.** (consistency in amount of time filters are allowed to sit at room temperature before weighing is important because of the increase in filter weight as it re-hydrates in open air)
8. Rinse the filter apparatuses with DI water to remove any dust or debris, and set up the filtering and vacuum apparatus.
9. Place the first filter in the filter apparatus wrinkled side up, start vacuum, and seat the filter with a spray of DI water.
10. Rinse this filter 2 or 3 times and allow it to vacuum dry for a few minutes. Using forceps, remove the filter and place it back in the same tray it came from. **Record the sample ID for this tray as "Blank."**
11. Place another filter in the funnel wrinkled side up and seat it with a squirt of DI water.
12. Organize sample bottles on the counter in the order which they were collected. R**ecord the sample ID for each sample in order on the datasheet. The number on the datasheet will correspond to the aluminum tray number for that sample's filter.**
13. Shake the sample bottle to suspend all sediment and pour the contents of the sample into the filter carefully to avoid displacing the filter.
14. Rinse the sample bottle into the filter using a DI squirt bottle to ensure all sediment is flushed into the filter.
15. As the sample is filtering, use the DI squirt bottle to wash the sediment from the edges of the funnel onto the filter paper.
16. Allow the filter to vacuum for a few minutes to remove excess water.
17. Using forceps, carefully remove the filter from the funnel and place it back on the tray it came from. Use caution to avoid spilling or wiping any sediment off the filter (it may be useful to fold the filter if necessary to avoid spilling excess sediment).
18. Empty the vacuum flask after every sample to avoid overfilling and sucking water into the vacuum pump. Always be sure to set-up a backup water catch with an extra vacuum flask in case water does reach the outlet on the filter vacuum flask.
19. Repeat steps 11-20 for each of the samples. It could be useful to adopt a convention for associating trays with sample bottles to avoid confusing which tray goes with which filter while they are on the funnels.
20. Place the filters in the oven on the top shelf to avoid debris falling on them if other materials are added to the oven.
21. Record the time that the filters are placed in the oven on the datasheet under "In Oven@"
22. While the filters are drying, refill the clean sample bottles with DI water to the line you marked on the bottle, dump this water into a graduated cylinder and **record the volume on the datasheet under sample volume for the associated Sample ID.**
23. Allow filters to dry for 2 hours. Remove the aluminum/filter combos from the oven one at a time closing the door to keep the other aluminum/filter combos hot. Place them directly on the scale and read the value as soon as it stabilizes (within 30 seconds). **Record aluminum/filter combo weights in the proper row on the datasheet.** (consistency in amount of time filters are allowed to sit at room temperature before weighing is important because of the increase in filter weight as it re-hydrates in open air)

E.2 IDEXX *E. coli* sample analysis

Concept

E. coli is a bacteria which is an indicator organism for fecal contamination of water. The amount of *E. coli* present in the water is used to estimate the risk of pathogens being present in the water which can cause disease. IDEXX uses a powdered media which provides food for bacteria and produces color and fluorescence changes when E. coli is present in the sample. The Quanti Tray method takes a 100 mL sample and splits it into a number of smaller samples to allow for a calculation of the most probable number (MPN) of bacteria present in the sample.

Equipment List

- Samples
- Colilert media packets
- UV light-6 watt, 365 nm
- Quanti-Tray/2000 trays
- Quanti-Tray/2000 sealer
- Incubator at 35^{o}C ±0.5^{o}C
- Color comparator
- MPN calculation table
- Germicide
- Nitrile gloves
- Goggles
- Lab coat

Procedure

1. Turn the Quanti-tray sealer on.
2. Clean the counter with disinfectant spray.
3. Samples for *E. coli* must be processed the same day they are collected.
4. Samples must be read between 24 and 28 hours from the time they are placed in the incubator.
5. Turn on the incubator and set it to 35 degrees C.
6. Remove samples from the field cooler and line them up on the counter in the order that they were collected in.
7. Put on a clean pair of nitrile gloves.
8. Get out enough Quanti Trays for all samples. Use a permanent marker for labeling but not a fine point because it could puncture the trays. Label trays on the back side with a permanent marker with the:
    a. Sample location
    b. Sample date and time
    c. Time the samples are placed in the incubator

