Boulder Creek Watershed Year 2008 Stream Team Report

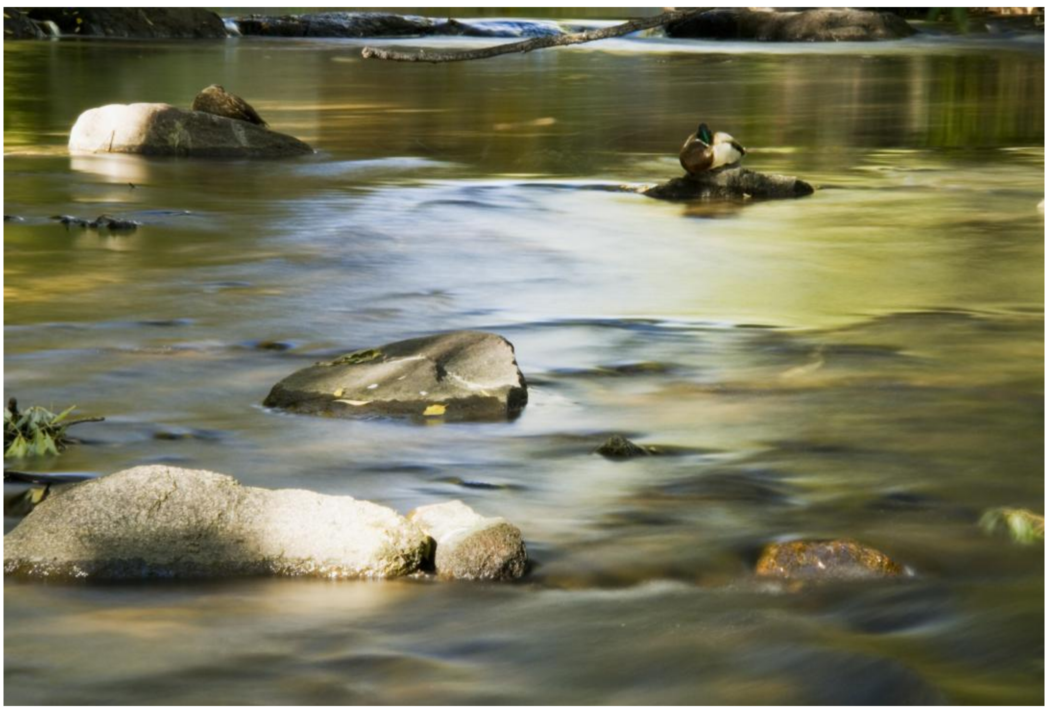

Photo: Sophia Floyd

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Boulder Creek Watershed Initiative

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Mission Statement:

To protect and enhance the health of the Boulder Creek watershed by community based stewardship through education, information and action

Boulder Creek Watershed Initiative Stream Team Report:

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1. Learning About Boulder Creek

This final Stream Team Report is a presentation of water quality data collected by Boulder Creek Watershed Initiative (BCWI) Stream Team volunteers for the year 2008. The data is displayed in tables for the purposes of this report. This information can be used to increase knowledge and awareness about the relationship between water quality and the health of Boulder Creek and its tributaries. The baseline of water quality information provided here represents an effective tool for observing trends over time and space and can act as a reference point for future data collection.

2. How to Use this Report

The heart of this report can be found in Section 10, which contains water quality data by parameter, sampling location, and sampling month for the year 2008. The sections that lead to the specific data descriptions provide historic information about the watershed, availability of historic data, description of water quality sampling sites, and the methodology that BCWI has implemented within its water quality monitoring program.

With this report BCWI is providing the raw data and the baseline information for future comparisons of data. Initial interpretation regarding trends and ecosystem health begins with this data set. Others are strongly encouraged to review this data, whether it is for general research, to inform public debate on water quality issues, for educational purposes, or for other reasons. BCWI plans to present this report during our Watershed Forum series in an effort to inform a broader constituency about the Boulder Creek watershed's water quality status and issues.

3. The Boulder Creek Watershed

Central to the landscape of Boulder County, Colorado is the Boulder Creek Watershed, an 1160 square kilometer basin that encompasses mountains, foothills, and plains (Figure 1). Boulder Creek and its tributaries originate as headwater streams at the Continental Divide and flow through historic mining districts, agricultural fields, and the communities of Nederland, Boulder, Arvada, Eldorado Springs, Lafayette, Louisville, Superior and Erie. The water in Boulder Creek flows into the Saint Vrain River and then the South Platte River, eventually ending up in the Mississippi River and the Gulf of Mexico.

a. Environmental Setting: The Boulder Creek Watershed lies within two physiographic provinces. The mountainous upper watershed is part of the Southern Rocky Mountain Province and is characterized by deep, steeply sloping valleys. The flatter, lower watershed is part of the Colorado Piedmont Section of the Great Plains province and slopes gently to the northeast. The two regions differ substantially in geology, climate, and land cover.

b. Land Cover and Use: The upper watershed consists primarily of forest, shrubs and alpine tundra. The lower watershed consists of grassland, agricultural land, and urban/developed land. Agricultural lands consist of pasture and fields of alfalfa, wheat, corn and barley. Metal and coal mining fueled settlement of the watershed in the late 1860's. Urbanized land of the plains and foothills has increased substantially in the past 30 years in areas that were previously forest, grassland, or agricultural land. Reservoirs have increased in number and size, sand and gravel is mined along Boulder Creek and oil and natural gas are extracted in the eastern part of the watershed.

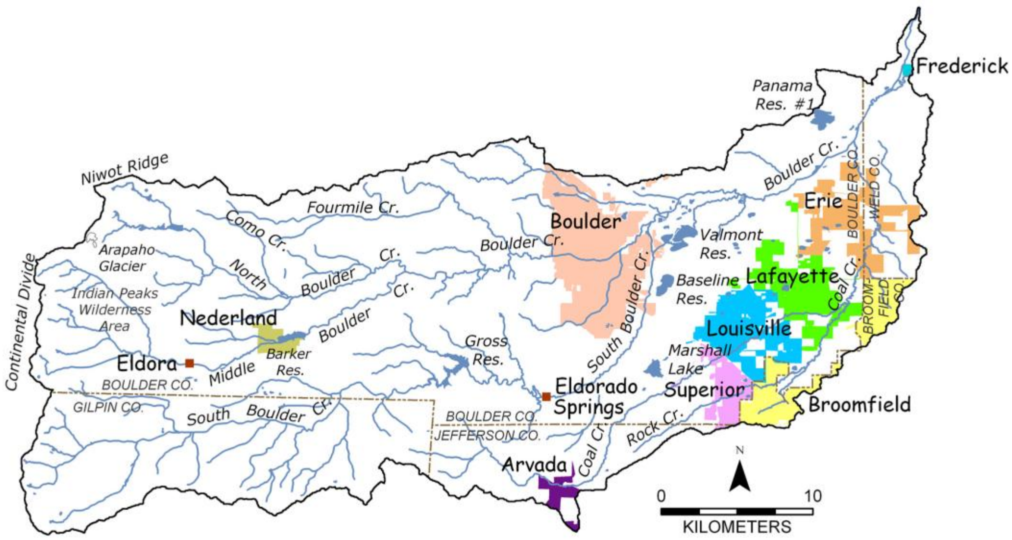

Figure 1: Boulder Creek Watershed, Sheila Murphy, USGS

c. Hydrology: Streamflow in Boulder Creek originates primarily as snowmelt near the Continental Divide, so discharge varies seasonally and annually depending on snowpack depth and air temperature. Low-flow conditions occur from October to March; high flow conditions occur from May to July and usually peak in June. Discharge (flow rate) of Boulder Creek and its tributaries is recorded by several streamflow-gaging stations. Stream discharge data are important in allocating water rights, estimating flood potential, and evaluating long term changes in hydrology and water quality.

d. Management: Boulder Creek and its tributaries are part of a complex water management system. Diversions remove water from streams for municipal, industrial and agricultural use. Reservoirs store water for a reliable year-round supply. Water is brought into and out of the watershed by transbasin diversions. Wastewater treatment plants contribute treated effluent that can account for a substantial portion of flow in streams in the lower watershed during low-flow conditions.
(S.F. Murphy, USGS, 2006)

e. Challenges and Opportunities:

* Population in the Boulder Creek Watershed grew by over a third since 1990; this has led to a corresponding one-third decrease in farmland acres and increased urbanization. Urbanization can lead to degradation of streambank riparian areas and introduce pollutants such as oil, metals, road salt, sediment, nutrients, and pesticides to streams.
* Two invasive species, the New Zealand Mud Snail and the Eurasian watermilfoil, have been accidentally introduced to Boulder Creek and its tributaries. These species have no natural

predators in the watershed, and spread rapidly. In addition, the diatom Didymosphenia geminata has formed excessive growths in Boulder Creek. These species outcompete native species and reduce biodiversity.

* Treated effluent from several wastewater plants dominate the chemistry of lower Boulder Creek and Coal Creek, in part due to diversion of upstream flow. Studies by the U.S. Geological Survey and the University of Colorado have shown that effluent entering Boulder Creek contains endocrine-disrupting compounds that have altered the sex of fish in the creek.

* The flow of water in South Boulder Creek during winter months is insufficient to sustain healthy aquatic ecosystems due to municipal and agricultural diversions.

Figure 2. Boulder Creek in Boulder, Colorado

4. Boulder Creeks Water Quality

Water quality and quantity in the watershed influence water uses, recreational pursuits (including angling and various forms of boating), and wildlife habitat dependent on flowing streams within the Boulder Creek watershed. As land uses have changed, so have water quality issues – with a historic focus on heavy metals from mining entering streams, and runoff from agricultural practices. Presently, attention has shifted to the influence of development pressures on Boulder Creek and its tributaries through wastewater treatment discharges, storm water runoff, and increased erosion and sediment-loading.

The mainstem of Boulder Creek, as well as all tributaries from the source to the confluence with the Saint Vrain River are categorized as Boulder Creek Basin, segments 1 through 12 by the State of Colorado's Water Quality Control Commission (WQCC). All tributaries to Boulder

Creek within the Indian Peaks Wilderness Area have been classified as Outstanding Resource Waters by the WQCC. The remaining segments of Boulder Creek and its tributaries have been classified by the WQCC as follows: Aquatic Life Coldwater – Class 1 (upstream portion to confluence with South Boulder Creek), Aquatic Life Warmwater – Class 1 (downstream portion to confluence with Saint Vrain River, Recreation – Class 1a, Water Supply, and Agriculture. Section 8 provides more detailed discussion of the significance of these classifications (CDPHE, 2005) (Appendix A).

