2. Subbasin Assessment – Water Quality Concerns and Status

This section contains an assessment of water quality concerns and status for all ten of the water quality impaired subwatersheds in the Lower Clark Fork River subbasin. Twenty-five water quality limited segments within these subwatersheds are identified in this section, along with a discussion of the applicable water quality standards for these water bodies, existing water quality data, and data gaps. Monitoring performed by DEQ, Avista Utilities, the Tri-State Water Quality Council and the USFS has identified water quality concerns in these subwatersheds.

2.1 Water Quality Limited Assessment Units Occurring in the Subbasin

The Clean Water Act mandates that the chemical, physical, and biological integrity of the nation's waters be restored and maintained (33 USC §§ 1251 – 1387). In accordance with this mandate, the State of Idaho has adopted water quality standards per section 318 of the CWA, to protect fish, shellfish, and wildlife while providing recreation in and on water whenever attainable. As required by section 303(d) of the CWA the state must identify and prioritize water bodies that are water quality limited (i.e., exhibit impaired beneficial uses). The list of water quality limited waters is published every two years. For waters identified as impaired, TMDLs are set at a level to achieve the state's water quality standards by supporting beneficial uses.

The river and its tributaries on the 303(d) list for impairment due to metals, sediment, total dissolved gas and temperature are shown in Table 5. A discussion of the pollutants, available data, beneficial uses, and exceedances of standards is presented in the following sections.

Section 303(d) of the CWA states that waters that are unable to support their beneficial uses and that do not meet water quality criterion must be listed as water quality limited waters. Subsequently, these waters are required to have TMDLs developed to set load targets consistent with water quality standards. In 2002, the DEQ further refined its system of managing data for water quality limited streams by establishing assessment units throughout the state. This process is described below.

About Assessment Units

Assessment units (AUs) are groups of similar streams that have similar land use practices, ownership, or land management. Stream order is the main basis for determining AUs. If ownership and land use change significantly, the AU can be further delineated. Over 5,200 AUs define all the waters of the state of Idaho. These units and the methodology used to describe them can be found in the Water Body Assessment Guidance II (Grafe et al. 2002).

Using assessment units to describe water bodies offers many benefits, the primary benefit being that all the waters of the state are now defined consistently. In addition, using AUs fulfills the fundamental requirement of EPA's section 305(b) report, a component of the Clean Water Act wherein states report on the condition of all the waters of the state. Because AUs are a subset of water body identification numbers identified in state code, there is now a direct tie to the water quality standards for each AU. Beneficial uses defined in the water quality standards are clearly tied to streams on the landscape.

The new framework of using AUs for reporting and the reconciliation of the legacy of 303 (d) listed streams occurred when Idaho submitted the 2002 Integrated Report and is reflected in this report. Due to the nature of court-ordered 1994 303(d) listings, and the subsequent 1998 303(d) list, all segments were added with boundaries from "headwaters to mouth" in 1998.

Impaired Waters

Table 5 shows the AU boundaries and the pollutants identified as impairing beneficial uses in the 2002 Integrated Report. The subbasin assessment is an opportunity for DEQ and Watershed Advisory Groups to take a deeper look at the status of assessment units. Not all of the water bodies identified as impaired will require a TMDL, as will be discussed later. In addition, the subbasin assessment process identified additional pollutants that are impairing beneficial uses and these are proposed for addition to Section 5 of the next Integrated Report. A thorough investigation of available data was performed before any status changes were recommended. This investigation, along with a presentation of the evidence of non-compliance with standards is contained in the following sections.

Table 5. Impaired water bodies in the Lower Clark Fork River Subbasin identified in the 2002 Integrated Report Section 5.

Water Body Name	Assessment Unit	Boundaries	Pollutants	Beneficial Uses [a]
Clark Fork River	17010213PN005_08	Mainstem Clark Fork River forebay portion from the Idaho/Montana Border to Cabinet Gorge Dam	TDG, Metals, Unknown[b], Temperature	CWAL, SS, PCR, DWS, SRW (Designated)
	17010213PN003_08	Mainstem Clark Fork River from Cabinet Gorge Dam to Mosquito Creek		
	17010213PN001_08	Mainstem Clark Fork River delta portion, Mosquito Creek to Lake Pend Oreille		
Cascade Creek	17010213PN012_02	First and second order portions of Cascade Creek, including the mainstem to Lightning Creek	Temperature	CWAL, SS, SCR (Existing)
Dry Creek	17010213PN004_02a	Dry Creek – source to Twin Creek	Temperature	CWAL, SS, SCR (Existing)
Twin Creek	17010213PN004_03	Third order portion of mainstem Twin Creek from Delyle Creek to the Lower Clark Fork River	Temperature	CWAL, SS, SCR (Existing)
	17010213PN004_02	First and second order portions of Twin Creek to Delyle Creek, including Delyle Creek		
Mosquito Creek	17010213PN009_02	Mosquito Creek source to Lower Clark Fork River	Temperature	CWAL, SS, SCR (Existing)

Water Body Name	Assessment Unit	Boundaries	Pollutants	Beneficial Uses [a]
East Fork Creek	17010213PN014_02	First and second order portions of East Fork Creek, including mainstem East Fork Creek from Idaho/Montana border to Savage Creek	Temperature, Sediment	CWAL,SS, SCR (Existing)
	17010213PN014_03	Third order portion of mainstem East Fork Creek from Savage Creek to Lightning Creek		
Johnson Creek	17010213PN002_02	First and second order portions of Johnson Creek, including West Johnson Creek	Temperature, Sediment	CWAL, SS, PCR (Existing)
	17010213PN002_03	Third order portion of Johnson Creek to the Clark Fork Delta		
Upper Lightning Creek	17010213PN0019_02	First and second order portions of Lightning Creek from source to Rattle Creek	Temperature, Unknown[c]	CWAL, SS, PCR, DWS, SRW (Designated)
	17010213PN0019_03	Third order portion of mainstem Lightning Creek from Fall Creek to Rattle Creek		
Middle Lightning Creek	17010213PN0017_02	First and second order portions of Lightning Creek from Rattle Creek to Wellington Creek, including Sheep and Bear Creeks	Temperature, Unknown[c]	CWAL, SS, PCR, DWS, SRW (Designated)
	17010213PN0017_03	Third order portion of mainstem Lightning Creek from Rattle Creek to Wellington Creek		
	17010213PN0016_02	First and second order portions of Lightning Creek from Wellington Creek to East Fork Creek, including Porcupine Creek		
	17010213PN0016_03	Third order portion of Lightning Creek mainstem from Wellington Creek to East Fork Creek		

Water Body Name	Assessment Unit	Boundaries	Pollutants	Beneficial Uses [a]
Lower Lightning Creek	17010213PN0013_02	First and second order portions of Lightning Creek from East Fork Creek to Cascade Creek, including Morris Creek	Temperature, Unknown[c]	CWAL, SS, PCR, DWS, SRW (Designated)
	17010213PN0013_04	Fourth order portion of mainstem Lightning Creek from East Fork Creek to Cascade Creek		
	17010213PN0011_02	First and second order portions of Lightning Creek from Cascade Creek to Spring Creek		
	17010213PN0011_04	Fourth order portion of mainstem Lightning Creek from Cascade Creek to Spring Creek		
	17010213PN0010_04	Fourth order portion of mainstem Lightning Creek from Spring Creek to the Clark Fork River		
Rattle Creek	17010213PN018_02	First and second order portions of Rattle Creek from headwaters to Lightning Creek	Temperature	CWAL,SS, SCR (Existing)
Savage Creek	17010213PN015_02	First and second order portions of Savage Creek from the Idaho/Montana border to East Fork Creek	Temperature	CWAL,SS, SCR (Existing)
Wellington Creek	17010213PN020_02	First and second order portions of Wellington Creek from the headwaters to Lightning Creek	Temperature, Sediment	CWAL,SS, SCR (Existing)

[a] CWAL – cold water aquatic life, SS – salmonid spawning, PCR – primary contact recreation, SCR – secondary contact recreation, AWS – agricultural water supply, DWS – domestic water supply, SRW – special resource water

[b] The Subbasin Assessment process determined that all known impairments in the Clark Fork River are identified as temperature, metals and total dissolved gas. This unknown listing is recommended for removal.

[c] Unknown biological impairments were identified as sediment during the development of the SBA and TMDLs for sediment were developed.

In addition to those pollutants listed in Table 5, all AUs in the mainstem Clark Fork River and Johnson Creek were included on the 2002 Integrated Report, Section 4C, "Rivers Impaired by Flow or Habitat Alteration," (IDEQ 2005). DEQ recognizes that these impairments impact beneficial uses of a water body. Because habitat and flow alterations are characterized as pollution, but are not measurable pollutants, TMDLs will not be developed for these impairments.

2.2 Applicable Water Quality Standards

Existing beneficial uses and water quality standards for water bodies in the Lower Clark Fork subbasin are discussed below. Designated beneficial uses for the Lower Clark Fork include cold water aquatic life, salmonid spawning, primary contact recreation, domestic water supply, and special resource water (IDAPA 58.01.02.04). The designated beneficial uses of water bodies in the subbasin are presented in Table 5 and Table 6. Section 303(d) listed tributaries that have not had beneficial uses designated have been assigned existing beneficial uses. These include cold water aquatic life, salmonid spawning, and primary or secondary contact recreation (IDAPA 58.01.02.101.01). Narrative and numeric water quality standards relevant to designated beneficial uses are also discussed in this section.

Beneficial Uses

Idaho water quality standards require that surface waters of the state be protected for beneficial uses, wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are interpreted as existing uses, designated uses, and presumed uses as briefly described in the following paragraphs. The *Water Body Assessment Guidance*, second edition (Grafe et al. 2002) gives a more detailed description of beneficial use identification for use assessment purposes.

Existing Uses

Existing uses under the CWA are "those uses actually attained in the waterbody on or after November 28, 1975, whether or not they are included in the water quality standards." The existing in-stream water uses and the level of water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.050.02, 58.01.02.051.01, and 58.01.02.053). Existing uses include uses actually occurring, whether or not the level of quality to fully support the uses exists. A practical application of this concept would be to apply the existing use of salmonid spawning to a waterbody that could support salmonid spawning, but salmonid spawning is not occurring due to other factors, such as dams blocking migration.