9. Lay out one Colilert nutrient packet for each sample next to the bottle.
10. Add the Colilert powder to the bottles and mix for 30 seconds or until the powder is dissolved.
11. Use one hand to hold a Quanti-Tray upright with the well side facing the palm. Squeeze the upper part of the Quanti-Tray so that the tray bends toward the palm. If someone assists with holding the tray, they should wear gloves too.
12. Gently pull the foil tab up and out to separate the foil from the tray. Avoid touching the inside of the foil or tray. Avoid separating too far which will cause leakage.
13. Pour the reagent/sample mixture directly into the Quanti-Tray, avoiding contact with the foil tab.
14. Tap the tray to remove air bubbles.
15. Place the sample-filled Quanti-Tray onto the Quanti-Tray rubber insert for the sealer with the well side facing down.
16. Gently push the tray through the Quanti-Tray sealer to seal the tray.
17. Start filling out the E. coli datasheet with the sample IDs and the time into the incubator.
18. Place the samples in the incubator and note the time on a IDEXX *E. coli* Lab Data Sheet . Do not stack trays unless necessary.
19. Allow the samples to incubate for 24 to 28 hours before removing them to read.
20. Count the number of small and large cells which have a color equal to or more yellow than the color comparator. Record these numbers on the Lab Data Sheet and use the MPN table to determine the most probably number of total coliform present. Record this number on the Lab Data Sheet along with the times that the samples went into the incubator and were read.
21. Use the UV light box to count the number of small and large cells that fluoresce equal to or more intensely than the comparator. Record these numbers on the Lab Data Sheet and use the MPN table to determine the most probably number of E. coli in the sample. Record this number on the Lab Data Sheet along with the times that the samples went into the incubator and were read.

Table 1. Result Interpretation Table

Less yellow than the comparator	Negative for total coliforms and *E. coli*
Yellow equal to or greater than the comparator	Positive for total coliform
Yellow and fluorescence equal to or greater than comparator	Positive for coliform and *E. coli*

22. After trays have all been checked against datasheets for recording errors, place in autoclave bags and autoclave for 45 minutes at 121^{o}C.

E.3 M-coli Blue *E. coli* Enumeration

This method is from Sue Broadaway in the MSU Microbiology Department.

Collection and processing water samples for isolation of *E. coli*

- Collect 1 liter samples from water sources using sterile 1 liter plastic bottles.
- Store samples at 4ºC until processed.
- Maintain spreadsheet with the ID number, location and date of sampling.

- Label plates with Date, ID number and volume filtered
- Saturate a pad in a 50 mm sterile plastic Petri dish with 2.0 ml m-ColiBlue according to manufacturer's instructions.
- Shake water sample bottle vigorously before filtration.
- Filter 1 ml and 10 ml samples (X 3 per dilution) through 0.45 µm pore size mixed cellulose filter and place filter on media soaked pad. (Total of 6 plates)
- Incubate upright at 35ºC for 24 hours.

- Controls: Run control each time by mixing E. *coli* and *Klebsiella pneumoniae* or other non *E. coli* coliform in saline at 100 cells/ml as a dual positive control and filter and plate on ColiBlue. Use *Alcalegenes fecalis* at 100 cells/ml as a negative control.

- m-ColiBlue is formulated so that *E. coli* colonies are blue to purple and non *E. coli* coliforms are red.

- After incubation enumerate colonies found on m-ColiBlue. Determine counts per ml.

Protocol for making Frozen Stock from agar surface

- Streak culture for isolation on non selective agar medium (R2A, nutrient agar etc.).

- Incubate until there is good growth but the colonies are still fresh, do not store for prolonged period before making stock. Check for purity.

- Working under laminar flow hood, using a sterile disposable pipette, place 2 to 3 ml of sterile storage solution (such as 20% glycerol, 2% peptone or 15% skim milk), onto the plate. Discard pipette. To avoid cross contamination, do not replace pipette in storage bulk solution

- Using a sterile swab, gently remove colonies from agar surface mixing to make a concentrated suspension. Don't gouge medium. (Alternatively, pipette storage solution into cryovial, remove colonies with a sterile swab and place in the solution. This method may not provide as many cells in the storage solution.
- Using a new sterile disposable pipette, remove the suspension from agar surface and place into cryovials. Label vials with date, bacterial strain and your initials. Place cryovial in a -80°C freezer in appropriate freezer box.
- Make record of colonies isolated along with the source of the sample and sample ID in EXCEL file and in lab notebook.