States are required by section 305(b) of the federal Clean Water Act to assess and report on the quality of the State's waters to Congress through the USEPA. Section 305(b) reports describe the ways a State measures water quality, the quality of water bodies in the State, and pollution-control programs. The State of Colorado 305(b) report is available from the CDPHE (2005c, d).

When credible data on the water quality of a stream or lake indicate that a standard is not met, the State proposes that the stream segment be placed on a list of impaired segments, called the "303(d) list." The Colorado Water Quality Control Commission has a public hearing to consider recommendations and adopts Colorado's 303(d) list as a State regulation. The USEPA accepts the 303(d) list from the State or can list additional segments. The 303(d) list identifies the component(s) (such as nitrate, lead, or sediment) that is (are) causing water-quality concerns for that water body. Some stream segments in the Boulder Creek Watershed have been on the 303(d) list for ammonia and E. coli (CDPHE, 2005c, d).

The State is required to prioritize water bodies on the 303(d) list based on the severity of impairment and other factors. It will then determine the causes of the water-quality concern and allocate responsibility for the impairment. This analysis is called the Total Maximum Daily Load (TMDL) process. The State of Colorado also identifies water bodies where there is reason to suspect water-quality impairment, but uncertainty exists about data quality or the cause of impairment. These waters are placed on the Monitoring and Evaluation (M&E) List (CDPHE, 2005c, d). Some stream segments in the Boulder Creek Watershed have been on the M&E list for aquatic life, E. coli, selenium, and chromium VI. (Figure 2).(S.F. Murphy, USGS, 2006)

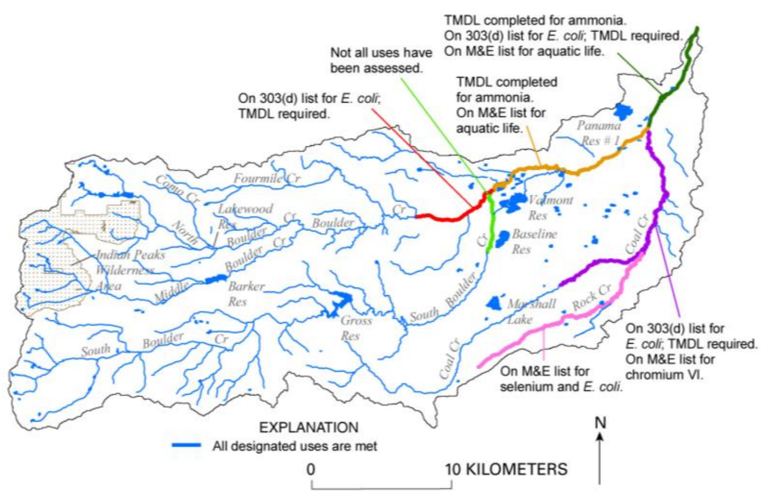

Figure 3: Segments not meeting designated uses in the Boulder Creek Watershed, 2005 (CDPHE, 2005c).

5. Available Water Quality Information

BCWI has investigated entities that have historically conducted water quality monitoring in the Boulder Creek watershed. These entities were contacted for information about parameters sampled, sample frequency and site locations, type of analysis used, and flow gage information. By charting gaps in sampling efforts and water quality information, BCWI saw this as the first step in the design of a comprehensive, coordinated water quality monitoring program.
The following entities have historically conducted water quality monitoring in the Boulder Creek watershed:

- United States Geologic Survey (USGS)
- Colorado Department of Public Health and Environment (CDPHE)
- Colorado Division of Wildlife (CDOW) River Watch sites (area schools)
- Boulder County
- Municipalities
- Wastewater treatment facilities
- United States Forest Service: monitoring of high mountain lakes

The investigation into historic water quality monitoring found a number of opportunities to build upon efforts that existed as of 2006 in the Boulder Creek watershed. The fact that so many different entities were testing water quality highlighted the excellent chance of building a strong community initiative for a more comprehensive and consistent monitoring program.

6. BCWI's Water Quality Monitoring Program

In 2008 BCWI initiated a comprehensive water quality monitoring program in order to better understand and define the overall chemical, biological, and physical health of Boulder Creek and its tributaries. Utilizing citizen volunteers to address water quality concerns was identified in BCWI's Boulder Creek Community Stewardship Plan completed in 2007. To date, five water quality monitoring Stream Teams consisting of 28 volunteers have been developed in Nederland, Boulder (3) and Louisville.

Overall Stream Team Program Objectives include:

- Educate people about their relationship to streams and watersheds
- Provide public involvement opportunities to protect local streams
- Protect water resources through pollution prevention and water conservation.

BCWI is currently collaborating with the Keep it Clean Partnership (KICP), the City of Boulder (COB) and the United States Geological Survey (USGS) for water quality monitoring and protection activities. KICP is helping to administer the Stream Team program and is collaborating with BCWI in agency program planning and volunteer recruitment, training and management and, data management. USGS is supplying technical support. COB is providing staff time and technical support.

Three sets of water quality monitoring equipment have been provided to the Stream Teams (Appendix B). Included in the parameters currently being monitored are flow, temperature, pH, dissolved oxygen, conductivity, nitrate and phosphate. Parameters such as *e-coli* bacteria and emerging contaminants may also be added in the future due to need and the evaluated success of volunteer participation during the first year of the program.

In addition to water quality monitoring, BCWI offered two advanced water quality training sessions to Stream Team volunteers. Physical habitat evaluations, and macroinvertebrate (aquatic bug) sampling was offered to volunteers in the summer and fall, respectively.

Important note: Contrary to the original assumption that data collected in the first year of the program would be distributed to various agencies, the general public and other interested parties and, posted on the internet, the BCWI and KICP technical committee decided to further evaluate that information to ensure that the quality of data collected during the first year of the program are representative and that precision and accuracy are clearly understood. *Therefore, the data found in the data tables should be used for informational purposes only and are not to be interpreted as a reflection of precise measurements taken at the various sampling locations.*

The main purpose of designing, implementing, and carrying out a water quality monitoring program for the Boulder Creek watershed was to gather baseline data of various chemical parameters over time. In the year 2008, BCWI accomplished its first "snapshot" of this effort. The direction the Water Quality Monitoring Program takes in the future is largely based on the findings found in this report. How this monitoring program evolves over time has been and will continue to be evaluated, and a discussion of the future of the monitoring program is provided in Section 9.

a. Planning Meetings: BCWI conducted three meetings with a representative from the appropriate water resources departments from Nederland, Louisville and Boulder to finalize the water quality monitoring plan. This included the incorporation of volunteers into the project. The location of water quality monitoring sites, the establishment of sampling dates, an overview of the parameters to be sampled and monitoring equipment to be used was discussed.

b. Volunteer Recruitment: Volunteers who have been previously identified through the BCWI/KICP summer 2007 outreach process were contacted to provide them the opportunity to join a water quality monitoring Stream Team. Volunteers were informed as to when and where the water quality monitoring trainings were occurring.

c. Volunteer Training: BCWI conducted five volunteer training workshops, one for each Stream Team. Announcements of the trainings were published via the local media. Training sites were confirmed and training materials organized. The overall goals of the project, sampling locations, dates and methods and, equipment used were explained at this time.

d. Volunteer Certification: BCWI conducted five volunteer QA/QC certification events, one for each Stream Team. Volunteers were evaluated on their sampling procedures and data collection techniques. This was to insure that volunteers could effectively accomplish monitoring tasks before they participated in a regular sampling event.

Figure 4: BCWI training volunteers to conduct water quality monitoring.

After the initial training sessions were completed, Stream Team participants were required to practice the methods on their own. BCWI staff then conducted a follow-up visit with each Stream Team to check on the quality and accuracy of the team's sampling and analysis techniques. Once the Stream Team was certified through this process, it began conducting sampling and analysis under no supervision.

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Figure 5: Eldora Stream Team volunteers brave the cold during a water quality training session.

e. Water Sampling and Analysis: In the year 2008, water quality samples were collected and analyzed by BCWI volunteers at the following five locations:
1. Middle Boulder Creek in Eldora at the Marysville Bridge
2. Coal Creek in Louisville at US 36
3. Bear Creek in Boulder at the confluence with Boulder Creek
4. Goose Creek in Boulder at 30th and Mapleton Streets
5. South Boulder Creek in Boulder at the Bobolink trailhead on Baseline Road

Safety is a priority of the program. Volunteers are strongly encouraged to work in teams of at least two people.

Data is stored in an excel spreadsheet format, has been compiled according to each of the five sampling locations and can be found in Appendix C. Highlights of the Stream Team data collection and analysis include:

- Five stream teams performed sampling in 2008,
- Five stream locations were monitored a total of 27 times throughout the year,
- Sampling occurred during nine of twelve months during this period,
- In-situ analyses and data gathering for each sampling event included:
    - Flow rate of stream
    - pH
    - Temperature
    - Dissolved Oxygen
    - Conductivity
    - Nitrate
    - Phosphate
    - Air temperature and other weather conditions

See Water Quality Test Procedures and Field Data Sheet, Appendix D and E, respectively.