Designated Uses

Designated uses under the Clean Water Act are "those uses specified in water quality standards for each water body or segment, whether or not they are being attained." Designated uses are simply uses officially recognized by the state. In Idaho, these include uses such as aquatic life support, recreation in and on the water, domestic water supply, and agricultural uses. Water quality must be sufficiently maintained to meet the most sensitive use. Designated uses may be added or removed using specific procedures provided for in state law, but the effect must not be to preclude protection of an existing higher quality use such as cold water aquatic life or salmonid spawning. Designated uses are specifically listed for water bodies in Idaho in tables in the Idaho water quality standards (see IDAPA 58.01.02.003.27 and 58.01.02.109-.02.160 in addition to citations for existing uses).

Presumed Uses

In Idaho, most water bodies listed in the tables of designated uses in the water quality standards do not yet have specific use designations. These undesignated uses are to be designated. In the interim, and absent information on existing uses, DEQ presumes that most waters in the state will support cold water aquatic life and either primary or secondary contact recreation (IDAPA 58.01.02.101.01). To protect these so-called "presumed uses," DEQ will apply the numeric cold water criteria and primary or secondary contact recreation criteria to undesignated waters. If in addition to these presumed uses, an additional existing use, (e.g., salmonid spawning) exists, because of the requirement to protect levels of water quality for existing uses, then the additional numeric criteria for salmonid spawning would additionally apply (e.g., intergravel dissolved oxygen, temperature).

Table 6. Lower Clark Fork Subbasin beneficial uses of streams that have not been assessed.

Water Body Name	Assessment Unit	Boundaries	Status	Beneficial Uses[a]
West Fork Elk Creek	17010213PN006_02	West Fork Elk Creek Source to Idaho/Montana Border	Not Assessed	CWAL, SS, SCR (Presumed)
West Fork Blue Creek	17010213PN007_02	West Fork Blue Creek source to Idaho/Montana border	Not Assessed	CWAL, SS, SCR (Presumed)
Gold Creek	17010213PN008_02	Gold Creek source to Idaho/Montana border	Not Assessed	CWAL, SS, SCR (Presumed)
Spring Creek	170213PN021_02	First and second order portions of Spring Creek from headwaters to confluence with Lightning Creek	Full Support Needs Verification	CWAL, SS, SCR (Presumed)
Cougar Creek	170213PN021_02a	Cougar Creek headwaters to Denton Slough	Not Assessed	CWAL, SCR (Presumed)
Johnson Creek delta area	17010213PN001_03	Johnson Creek – third order portion in the delta area of the Lower Clark Fork River	Not Assessed	CWAL, SS, PCR (Presumed)
Clark Fork River	17010213PN003_02	First and second order unnamed tributaries to Clark Fork River	Not Assessed	CWAL, SS, SCR (Presumed)
Dry Creek	17010213PN004_02a	First and second order portions of Dry Creek to its confluence with Twin Creek	Not Assessed	CWAL, SS, SCR (Presumed)
Derr Creek	17010213PN001_02	Derr Creek – source to Johnson Creek	Not Assessed	CWAL, SS, SCR (Presumed)

[a] CW – cold water, SS – salmonid spawning, PCR – primary contact recreation, SCR – secondary contact recreation, AWS – agricultural water supply, DWS – domestic water supply

Criteria to Support Beneficial Uses

Beneficial uses are protected by a set of criteria, which include *narrative* criteria for pollutants such as sediment and nutrients and *numeric* criteria for pollutants such as bacteria, dissolved oxygen, pH, ammonia, temperature, and turbidity (IDAPA 58.01.02.250) (Table 7).

Excess sediment is described by narrative criteria (IDAPA 58.01.02.200.08): "Sediment shall not exceed quantities specified in Sections 250 and 252 or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Determinations of impairment shall be based on water quality monitoring and surveillance and the information utilized as described in Subsection 350."

Narrative criteria for excess nutrients are described in IDAPA 58.01.02.200.06, which states: "Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses."

Narrative criteria for floating, suspended, or submerged matter are described in IDAPA 58.01.02.200.05, which states: "Surface waters of the state shall be free from floating, suspended, or submerged matter of any kind in concentrations causing nuisance or objectionable conditions or that may impair designated beneficial uses. This matter does not include suspended sediment produced as a result of nonpoint source activities."

DEQ's procedure to determine whether a water body fully supports designated and existing beneficial uses is outlined in IDAPA 58.01.02.053. The procedure relies heavily upon biological parameters and is presented in detail in the DEQ Water Body Assessment Guidance (Grafe et al. 2002). This guidance requires the use of the most complete data available to make beneficial use support status determinations.

Figure 7 provides an outline of the stream assessment process for determining support status of the beneficial uses of cold water aquatic life, salmonid spawning, and contact recreation.

Table 7. Selected numeric criteria supportive of designated beneficial uses in Idaho water quality standards.

Designated and Existing Beneficial Uses				
Water Quality Parameter	**Primary Contact Recreation**	**Secondary Contact Recreation**	**Cold Water Aquatic Life**	**Salmonid Spawning (During Spawning and Incubation Periods for Inhabiting Species)**
Water Quality Standards: IDAPA 58.01.02.250				
Bacteria, ph, and Dissolved Oxygen	Less than 126 *E. coli*/100 ml[a] as a geometric mean of five samples over 30 days; no sample greater than 406 *E. coli* organisms/100 ml	Less than 126 *E. coli*/100 ml as a geometric mean of five samples over 30 days; no sample greater than 576 *E. coli*/100 ml	pH between 6.5 and 9.0 DO[b] exceeds 6.0 mg/L[c]	pH between 6.5 and 9.5 Water Column DO: DO exceeds 6.0 mg/L in water column or 90% saturation, whichever is greater Intergravel DO: DO exceeds 5.0 mg/L for a one day minimum and exceeds 6.0 mg/L for a seven day average
Tempera-ture[d]			22 °C or less daily maximum; 19 °C or less daily average	13 °C or less daily maximum; 9 °C or less daily average Bull trout: not to exceed 13 °C maximum weekly maximum temperature over warmest 7-day period, June – August; not to exceed 9 °C daily average in September and October
			Seasonal Cold Water: Between summer solstice and autumn equinox: 26 °C or less daily maximum; 23 °C or less daily average	
Turbidity			Turbidity shall not exceed background by more than 50 NTU[e] instantaneously or more than 25 NTU for more than 10 consecutive days.	

Designated and Existing Beneficial Uses				
Water Quality Parameter	Primary Contact Recreation	Secondary Contact Recreation	Cold Water Aquatic Life	Salmonid Spawning (During Spawning and Incubation Periods for Inhabiting Species)
Ammonia			Ammonia not to exceed calculated concentration based on pH and temperature.	
EPA Bull Trout Temperature Criteria: Water Quality Standards for Idaho, 40 CFR Part 131				
Tempera-ture				7 day moving average of 10 °C or less maximum daily temperature for June - September

[a] *Escherichia coli* per 100 milliliters
[b] dissolved oxygen
[c] milligrams per liter
[d] Temperature Exemption - Exceeding the temperature criteria will not be considered a water quality standard violation when the air temperature exceeds the ninetieth percentile of the seven-day average daily maximum air temperature calculated in yearly series over the historic record measured at the nearest weather reporting station.
[e] Nephelometric turbidity units

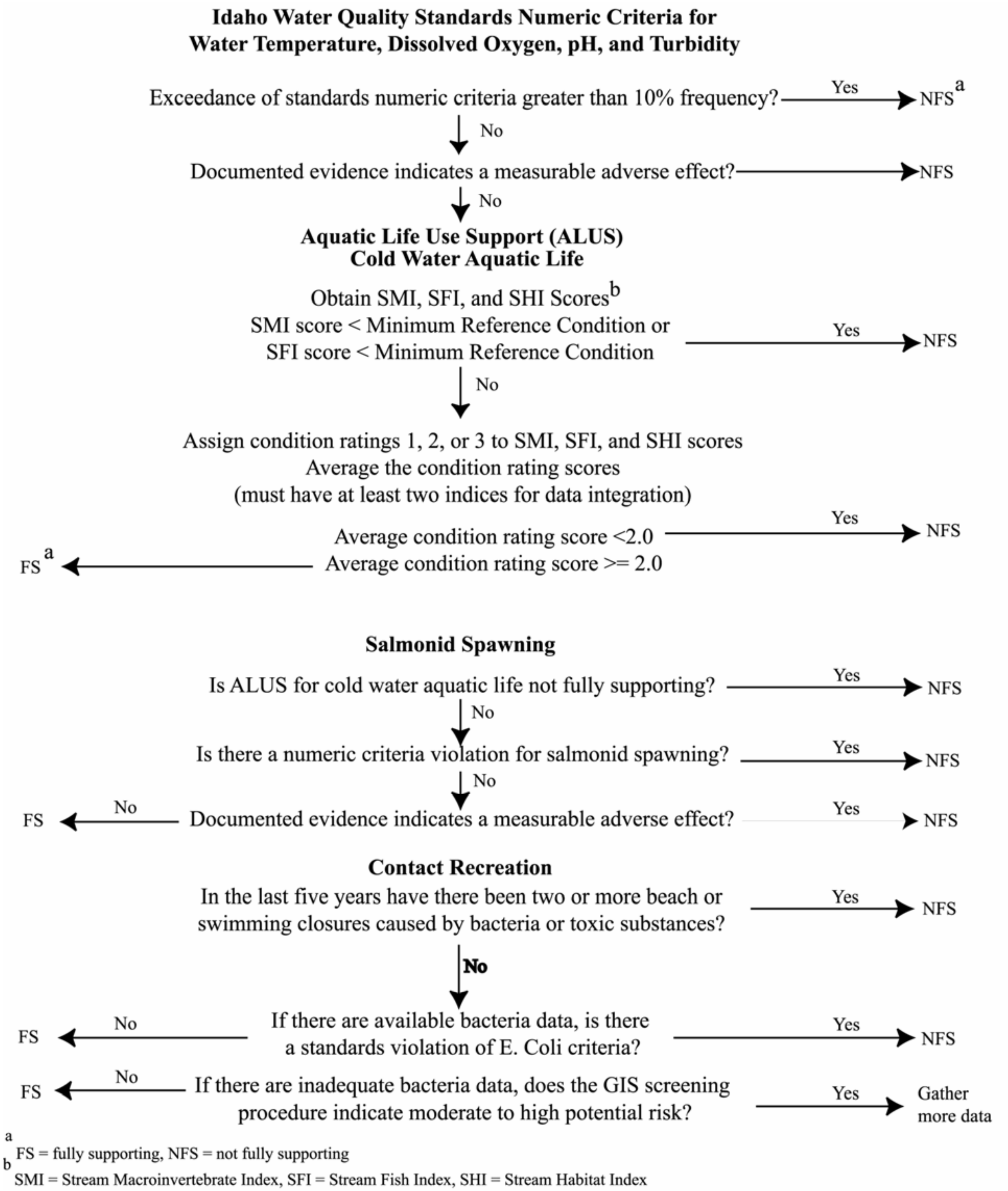

Figure 7. Determination Steps and Criteria for Determining Support Status of Beneficial Uses in Wadeable Streams: *Water Body Assessment Guidance*, Second Addition (Grafe et al 2002).