APPENDIX F
CHECK LISTS

F.1 Detailed Sampling Checklist

Upon arriving at the site:

- ☐ Identify stream reach(es) for monitoring.
- ☐ Determine representative sampling site(s) within each reach.
- ☐ Make sure proper landowner permission has been obtained to access site.
- ☐ Sample selected site from downstream to upstream (to avoid contaminating later samples).
- ☐ Begin filling out all required field forms for each sampling event.

Sampling Sequence:

Field Measurements

- ☐ Calibrate YSI 556 meter and record in the meter calibration and maintenance log book.
- ☐ Measure pH, specific conductivity (SC), water temperature, dissolved oxygen (DO), and total dissolved solids (TDS).
- ☐ Record measurements on the Site Visit Form.
- ☐ After measurements, rinse the probe and replace the storage cup with half an inch of tap water to keep the probes moist.

Water Sampling

- ☐ Record information on all sample container labels using waterproof marker or pencil if using write in rain paper.
- ☐ Collect water chemistry, suspended sediment, turbidity and bacteria samples according to methods for the type of site being sampled.
- ☐ Complete any required field preservation and/or filtration of samples and place in a Ziploc freezer bag, on ice, in the cooler.

Flow measurement

- ☐ Measure discharge if it is a wadeable site

Photo sequence and site location verification

- ☐ Take a picture with digital camera upstream, downstream, straight down into the stream proximal to the sampling site, and any other notable conditions at the site
- ☐ Verify sample site location with a GPS and record latitude/longitude (NAD83) on the site visit form.
- ☐ Verify that all pertinent field forms are completed before leaving the site.
- ☐ Make sure to leave the site "as you find it" (no trash, etc.)
- ☐ Record water chemistry samples on the chain-of-custody (COC) and site visit form.
- ☐ Make sure all sample bottles are tightly closed, and Ziploc bags are sealed including bags with ice.

At the end of the day:

- ☐ Place suspended sediment samples in the refrigerator at LBHC
- ☐ Process *E. coli* samples and place them in the incubator. Bacteria samples that are to be analyzed through filtration on the following day should be placed in the refrigerator.
- ☐ Inventory chemistry samples and make sure the Chain of Custody form is filled out and deliver or ship the samples to the lab, or prepare to ship them well within the hold time requirements. Samples should be kept refrigerated or on ice until they are sent to the lab.
- ☐ Make sure all pertinent field data sheets are filled out and placed in the binder at LBHC.
- ☐ Ensure all equipment is in good condition and clean before returning it to storage at LBHC.
- ☐ Ensure that YSI is clean and has half an inch of water in the storage cup to keep probes moist.

F.2 Quick Site Checklist

□ YSI measurements taken
□ YSI is rinsed and stored in tap water
□ Sample bottles are fully labeled, filled and stored on ice
□ Any necessary sample preservation is complete
(example: sulfuric acid for nutrient samples)
□ Turbidity measured and recorded
□ DH-81, DH-95 and churn bucket rinsed with tap water
□ Discharge measured, datasheet complete
□ Site photos taken and recorded on datasheet
□ Field visit datasheet is completely filled out

F.3 Field Supply Checklist

General

- Field Visit Forms
- Crow/LBHC QAPP
- Hand Held Thermometer for Measuring Air Temperature
- Cell phone and phone numbers (for emergencies)
- Field forms/data sheets (photocopied, preferably on “Rite-in-the-Rain” paper)
- Clipboard & pens/pencils & Sharpies (waterproof markers)
- Calculator
- First aid kit
- Trash bag
- Sunscreen, insect repellent
- Rain gear
- Hip boots/waders
- Paper towels
- Kim-wipes
- Clear packing tape (for covering bottle labels and shipping samples)
- Ziploc freezer bags (gallon-size) for ice
- Ice (cubed)
- Nitrile, powderless (latex-free) gloves