7. Boulder Creeks' Signals: What we Measure and Why

This section provides background on what is measured for the BCWI's water quality monitoring program, what influences these parameters, how and why they fluctuate over time, and why we care about them. By understanding these specific physical, chemical, and biological variables, we can ask deeper questions about our results. The "River Continuum Concept" provides a predictive model to hypothesize what we would expect to find from the headwaters to the mouth of each river. The River Continuum Concept proposes that natural stream ecosystems may be characterized as extending continuously from their headwater beginnings to their mouth or estuary. Furthermore, this continuous stream system provides a gradient of changing physical, chemical, and biological conditions (Vannote, 1983). The following information was compiled by Sheila Murphy of the USGS:

a. Flow is the volume of water moving past a point in a unit of time. Two things make up flow: the volume of water in the stream, and the velocity of the water moving past a given point. Flow affects the concentration of dissolved oxygen, natural substances, and pollutants in a water body. Flow is measured in units of **cubic feet per second (cfs).**

b. Conductivity (Specific Conductance) is a measure of how well water can pass an electrical current. It is an indirect measure of the presence of inorganic dissolved solids, such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, and iron. These substances conduct electricity because they are negatively or positively charged when dissolved in water. The concentration of dissolved solids, or the conductivity, is affected by the bedrock and soil in the watershed. It is also affected by human influences. For example, agricultural runoff can raise conductivity because of the presence of phosphate and nitrate.

c. Dissolved Oxygen (DO) is the amount of oxygen dissolved in the water. DO is a very important indicator of a water body's ability to support aquatic life. Fish "breathe" by absorbing dissolved oxygen through their gills. Oxygen enters the water by absorption directly from the atmosphere or by aquatic plant and algae photosynthesis. Oxygen is removed from the water by respiration and decomposition of organic matter. The amount of DO in water depends on several factors, including temperature (the colder the water, the more oxygen can be dissolved); the volume and velocity of water flowing in the water body; and the amount of organisms using oxygen for respiration. Human activities that affect DO levels include the removal of riparian vegetation, runoff from roads, and sewage discharge.

d. Nitrogen is required by all organisms for the basic processes of life to make proteins, to grow, and to reproduce. Nitrogen is very common and found in many forms in the environment. Inorganic forms include **nitrate (NO_3)**, **nitrite (NO_2)** , **ammonia (NH_3)**, and **nitrogen gas (N_2)** . Organic nitrogen is found in the cells of all living things and is a component of proteins, peptides, and amino acids. Excessive concentrations of **nitrate**, nitrite, or ammonia can be harmful to humans and wildlife. High levels of nitrate, along with **phosphate**, can overstimulate the growth of aquatic plants and algae, resulting in high dissolved oxygen consumption, causing death of fish and other aquatic organisms. This process is called ***eutrophication***. Nitrate, nitrite, and ammonia enter waterways from lawn fertilizer run-off, leaking septic tanks, animal wastes, industrial waste waters, sanitary landfills and discharges from car exhausts.

e. pH measures hydrogen concentration in water and is presented on a scale from 0 to 14. A solution with a pH value of 7 is neutral; a solution with a pH value less than 7 is acidic; a solution with a pH value greater than 7 is basic. Natural waters usually have a pH between 6 and 8.5. The scale is negatively logarithmic, so each whole number (reading downward) is ten times the preceding one (for example, pH 5.5 is 100 times as acidic as pH 7.5). The pH of natural waters can be made acidic or basic by human activities such as acid mine drainage and emissions from coal-burning power plants and heavy automobile traffic.

f. Phosphate: Phosphorus is a nutrient required by all organisms for the basic processes of life. Phosphorus is a natural element found in rocks, soils and organic material. Its concentrations in clean waters is generally very low; however, phosphorus is used extensively in fertilizer and other chemicals, so it can be found in higher concentrations in areas of human activity. Phosphorus is generally found as **phosphate** (PO_4^{-3}). High levels of phosphate, along with **nitrate**, can overstimulate the growth of aquatic plants and algae, resulting in high dissolved oxygen consumption, causing death of fish and other aquatic organisms. The primary sources of phosphates to surface water are detergents, fertilizers, and natural mineral deposits.

g. Temperature of water is a very important factor for aquatic life. It controls the rate of metabolic and reproductive activities. Most aquatic organisms are "cold-blooded," which means they can not control their own body temperatures. Their body temperatures become the temperature of the water around them. Cold-blooded organisms are adapted to a specific temperature range. If water temperatures vary too much, metabolic activities can malfunction. Temperature also affects the concentration of dissolved oxygen and can influence the activity of bacteria in a water body.

Figure 6: Volunteers at a physical habitat analysis training.

8. The Clean Water Act and Water Quality Standards

The Clean Water Act is a federal law that sets forth how the United States will restore and maintain the chemical, physical, and biological integrity of its waters (oceans, lakes, streams and rivers, ground water, and wetlands). The law provides protection of the nation's surface waters from both point and non-point pollution sources. The US EPA has delegated the administration of certain portions of the Clean Water Act program to many of the 50 states, including Colorado.

a. Clean Water Act Overview

The Clean Water Act directs public agencies and pollutant discharge permit-holders to track water quality, ranging from comprehensive national reports to monitoring data from single dischargers. The following are a few of the most important types of information available through the state water quality agencies and the EPA:

- The National Water Quality Inventory: Report to Congress
- List of Impaired Waters
- List of Permitted Discharges
- Basin-Wide Water Quality Plans

- ♦ Allocating resources for a Non-point Source Program
- ♦ Intended Use Plans
- ♦ Wasteload Allocation Studies
- ♦ National Estuary Program

Under the Clean Water Act, states establish water quality standards that define the goals and limits for all waters within their jurisdictions. Water quality standards provide the means for enforcement that support the Act's goals. In establishing water quality standards, states must undertake three major interrelated actions as specified under the Clean Water Act. They must: 1) designate uses, 2) establish water quality criteria, and 3) develop and implement anti-degradation policies and procedures. It is these standards that can be used for comparison and interpretation of the data collected for this State of the River Report.

b. Colorado Water Quality Standards

Specific to Colorado, in 1973 the State legislature passed the Colorado Water Quality Control Act, which established a procedure to protect surface waters in the State of Colorado based on their "beneficial uses." The State Act provides for a nine-member board appointed by the Governor to determine standards and other rules for water quality protection. This is the Colorado Water Quality Control Commission. Commission members are appointed from geographical areas of the state and serve three-year terms. The Commission has authority to establish regulations for water quality standards, control regulations, permit regulations for wastewater discharge, and 401certification for Army Corps of Engineers 404 permits. These regulations are reviewed every three years as to the need for changes, as required by the Clean Water Act. The Commission sets policies and guidelines for water quality programs that are carried out by the CDPHE Water Quality Control Division.

All surface waters are subdivided into "segments" that are determined by the uses of the specific stretch of water and the level of protection required to maintain those uses. Standards represent assigned values to protect the uses in each segment. A new segment is assigned when the water use or quality of water changes from the segment upstream. WQCC decisions are made by the Board based on testimony and data supplied by interested entities along those segments. This was the process through which Landis Creek's ammonia standards and aquatic life classification were lowered, as described earlier in the report.

Standards establish the maximum amount of degradation of a particular water quality parameter to which a stream segment may be exposed to from point sources (e.g. discharges from a pipe). Standards are mainly focused on regulating the **maximum** levels of pollution that may be discharged to a stream (e.g. metals) but they can also set forth **minimum** standards (e.g. dissolved oxygen). Other standards may establish a minimum *and* maximum, or range (e.g. pH).

c. Designated Use Classifications

Standards are set to protect the designated uses of a stream segment. In Colorado, these uses are broken down into one of five categories:

1) Aquatic life
2) Water supply
3) Agriculture
4) Recreation
5) Outstanding Waters

A stream may have any or all of these classifications. Criteria are developed to protect the specified beneficial use of a stream segment. Specific standards, numeric or narrative, can be established to protect the different criteria in the standards. Aquatic life protection is broken down into Class 1 and Class 2. Class 1 water has a higher level of protection (lower limits for pollution) than Class 2 water. Each of these classes is further divided into cold and warm water. Class 1 water, either cold or warm, can support a wide variety and number of individual sensitive species, while Class 2 water is unable to support such species diversity.

Standards also are applied to domestic water supplies. Water used for agriculture must be suitable for irrigation and as drinking water for livestock. Water designated for recreation is also separated into 2 classes. Class 1 has the higher level of protection and is suitable for primary contact – activities where some water might be ingested such as swimming or water skiing. Class 2 recreation waters are assumed to have less potential for swimming and boating and are used for activities such as fishing or wading.

d. Types of Stream Standards

Stream standards are either “narrative” or “numeric”.
Narrative standards apply to all surface waters of the State, providing protection from human-caused or non-point sources of the following types:

- Material that can settle out to form deposits that are detrimental to use (sedimentation),
- Floating debris,
- Material that produces color, odor or taste (sludge),
- Material that is harmful to humans, plants, animals, or aquatic life,
- Material that will cause the proliferation of undesirable aquatic life (excess nutrients),
- Material that will cause a film or deposit (oil and grease).

Numeric standards fall into four categories: 1) site specific, 2) Table Value Standards, 3) Ambient quality-based, and 4) wetlands.

Site-specific standards are set for stream segments where studies have been done that show indicator species present in a stream reach. Data are presented to the WQCC and standards set to protect the species and water uses from degradation. Table Value Standards (TVS) are provided for physical and biological parameters, inorganic parameters, and metals (see Appendix A). The numeric levels are based on available information and generally protect the beneficial use of the water where site-specific standards do not appear to be needed.

The standards for inorganic and metals may also be “acute” or “chronic.” An acute standard represents one-half the concentration that will kill five percent of a test population in 96 hours. The maximum standard may not be exceeded more than once in a three-year period. A chronic standard is lower, and represents the maximum concentration that still protects 95 percent of the population from growth or reproductive abnormalities. A chronic standard also may not be exceeded more than once in a three- year period. A stream standard incorporates multiple species thresholds established by compiling species-specific biological thresholds. The acute and chronic standards cover a wide range of plant and animal species. The standards for protecting the most sensitive species are those that are enforced. Also, when there is more than one use classified, the most sensitive standards will be applied. Please see Appendix B for a list of standards adopted for the Boulder Creek watershed. If a parameter is not listed in these tables, then no standards exist for it.

Sometimes standards might be a function of another parameter as in the case of some metals and water hardness. For most metals the standard is set for the dissolved fraction. In other examples, dissolved oxygen has a low standard and pH has both a high and a low standard.

Ambient quality-based standards are set for stream segments where natural or human-caused concentrations of harmful substances are higher than the TVS and cannot be reasonably lowered. Wetlands may have their own set of site-specific standards, or are covered by standards that protect the stream segment with which they are most directly connected.

Figure 7: South Boulder Creek

9. Future Directions

Reflecting back upon 2008, although funding was in place for the creation of only three Stream Teams, a total of five Stream Teams representing 30 individuals were trained and certified to conduct water quality monitoring. Three sets of water quality equipment were then subsequently circulated among the five Stream Teams. Additional funding via the Healthy Rivers Fund will see BCWI train and certify two additional Stream Teams in 2009. Through this funding, equipment will now be available for all seven Stream Teams.

In the first year of data collection, the purpose of BCWI's water quality monitoring Stream Team program was to gather baseline water chemistry information in order to evaluate the chemical health of Stream Team sampling sites chosen for Boulder Creek and its tributaries. It is now important to review what questions we asked when we first initiated the program and if the data collected has answered these questions. For instance, did the data collected meet WQCC stream standards? If not, why? Have we established a solid baseline monitoring program with which to compare future data and establish trends? Are we sampling in the proper locations, at the proper frequency, and for the appropriate constituents that we originally configured? Further, what program changes need to be made in order to address these questions and future questions about the health of Boulder Creek and its tributaries over the long term? Using this as a barometer, BCWI will continue to adjust the monitoring design as a result of data analysis, outside input, and evolving needs throughout the watershed and over time.