2.3 Pollutant/Beneficial Use Support Status Relationships

Some of the pollutants that impair beneficial uses in streams are naturally occurring stream characteristics that have been altered by humans. That is, streams naturally have sediment, nutrients, and the like, but when human-caused sources contribute these to reach unnatural levels, they are considered "pollutants" and can impair the beneficial uses of a stream.

The following section describes the most common pollutants in Idaho's waters and the potential impacts on beneficial uses. While the discussion of temperature and sediment are the most relevant to the Lower Clark Fork subbasin, other pollutants covered by the state water quality standards are discussed for general informational purposes. (Note that most streams in the subbasin have not been assessed for many of these pollutants. For example, only the mainstem Lower Clark Fork River was assessed for nutrients.)

Temperature

Temperature is a water quality factor integral to the life cycle of fish and other aquatic species. Different temperature regimes also result in different aquatic community compositions. Water temperature dictates whether warm, cool, or coldwater aquatic species and communities are present. Many factors, natural and anthropogenic, affect stream temperatures. Natural factors include altitude, aspect, climate, weather, riparian vegetation (shade), and channel morphology (width and depth). Human influenced factors include heated discharges (such as those from point sources), riparian alteration, channel alteration, and flow alteration.

Elevated stream temperature can be harmful to fish at all life stages, especially if it occurs in combination with other habitat limitations such as low dissolved oxygen or poor food supply. Acceptable temperature ranges vary for different species of fish, with cold water species being the least tolerant of high water temperatures. Temperature as a chronic stressor to adult fish can result in reduced body weight, reduced oxygen exchange, increased susceptibility to disease, and reduced reproductive capacity. Acutely high temperatures can result in death if they persist for an extended length of time. Juvenile fish are even more sensitive to temperature variations than adult fish, and can experience negative impacts at a lower threshold value than the adults, manifesting in retarded growth rates. High temperatures also affect embryonic development of fish before they even emerge from the substrate. Similar types of effects may occur to aquatic invertebrates, amphibians and mollusks.

Dissolved Oxygen

Oxygen is necessary for the survival of most aquatic organisms and essential to stream purification. Dissolved oxygen (DO) is the concentration of free (not chemically combined) molecular oxygen (a gas) dissolved in water, usually expressed in milligrams per liter (mg/L), parts per million, or percent of saturation. While air contains approximately 20.9% oxygen gas by volume, the proportion of oxygen dissolved in water is about 35%, because nitrogen (the remainder) is less soluble in water. Oxygen is considered to be moderately soluble in water. A complex set of physical conditions that include atmospheric and hydrostatic pressure, turbulence, temperature, and salinity affect the solubility.

Dissolved oxygen levels of 6.0 mg/L and above are considered optimal for aquatic life. When DO levels fall below 6.0 mg/L, organisms are stressed, and if levels fall below 3.0 mg/L for a prolonged period, these organisms may die; oxygen levels that remain below 1.0-2.0 mg/L for a few hours can result in large fish kills. Dissolved oxygen levels below 1.0 mg/L are often referred to as hypoxic; anoxic conditions refer to those situations where there is no measurable DO.

Fish avoid areas with low DO when they are able. Juvenile aquatic organisms are particularly susceptible to the effects of low DO due to their high metabolism and low mobility (they are unable to seek more oxygenated water). In addition, oxygen is necessary to help decompose organic matter in the water and bottom sediments. Dissolved oxygen reflects the health and balance of the aquatic ecosystem.

Oxygen is produced during photosynthesis and consumed during plant and animal respiration and decomposition. Oxygen enters water from photosynthesis and from the atmosphere. Where water is more turbulent (e.g., riffles, cascades), the oxygen exchange is greater due to the greater surface area of water coming into contact with air. The process of oxygen entering the water is called aeration.

Water bodies with significant aquatic plant communities can have significant DO fluctuations throughout the day. An oxygen sag will typically occur once photosynthesis stops at night and respiration/decomposition processes deplete DO concentrations in the water. Oxygen will start to increase again as photosynthesis resumes with the advent of daylight.

Temperature, flow, nutrient loading, and channel alteration all impact the amount of DO in the water. Colder waters hold more DO than warmer waters. As flows decrease, the amount of aeration typically decreases and the instream temperature increases, resulting in decreased DO. Channels that have been altered to increase the effectiveness of conveying water often have fewer riffles and less aeration. Thus, these systems may show depressed levels of DO in comparison to levels before the alteration. Nutrient enriched waters have a higher biochemical oxygen demand due to the amount of oxygen required for organic matter decomposition and other chemical reactions. This oxygen demand results in lower instream DO levels.

Total Dissolved Gas

The Idaho water quality criterion for TDG is 110% saturation or less in order to protect aquatic life beneficial uses. TDG supersaturation can occur during spring runoff, when spill at hydroelectric facilities is at its highest. This spill activity causes supersaturation of gas when high volumes of water are passing over spillways because the river flows are exceeding the hydraulic capacity of the dams. Significant volumes of atmospheric gases become entrained by the increased pressure at the pools below dams, and can remain in the river for significant distances. Less turbulent reaches below dams are less-effective at dissipating the entrained gases than more turbulent river systems. TDG superstaturation can cause gas bubble disease in fish and other aquatic organisms, and may limit habitat due to the potentially lethal presence of elevated gas levels in prime habitat areas. As the bubbles dissipate and the water enters the downstream reach, excess TDG will remain in solution unless wind- or channel-induced turbulence causes more degassing.

Metals

Metals can be toxic to aquatic organisms and fish if absorbed into their systems. The uptake of metals by aquatic life is an active, rather than a passive, biological process. Because the primary pathway for most metal uptake by aquatic life is through respiratory organs of fish and aquatic invertebrates, and only ionic forms of metals can pass through cell membranes, the toxicity of most metals to aquatic life is a function of the concentration of dissolved ionic forms of metals in the stream. Consequently, particulate metals are not directly toxic to most forms of aquatic life.

Many toxic substances, including metals, have a tendency to leave the dissolved phase and attach to suspended particulate matter. The fractions of total metal concentration present in the particulate and dissolved phases depend on the partitioning behavior of the metal ion and the concentration of suspended particulate matter. The dissolved fraction may also be affected by complexing of metals with organic binding agents. Idaho water quality standards are based on the bioavailable dissolved forms of metals.

Trace metals, including cadmium and lead, have been demonstrated to be endocrine disrupters in fish. Dill et al (2002) cite a study by Fairchild et al. (1999) that shows endocrine disruptors are believed to disrupt hormone systems is Atlantic salmon affecting smoltification, the physiological processes necessary for seawater adaptation.

Sediment

Both suspended (floating in the water column) and bedload (moves along the stream bottom) sediment can have negative effects on aquatic life communities. Many fish species can tolerate elevated suspended sediment levels for short periods of time, such as during natural spring runoff, but longer durations of exposure are detrimental. Elevated suspended sediment levels can interfere with feeding behavior (difficulty finding food due to visual impairment), damage gills, reduce growth rates, and in extreme cases eventually lead to death.

Newcombe and Jensen (1996) reported the effects of suspended sediment on fish, summarizing 80 published reports on streams and estuaries. For rainbow trout, physiological stress, which includes reduced feeding rate, is evident at suspended sediment concentrations of 50 to 100 mg/L when those concentrations are maintained for 14 to 60 days. Similar effects are observed for other species, although the data sets are less reliable. Adverse effects on habitat, especially spawning and rearing habitat presumably from sediment deposition, were noted at similar concentrations of suspended sediment.

Organic suspended materials can also settle to the bottom and, due to their high carbon content, lead to low intergravel DO through decomposition.

In addition to these direct effects on the habitat and spawning success of fish, detrimental changes to food sources may also occur. Aquatic insects, which serve as a primary food source for fish, are affected by excess sedimentation. Increased sedimentation leads to a macroinvertebrate community that is adapted to burrowing, thereby making the macroinvertebrates less available to fish. Community structure, specifically diversity, of the aquatic macroinvertebrate community is diminished due to the reduction of coarse substrate habitat.

Settleable solids are defined as the volume (milliliters [ml]) or weight (mg) of material that settles out of a liter of water in one hour (Franson et al. 1998). Settleable solids may consist of large silt, sand, and organic matter. Total suspended solids (TSS) are defined as the material collected by filtration through a 0.45 µm (micrometer) filter (Standard Methods 1975, 1995). Settleable solids and TSS both contain nutrients that are essential for aquatic plant growth. Settleable solids are not as nutrient rich as the smaller TSS, but they do affect river depth and substrate nutrient availability for macrophytes. In low flow situations, settleable solids can accumulate on a stream bottom, thus decreasing water depth. This increases the area of substrate that is exposed to light, facilitating additional macrophyte growth.

Stream siltation caused by silviculture activities and related road construction can be especially damaging to spawning gravels. The reduction of interstitial space between gravels can make it difficult for the incubation of eggs and the survival of juvenile trout.

Sediment-Temperature Relationship

In addition to reducing shading, activities that remove streamside vegetation reduce bank stability, causing accelerated bank erosion and increased sediment loading. Bank erosion and other sources of increased sedimentation can result in wider and shallower streams, which increase the stream's heat load by increasing the surface area subject to solar radiation and heat exchange with the air. When addressing sediment pollution, it is useful to recognize the potential benefit to stream temperatures from sediment reduction activities as well. Conversely, when addressing temperature pollution by increasing riparian vegetation, it is useful to recognize the additional benefits of stabilized banks and reduced erosion.

Bacteria

Escherichia coli or *E. coli*, a species of fecal coliform bacteria, is used by the state of Idaho as the indicator for the presence of pathogenic microorganisms. Pathogens are a small subset of microorganisms (e.g., certain bacteria, viruses, and protozoa), which, if taken into the body through contaminated water or food, can cause sickness or even death. Some pathogens are also able to cause illness by entering the body through the skin or mucous membranes.