Physical Attributes

- Stream Flow Datasheet
- GPS unit
- Extra batteries for GPS (probably AA)
- Maps (topographic, if needed) ***optional***
- Digital camera (with additional memory card and battery)
- Marsh McBirney Flow meter
  - top setting rod
  - 2 - extra D batteries
  - 1 – tape measure (100 ft)
  - 4 - chaining pins or bank stakes
  - 1 – hammer ***optional***
- YSI 556 meter
  - pH 7.00, pH 10.00, 447 µS TDS (specific conductivity) calibration solutions
  - calibration log
  - users manual
  - extra batteries for YSI (4 C batteries)
  - Phillips screwdriver for changing batteries
  - Tap water for rinsing YSI probe and storage in the YSI cup after sampling
- 1 – small squirt bottle of deionized (DI) water to clean YSI meter probes
- thick waterproof black marker

Continued on next page.

Water Samples

- Site Visit Form
- DI water (for one suspended sediment blank and a chemistry blank when applicable)
- Cooler containing:
  - plastic sample bottles
  - preservatives for nutrient samples
  - chain-of-custody forms and
  - pre-paid mailing label (Energy Labs)
- DH-81 Sample Rod
- DH-95 Sampler
- Sterilized DH-81 nozzel and bottle sets for *E. coli*
- Sterile sample bottles for *E. coli*
- Rope to suspend the DH-95 sampler
- Churn Bucket Sample Splitter
- Sample nozzles and bottles (one clean/sterile nozzle and bottle for each site to be sampled with the depth integrated method)
- Hach turbidity meter and cuvettes
- Syringe filters and syringes or Nalgene filter apparatus and filters
- 1 liter sample bottles, (one clean/sterile bottle for each site to be sampled with the grab method)

Field Visit Data Sheet

River: _____ Site Name: _____ Date : _____

Stream Name:	Sample Site ID:	Date:	Start Time:	Finish Time:
Sample Collection Location:	Access Type (Circle One)	Wadable	Non-Wadable with Bridge	Non-Wadable without Bridge
Team Members:				
Latitude:	Longitude:	GPS Datum:	Elevation:	

Visit Comment:

Meter calibrated in last 24 hours? Yes No		
Temperature:	Water _____ C or F	Air _____ C or F
pH: _____	Barometric Pressure: _____ mmhg	
Specific Conductance:	_____ us/cm^c	
Conductance:	_____ us/cm	
Dissolved Oxygen:	_____ mg/l	_____ % Sat.
Turbidity: _____ (Circle One)	Clear	Slight / Turbid
Discharge:	_____ cfs	Measured ◯ Estimated ◯ USGS Station ◯
Comments:		

Number of Bottles Collected _____

Preservative : F—Filtered, S—Sulfuric Acid, N—Nitric Acid

Site ID, QC ID	Lab	Parameter	
Ex LBHR-120, D1	*Energy*	*Ammonia*	*S*
1			
2			
3			
4			
5			
6			
7			
8			

Comments:

Photo Description	Jpeg #	Latitude	Longitude	Compass Bearing

Field Visit Data Sheet

CALIBRATION LOG SHEETS

Date:_____ Time:_____
Name:_____
Location: _____
Temperature: _____

SPECIFIC CONDUCTIVITY

Standard	Reading Before Cal	Set To	Reading After Cal	Expiration Date
_____uS/cm^c	_____uS/cm^c	_____uS/cm^c	_____uS/cm^c	_____

DISSOLVED OXYGEN

BP	Standard	Reading Before Cal	Set To
_____	100%	_____	_____
	mg/L	_____	_____

pH

Standard	Reading Before Cal	Set To	Reading After Cal	Expiration Date
7	_____	_____	_____	_____
10	_____	_____	_____	_____
4	_____	_____	_____	_____

Date:_____ Time:_____
Name:_____
Location: _____
Temperature: _____

SPECIFIC CONDUCTIVITY

Standard	Reading Before Cal	Set To	Reading After Cal	Expiration Date
_____uS/cm^c	_____uS/cm^c	_____uS/cm^c	_____uS/cm^c	_____