Chemical monitoring is scheduled to continue into 2009. However, the BCWI technical committee for the Stream Team program has decided that in order to more comprehensively study the health of Boulder Creek and its tributaries, additional steps will be taken to both upgrade and strengthen the program.

Sampling sites, parameters, and frequency of sampling will be re-evaluated to address the need for long-term trend analysis spatially and temporally. Further, by including the use of statistical models designed to quantify trends and significant changes more accurately and consistently, BCWI will be able to make sound scientific and managerial decisions on where to direct the program into the future.

BCWI plans to schedule four physical habitat evaluations and two macroinvertebrate collections at each site for 2009. These studies will be added in order to address the physical and biological health of the watershed, and to provide additional baseline information to supplement water chemistry data. By incorporating chemical data from the first and second years of monitoring with physical habitat evaluations and biological data collected in 2009 and beyond, a more comprehensive look at the health of the Boulder Creek watershed will be accomplished.

Additions to the program include the following:

- Physical habitat evaluations: An overview of the methods to accomplish this was conducted in the summer of 2008. These evaluations help determine physical changes over time at a particular sampling location. Changes in the physical habitat influence water chemistry and aquatic life. These evaluations will be accomplished quarterly and will be used along with chemical and biological data in order to fully assess river health.
- Macroinvertebrates monitoring: Stream Team volunteers were trained on the methods necessary to accomplish this task in the fall of 2008. Two macroinvertebrate collection activities are planned for the spring and fall of 2009.
- Nutrient sampling: BCWI will continue sampling and analyzing phosphates and nitrates on a monthly basis in 2009.
- Flow measurements: Flow measurements provide information on how much water is diluting a particular parameter, and how parameter levels change during different flow regimes such as high and low flow, snowmelt, or thunderstorms. BCWI will continue to have volunteers monitor for flow during each of their 12 month sampling periods.

Figure 8: Stream Team volunteers identify macroinvertebrates

BCWI hopes that the continued monitoring of the chemical, physical, and biological parameters of Boulder Creek and its tributaries will eventually lead state and local governments, as well as individuals to make better-informed decisions about water quality in the watershed. Based upon our work, we strongly encourage the use of Best Management Practices (BMP's), stream restoration projects, other improvements (based upon the need), and regulatory decisions where appropriate. Such committed and comprehensive attention to studying Boulder Creek will help ensure the health and integrity of the Boulder Creek watershed for generations to come.

10. River Stewardship

The mission of the Boulder Creek Watershed Initiative is to "protect and enhance the health of the Boulder Creek watershed by community based stewardship through education, information and action". Engaging the community to become stewards of the Boulder Creek watershed is an integral approach in actively realizing this mission. BCWI, through its water quality monitoring program, strives to foster long-term conservation and stewardship of the Boulder Creek watershed through participation of community members who are intimately involved with their rivers and streams.

Creating a stewardship ethic includes the building of partnerships. These partnerships link government agencies, schools, local businesses, foundations, and the general public, working together to achieve a common goal of river protection and preservation. It is also through these partnerships that BCWI can assure continuation of the water quality program, which will allow ongoing tracking of and response to changes in the water quality of Boulder Creek and its tributaries. Finally, working cooperatively with others improves the chances of a grassroots effort toward protection of the Boulder Creek watersheds environmental quality for all current and future inhabitants.

a. Partners
We gratefully acknowledge the following ***project partners*** for the valuable guidance and input they have provided to the BCWI water quality monitoring program:

City of Boulder
City of Louisville
Town of Nederland
Boulder County
Keep It Clean Partnership
United States Environmental Protection Agency
United States Geological Survey
Colorado Department of Public Health and Environment
Colorado Division of Wildlife

b. Supporters
BCWI wishes to thank the following ***supporters*** for their financial and/or in-kind support.

Colorado Watershed Protection Fund (Healthy Rivers Fund)
Community Foundation Serving Boulder County
Boulder County
Roche Colorado

c. Volunteers
The program is sustained by a dedicated and passionate group of Stream Team ***volunteers*** that we would like to recognize:

Eldora
Bonnie Greenwood
Pam Sherman
Daniel Sherman
Sally Grahn
Noah Greenburg
Tony Farace
Audrey Godell
Fiona Drozda-Samuels
Elizabeth Drozda-Freeman
Barbara Werner

Louisville
Wolfgang Reitz
Bob Rowland
Bob Bennett

Goose Creek
Moriah Fremd
Lee Stanish
Megan Rheel
Cassy Bohnet

Bear Creek
Holly Stevenson
Anna Lieb
Anna Herring
Anna Triebel
Kathleen Fuller

South Boulder Creek
Brian Vickers
Chris Friedman
Dave Gochis
Matt Kelsch
Brad Thoms
Roy Young

11. Stream Team Report Review

Jim Cowart, Walsh Environmental

12. References

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Appendix A: Colorado Department of Health Water Quality Control Commission Stream Classifications and Water Quality Standards for Boulder Creek Watershed

REGION: 2 and 3 BASIN: Boulder Creek Stream Segment Description	Desig.	Classifications	NUMERIC STANDARDS PHYSICAL and BIOLOGICAL	INORGANIC mg/l		METALS ug/l		
1. All tributaries to Boulder Creek, including all lakes, reservoirs, and wetlands, within the Indian Peaks Wilderness Area.	OW	Aq Life Cold 1 Recreation 1a Water Supply Agriculture	D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 F.Coli=200/100ml E.Coli=126/100ml	NH3 (ac)=TVS NH3 (ch)=0.02 Cl2 (ac)=0.019 Cl2 (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO2 =0.05 NO3 =10 Cl=250 SO4 =WS	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(Tot)	Ni(ac/ch)=TVS Se(ac/ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
2. Mainstem of Boulder Creek, including all tributaries, lakes, reservoirs, and wetlands, from the boundary of the Indian Peaks Wilderness Area to a point immediately above the confluence with South Boulder Creek, except for the specific listings in Segment 3 and 12.		Aq Life Cold 1 Recreation 1a Water Supply Agriculture	D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 F.Coli=200/100ml E.Coli=126/100ml	NH3 (ac)=TVS NH3 (ch)=0.02 Cl2 (ac)=0.019 Cl2 (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO2 =0.05 NO3 =10 Cl=250 SO4 =WS	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(Tot)	Ni(ac/ch)=TVS Se(ac/ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
3. Mainstem of Middle Boulder Creek, including all tributaries, lakes, reservoirs, and wetlands, from the source to the outlet of Barker Reservoir.		Aq Life Cold 1 Recreation 1a Water Supply Agriculture	D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 F.Coli=200/100ml E.Coli=126/100ml	NH3 (ac)=TVS NH3 (ch)=0.02 Cl2 (ac)=0.019 Cl2 (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO2 =0.05 NO3 =10 Cl=250 SO4 =WS	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(Tot)	Ni(ac/ch)=TVS Se(ac/ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
4a. Mainstem of South Boulder Creek, including all tributaries, lakes, reservoirs, and wetlands, from the source to the outlet of Gross Reservoir.		Aq Life Cold 1 Recreation 1a Water Supply Agriculture	D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 F.Coli=200/100ml E.Coli=126/100ml	NH3 (ac)=TVS NH3 (ch)=0.02 Cl2 (ac)=0.019 Cl2 (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO2 =0.05 NO3 =10 Cl=250 SO4 =WS	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(Tot)	Ni(ac/ch)=TVS Se(ac/ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
4b. Mainstem of South Boulder Creek, including all tributaries, lakes, and reservoirs, from the outlet of Gross Reservoir to South Boulder Road, except for specific listings in Segments 4c and 4d.		Aq Life Cold 1 Recreation 1a Water Supply Agriculture	D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 F.Coli=200/100ml E.Coli=126/100ml	NH3 (ac)=TVS NH3 (ch)=0.02 Cl2 (ac)=0.019 Cl2 (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO2 =0.05 NO3 =10 Cl=250 SO4 =WS	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(Tot)	Ni(ac/ch)=TVS Se(ac/ch)=10(Trec) Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
4c. Mainstem of Cowdrey Drainage from the source below Cowdrey Reservoir #2 to the Davidson Ditch.	UP	Aq Life Warm 2 Recreation 1a Water Supply Agriculture	D.O.=5.0 mg/l pH=6.5-9.0 F.Coli=200/100ml E.Coli=126/100ml	CN=0.2 F=2 NO2 =1.0	NO3 =10 Cl=320 SO4 =WS	As(ac)=50 Ba(ac)=1000 Cd(ac)=10 CrIII(ac)=50	Cu(ch)=1000 Fe(ch)=WS(dis) Pb(ac)=50 Mn(ch)=WS(dis)	Se(ch)=10 Ag(ac)=50 Zn(ch)=5000

