Libby Dam Spill Test
Libby, Lincoln County, Montana
Draft Environmental Assessment
April 2nd, 2002

Responsible Agency: The responsible agency for this project is the Seattle District, U.S. Army Corps of Engineers (Corps).

Abstract: This draft environmental assessment evaluates the potential impacts of a proposed 4-day test of the Libby Dam spillway in the latter half of June, 2002. The proposed spill test is a necessary part of a number of actions required to bring operation of the Libby Dam-Lake Koocanusa project into compliance with Sections 7 and 9 of the Endangered Species Act of 1973, as amended. The purpose of the proposed test is to determine how much spill can occur at Libby Dam without generating harmful levels of total dissolved gas (TDG) in the river downstream. Monitoring during the test would consist of measuring water quality parameters and observations of fish condition. Spill volumes would increase until:

- The total spill volume equals 10,000 cubic feet per second;
- The spill volume generates TDG levels that exceed approved thresholds; or
- Any gas bubble disease symptoms are observed in fish.

THE OFFICIAL COMMENT PERIOD ON THIS ENVIRONMENTAL ASSESSMENT ENDS ON MAY 10, 2002.

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LIBBY DAM

SPILL TEST

DRAFT ENVIRONMENTAL ASSESSMENT

April 2, 2002

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BPA: Bonneville Power Administration

CFR: Code of Federal Regulations

DPS: distinct population segment

ESU: evolutionarily significant unit

FCRPS: Federal Columbia River Power System

FWCA: Fish and Wildlife Coordination Act

GBD: gas bubble disease

IJC: International Joint Commission

NEPA: National Environmental Policy Act

NMFS: National Marine Fisheries Service

RCC: Reservoir Control Center

RM: river mile

TDG: total dissolved gas

U.S.: United States

USFWS: United States Fish and Wildlife Service

USC: United States Code

VARQ: variable discharge (“VAR" is short for variable and "Q" is an engineering symbol representing discharge)

1. INTRODUCTION

The United States (U.S.) Army Corps of Engineers (Corps) proposes to conduct a 4-day test of the Libby Dam spillway in the latter half of June, 2002. In accordance with the National Environmental Policy Act (NEPA), this document examines the potential impacts of the proposed spill test. This environmental assessment document addresses the potential individual and cumulative effects of the proposed spill test only. All other potential future actions at Libby Dam that are related or commonly perceived to be related to the spill test, will require additional analysis and study of their potential effects before the Corps reaches a decision on their form and implementation schedule (see Paragraph 6, Cumulative Effects, for more details).

2. BACKGROUND

In December, 1999, the Bonneville Power Administration (BPA), the Corps, and the Bureau of Reclamation (Reclamation) submitted a biological assessment evaluating the effects of the Federal Columbia River Power System (FCRPS) on species and habitats protected under the Endangered Species Act of 1973. In December, 2000, the U.S. Fish and Wildlife Service (USFWS) released their biological opinion on the operation of the FCRPS. The biological opinion contains a series of reasonable and prudent measures designed to minimize the potential impacts to listed species and their habitats.

One of the reasonable and prudent measures for Kootenai River white sturgeon requires the Corps to conduct a spill test at Libby Dam to "reliably estimate the maximum spillway flow dilution capability and compliance with the state water quality standard of 110 percent gas saturation…" (USFWS, 2000). This year, we anticipate that runoff will be adequate to supply enough water to conduct the spill test, pending compliance with the pertinent regulatory requirements.

2.1. Project Authority

The proposed spill test is a necessary part of a number of actions required to bring operation of the Libby Dam-Lake Koocanusa project into compliance with Sections 7 and 9 of the Endangered Species Act of 1973, as amended. The proposed test is being funded under operations and maintenance authority using a mix of ratepayer funds from the BPA and Congressionally appropriated funds.

Construction of Libby Dam on the Kootenai River, Montana, was authorized by Public Law 516, the Flood Control Act of 17 May 1950, 81st Congress, Second Session, in accordance with the plan set forth in House Document 531, 81st Congress, Second Session. The dam was constructed in accordance with the treaty between the United States and Canada relating to international cooperation in water resources development of the Columbia River basin. The reservoir created by Libby Dam was designated Lake Koocanusa (a combination of the first syllables of the words Kootenai and Canada, and initials USA) by Public Law 91-625 dated 31 December 1970. The authority for public use development is derived from the Flood Control Act of 1944, Public Law 78-534, as amended.

2.2. Purpose and Need

The purpose of the proposed action is to determine how much spill can occur at Libby Dam without generating harmful levels of total dissolved gas (TDG) in the river downstream.

There is an urgent need to research the capability of Libby Dam, Montana, to pass water over its spillway without creating TDG levels harmful to aquatic life in the river downstream. Though spill has not recently occurred at Libby Dam, there is always the chance that it will, due to large runoff events or other emergencies.

Furthermore, the USFWS has mandated the Corps to move toward increased flow capacity to benefit the recovery of the endangered Kootenai River white sturgeon, under the Endangered Species Act. Alternatives to provide increased flow include use of the spillway (to the extent possible without generating harmful levels of dissolved gas) or increasing powerhouse capacity with installation of additional turbines. See Paragraph 6 (Cumulative Effects) for further discussion of the relationship between the spill test and additional flow capacity. The spill test would also provide an opportunity to assess the condition of the spillway facing, leading to a plan to repair the spillway, as necessary (see Paragraph 3.4.3—Dam Safety). Finally, the proposed implementation of the variable discharge (or VARQ—"VAR" is short for variable and "Q" is an engineering symbol representing discharge) alternative flood control operation at Libby Dam may increase the risk of involuntary spill.[1] Information from the proposed spill test would be used in the NEPA evaluation of the VARQ alternative flood control operation currently being done by the Corps and the Reclamation of Reclamation.