Direct measurement of pathogen levels in surface water is difficult because pathogens usually occur in very low numbers and analysis methods are unreliable and expensive. Consequently, indicator bacteria which are often associated with pathogens, but which generally occur in higher concentrations and are thus more easily measured, are assessed.

Coliform bacteria are unicellular organisms found in feces of warm-blooded animals such as humans, domestic pets, livestock, and wildlife. Coliform bacteria are commonly monitored as part of point source discharge permits (National Pollution Discharge Elimination System [NPDES] permits), but may also be monitored in nonpoint source arenas. The human health effects from pathogenic coliform bacteria range from nausea, vomiting, and diarrhea to acute respiratory illness, meningitis, ulceration of the intestines, and even death. Coliform bacteria do not have a known effect on aquatic life.

Coliform bacteria from both point and nonpoint sources impact water bodies, although point sources are typically permitted and offer some level of bacteria-reducing treatment prior to discharge. Nonpoint sources of bacteria are diffuse and difficult to characterize. Unfortunately, nonpoint sources often have the greatest impact on bacteria concentrations in water bodies. This is particularly the case in urban storm water and agricultural areas. *E. coli* is often measured in colony forming units (cfu) per 100 ml.

Nutrients

While nutrients are a natural component of the aquatic ecosystem, natural cycles can be disrupted by increased nutrient inputs from human activities. The excess nutrients result in accelerated plant growth and can result in a eutrophic or enriched system.

The first step in identifying a water body’s response to nutrient flux is to define which of the critical nutrients is limiting. A limiting nutrient is one that normally is in short supply relative to biological needs. The relative quantity affects the rate of production of aquatic biomass. Either phosphorus or nitrogen may be the limiting factor for algal growth, although phosphorous is most commonly the limiting nutrient in Idaho waters. Ecologically speaking, a resource is considered limiting if the addition of that resource increases growth.

Total phosphorus (TP) is the measurement of all forms of phosphorus in a water sample, including all inorganic and organic particulate and soluble forms. In freshwater systems, typically greater than 90% of the TP present occurs in organic forms as cellular constituents in the biota or adsorbed to particulate materials (Wetzel 1983). The remainder of phosphorus is mainly soluble orthophosphate, a more biologically available form of phosphorus than TP that consequently leads to a more rapid growth of algae. In impaired systems, a larger percentage of the TP fraction is comprised of orthophosphate. The relative amount of each form measured can provide information on the potential for algal growth within the system.

Nitrogen may be a limiting factor at certain times if there is substantial depletion of nitrogen in sediments due to uptake by rooted macrophyte beds. In systems dominated by blue-green algae, nitrogen is not a limiting nutrient due to the algal ability to fix nitrogen at the water/air interface.

Total nitrogen to TP ratios greater than seven are indicative of a phosphorus-limited system while those ratios less than seven are indicative of a nitrogen-limited system. Only biologically available forms of the nutrients are used in the ratios because these are the forms that are used by the immediate aquatic community.

Nutrients primarily cycle between the water column and sediment through nutrient spiraling. Aquatic plants rapidly assimilate dissolved nutrients, particularly orthophosphate. If sufficient nutrients are available in stream sediments or the water column, aquatic plants will store an abundance of such nutrients in excess of the plants’ actual needs; this is a chemical phenomenon known as luxury consumption. When a plant dies, the tissue decays in the water column and the nutrients stored within the plant biomass are either restored to the water column or the detritus becomes incorporated into the river sediment. As a result of this process, nutrients (including orthophosphate) that are initially released into the water column in a dissolved form will eventually become incorporated into the river bottom sediment. Once these nutrients are incorporated into the river sediment, they are available once again for uptake by yet another life cycle of rooted aquatic macrophytes and other aquatic plants. This cycle is known as nutrient spiraling. Nutrient spiraling results in the availability of nutrients for later plant growth in higher concentrations downstream.

Excess nutrient loading can be a water quality problem due to the direct relationship of high TP concentrations on excess algal growth within the water column, combined with the direct effect of the algal life cycle on DO and pH within aquatic systems. Therefore, the reduction of TP inputs to the system can act as a mechanism for water quality improvements, particularly in surface-water systems dominated by blue-green algae, which can acquire nitrogen directly from the atmosphere and the water column. Phosphorus management within these systems can potentially result in reduction of nutrients (phosphorus), nuisance algae, DO, and pH.

Sediment – Nutrient Relationship

The linkage between sediment and sediment-bound nutrients is important when dealing with nutrient enrichment problems in aquatic systems. Phosphorus is typically bound to particulate matter in aquatic systems and, thus, sediment can be a major source of phosphorus to rooted macrophytes and the water column. While most aquatic plants are able to absorb nutrients over the entire plant surface due to a thin cuticle (Denny 1980), bottom sediments serve as the primary nutrient source for most sub-stratum attached macrophytes. The USDA (1999) determined that other than harvesting and chemical treatment, the best and most efficient method of controlling growth is by reducing surface erosion and sedimentation.

Sediment acts as a nutrient sink under aerobic conditions. However, sediments release phosphorous into the water column when conditions become anoxic. Nitrogen can also be released, but the mechanism by which it happens is different. The exchange of nitrogen between sediment and the water column is for the most part a microbial process controlled by the amount of oxygen in the sediment. When conditions become anaerobic, the oxygenation of ammonia (nitrification) ceases and an abundance of ammonia is produced. This condition results in a reduction of nitrogen oxides (NO_x) lost to the atmosphere.

Sediments can play an integral role in reducing the frequency and duration of phytoplankton blooms in standing waters and large rivers. In many cases, there is an immediate response in phytoplankton biomass when external sources are reduced. In other cases, the response time is slower, often taking years. Nonetheless, the relationship is important and must be addressed in waters where phytoplankton is in excess.

Floating, Suspended, or Submerged Matter (Nuisance Algae)

Algae are an important part of the aquatic food chain. However, when elevated levels of algae impact beneficial uses, the algae are considered a nuisance aquatic growth. The excess growth of phytoplankton, periphyton, and/or macrophytes can adversely affect both aquatic life and recreational water uses. Algal blooms occur where adequate nutrients (nitrogen and/or phosphorus) are available to support growth. In addition to nutrient availability, flow rates, velocities, water temperatures, and penetration of sunlight in the water column all affect algae (and macrophyte) growth. Low velocity conditions allow algal concentrations to increase because physical removal by scouring and abrasion does not readily occur. Increases in temperature and sunlight penetration also result in increased algal growth. When the aforementioned conditions are appropriate and nutrient concentrations exceed the quantities needed to support normal algal growth, excessive blooms may develop.

Commonly, algae blooms appear as extensive layers or algal mats on the surface of the water. When present at excessive concentrations in the water column, blue-green algae often produce toxins that can result in skin irritation to swimmers and illness or even death in organisms ingesting the water. The toxic effect of blue-green algae is worse when an abundance of organisms die and accumulate in a central area.

Algal blooms also often create objectionable odors and coloration in water used for domestic drinking water and can produce intense coloration of both the water and shorelines as cells accumulate along the banks. In extreme cases, algal blooms can also result in impairment of agricultural water supplies due to toxicity. Water bodies with high nutrient concentrations that could potentially lead to a high level of algal growth are said to be eutrophic. The extent of the effect is dependent on both the type(s) of algae present and the size, extent, and timing of the bloom.

When algae die in low flow velocity areas, they sink slowly through the water column, eventually collecting on the bottom sediments. The biochemical processes that occur as the algae decompose remove oxygen from the surrounding water. Because most of the decomposition occurs within the lower levels of the water column, a large algal bloom can substantially deplete DO concentrations near the bottom. Low DO in these areas can lead to decreased fish habitat as fish will not frequent areas with low DO. Both living and dead (decomposing) algae can also affect the pH of the water due to the release of various acid and base compounds during respiration and photosynthesis. Additionally, low DO levels caused by decomposing organic matter can lead to changes in water chemistry and a release of sorbed phosphorus to the water column at the water/sediment interface.

2.4 Summary and Analysis of Existing Water Quality Data

Numerous sources of water quality data were used in this SBA and TMDL. DEQ monitoring (BURP) data were used as the baseline information. Several detailed studies of the Lightning Creek drainage, Forest Service information and Idaho Department of Lands Cumulative Watershed Effects (CWE) analyses were all used to summarize existing water quality in this section. Monthly and continuous water quality monitoring by the Tri-State Water Quality Council and the USGS were also used.

Data Sources

DEQ has collected Beneficial Use Reconnaissance Program (BURP) data on most of the larger streams in the subbasin. From 1994-2002, 33 BURP surveys were completed in the subbasin. Data sets reflected in BURP surveys include temperature, habitat, macroinvertebrate and fisheries information. Locations of BURP surveys are shown in Figure 8. The USGS operates two gaging stations in the subbasin. Stream flow and water quality samples were taken intermittently at the mouth of Lightning Creek and below Cabinet Gorge dam on the Lower Clark Fork River. Water quality samples collected by the USGS and Land and Water Consulting Inc. from 1993-2003 are considered in the following analysis. Discharge has been gauged since 1928 on the Clark Fork River below the Cabinet Gorge dam and since 1988 on Lightning Creek near Clark Fork, Idaho. Eleven temperature data loggers have been deployed in the subbasin by the DEQ to constantly monitor water temperature during the hottest period of the year. In addition, where it was available, other watershed specific data were used.

Biological data available for examination include macroinvertebrate, fish, and habitat data collected through BURP. The data are arranged in indices and scored to determine if the water body in question is supporting its beneficial uses. Three indices are considered when making a beneficial use support status determination. The indices are classified by ecoregion. For all the indices, the entire Lower Clark Fork River is considered to be located in the Northern Mountains ecoregion.

The first index is the Stream Macroinvertebrate Index (SMI). By recording the abundance of macroinvertebrates known to live only in specific temperature conditions, the index is used as a direct biological measure of cold water aquatic life (Grafe et al. 2002). A detailed description of this index can be found in Jessup and Gerritsen (2000). A high score (three) on the index indicates a healthy assemblage of species close to reference condition streams in the state.