4d. Mainstem of Cowdrey Drainage from immediately downstream of the Davidson Ditch to the confluence with South Boulder Creek.	UP	Aq Life Warm 2 Recreation 1a Water Supply Agriculture	D.O.=5.0 mg/l pH=6.5-9.0 F.Coli=200/100ml E.Coli=126/100ml	NH3 (ac)=TVS NH3 (ch)=0.06 Cl2 (ac)=0.019 Cl2 (ch)=0.011 CN=0.003	S=0.002 B=0.75 NO2 =0.5 NO3 =10 Cl=320 SO4 =WS	As(ac)=50(Trec) Cd(ac/ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(Tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac/ch)=TVS Zn(ac/ch)=TVS
5. Mainstem of South Boulder Creek from South Boulder Road to the confluence with Boulder Creek.	UP	Aq Life Warm 1 Recreation 1a Water Supply Agriculture	D.O.=5.0 mg/l pH=6.5-9.0 F.Coli=200/100ml E.Coli=126/100ml	NH3 (ac)=TVS NH3 (ch)=0.06 Cl2 (ac)=0.019 Cl2 (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO2 =0.5 NO3 =10 Cl=250	As(ac)=50 Cd(ac/ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(Tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac/ch)=TVS Zn(ac/ch)=TVS
6. Mainstem of Coal Creek, including all tributaries, lakes, reservoirs, and wetlands, from the source to highway 93.	UP	Aq Life Cold 2 Recreation 1a Water Supply Agriculture	D.O.=6.0 mg/l D.O.(sp)=7.0 mg/l pH=6.5-9.0 F.Coli=200/100ml E.Coli=126/100ml	NH3 (ac)=TVS NH3 (ch)=0.02 Cl2 (ac)=0.019 Cl2 (ch)=0.011 CN=0.2	S=0.002 B=0.75 NO2 =0.05 NO3 =10 Cl=250 SO4 =WS	As(ac)=50(Trec) Cd(ac)=TVS(tr) Cd(ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=300(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(Tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac)=TVS Ag(ch)=TVS(tr) Zn(ac/ch)=TVS
7a. Mainstem of Coal Creek from highway 93 to highway 36 (Boulder Turnpike).	UP	Aq Life Warm 1 Recreation 1a Agriculture	D.O.=5.0 mg/l pH=6.5-9.0 F.Coli=200/100ml E.Coli=126/100ml	NH3 (ac)=TVS NH3 (ch)=0.06 Cl2 (ac)=0.019 Cl2 (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO2 =0.5	As(ch)=100(Trec) Cd(ac/ch)=TVS CrIII(ac/ch)=TVS CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Hg(ch)=0.01(Tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac/ch)=TVS Zn(ac/ch)=TVS
7b. Mainstem of Coal Creek from Highway 36 to the confluence with Boulder Creek.	UP	Aq Life Warm 2 Recreation 1a Agriculture	D.O.=5.0 mg/l pH=6.5-9.0 F.Coli=200/100ml E.Coli=126/100ml	NH3 (ac)=TVS NH3 (ch)=0.06 Cl2 (ac)=0.019 Cl2 (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO2 =0.5	As(ch)=100(Trec) Cd(ac/ch)=TVS CrIII(ac/ch)=TVS CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Hg(ch)=0.01(Tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac/ch)=TVS Zn(ac/ch)=TVS
8. All tributaries to South Boulder Creek, including all lakes, reservoirs, and wetlands, from South Boulder Road to the confluence with Boulder Creek and all tributaries to Coal Creek, including all lakes, reservoirs, and wetlands, from Highway 93 to the confluence with Boulder Creek.	UP	Aq Life Warm 2 Recreation 1a Agriculture	D.O.=5.0 mg/l pH=6.5-9.0 F.Coli=200/100ml E.Coli=126/100ml	NH3 (ac)=TVS NH3 (ch)=0.10 Cl2 (ac)=0.019 Cl2 (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO2 =0.5 NO3 =10 Cl=250 SO4 =WS	As(ch)=50(Trec) Cd(ac/ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(Tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac/ch)=TVS Zn(ac/ch)=TVS
9. Mainstem of Boulder Creek from a point immediately above the confluence with South Boulder Creek to the confluence with Coal Creek.		Aq Life Warm 1 Recreation 1a Water Supply Agriculture	D.O.=5.0 mg/l pH=6.5-9.0 F.Coli=200/100ml E.Coli=126/100ml	NH3 (ac)=TVS NH3 (ch)=0.06 Cl2 (ac)=0.019 Cl2 (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO2 =0.5 NO3 =10 Cl=250	As(ac)=50(Trec) Cd(ac/ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac/ch)=TVS Zn(ac/ch)=TVS

					SO4 =WS		Hg(ch)=0.01(Tot)	
10. Mainstem of Boulder Creek from the confluence with Coal Creek to the confluence with St. Vrain Creek.	UP	Aq Life Warm 1 Recreation 1a Water Supply Agriculture	D.O.=5.0 mg/l pH=6.5-9.0 F.Coli=200/100ml E.Coli=126/100ml	NH3 (ac)=TVS NH3 (ch)=0.06 Cl2 (ac)=0.019 Cl2 (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO2 =0.5 NO3 =10 Cl=250 SO4 =WS	As(ac)=50(Trec) Cd(ac/ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(Tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac/ch)=TVS Zn(ac/ch)=TVS
11. All tributaries to Boulder Creek from a point immediately above the confluence with South Boulder Creek to the confluence with St. Vrain Creek, except for specific listings in Segments 5 and 7.	UP	Aq Life Warm 2 Recreation 1a Agriculture	D.O.=5.0 mg/l pH=6.5-9.0 F.Coli=200/100ml E.Coli=126/100ml	NH3 (ac)=TVS NH3 (ch)=0.10 Cl2 (ac)=0.019 Cl2 (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO2 =0.5 NO3 =10 Cl=250 SO4 =WS	As(ac)=50(Trec) Cd(ac/ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(Tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac/ch)=TVS Zn(ac/ch)=TVS
12. Boulder Reservoir and Coot Lake.		Aq Life Warm 1 Recreation 1a Water Supply Agriculture	D.O.=5.0 mg/l pH=6.5-9.0 F.Coli=200/100ml E.Coli=126/100ml	NH3 (ac)=TVS NH3 (ch)=0.06 Cl2 (ac)=0.019 Cl2 (ch)=0.011 CN=0.005	S=0.002 B=0.75 NO2 =0.5 NO3 =10 Cl=250 SO4 =WS	As(ac)=50(Trec) Cd(ac/ch)=TVS CrIII(ac)=50(Trec) CrVI(ac/ch)=TVS Cu(ac/ch)=TVS	Fe(ch)=WS(dis) Fe(ch)=1000(Trec) Pb(ac/ch)=TVS Mn(ac/ch)=TVS Mn(ch)=WS(dis) Hg(ch)=0.01(Tot)	Ni(ac/ch)=TVS Se(ac/ch)=TVS Ag(ac/ch)=TVS Zn(ac/ch)=TVS

Appendix B: Water Quality Equipment						
Company	**Contact**	**Phone #**	**What**	**Quantity**	**Product #**	
Chemetrics	Holly	800-356-3072	V 2000 Photometer	3	V-2000	
			Phosphat ampuoles	3	K-8513	
			Nitrate ampuoles	3	K-6903	
			DO ampuoles	3	K-7513	
			Carrying case	3		
Oakton	Loretta	800-545-0530 #5122	Acorn pH 5 meter	3ea	WD-35613-70	
Extech	Frank	352-683-9095	Exstick Conductivity Meter	3ea	EC410	
VWR		800-865-5220	16 oz wide mouth bottle	1 pack-12	16126-100	
Scientific			250 ml wash bottle	1 pack-4	16651-573	
			1000 ml wide mouth	1 pack-6	16121-081	
Fisher	Misc.	800-766-7000	Field Thermometer	3ea	15-021-B	
Scientific			Latex gloves	1 bx-M	19121-915-B	
				1 bx-L	19121-915-C	
			Kemwipes	3ea	066-66-A	
Dicks Sporting			Waders	11		
Goods						
McGuckin	Randy Dilkes	303-443-1822				
Hardware			Clippers	3ea	Reel tape	3ea
			AA Batteries	12ea	Clipboard	3ea
			pocket protectors	3ea	Pencils	1ea
			Stop watches	3ea	Pens	2ea
			Large tote	3ea	Calculators	3ea
			Carry tote	3ea	Sharpies	3ea
			Blue gloves	4ea	Memo pads	3ea
			Farm gloves	3ea	Clippers	3ea
			Alluminum yardstick	3 ea	Air thermometers	3ea
			Safety glasses	3ea	Screwdrivers	3ea

Appendix C: Data Tables

Stream Team	Team Leader	# of participants	Stream Name	City	Location	Date	Time (24 hr)
Louisville	Bob Roland	2	Coal Creek	Louisville	Above CC Golf Course	1/30/2008	10:30
Eldora	Bonnie Greenwood	5	Middle Bld Cr	Eldora	Marysville Bridge	1/30/2008	14:00
CU Wild	Anna Lieb	4	Skunk Creek	Boulder	CU Research Park	3/19/2008	15:00
S Boulder Creek	Brian Vickers	6	S Boulder Creek	Eldo Spring	Mesa Trailhead	3/22/2008	10:30
4 Mile Creek	Mariah Fremd	6	4 Mile Cany Creek	Boulder	47th Street	4/5/2008	14:30
Louisville	Bob Roland	2	Coal Creek	Louisville	Above CC Golf Course	4/11/2008	9:30
CU Wild	Anna Lieb	4	Skunk Creek	Boulder	End of Walnut	6/14/2008	17:45
S Boulder Creek	Brian Vickers	4	S Boulder Creek	Boulder	Bobolink	6/28/2008	8:20
Eldora	Bonnie Greenwood	5	Middle Bld Cr	Eldora	Marysville Bridge	6/28/2008	16:00
Louisville	Bob Roland	3	Coal Creek	Louisville	Above CC Golf Course	6/29/2008	9:15
S Boulder Creek	Brian Vickers	5	S Boulder Creek	Boulder	Bobolink	7/9/2008	6:20
Eldora	Bonnie Greenwood	7	Middle Bld Cr	Eldora	Marysville Bridge	7/12/2008	14:30
Louisville	Bob Roland	3	Coal Creek	Louisville	Above CC Golf Course	7/13/2008	10:15
CU Wild	Anna Lieb	2	Bear Creek	Boulder	at BC influence	7/13/2008	16:00
S Boulder Creek	Brian Vickers	5	S Boulder Creek	Boulder	Bobolink	8/7/2008	18:15
Louisville	Bob Rowland	3	Coal Creek	Louisville	Above CC Golf Course	8/24/2008	9:30
S Boulder Creek	Brian Vickers	5	S Boulder Creek	Boulder	Bobolink	9/2/2008	18:10
Eldora	Bonnie Greenwood	6	Middle Bld Cr	Eldora	Marysville Bridge	9/20/2008	13:30
CU Wild	Anna Lieb	3	Bear Creek	Boulder	at BC influence	9/21/2008	15:30
S Boulder Creek	Brian Vickers	5	S Boulder Creek	Boulder	Bobolink	10/4/2008	8:00
Goose Creek	Moriah Fremd	2	Goose Creek	Boulder	30th and Mapleton	10/1/2008	17:10
Goose Creek	Moriah Fremd	1	Goose Creek	Boulder	31st and Mapleton	10/24/2008	17:00
S Boulder Creek	Brian Vickers	5	S Boulder Creek	Boulder	Bobolink	11/1/2008	8:05
Eldora	Bonnie Greenwood	8	Middle Bld Cr	Eldora	Marysville Bridge	11/2/2008	14:10
Eldora	Bonnie Greenwood	3	Middle Bld Cr	Eldora	Fisher Property	11/2/2008	16:10
Goose Creek	Moriah Fremd	3	Goose Creek	Boulder	32nd and Mapleton	11/16/2008	13:15
S Boulder Creek	Brian Vickers	6	S Boulder Creek	Boulder	Bobolink	12/6/2008	9:15