DISSOLVED OXYGEN

BP	Standard	Reading Before Cal	Set To
_____	100%	_____	_____
	mg/L	_____	_____

pH

Standard	Reading Before Cal	Set To	Reading After Cal	Expiration Date
7	_____	_____	_____	_____
10	_____	_____	_____	_____
4	_____	_____	_____	_____

Discharge Data Sheet

Stream Name:				Sample Site ID:		
Team Members:						
Date:				Time Measurement Started:		
Left Wetted* Edge Measurement:			Right Wetted* Edge Measurement:		Wetted Width:	
#	Measurement on Tape	Depth	Velocity	Velocity 2 (for depths over 2ft)	Average Velocity	Section Discharge
1	Left Wetted Edge	0	0			
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						

* Note: left and right side of channel are determined when looking down stream.

River _____ Sample Site _____ Date _____

Sample Date _____

E.Coli IDEXX Data Sheet

	River	Sample Site	Sample Collection Time	Time into Incubator Date	Time into Incubator Time	Time Read Date	Time Read Time	Coliform (yellow) Large Cells	Coliform (yellow) Small Cells	Coliform (yellow) MPN	E. Coli (flourescence) Large Cells	E. Coli (flourescence) Small Cells	E. Coli (flourescence) MPN
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													

River(s) _____

Date _____

E.Coli IDEXX Data Sheet

Suspended Sediment Analysis Data Sheet

River _____ Sample Site _____ Date _____

Filterer:	Date:	Samples From:

Tray #	Sample ID	Sample Date	Sample Time	Start Wt. (mg)	Smpl. Vol. (ml)	In Oven @	Out Oven @	End Wt. (1) (mg)	Wt. Change (mg)
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									

Suspended Sediment Analysis Data Sheet

APPENDIX H
EQUIPMENT COSTS

H.1 Equipment Costs

- YSI 556 is approximately $3,000
- YSI Calibration Solutions from Northwest Scientific in Billings (406-252-3269), LBHC Account #: 421472
    - 500 mL bottles range from $15 to $20
    - 2.5 L bottle range from $75 to $100
- Marsh McBirney Flomate is approximately $5,000 for the meter and the top setting rod

Depth Integrated Equipment ordered summer 2009

Rickly Hydrological Company

www.rickly.com

http://www.rickly.com/USPricelist-0408.pdf

Depth-Integrating Wading Type- US DH-81

To collect depth and width integrated samples from wadable streams.

401-050 = $ 285.00

This comes with an adapter to connect the rod to the sampler cap, the sampler cap and the nozzle for the sampler cap (we probably want the 5/16th inch nozzle size which is the largest and will fill the fastest)

Adapter = DH-81A

Cap = D-77 (401-025-1) = $106.60

Nozzle = D-77 5/16 inch (405-307-1) = $28

http://www.rickly.com/ss/depth-integrating-samplers.htm#Depth-Integrating%20Wading%20Type-%20US%20DH-81

Wading Rod for DH-81

Rod that the DH-81 is attached to for sampling.

405-021 = $ 43.00

See the DH-81 for picture.

Depth-Integrating Suspended Type- US DH-95

To collect depth and width integrated samples from non-wadable streams.

401-055 = $2,100

http://www.rickly.com/ss/depth-integrating-samplers.htm#Depth-Integrating%20Wading%20Type-%20US%20DH-81

Churn Sample Splitter, 8L

For mixing large volumes of sample from the samplers to allow a representative sub sample to be taken.

505-289 =$ 374.75

http://www.rickly.com/sai/ChurnSplitter.htm

Fisher Scientific

Sample Bottles

32 oz Nalgene sample bottles

11-825B =6 for $ 111.18

http://www.fishersci.com/wps/portal/PRODUCTDETAIL?prodcutdetail='prod'&productId=764277&catalogId=29104&matchedCatNo=11825A||11825B||11825D||11825C&pos=1&catCode=RE_SC&endecaSearchQuery=%23store%3DScientific%23N%3D0%23rpp%3D15%23Nao%3D195&fromCat=yes&keepSessionSearchOutPut=true&fromSearch=Y&searchKey=nalgene&highlightProductsItemsFlag=Y

Hardware Store

Rope from a local hardware store for use with the DH-95