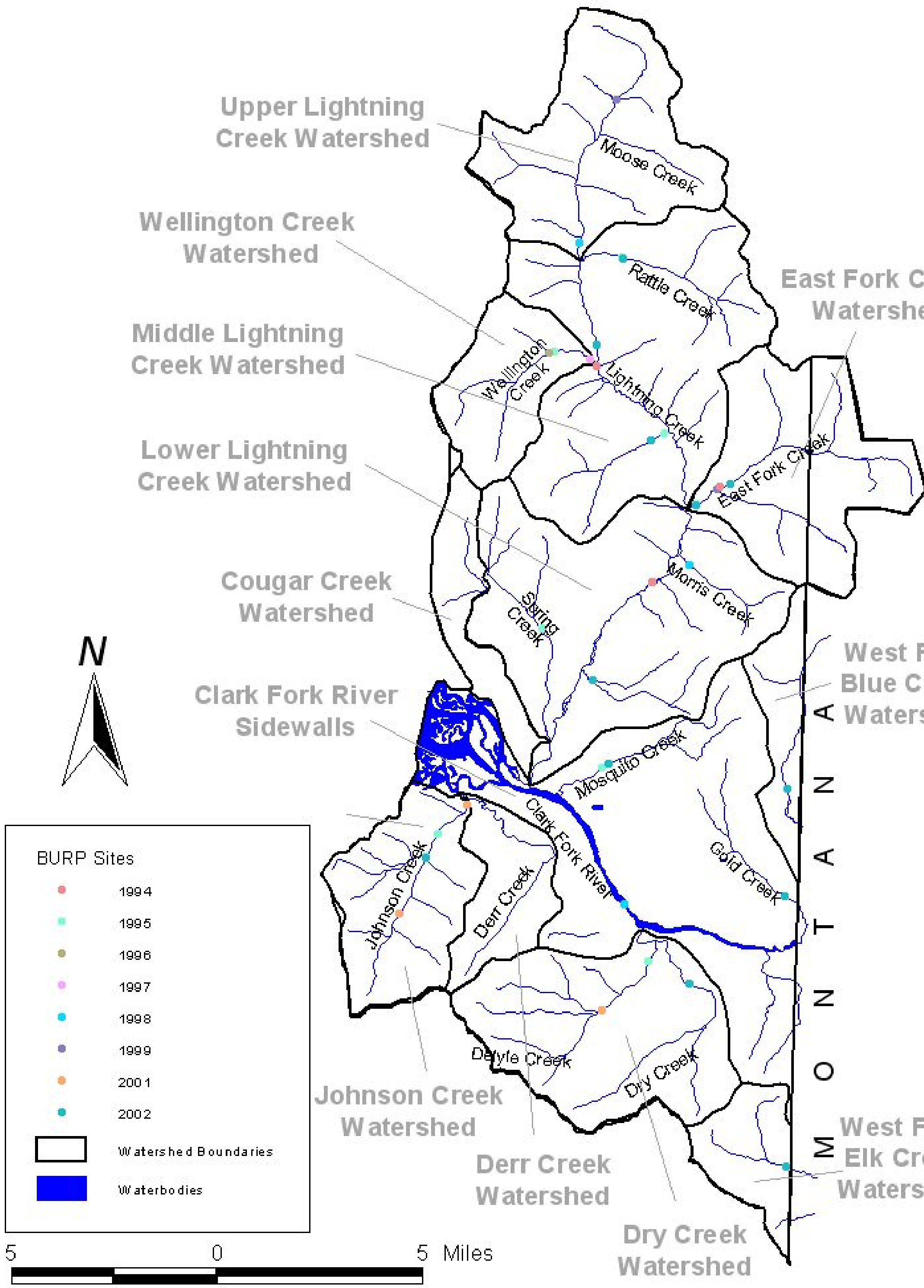

Figure 8. Locations of BURP monitoring sites, 1994-2002.

The second index is the Stream Fish Index (SFI). This index is also considered a direct biological measure of cold water aquatic life and is used to determine how close the stream is to achieving the Clean Water Act "fishable" goal. The details of the development of this index can be found in Mebane (2002). Mebane developed this index based on least impacted and stressed sites. Fish counts are taken in each watershed and the index relates data found to known index, or reference sites.

The last index considered when determining beneficial use support is the Stream Habitat Index (SHI). Details of this index can be found in Fore and Bollman (2000). The habitat index considers ten habitat metrics such as: instream cover, substrate composition, bank and canopy cover and zone of influence. SHI is not considered to be a direct biological measure, therefore it is recommended that it always be used in conjunction with at least one other index. This is due to significant variability in physical habitat measures (Grafe et al. 2002). Metrics tailored to forested areas were used for the SHI.

Each index uses a scale of one to three. The values resulting from each index are averaged to determine the support status of each waterbody as described in DEQ's Water Body Assessment Guidance, Second Edition (Grafe et al. 2002). A score of three indicates the stream is most likely to fully support beneficial uses. Average values of two or greater indicate a water body that is in full support of its beneficial uses, however, the condition significantly varies from reference conditions and assessors can examine additional information, if available, to determine support status of the water body. Scores of less than two indicate that a water body is not supporting its beneficial uses. Scores from at least two indices are required to make a support status determination. If either the macroinvertebrate or fish score is zero, the water body is considered to not fully support beneficial uses. Index scores and the beneficial use support status for each water body in the subbasin are presented in summary tables in Appendix A.

In addition to BURP data, other sources of water quality data were compiled and summarized to give a snapshot of water quality in the subbasin. A detailed watershed analysis report for Lightning Creek and its tributaries was completed in 2004 by Philip Williams and Associates, Limited, with consultation from land and resource management agencies (referred to as PWA 2004 throughout the document). The report includes extensive field surveys, especially regarding road condition and mass wasting potential, and it summarizes existing data on the area. The report is extensive and while summary results are used to inform this analysis of water quality, there is a wealth of additional information. The report includes both an overview of watershed health and an implementation plan that prioritizes restoration opportunities in the Lightning Creek watershed. The reader is encouraged to review the *Lightning Creek Watershed Assessment* (PWA 2004) for additional information on that portion of the subbasin and to use it as a basis for TMDL implementation.

In addition to the Lightning Creek Watershed Assessment mentioned above, there are other documents and research funded by Avista Utilities as part of the federal relicensing process and the on-going settlement agreement to mitigate the impacts of its hydropower operations in the subbasin. A virtual library of information on fisheries and water quality status were compiled during the relicensing process in the 1990s, and over the last five-years additional monitoring and research reports have been compiled, especially in relation to impacts of hydropower development and native aquatic species restoration opportunities. Where applicable, these data are incorporated in this analysis as well.

The following section summarizes existing water quality data from BURP and other sources, used to determine the status of beneficial uses for each subwatershed in the basin.

Flow Characteristics

Flow characteristics are available for the Clark Fork River and Lightning Creek.

Clark Fork River

The mainstem Clark Fork River from Cabinet Gorge dam flows for about nine miles before it enters Lake Pend Oreille. In addition to the main channel, there is a side channel that starts at Foster Rapids and the river delta area, including Mosquito Creek. Unless otherwise noted, the information presented below pertains to the mainstem.

Due to the significantly altered flow regime from hydropower operations, all three mainstem AUs of the Clark Fork River in Idaho are considered impaired by flow alteration.

Stream flow data is collected by the USGS on the Clark Fork River below the Cabinet Gorge dam (Figure 9). Data collected at this station was also recorded under the name Whitehorse Rapids gaging station (O'Dell, pers comm). Data collected at this station represent flow conditions in 22,073 mi^2 of the watershed, the majority of which lies in Montana. Recording of data began in 1929. Mean annual runoff recorded at the station below the Cabinet Gorge Dam, through water year 2001, is 22,548 cfs.

The main river flows are influenced by the hydropower operation at Cabinet Gorge Dam. Under the current Clark Fork River Settlement Agreement, minimum flows will not be below 5,000 cfs.

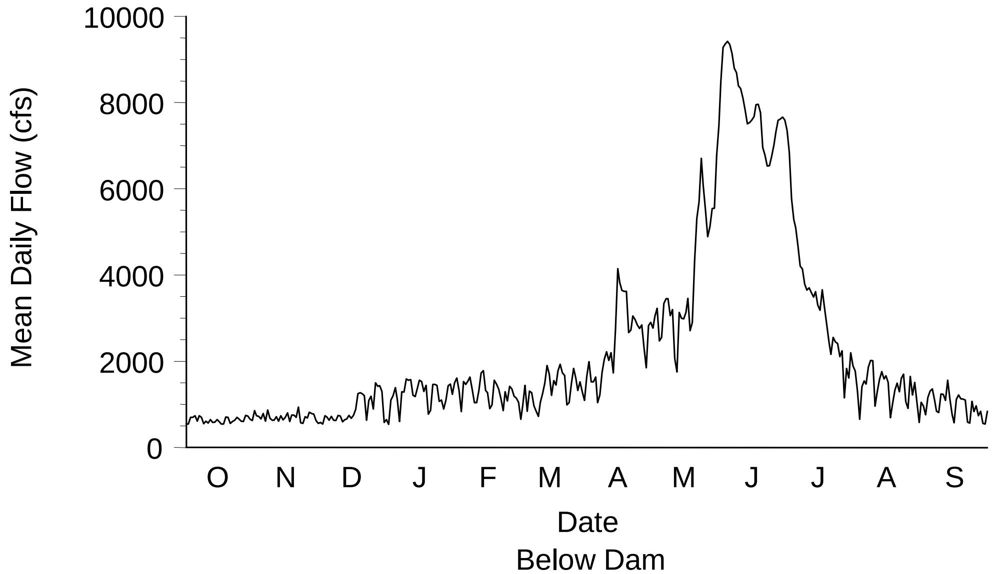

Figure 9. Mean Daily Flow of the Clark Fork River at USGS Gaging Station Below the Cabinet Gorge Dam.

Annual runoff in the Clark Fork River is produced mostly by melting snow, with peak flows typically occurring in May or June, but occasionally in April or July. Midwinter rain on snow events can result in a rapid snowmelt, and in some years, peak flow from tributary watersheds occurs during these events. Due to the effects of high precipitation, location in relation to Lake Pend Oreille, prevailing winds, and the tendency for warm winter storms to pick up moisture from the lake, Lightning Creek and other tributaries draining the Cabinet Mountains are particularly susceptible to rain on snow events.

Lightning Creek

Flows in the Lightning Creek watershed are driven by heavy seasonal variation in precipitation, and high flows often occur at times of rain on snow event. A USGS station is located on Lightning Creek at the city of Clark Fork. Mean daily flows are shown in Figure 10. This station records data from 115.2 mi^2 of watershed. Data have been recorded at Lightning Creek since 1989. Mean annual runoff at the Lightning Creek gaging station, through water year 2001, is 411 cfs. Peak flows are summarized in Table 8.