Data Tables

Stream Team	Air Temp (°C)	Weather	Flow Rate (cfs)	Dissolved Oxygen (ppm)	Nitrate (.2 - 1.5 ppm)	Phosphate (.3 - 8.0 ppm)	pH	H2O Temp (°C)	Conduc-tivity
Louisville	-1	cold	<5cfs	6.52	0.86	0	n/a	0	n/a
Eldora	-4	cold	n/a	9.3	0.177	0	n/a	n/a	n/a
CU Wild	70	sunny	<5 cfs	9.37	0.105	0.896	6.34	6	789
S Boulder Creek	37F	clear, cool	3 cfs	10.07	0.116	0.019	8.35	5.8	196
4 Mile Creek	55F	sunny	<5cfs	9.9	0.616		n/a	15.2	n/a
Louisville	n/a	cool, sunny	.89cfs	7.03	0.123	n/a	7.41	8.3	n/a
CU Wild	30	sunny, hot	1.164	9.24	0.23	0.226	7.12	26.1	803
S Boulder Creek	21	warm	10.6	7.35	0.139	0.048	7.6	12.4	88
Eldora	74F	warm		8.68	0.124	0	7	17	239
Louisville	70F	warm	12.13	7.7	0.1	0.1	7.48	17.6	243
S Boulder Creek	82F	Partly cloudy	12.8	7.66	0.1	0.019	7.05	18.3	87
Eldora	68	sunny	100.88	8.17	0.108	0.02	7.84	15.7	22
Louisville	75F	sunny	1.39	6.4	0.1	0	7.39	17.2	376
CU Wild	32C	hot, sunny	0.58	10.2	0.2	0	8.01	27.7	727
S Boulder Creek	22	overcast/sprinkling	15	8.05	0.106	0.004	6.82	17.3	55
Louisville	68F	n/a	0.37	5.24	0.31	0.04	7.37	25	n/a
S Boulder Creek	16C	overcast/breezy	9.2	8.032	0.1	0.024	7.1	16.5	66.8
Eldora	59F	partly cloudy	38.16	8.41	0.114	0.109	7.56	8	49
CU Wild	24C	partly cloudy	0.915	12.7	0.29	0.04	7.82	20.4	803
S Boulder Creek	10C	partly cloudy	5	7.75	0.105	below det. Limit	7.03	11.7	74.7
Goose Creek	na	partly cloudy	na	8.08	1.97	0.02	7.99	18.1	988
Goose Creek	15.5C	sunny	0.178	7.99	na	na	7.86	11.2	905
S Boulder Creek	45 F	sunny	9.2	9.1	0.12	below det. Limit	7.24	7.9	131.1
Eldora	58F	partly cloudy	13.55	9.4	0.124	0.056	7.81	5	n/a
Eldora	10C	partly cloudy	34.73	9.6	0.141	0.00 UR	7.75	7.8	n/a
Goose Creek	22.0c	sunny	0.246	9.14	1.42	0.02	8.04	16.2	898
S Boulder Creek	40 C	partly cloudy	NA	8.399	0.141	0.00	7.22	2.3	292

Data Tables

StreamTeam	Team Leader	# of participants	Stream Name	City	Location	Date	Time (24 hr)
Eldora	Bonnie Greenwood	5	Middle Bld Cr	Eldora	Marysville Bridge	1/30/2008	14:00
Eldora	Bonnie Greenwood	5	Middle Bld Cr	Eldora	Marysville Bridge	6/28/2008	16:00
Eldora	Bonnie Greenwood	7	Middle Bld Cr	Eldora	Marysville Bridge	7/12/2008	14:30
Eldora	Bonnie Greenwood	6	Middle Bld Cr	Eldora	Marysville Bridge	9/20/2008	13:30
Eldora	Bonnie Greenwood	8	Middle Bld Cr	Eldora	Marysville Bridge	11/2/2008	14:10
Eldora	Bonnie Greenwood	3	Middle Bld Cr	Eldora	Fisher Property	11/2/2008	16:10
Louisville	Bob Roland	2	Coal Creek	Louisville	Above CC Golf Course	1/30/2008	10:30
Louisville	Bob Roland	2	Coal Creek	Louisville	Above CC Golf Course	4/11/2008	9:30
Louisville	Bob Roland	3	Coal Creek	Louisville	Above CC Golf Course	6/29/2008	9:15
Louisville	Bob Roland	3	Coal Creek	Louisville	Above CC Golf Course	7/13/2008	10:15
Louisville	Bob Rowland	3	Coal Creek	Louisville	Above CC Golf Course	8/24/2008	9:30
CU Wild	Anna Lieb	4	Skunk Creek	Boulder	CU Research Park	3/19/2008	15:00
CU Wild	Anna Lieb	4	Skunk Creek	Boulder	End of Walnut	6/14/2008	17:45
CU Wild	Anna Lieb	2	Bear Creek	Boulder	at BC influence	7/13/2008	16:00
CU Wild	Anna Lieb	3	Bear Creek	Boulder	at BC influence	9/21/2008	15:30
Goose Creek	Moriah Fremd	2	Goose Creek	Boulder	30th and Mapleton	10/1/2008	17:10
Goose Creek	Moriah Fremd	1	Goose Creek	Boulder	30th and Mapleton	10/24/2008	17:00
Goose Creek	Moriah Fremd	3	Goose Creek	Boulder	30th and Mapleton	11/16/2008	13:15
S Boulder Creek	Brian Vickers	6	S Boulder Creek	Eldo Springs	Mesa Trailhead	3/22/2008	10:30
S Boulder Creek	Brian Vickers	4	S Boulder Creek	Boulder	Bobolink	6/28/2008	8:20
S Boulder Creek	Brian Vickers	5	S Boulder Creek	Boulder	Bobolink	7/9/2008	6:20
S Boulder Creek	Brian Vickers	5	S Boulder Creek	Boulder	Bobolink	8/7/2008	18:15
S Boulder Creek	Brian Vickers	5	S Boulder Creek	Boulder	Bobolink	9/2/2008	18:10
S Boulder Creek	Brian Vickers	5	S Boulder Creek	Boulder	Bobolink	10/4/2008	8:00
S Boulder Creek	Brian Vickers	5	S Boulder Creek	Boulder	Bobolink	11/1/2008	8:05
S Boulder Creek	Brian Vickers	6	S Boulder Creek	Boulder	Bobolink	12/6/2008	9:15

Data Tables

StreamTeam	Air (°C)	Weather	Flow (cfs)	Dissolved O2 (ppm)	Nitrate (.2 - 1.5 ppm)	Phosphate (.3 - 8.0 ppm)	pH	Water Temp (°C)	Conduc-tivity
Eldora	-4	cold	n/a	9.3	0.177	0	n/a	n/a	n/a
Eldora	74F	warm		8.68	0.124	0	7	17	239
Eldora	68	sunny	100.88	8.17	0.108	0.02	7.84	15.7	22
Eldora	59F	partly cloudy	38.16	8.41	0.114	0.109	7.56	8	49
Eldora	58F	partly cloudy	13.55	9.4	0.124	0.056	7.81	5	n/a
Eldora	10C	partly cloudy	34.73	9.6	0.141	0.00 UR	7.75	7.8	n/a
Louisville	-1	cold	<5cfs	6.52	0.86	0	n/a	0	n/a
Louisville	n/a	cool, sunny	.89cfs	7.03	0.123	n/a	7.41	8.3	n/a
Louisville	70F	warm	12.13	7.7	0.1	0.1	7.48	17.6	243
Louisville	75F	sunny	1.39	6.4	0.1	0	7.39	17.2	376
Louisville	68F	n/a	0.37	5.24	0.31	0.04	7.37	25	n/a
CU Wild	70	sunny	<5 cfs	9.37	0.105	0.896	6.34	6	789
CU Wild	30	sunny, hot	1.164	9.24	0.23	0.226	7.12	26.1	803
CU Wild	32C	hot, sunny	0.58	10.2	0.2	0	8.01	27.7	727
CU Wild	24C	partly cloudy	0.915	12.7	0.29	0.04	7.82	20.4	803
Goose Creek	na	partly cloudy	na	8.08	1.97	0.02	7.99	18.1	988
Goose Creek	15.5c	sunny	0.178	7.99	na	na	7.86	11.2	905
Goose Creek	22.0c	sunny	0.246	9.14	1.42	0.02	8.04	16.2	898
S Boulder Creek	37F	clear, cool	3 cfs	10.07	0.116	0.019	8.35	5.8	196
S Boulder Creek	21	warm	10.6	7.35	0.139	0.048	7.6	12.4	88
S Boulder Creek	82F	Partly cloudy	12.8	7.66	0.1	0.019	7.05	18.3	87
S Boulder Creek	22	overcast/sprinkling	15	8.05	0.106	0.004	6.82	17.3	55
S Boulder Creek	16C	overcast/breezy	9.2	8.032	0.1	0.024	7.1	16.5	66.8
S Boulder Creek	10C	partly cloudy	5	7.75	0.105	below det. Limit	7.03	11.7	74.7
S Boulder Creek	45 F	sunny	9.2	9.1	0.12	below det. Limit	7.24	7.9	131.1
S Boulder Creek	40 C	partly cloudy	NA	8.399	0.141	0.00	7.22	2.3	292

Water Quality Monitoring

Water Quality Testing Procedures

Discharge, Dissolved Oxygen (Oxygen 2), Nitrate, Phosphate, pH, Temperature, Conductivity

Materials provided:

- Clear container for storage of all Stream Team materials
- Rubbermaid carrying case for sample bottles
- Water Quality Monitoring Field Data Sheet
- Blue folder: Information and Procedures
- **V - 2000 Photometer** (in blue hard case)
- Water Quality parameter Test Kits including laminated instructions (also in blue hard case)
  - **Nitrate** Test Kit
  - **Phosphate 2** Test Kit
  - **Oxygen 2** Test Kit
- **Oakton pH 5 meter in black case** pH and temperature
- **Extech Exstik II** Conductivity meter (also stored in the pH meter's case)
- Safety goggles (3)
- Gloves
- Reel tape measure
- Stakes (2)
- Calculator
- Stop watch
- Thermometer (in degrees Celsius)
- Yard stick (steel)
- Kem-wipes
- Deionized water (in squirt bottle)
- Deionized water (extra bottle)
- pH buffer solutions (7 = yellow, 10 = blue)
- Conductivity calibration solution: 1413 μS/cm conductivity/TDS standard solution
- Used ampoule and waste water container
- Sample Bottle: **Dissolved Oxygen** , **Phosphate and Nitrate**
- Sample Bottle: **pH and conductivity**
- 50/50 alcohol/deionized water solution for cleaning conductivity probe
- Clip Boards (3)
- Pens/Pencils
- Field Journal
- Waders (not included in case; pick up your size when you pick up the case)

Materials needed:

- Oranges for measuring rate of flow.

Water Quality Monitoring

Water Quality Testing Procedures
Discharge, Dissolved Oxygen (Oxygen 2), Nitrate, Phosphate, pH, Temperature, Conductivity

Table of Contents

SETUP PROCEDURES

1. Remove cover and wetting cap from the **pH** meter. Place pH electrode in the pH 7 buffer solution to soak for at least 10 minutes. You may collect samples as electrode is soaking.
2. Fill out site information on the **Field Data Sheet.**
3. Using the thermometer inside of the blue case, take the air temperature measurement.
4. Follow the testing procedures in order.

TESTING PROCEDURES

I. DISCHARGE (RATE OF FLOW)

1. The stream length chosen for the measurement of rate of flow should be straight (no bends), at least 6 inches deep, and should not contain an area of slow water such as a pool.
2. Measure a 20 foot length of stream you will study. Mark the beginning and end of the segment with a stick or stone. Record length on the Field Data Sheet.
3. Use the tape measure to measure stream width, and stake ends on each bank. Keep the tape measure in this position to identify where you will take stream depth measurements.
4. Using the yard stick, take stream depth measurements at ¼, ½, and ¾ way across the stream. Record stream width and depths and calculate and record the average stream depth on the Field Data Sheet.
5. One person releases an orange in the fastest part of the stream 20 feet upstream of the stream segment. Another person stands at the downstream and uses the stop watch to measure the time it takes for the orange to float the 20 foot stream length. Another person scoops the orange out of the water. This "time of travel" measurement should be conducted **three (3) times** and recorded on the Field Data Sheet. Calculate the average time of travel.
6. Calculate discharge and record on the Field Data Sheet.

II. COLLECTING WATER SAMPLES

Grab Sample for Dissolved Oxygen

A **grab sample** is a sample of water collected at one point in the stream.

1. Carefully wade into the fastest part of the stream.
2. Rinse the sample bottle three times with stream water, emptying the water downstream of you.
3. Submerge the sample bottle completely, and allow water to flow into it for 2 minutes to ensure that no air bubbles are trapped inside the sample bottle. Cap bottle while it is submerged under water.

Composite Sample for Nitrate, Phosphate, pH, and Conductivity

A **composite sample** is a sample of water collected across the width of a stream at appropriate frequencies based upon stream width.

1. Carefully wade into the stream.
2. Rinse the sample bottle three times with creek water, emptying the water downstream. Be sure to fill the sample bottle upstream of you so that you are not collecting sediment disturbed by your feet.
3. At ¼ way across the stream, fill 1/3 of the sample bottle gradually, avoiding any turbulence (which would add oxygen to the sample).
4. Repeat this step ½ way across the stream.
5. At ¾ way across the stream, fill the rest of the bottle with water. Cap the bottle under water.

III. MEASURING DISSOLVED OXYGEN, NITRATE AND PHOPHATE

1. **FOR ALL PARTICPANTS' SAFETY, WHEN WORKING WITH CHEMICALS** each participant using and/or observing close to equipment must wear **safety goggles and gloves.**
2. Photometer is in the blue case. All three test kits also belong in this case.
3. Turn on the photometer by pressing the **(power)** key.
4. Remove all dirt and fingerprints from the ampoule before inserting in photometer.
5. Make sure the ampoule is seated properly all the way down.
6. Always cover the ampoule with the ***light shield*** prior to zeroing the instrument, setting a reagent blank value, or measuring a sample.

Dissolved Oxygen

1. Press the **(prgm)** key; enter **Program number 141: Oxygen 2.**
2. Using a paper towel, remove all dirt and fingerprints from the zeroing ampoule.
3. Insert the zeroing ampoule into the photometer with the white line on the ampoule facing the key pad. Cover the zeroing ampoule with the ***light shield***, and press the **(zero)** key.
   "WAIT" is displayed until the result is displayed as **"0.000".**
4. Fill the sample cup to the **25 mL** mark with the DO sample.
5. Place the Vacu-vial ampoule against the side of the cup. Snap the tip by pressing the ampoule down against the side of the cup. The ampoule will fill, leaving a small bubble to facilitate mixing.
6. Mix the contents of the ampoule by inverting several times, allowing the bubble to travel from end to end each time. ***BE CARFUL NOT TO PLACE FINGER ON TIP OF AMPOULE, TIP WILL BE VERY SHARP.*** Using a paper towel, wipe all liquid from exterior of the ampoule.
7. Insert the resulting test ampoule in the photometer. Cover the test ampoule with the ***light shield.***
8. Press **(meas)** key. Color development wait time is specified in the parameter specific test procedure. Color development for DO will take **2 minutes**. The photometer timer will begin countdown and automatically proceed to the measure mode when wait time is complete. The instrument will read the test ampoule and display the test result.
9. Record the test result on the Field Data Sheet.
10. Place used ampoule and chemicals in the WASTE bottle.

Nitrate

1. Press the **(prgm)** key; enter the **Program number 119: Nitrate.**
2. Using a paper towel , remove all dirt and fingerprints from the zeroing ampoule
3. Insert the zeroing ampoule into the photometer; cover the zeroing ampoule with the light shield and press the **(zero)** key. "**WAIT**" is displayed until the result is displayed as"**0.000**".
4. Fill the **reaction tube** (small bottle with lime green lid) to the **15 mL** mark with Nitrate sample.
5. Empty the contents of **one (1) cadmium foil pack** into the reaction tube. Cap the reaction tube and shake vigorously for ***exactly 3 minutes***. Allow sample to sit undisturbed for ***2 minutes.***
6. Pour **10 mL** of the sample into the sample cup, being careful not to transfer any cadmium particles to the **sample cup**.
7. Place the Vacu-vial ampoule against the side of the cup. Snap the tip by pressing the ampoule down against the side of the cup. The ampoule will fill, leaving a small bubble to facilitate mixing.
8. Mix the contents of the ampoule by inverting several times, allowing the bubble to travel from end to end each time. ***BE CARFUL NOT TO PLACE FINGER ON TIP OF AMPOULE, TIP WILL BE VERY SHARP.*** Using a paper towel, wipe all liquid from exterior of the ampoule.

9. Insert the resulting test ampoule in the photometer. Cover the test ampoule with the ***light shield.***
10. Press (**meas)** key. Color development for Nitrate will take **10 minutes**. The photometer timer will begin to countdown, and automatically proceed to the measure mode when wait time is complete. The instrument will read the test ampoule and display the test result.
11. Record the test result on the Field Data Sheet.
12. Place used ampoule and chemicals in the WASTE bottle.

Phosphate

1. Press the **(prgm)** key; enter the **Program number 159: Phosphate 2.**
2. Using a paper towel, remove all dirt and fingerprints from the zeroing ampoule.
3. Insert the zeroing ampoule into the photometer; cover the zeroing ampoule with the ***light shield***, and press the **(zero)** key." **WAIT**" is displayed until the result is displayed as "**0.000**".
4. Fill the sample cup to the **25 mL** mark with the sample.
5. Add **2 drops** of **A-8500 Activator Solution**. Cap the sample cup and shake it to mix the contents well.
6. Place the Vacu-vial ampoule against the side of the cup. Snap the tip by pressing the ampoule down against the side of the cup. The ampoule will fill, leaving a small bubble to facilitate mixing.
7. Mix the contents of the ampoule by inverting several times, allowing the bubble to travel from end to end each time. ***BE CARFUL NOT TO PLACE FINGER ON TIP OF AMPOULE, TIP WILL BE VERY SHARP.*** Using a paper towel, wipe all liquid from exterior of the ampoule.
8. Insert the resulting test ampoule in the photometer. Cover the test ampoule with the ***light shield.***
9. Press (**meas)** key. Color development for Phosphate will take **3 minutes**. Photometer timer will begin to countdown, and will automatically proceed to the measure mode when wait time is complete. The instrument will read the test ampoule and display the test result.
10. Record the test result on the Field Data Sheet.
11. Place used ampoule and chemicals in the WASTE bottle.

Troubleshooting the V-2000

- If the V-2000 Photometer gives an error message, produces a suspect test result or in any way malfunctions, see directions for the Self-test in Section 2-9 of the V-2000 Photometer Operator's Manual.
- If battery dies, please see instructions in V-2000 Photometer Operator's Manual, Chapter 1: **Battery Installation**.
- If you have to insert the adaptor: The tabs on the adaptor (left and right sides) should be matched up with the alignment slots to the left and right of the sample cell compartment. Insert the adapter with the correct alignment and push down firmly until it snaps into place. Disregard the lock-unlock feature on the ampoule cell compartment. Do not attempt to turn the adaptor from left to right when inserting or removing it.

IV. pH, TEMPERATURE AND CONDUCTIVITY

pH and TEMPERATURE

1. Remove the pH probe from the electrode storage solution. Pour used electrode storage solution into the waste bottle.
2. pH meter should have been soaking for at least 10 minutes (see Setup Procedures). If not, soak it in the pH 7 buffer solution for 10 minutes.
3. Follow the procedures under "Composite Sample" to collect a composite sample for pH, Temperature and Conductivity tests.
4. Rinse pH and temp probes with deionized water using DI squirt bottle.
5. Calibrate probe using **pH 7 *and* pH 10 buffers** following steps 10 – 17.
6. Pour **10 mL of pH 7 in the bottle marked pH 7.**
7. Power on the meter and it automatically enters into measurement mode. Select pH mode by pressing mode key, if necessary.
8. Dip both pH electrode and temperature probe into **pH 7.00** buffer solution. Swirl gently and wait for reading to stabilize (approx. 30 seconds depending on your electrode condition).
9. Press **CAL** key to enter pH calibration mode. A **"CA"** displays momentarily and the display shows the current uncalibrated reading flashing while in the calibration mode.
10. To abort or cancel calibration without accepting new value, press **CAL** key. The meter then reverts to pH measurement mode.
11. To proceed with calibration, allow reading to stabilize. The meter automatically recognizes pH 4.01, 7.00, or 10.01 buffers. Press **ENTER** key to confirm calibration and LCD displays **"CO"** momentarily. The meter reverts to *measurement* mode.
12. For 2 point calibration, repeat with pH **10.01** buffer. See steps 13 – 16.
13. Rinse pH electrode and temperature probe with deionized water using DI squirt bottle.
14. Pour **10 mL** of **pH 10** in the bottle marked **pH 10.**
15. Dip both pH electrode and temperature probe into pH 10.01 buffer solution. Swirl gently and wait for reading to stabilize (approx. 30 seconds depending on your electrode condition).
16. Press **CAL** key to enter pH calibration mode. A **"CA"** displays momentarily and the display shows the current uncalibrated reading flashing while in the calibration mode.
17. Record calibration readings for pH 7 and 10 buffer test result on the **Calibration readings: 7pH buffer**/ **10 pH buffer** line on the Field Data Sheet.
18. Rinse pH electrode, temperature probe, and both small bottles with deionized water using DI squirt bottle. Pour used buffer solutions and wastewater into the waste bottle.
19. Power on the meter and it automatically enters into measurement mode. Select pH mode by pressing mode key if necessary.
20. Dip both pH electrode and temperature probe into test sample. Swirl gently and wait for reading to stabilize (approx. 30 seconds depending on your electrode condition). **Take readings until same endpoint is reached twice in a row.**
21. Record the pH and temperature test results on the **pH / Temperature (°C)** line on the Field Data Sheet.
22. Rinse pH electrode and temperature probe with deionized water.
23. When finished with pH and temperature measurement, refill wetting cap with new electrode storage solution and replace on end of pH probe.