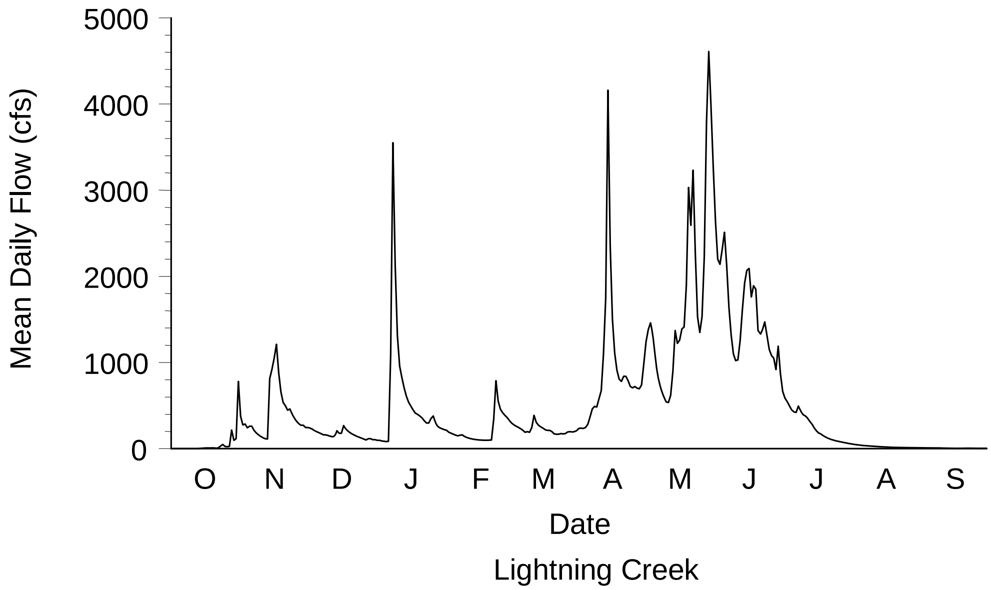

Figure 10. Mean Daily Flow of Lightning at USGS Gaging Station near Clark Fork, Idaho.

Table 8. Peak flows for Lightning Creek USGS gage by water year, 1989-2003. (Reproduced from PWA 2004)

Water Year	Date	Discharge (m^3/s)	Discharge (cfs)
1989	5/09/1989	81.0*	2,860*
1990	12/05/1989	85.8*	3,030*
1991	6/30/1991	39.6	1,400
1992	4/30/1992	72.2*	2,550*
1993	5/13/1993	92.9*	3,280*
1994	5/09/1994	79	2790
1995	2/20/1995	100.8*	3,560*
1996	2/09/1996	140.8*	4,970*
1997	5/15/1997	115.5*	4,080*
1998	5/27/1998	92.3	3,260
1999	5/25/1999	80.7	2,850
2000	5/22/2000	107.3*	3,790*
2001	4/28/2001	57.5	2,030
2002	4/14/2002	170.2	6,010
2003	5/25/2003	176.2	6,220

*****Maximum daily average

Water Column Data

Water column data are collected by the USGS below Cabinet Gorge dam and on Lightning Creek. BURP samples included bacteria testing, and no exceedances of bacteria standards were found.

Clark Fork River

Water column nutrient and pH data collected by USGS below Cabinet Gorge dam from 1998-2002 are presented in Appendix C. Nutrients and pH levels were within Idaho Water Quality Standards, but temperatures above the standard for Salmonid Spawning were recorded. Nutrient information was also collected by the Tri-State Water Quality Council and is reported in annual monitoring reports and summarized in a trend analysis report (PBS&J 2005). Levels of nutrients appear to meet Idaho Water Quality Standards in the Lower Clark Fork River. However, the WAG noted that excess algae growth is an increasing problem in the unassessed delta area (Lower Johnson Creek, Assessment Unit 17010213PN001_03).

General water quality information collected during the Clark Fork Project relicensing process includes water temperatures and information on total dissolved gas concentrations above and below the Cabinet Gorge Dam. Under the NPDES permit, wastewater discharge from the dam is monitored to insure that effluent limits for chlorine, bacteria, total suspended solids and biological oxygen demand are met.

Lower Lightning Creek

Periodic nutrient, pH and other water column data were collected in the water column at the USGS gaging station. These data are presented in Appendix C. All nutrient parameters measured were found to be within Idaho state WQS. Temperature data available from the USGS gaging station in addition to data collected by DEQ and the USFS indicate temperature exceedances throughout the Lightning Creek drainage.

Temperature

Tributaries

Nine temperature data logger data sets have been collected in the Idaho portions of the Lower Clark Fork River basin by DEQ (Table 9). Data were collected during the warmest summer months thru fall spawning periods. Data were collected during this time to identify periods of critical temperature criteria exceedances. All data recorded are in exceedance of Idaho water quality standard temperature criteria for fall salmonid spawning and one temperature data logger site (2001) on Lower Lightning Creek, .5 miles downstream of Morris Creek confluence, was also in exceedance of cold water aquatic biota criteria.

The following table outlines the number of days evaluated for cold water aquatic biota criteria, bull trout fall spawning 9ºC temperature criteria and the percent exceedance of each.

Table 9. Temperature criteria exceedances in the Idaho portion of the Lower Clark Fork HUC.

Stream name and Temperature Logger site ID	Cold Water Aquatic Biota Criteria		Fall Salmonid Spawning 9ºC Criteria		
	Days evaluated	*% Exceedance*	*Days evaluated*	*% Exceedance*	*Duration of Deployment*
Char Creek 1998SCDATL0011	67	0	76	61%	07/18/1998-11/11/1998
Porcupine Creek 1998SCDATL0013	67	0	76	83%	07/18/1998-11/11/1998
Rattle Creek 1998SCDATL0014	67	0	76	70%	07/18/1998-11/11/1998
Quartz Creek 1998SCDATL0015	67	0	76	63%	07/18/1998-11/08/1998
Wellington Creek 1998SCDATL0016	67	0	76	68%	07/18/1998-11/11/1998
Lightning Creek 1999SCDATL0032	68	0	57	49%	07/17/1999-09/26/1999
Morris Creek 1999SCDATL0038	68	0	76	70%	07/17/1999-10/17/1999
Johnson Creek 2001SCDATL0028	94	0	72	92%	06/20/2001-10/11/2001
Lightning Creek 2001SCDATL0042	81	20%	40	100%	06/21/2001-09/09/2001

Lower Clark Fork River

Periodic instantaneous temperature readings show that the Lower Clark Fork River itself exceeds numeric water quality criteria for Salmonid Spawning and bull trout. The Lower Clark Fork River is a large river system, and little data are available to evaluate whether current conditions are similar to natural background condition, or whether temperature cycles are being altered by human activities. Analyses done during the relicensing of Cabinet Gorge and Noxon Rapids dam did not show significant impacts to river temperatures from operation of these hydroelectric facilities (Beak Consultants 1997). The Lower Clark Fork River meets Montana water quality standards for temperature above the Idaho/Montana border.

Dissolved Oxygen

All dissolved oxygen samples met or exceeded water quality standards in the Lower Clark Fork River and Lightning Creek. These are the only areas of the subbasin where dissolved oxygen data were available.

Total Dissolved Gas

All three mainstem Clark Fork River Assessment Units show an exceedance of Total Dissolved Gas (TDG) levels.

Since 1995, Avista Utilities has been monitoring Total Dissolved Gas below Cabinet Gorge Dam during spring runoff periods (generally April – July). Below Cabinet Gorge Dam, peak hourly TDG levels were frequently 125-130% saturation in June. In 2002, levels exceeded 130% about 16% of the time. Because of frequent exceedances of the 110% saturation standard during peak flows, there is on-going total dissolved gas monitoring and a mitigation plan in place. Details are available in *The Gas Supersaturation Control Program for the Cabinet Gorge and Noxon Rapids Hydroelectric Projects* (Avista 2004b) as approved by the DEQ and USFWS as a part of the required water quality certification for the project operations and federal license.

In the assessment unit above Cabinet Gorge Dam near the Idaho/Montana border, TDG levels can reach 110-111% saturation during peak flows, violating Idaho water quality standards (Parametrix 1995-2004). At these same times, TDG is measured at the Noxon Rapids dam, and typically, the TDG levels are slightly lower at the Cabinet Gorge forebay area than at the Noxon Rapids forebay. This indicates that waters with elevated TDG are entering Idaho, with the source above Noxon Rapids dam. In order to fully address elevated TDG levels, especially at the critical peak flow times, reductions in TDG levels of the waters entering Idaho are necessary in addition to the extensive mitigation plan in place for below Cabinet Gorge dam.

Metals

Idaho's metals criteria are based on the bioavailable dissolved form of metals found in the water column. Numeric standards are set to be protective of aquatic life. The toxicity of the metals of concern in the Lower Clark Fork River (copper, zinc, arsenic, cadmium and lead) is directly related to the water's hardness[3]. Standards based on the minimum measured hardness values (64 mg/L) in the Lower Clark Fork River are presented in Table 10. To determine compliance with Idaho's metals criteria, a calculation that relates the flow at the time of the sampling is used. Water Quality Standards are expressed as both an acute value, Criterion Maximum Concentration (CMC), and a chronic value, Criterion Continuous Concentration (CCC). Per Idaho's water quality standards, the one-hour average concentration of a constituent is not to exceed the CMC more than once every three years, while the four-day average concentration of a constituent is not to exceed CCC more than once every three years. Due to the limited number of metals samples available for analysis, DEQ was not able to calculate one-hour and four-day average concentrations. Therefore, single sample values were used to determine whether the CCC and CMC standards were being met. This is a conservative assumption, however, given the expense and effort required to monitor dissolved metals, it is the only available data. Conservative assumptions regarding concentrations are also appropriate given Nimick et al. (2003) found diel cycles in metals at 14 sites across Montana and northern Idaho. Samples available have all been from daylight hours. Metals may be more bio-available in the Clark Fork system during times outside of the standard sampling collection hours for Clark Fork monitoring programs.

[3] Hardness is a calculated value based on measured calcium and magnesium levels in the water at the USGS gaging station below Cabinet Gorge dam.

Data on dissolved metals concentrations are available for Lightning Creek and the Lower Clark Fork River.

Lightning Creek

USGS sampled the water column for arsenic, cadmium, copper, lead, mercury, and other trace metals at the Lightning Creek gaging station between 1999 and 2001 (Beckwith 2003). No exceedances of water quality standards in Lightning Creek were found.

Clark Fork River

The main stem of the Clark Fork River was added to the Idaho 303(d) list in 1994 and this listing has carried through to Section 5 of the 2002 Integrated Report. There are no known significant sources of metals pollution to the Lower Clark Fork subbasin in Idaho. The primary source of metals contamination is believed to be historic activities in the Upper Clark Fork River basin. The original listing is based on public comment and data showing that through the late 1980s, metals concentrations routinely exceeded standards. In 2001, DEQ deferred TMDL development for metals until more recent data were available for assessment (IDEQ 2001).

Periodic monitoring of dissolved metals occurred at the USGS gaging station below the Cabinet Gorge dam quarterly from 1990-1993, annually from 1994-1997, and monthly during 2001 (Hardy et al 2005). Results are summarized in Table 11 and complete data tables are presented in Appendix C. The results of samples dating from 1988 through 2003 were used in the problem assessment for this TMDL. (Earlier data are reported in IDEQ 2001.) Samples below Cabinet Gorge dam were collected by PBS&J Consulting (formerly Land and Water Consulting, Inc.) for the Tri State Water Quality Council from 2001 to the present. Results are summarized in Table 1 and complete data tables are presented in Appendix C. Constituents analyzed include arsenic, cadmium, chromium, copper, lead, mercury, silver, and zinc.

Since 1990, exceedances of the acute criterion (CMC) occurred for cadmium (1991), and copper (twice in 1992). Exceedances of the chronic criterion (CCC) for cadmium (1990, 1991, 2003), copper (1990, three times in 1992) and zinc (2003) have also occurred. Note that both criteria are evaluated using the best available data, which are single event samples.

Table 10. EPA approved standards for hardness dependent toxic metals at the minimum measured hardness level[4]. Standards were calculated using hardness based conversion formula outlined in IDAPA 58.01.02.210.02 (IAC 2005).

	Acute Exposure Criterion CMC[5] (ug/l)	Chronic Exposure Criterion CCC[6] (ug/l)
Cadmium	1.30	0.74
Chromium III	395	51
Chromium IV	15	10
Copper	11.2	7.8
Lead	40	1.54
Mercury	Fish tissue based standard	
Nickel	321	36
Silver	1.6	NA
Zinc	80.3	80.9

Table 11. Summary of available dissolved Cadmium, Zinc and Copper data in the Lower Clark Fork River.

	Source	**Dissolved Cadmium**	**Dissolved Copper**	**Dissolved Zinc**	**Date of Record**
Sample Size	USGS	33	33	33	Variable between 1989-1999; 2000-2001
	Tri-State	44	45	44	2001-2003 (sampling continued to present)
Number of Exceedances	USGS	2 CCC 1 CMC	4 CCC 2 CMC	0	
	Tri-State	1 CCC	0	1 CCC	
Minimum Value (ug/L)	USGS	< 0.04	<1.0	1	
	Tri-State	0.5 (U[7])	0.5 (U)	0.25 (U)	
Maximum Value (ug/L)	USGS	2	38	28	
	Tri-State	1	3	80.8	

[4]Minimum Value = 64 mg/l. Calculated from USGS calcium and magnesium values below the Cabinet Gorge Dam.

[5] Criterion Maximum Concentration

[6] Criterion Continuous Concentration

[7] U = Below laboratory detection limit. Reported as one-half the detection limit.

Table 12. Date, Flow and Data Source information for metals samples that exceeded Idaho Water Quality Standards.

Parameter	Measured Value (ug/l)	Date	Flow (cfs)	Data Source
Dissolved Cadmium	1	11/25/1990	27,100	USGS
	2	5/13/1991	34,200	USGS
	1	7/16/2003	18,200[8]	Tri-State
Dissolved Copper	38	5/12/1992	34,400	USGS
	12	11/16/1992	25,600	USGS
Dissolved Zinc	80.8	10/15/2003	6,040[1]	Tri-State

Because laboratory detection limits were often above the level of cadmium that is considered to impair beneficial uses, the cadmium data were particularly difficult to assess. More data with a sensitive level of detection are needed to determine conclusively the level of cadmium impairment. In its report to the state of Idaho on water quality trend monitoring sites, USGS (2004) trend analysis reports one exceedance of the CMC and that greater than 25% of the samples taken between 1989-1995 exceeded the CCC for cadmium. Especially with peak flows frequently in excess of 30,000 cfs, even very low concentrations of metals could represent significant human caused metals contributions to the system. The USGS data reported are censored based upon the level of confidence of the laboratory. If the metal is not detected at all in the sample, a designation of undetected is given to the value, and this was not the case with cadmium samples taken by the USGS. Samples reported as below laboratory reporting limits generally indicate that the material was detected, but at unquantifiable levels based on the laboratory reporting limit for the metal. Therefore, these values can not be considered to be at zero concentrations.

There was one exceedance of the lead CMC and two of the CCC in 1992. No exceedances have been measured since then, but limited data are available regarding lead levels as the USGS stopped sampling lead at this site in 1994. The Tri-State Water Quality Council sampled for lead below Cabinet Gorge dam in 2004 and in only one sample (n = 18 for the year), was lead detected, and it was measured at the detection limit (.001 mg/l), but not in exceedance of the water quality standard (PBS&J 2005). In 2005, no lead was detected below Cabinet Gorge dam (n=18). In addition, data from two sites upstream of Cabinet Gorge showed levels of lead below the detection limit (PBS&J 2006) during both 2004 and 2005 indicating low lead levels in the Lower Clark Fork River system overall. (This is contrary to other metals analyzed for this TMDL, where samples generally are below the Idaho water quality standard, but some concentrations of the metals are consistently measured in the system.) Therefore, no TMDL is recommended for lead at this time. While there does not seem to be excess lead in the Lower Clark Fork River system, it is assumed that by developing TMDLs for the other metals, lead levels will also be controlled. Lead will

[8] Flows were not recorded at the time of sample. USGS station below Cabinet Gorge Dam reported daily mean flow as shown in table.

continue to be monitored by the Tri-State Water Quality Council, and a TMDL will be developed in the future if lead levels are found to exceed Idaho Water Quality Standards.

In 1993, there was an exceedance of the total recoverable mercury standard in place at that time, however, the detection limit was equal to the exceedance level, making measurement difficult. The last total recoverable mercury samples were taken in 1994. Idaho's mercury standard has since been updated to be a methyl-mercury fish tissue standard. Some studies have been done in the area to assess the level of mercury in fish. In 1986, Barnard and Vashro determined that bioaccumulation of copper and mercury was comparable to other non-contaminated waters elsewhere in the region. They found elevated levels of zinc (55 to 166 ppm) in the 68 fish sampled. In 1993, a limited study of fish tissue indicated that mercury levels were high in pike minnow and that further research was necessary. In 2005, a mercury advisory on Lake Pend Oreille was issued by the Idaho Department of Health and Welfare based on fish tissue analysis of trout and whitefish by Idaho Fish and Game (Jin 2005). Montana Fish Wildlife and Parks completed a fish tissue analysis of fish in Cabinet Gorge reservoir in 2005 and results will be available for review in the near future. Recent studies have shown that sources of mercury are prevalent in the atmosphere throughout the United States and may be difficult to pinpoint. It is likely that future monitoring will occur to determine the accumulated level of mercury in area fish, as well as potential contributions from atmospheric sources of mercury. When data are available, the Clark Fork River should be re-evaluated for potential mercury impairment.

Biological and Other Data

Lower Clark Fork River

The Lower Clark Fork is an eighth order river by the time it enters Idaho. As such, the BURP wadeable stream monitoring methods are not appropriate. No macroinvertebrate data are available from Idaho DEQ sampling. Extensive fisheries information and other indicators of the biological status of the river are available from other sources.

Since the construction of the Cabinet Gorge and other hydropower facilities, native fish populations have been declining in the area. The Bull Trout Problem Assessment ranks the Clark Fork River as a high priority for bull trout restoration. The largest impact to bull trout and other fisheries populations comes from the Cabinet Gorge dam upstream of the Lake and Albeni Falls dam downstream of the Lake. Impacts include loss of access to upstream habitat, artificially high lake levels, fluctuating flows and total dissolved gas levels that are in exceedance of Idaho WQS the majority of the time. Delta conditions have been altered over time by operation of the Albeni Falls and Cabinet Gorge projects, increasing erosion and decreasing sediment deposition from upstream (PBTTAT 1998).

When constructed, the Cabinet Gorge Dam cut off access to 46 percent of bull trout spawning and rearing habitat available at the time of construction. (The earlier construction of Thompson Falls dam cut off a much larger portion of the habitat in the early 1900s). Current efforts through the Clark Fork Settlement Agreement studied possible fish passage methods, and "trap and haul" operations are being tested and developed to move fish upstream and downstream of Noxon Rapids and Cabinet Gorge dams (Avista 2005).

Recent studies by Avista in coordination with resource and regulatory agencies have explored the impacts of Total Dissolved Gas supersaturation on fisheries populations. While it is clear there is some displacement, there is still some question as to the extent of impact the increased gas levels have on fish populations in the river. It is known that levels above 110 percent saturation, the current Idaho WQS, can be detrimental to fish populations and fish exposed to high total dissolved gas levels for extended periods of time can be harmed or killed (PBTTAT 1998). Site specific studies that have examined TDG include Weitkamp et al (2003a, 2003b).

Lightning Creek

Biological data are available for those streams assessed by BURP crews, with index scores presented in Table 13, and relative condition ratings are presented in Table 14.

Macroinvertebrate sampling was done at several BURP sites on mainstem Lightning Creek and its tributaries (Figure 8). Relatively healthy populations of cold water specific macroinvertebrates were found in the samples. BURP sampling was done in 1994, 1995, 1998 and 2002 on the mainstem and throughout the tributaries.

BURP data are considered reconnaissance and the indices applied give a coarse screen assessment on whether a water body is impaired or thought to be fully supporting its beneficial uses. Where other data are available, they may be used to assess the support status of an assessment unit. This was the case for the majority of the Lightning Creek watershed. DEQ utilized extensive field information from PWA (2004), the Avista relicensing process, IDFG and staff observation of extreme bank destabilization to determine the impaired status of Lightning Creek and its tributaries. While some of the BURP indices indicated possible support of beneficial uses (with mid-range scores), often all three indices were not available. DEQ relied heavily upon IDFG redd counts for bull trout that show a declining trend in redds despite a reduction in land management activities that impact water quality in the Lightning Creek drainages. The WAG agreed with DEQ’s assessments of data showing Lightning Creek and its tributaries are impaired by excess sediment and TMDL development was recommended.