When not in use, the pH probe should always have the wetting cap with electrode storage covering the tip. FAILURE TO REPLACE WETTING CAP WILL RESULT IN PERMANENT DAMAGE TO THE pH electrode.

CONDUCTIVITY

1. Conductivity is measured in **µS/cm (**microSiemens per centimeter) with Extech ExStik II meter. Calibrate the conductivity probe using **1413 µS/cm conductivity standard solution**. Follow steps 2 – 7 below. Calibration should always be done in *conductivity* mode.
2. Rinse electrode with deionized water and dry with Kimwipe.
3. Fill plastic sample cup with 20 mL 1413 µS/cm conductivity standard solution.
4. Turn the meter **ON** and insert the electrode into the standard solution. Tap or move the electrode in the solution to dislodge any air bubbles.
5. Press and hold the **CAL/RECALL** button (approximately 2 seconds) until **"CAL"** appears in the lower (temp) display. The main display will start flashing.
6. The meter will automatically recognize and calibrate to the standardizing solution. The display will briefly indicate **"SA",** end then return to the measurement mode after calibration.
7. The "range calibrated" symbol will appear in the display for the range calibrated, in this case, **M** for medium range, 1413 µS/cm.
8. Record calibration on the Field Data Sheet.
9. Rinse electrode with deionized water and dry with Kimwipe. Pour used solution into the waste bottle.
10. Depress and hold the **MODE/HOLD** key to scroll to the desired measurement mode.
11. Insert the electrode into the sample making sure that the electrodes are completely submerged. Tap or move the electrode in the sample to dislodge any air bubbles.
12. The meter will auto-range to the proper range and then display the reading. Take readings until same endpoint is reached ***twice in a row***.
13. Record the test result on the **Conductivity: ________ µS/cm** line on the Field Data Sheet.
14. Rinse electrode with deionized water and dry with Kimwipe. Pour out sample water.
15. When finished with conductivity measurements, rinse conductivity probe with **50/50 alcohol/deionized water solution** by placing in solution and stirring for a few seconds. Dry with a Kimwipe.
16. Replace protective cover over meter and store meter in the black hard case with the pH meter.

V. CLEAN UP

- Carefully replace all equipment and sample bottles in carrying case. Empty all sample bottles. Rinse with deionized water and empty. Leave lids off sample bottles in fabric carrying case so bottles can dry.

- Make sure all solution bottle lids are on tight. Replace all calibrating solutions in their ziplock bags.

- Tightly seal top of WASTE bottle.

- Place all sample bottles in carrying case and pack all equipment in clear container.

- Complete any notes on the Field Data Sheet.

- Double check site for any remaining equipment, sample bottles, lids, trash, etc.

Updated 4/01/08

Stream Team Water Quality Terminology
Provided by Sheila Murphy – USGS and basin.org

Water quality parameters provide important information about the health of a water body. These parameters are used to find out if the quality of water is good enough for drinking water, recreation, irrigation, and aquatic life. But what do the parameters really mean? How are they measured? What natural and man-made factors affect them? This page provides a brief summary of what each water quality parameter means. For more information, visit www.basin.org.

Conductivity (Specific Conductance) is a measure of how well water can pass an electrical current. It is an indirect measure of the presence of inorganic dissolved solids, such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, and iron. These substances conduct electricity because they are negatively or positively charged when dissolved in water. The concentration of dissolved solids, or the conductivity, is affected by the bedrock and soil in the watershed. It is also affected by human influences. For example, agricultural runoff can raise conductivity because of the presence of phosphate and nitrate.

Dissolved Oxygen (DO) is the amount of oxygen dissolved in the water. DO is a very important indicator of a water body's ability to support aquatic life. Fish "breathe" by absorbing dissolved oxygen through their gills. Oxygen enters the water by absorption directly from the atmosphere or by aquatic plant and algae photosynthesis. Oxygen is removed from the water by respiration and decomposition of organic matter. The amount of DO in water depends on several factors, including temperature (the colder the water, the more oxygen can be dissolved); the volume and velocity of water flowing in the water body; and the amount of organisms using oxygen for respiration. Human activities that affect DO levels include the removal of riparian vegetation, runoff from roads, and sewage discharge.

Flow is the volume of water moving past a point in a unit of time. Two things make up flow: the volume of water in the stream, and the velocity of the water moving past a given point. Flow affects the concentration of dissolved oxygen, natural substances, and pollutants in a water body. Flow is measured in units of **cubic feet per second (cfs).**

Nitrogen is required by all organisms for the basic processes of life to make proteins, to grow, and to reproduce. Nitrogen is very common and found in many forms in the environment. Inorganic forms include **nitrate (NO_3)**, **nitrite (NO_2)** , **ammonia (NH_3)**, and **nitrogen gas (N_2)** . Organic nitrogen is found in the cells of all living things and is a component of proteins, peptides, and amino acids. Excessive concentrations of **nitrate**, nitrite, or ammonia can be harmful to humans and wildlife. High levels of nitrate, along with **phosphate**, can overstimulate the growth of aquatic plants and algae, resulting in high dissolved oxygen consumption, causing death of fish and other aquatic organisms. This process is called ***eutrophication***. Nitrate, nitrite, and ammonia enter waterways from lawn fertilizer run-off, leaking septic tanks, animal wastes, industrial waste waters, sanitary landfills and discharges from car exhausts.

pH measures hydrogen concentration in water and is presented on a scale from 0 to 14. A solution with a pH value of 7 is neutral; a solution with a pH value less than 7 is acidic; a solution with a pH value greater than 7 is basic. Natural waters usually have a pH between 6 and 8.5. The scale is negatively logarithmic, so each whole number (reading downward) is ten times the preceding one (for example, pH 5.5 is 100 times as acidic as pH 7.5). The pH of natural waters can be made acidic or basic by human activities such as acid mine drainage and emissions from coal-burning power plants and heavy automobile traffic.

Phosphate: Phosphorus is a nutrient required by all organisms for the basic processes of life. Phosphorus is a natural element found in rocks, soils and organic material. Its concentrations in clean waters is generally very low; however, phosphorus is used extensively in fertilizer and other chemicals, so it can be found in higher concentrations in areas of human activity. Phosphorus is generally found as **phosphate** (PO_4^{-3}). High levels of phosphate, along with **nitrate**, can overstimulate the growth of aquatic plants and algae, resulting in high dissolved oxygen consumption, causing death of fish and other aquatic organisms. The primary sources of phosphates to surface water are detergents, fertilizers, and natural mineral deposits.

Temperature of water is a very important factor for aquatic life. It controls the rate of metabolic and reproductive activities. Most aquatic organisms are "cold-blooded," which means they can not control their own body temperatures. Their body temperatures become the temperature of the water around them. Cold-blooded organisms are adapted to a specific temperature range. If water temperatures vary too much, metabolic activities can malfunction. Temperature also affects the concentration of dissolved oxygen and can influence the activity of bacteria in a water body.

StreamTeam Water Monitoring Field Data Sheet

StreamTeam Group: ____

Team Leader _______________ # of participants: __________ Hours worked: __________

Stream Name: __________________________ City: _______________________________

Location name/trailhead/streets/etc.: ____

Date of Sample: ________/_______/_______ Time of Sample (24 hr): ________ : ________

Air Temp (°C) / Weather Conditions: ____

Discharge (Flow rate)

Width of stream: ________ feet (ft) ***(Remember, 12 inches = 1 foot, so 5 feet 6 inches = 5.5 feet)***

Depth: ¼ way across: _______ ft ½ way across: _______ ft ¾ way across: _______ ft

Average depth: _______ ft

Length of stream measured: ____20____ ft

Time of travel: First time: _____ seconds (s) Second time: _____ (s) Third time: _____ (s)

Average time of travel: _______ (s)

Surface velocity (speed) = length / average time = _______ ft/s

Average velocity = surface velocity x 0.80 = __________ ft/s

(Water at the surface travels faster than the rest of the stream due to resistance from the stream bottom, so surface velocity is multiplied by a correction coefficient to estimate average velocity)

Discharge = width x depth x velocity = __________________ cubic feet per second (cfs or ft^3/s)

Measurements with Chemetrics V-2000: Grab and composite samples

1. **Dissolved Oxygen (DO)**
Grab sample from mid-stream. ***Remember to set program and zero unit out before inserting sample ampoule.***

Dissolved Oxygen reading __________ ppm

2. **Nitrate**
Composite sample of left bank, mid-stream, and right bank. ***Remember to set program and zero unit out before inserting sample ampoule.***

Nitrate reading __________ ppm

3. **Phosphate**
Composite sample of left bank, mid-stream, and right bank. ***Remember to set program and zero unit out before inserting sample ampoule.***

Phosphate reading __________ ppm

Measurements with pH meter: *Composite sample*

pH/ Temperature measurement with Oakton pH 5 meter

1. **Soak pH probe in 7 buffer solution for at least 10 minutes prior to use.**

2. **Calibrate probe *before* taking measurements of samples. Rinse with Deionized water and dry with Kimwipe before dipping in new buffer or sample.**

   Calibration readings: 7pH buffer (yellow) _________ **10 pH buffer** (blue) ________

3. **Measurements: *Take readings until same endpoint appears twice in a row.***

   pH _________ Temperature (°C) __________

Rinse tips of pH electrode and temperature probe with deionized water. Dry with Kimwipe. Replace wetting cap with electrode storage solution on tip of pH electrode. Failure to replace the wetting cap will result in PERMANENT DAMAGE to the unit.

Conductivity measured in **µS/cm (**microSiemens per centimeter) with Extech Exstik meter.

1. **Calibrate probe in 1413 µS/cm solution *before* taking measurements of samples.**

2. **Measurements: *Take readings until same endpoint appears twice in a row.***

   Conductivity: ________ µS/cm

When finished with conductivity measurements, rinse conductivity probe with **50/50 alcohol/deionized water solution.** Dry with Kimwipe, replace protective cap, and place in black hard case with pH meter.

Updated 006/02/08