Table 13. BURP Sites and Index Scores for Lower Clark Fork River subwatersheds.

STREAM NAME	Assessment Unit (17010213PN ____)	BURP Site ID	Stream Macro-invertebrate Index (SMI)	Stream Fish Index (SFI)	Stream Habitat Index (SHI)
Cascade Creek	09_02	2002SCDAA027	41.27	47.17	59
East Fork Lightning Creek	14_02	1994SCDAA024	39.32	89.43	30
		2002SCDAA012	51.45	85.51	74
East Fork Lightning Creek	14_03	2002SCDAA013	49.37	89.76	77
		1995SCDAB025	69.43	NA	41
Gold Creek	08_02	2002SCDAA054	Dry		
Johnson Creek (Upper)	02_02	2002SCDAA025	Dry		
		2001SCDAA048	Dry		
		1995SCDAA020	27.01	NA	60
Johnson Creek (Lower)	02_03	2001SCDAA049	58.93	78.62	68
		1995SCDAA019	38.12	94.61	61
Lower Lightning Creek	13_04	1994SCDAA023	57.69	NA	25
Lightning Creek	16_03	1994SCDAA025	75.13	NA	35
Lightning Creek (above Quartz)	19_02	1999SCDAA009	47.78	70.79	80
Lightning Creek (Upper)	19_03	1998SCDAA013	63.51	NA	69
Lightning Creek (mid)	17_03	2002SCDAA026	68.95	48.43	59
Lightning Creek (Morris Creek)	13_02	1998SCDAA014	50.61	97.7	71
Mosquito Creek	09_02	2002SCDAA028	70	42.83	63
		1995SCDAA053	46.08	NA	30
Lightning Creek (Porcupine Creek)	16_02	2002SCDAA015	57.28	83.66	75
		1995SCDAA021	68.01	NA	58
Rattle Creek	18_02	2002SCDAA014	56.72	85.26	78
		1995SCDAB019	56.48	NA	44
Savage Creek	15_02	1999SCDAA008	49.06	NA	85
Spring Creek (Upper)	21_02	1995SCDAB012	54.98	NA	45
Twin Creek	04_03	2001SCDAA050	66.46	80.62	81
		1995SCDAA055	45.51	57.62	59
Dry Creek	04_02	2002SCDAA024	Dry		
Wellington Creek	20_02	1996SCDAB033	49.07	NA	71
		1995SCDAB017	67.87	NA	52
		1997SCDAA041	NA	NA	67
West Fork Blue Creek	07_02	2002SCDAA055	Dry		
West Fork Elk Creek	06_02	2002SCDAA023	Dry		

Table 14. SMI, SFI and SHI scores for BURP monitoring data.

Condition Category	SMI (Northern Mountains)	SFI (Forest)	SHI (Northern Rockies)	Condition Rating
Above the 25th percentile of reference condition	≥65	≥81	≥66	3
10th to 25th percentile of reference condition	57-64	67-80	58-65	2
Minimum to 10th percentile of reference condition	39-56	34-66	<58	1
Below minimum of reference condition	<39	<34		Minimum Threshold

Scoring criteria are based upon known values of streams in Idaho that are considered to be functioning, or reference condition streams. A condition rating of three indicates that the index values do not significantly differ from index scores of reference streams. Condition ratings of two or one do significantly vary from index scores associated with reference conditions, however a condition rating of two is considered likely to still support beneficial uses (Grafe et al. 2002).

IDFG regularly conducts redd counts for bull trout in the Lower Clark Fork River subbasin. The trend (1983-2001) has generally been a flat line throughout all tributaries to Lake Pend Oreille and the Clark Fork River. However, comparing the 1980s with the 1990s in Lightning Creek drainage, there was a drop in redds, with the last several years having erratic, but somewhat stabilized counts (DuPont et al. 2004). IDFG attributes erratic redd counts to unstable habitat conditions in the drainage. Redd counts are one of the best tools for estimating overall population status and these data were used as an indication of lack of full support of salmonid spawning in the Lightning Creek drainage when IDEQ kept Lightning Creek AUs listed as impaired in the 2002 integrated report.

The Lower Clark Fork River assessment units are considered impaired by habitat alteration. Delta conditions have been altered over time by operation of Albeni Falls and Cabinet Gorge projects, increasing erosion and decreasing sediments from upstream (PBTTAT 1998). At the second vehicle bridge (no longer used), varying lake levels begin to impact the water velocities, depth and hydrologic conditions of the river channel and delta (PBTTAT 1998).

A spawning channel created in the early 1960s as mitigation for impacts of Cabinet Gorge Dam continues to provide spawning and rearing habitat, though the number of bull trout redds has declined over the years (DuPont et al. 2004).

Summary tables of water quality data used to inform TMDL are presented in Appendix B. The WAG reviewed and supplemented information in these tables.

Status of Beneficial Uses

The basis for the status of beneficial use determinations was BURP data collected from1995 to 2002. Figure 8 shows the locations of BURP monitoring sites, and Table 13 documents index scores for each site, results of which are discussed above. Of the 33 records, 16 sites were not assessed due to lack of data, while the other 19 sites were evaluated for their support of beneficial uses based upon reference condition indices. Johnson Creek BURP data indicated that the water body is not fully supporting cold water aquatic life and salmonid spawning and it is listed as impaired by sediment and temperature. BURP data are intended to be reconnaissance data and additional data were used to determine beneficial use support status in many of the Lightning Creek Assessment Units. While BURP scores indicated full support for several water bodies in the Lightning Creek drainage, there is a margin of error inherent in the indices, and often not all three indices were used to determine the score due to limited data sets. Extensive field information from the Forest Service and DEQ led to the Lightning Creek Assessment Units being listed as impaired by an unknown biological impairment in the 2002 Integrated Report. The available data summarized in the Lightning Creek Watershed Assessment (PWA 2004) indicate that the unknown biological impairment can most logically be attributed to sediment pollution, and therefore, sediment TMDLs will be developed for the Lightning Creek drainage. The Lower Clark Fork River WAG supports this determination of sediment impairment, primarily due to excessive bedload evident in the system.

In addition, temperature data were collected by DEQ and other entities and show exceedances in every water body measured. Eleven watersheds in the subbasin are listed for temperature impairment in the 2002 Integrated Report (IDEQ 2005).

The unassessed sites were spread throughout the subbasin and generally were not assessed due the site being dry when the BURP crew visited the site. BURP data from Spring Creek were collected in 1995 when DEQ used a different macroinvertebrate index, and reassessment was recommended to accurately determine the support status of the water body. Updated BURP data were collected in 2006 and will be considered in the five year review of this TMDL.

Conclusions

Existing data indicate continued impairment on the Lower Clark Fork River mainstem by temperature and total dissolved gas, as well as flow and habitat alteration. A TMDL will address TDG. Metals TMDLs will be developed for the three Lower Clark Fork Assessment Units, and on-going monitoring should continue. It is believed that the reservoirs act as metal and nutrient sinks, and the water quality in the mainstem below Cabinet Gorge dam is generally better than further upstream, however future monitoring and a TMDL are necessary to restore water quality during the critical peak flow seasons.

Temperature exceedances occur throughout the watershed. Critical times for exceedance follow seasonal temperature and native fish requirements. East Fork Creek and Johnson Creek were found to need further monitoring and a TMDL is developed to address the level of sediment pollutants which are known. Cascade Creek is listed for temperature impairment, however the BURP data indicate there may be other biological impairments. A stressor identification report identified sediment as a possible impairment (Clyne 2006). A sediment TMDL was considered, but is not recommended at this time. It is recommended that further information be collected on Cascade Creek to determine if sediment or other pollutants beyond temperature are causing impairment. Cascade Creek received a sediment reduction allocation to reduce its contribution to sediment impairment in Lightning Creek.

The instability of stream structure in Lightning Creek and its tributaries, and their ability to support healthy bull trout populations is a critical indicator of impairment and subsequent restoration that will be targeted in the TMDLs. Middle Lightning Creek, as the major depositional reach in the drainage, demonstrates the level of aggradation and stream channel alteration due to excess sediment. Currently, the Lightning Creek system does not have the capacity to assimilate the amount of bedload material moved through the system, resulting in a widening channel structure and water going underground in the lower reaches, sometimes creating fish passage barriers during critical fall spawning periods. The goal of the sediment TMDL is to return Lightning Creek to a condition that will fully support beneficial uses, and reduce excess sediment contributions to the stream. Because of the dynamic nature of Lightning Creek and its tributaries, a long time frame to recovery is expected.

2.5 Data Gaps

The beneficial use status of Spring Creek needs verification. Due to a change in BURP indexing and changes in the watershed, it is unknown whether the previous support status determination is still valid. Two factors influencing water quality are the non-operational status of the Clark Fork hatchery, which is expected to improve water quality, and changed land use activities due to increased development that may be impacting water quality in Spring Creek. Additional BURP monitoring of Spring Creek to reassess its support status was conducted in 2006 and will be reviewed in the next assessment cycle.

BURP data collected on Cascade Creek indicate biological impairment. A stressor identification report indicated that sediment may be an impairment. Limited data on harvest or other sediment generating activities on private lands are available to fully assess whether sediment is impairing beneficial uses on Cascade Creek.

Exceedances of water quality standards for metals have decreased since the Lower Clark Fork River was first listed for metals in 1994. This can be attributed to on-going remediation efforts upstream in Montana and changes in upstream dam operations that impact the timing and magnitude of peak flows that may transport metals. Continued monitoring is necessary in the Lower Clark Fork River to determine progress toward the TMDL target and to monitor potential excursions from the standards due to the proposed Rock Creek mine directly upstream of the Idaho/Montana border, and remediation efforts at the Milltown dam site.

As TDG mitigation projects progress, continued assessment to ensure desired conditions are reached is necessary.

While exceedances of the numeric water quality standard for temperature have been measured in the mainstem Lower Clark Fork River Assessment Units, information on upstream temperature influences from reservoirs in Montana and overall natural background conditions for temperature are not known. It is possible to model natural background temperatures and the potential for heating in reservoirs and from other sources, but this effort has not been attempted to date. Therefore, no TMDL for temperature will be completed on the mainstem Lower Clark Fork River in Idaho until additional information on background conditions is understood. It is anticipated that this review will occur before 2011, when the five-year review of TMDLs in the subbasin will be completed, and Montana DEQ will be working on other TMDLs for the Lower Clark Fork River. At this time, the Lower Clark Fork River has not been determined to exceed Montana water quality standards for temperature.