2.3. Libby Dam-Lake Koocanusa History

The Libby Dam-Lake Koocanusa project was constructed on the Kootenai River in Montana (Figures 1 and 2) by the Seattle District, U.S. Army Corps of Engineers. Libby Dam (Figure 3) is a straight concrete gravity gate controlled dam, 370 feet high (from the stream bed) and 2,887 feet long (length of the dam crest), located at river mile (RM) 221.9 of the Kootenai River.

Construction of the project was initiated in 1966. The dam became operational for flood control in 1972, at which time only the sluiceways were available to pass water. Use of the sluiceways caused supersaturation of the river with atmospheric gas and gas bubble disease (GBD, also known as gas bubble trauma) in fish and aquatic insects below the dam (Battelle Laboratories, 1974).

The first hydroelectric generating unit came on line in 1975. The powerhouse had an initial installed capacity of 420,000 kilowatts from four hydroelectric generating units, with provision for four additional units. Generating unit No. 5 was completed and went on line in 1984. The remaining three turbines have not been installed due, in part, to litigation in the late 1970s concerning a proposed re-regulation dam downstream of Libby Dam.

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[1] If implemented, the VARQ flood control operation would likely be paired with releases of water during the spring for the benefit of fish populations. Release of the spring fish flows may mitigate for any increased probability and frequency of involuntary spill predicted to result from the VARQ flood control operation alone.

The project provides local flood control protection in Montana and Idaho, mainstem flood control in the lower Columbia River, and hydroelectric power generation at Libby Dam and downstream plants through release of stored water. Libby Dam is authorized for flood control, hydroelectric power, and other purposes, including recreation. Specific project operations are under the direction of the Corps of Engineers, Northwestern Division, Reservoir Control Center (RCC) in Portland, Oregon. The RCC maintains frequent contact with local and state interests,

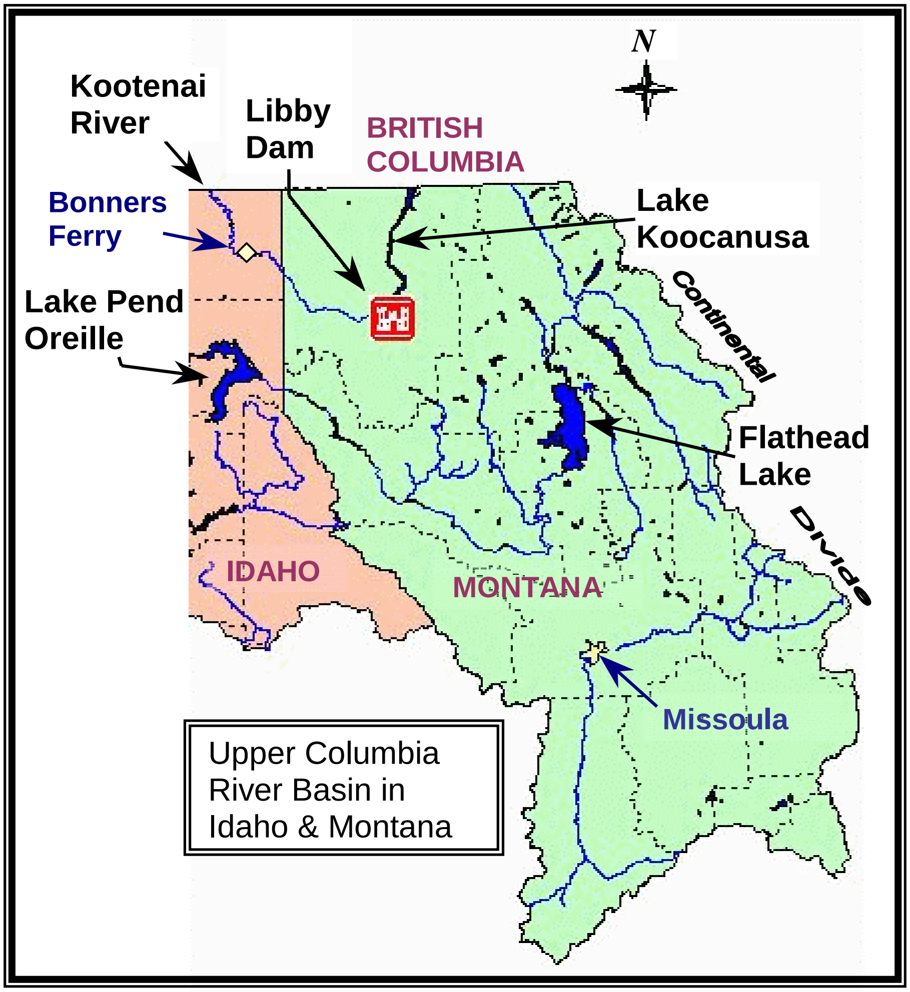

Figure 1. Location of the Kootenai River within the upper Columbia River Basin

and with the BPA to help meet Federal system electric power needs. The RCC also coordinates with tribal, state, local and other federal authorities, as well as Canadian public agencies, to account for all interests and stakeholders in project operation.

The local flood control objective of Libby Dam is to protect the Bonners Ferry area from river stages in excess of elevation 1764 feet.[2] The system flood control objective of Libby Dam is to provide up to 4.98 million acre-feet[3] of water storage to help control floods on the lower

[2] Unless otherwise noted, all elevations in this document are referenced to the National Geodetic Vertical Datum of 1929.

[3] An acre-foot equals the volume that would cover 1 acre to a depth of 1 foot, equal to 43,560 cubic feet or 325,804 gallons.

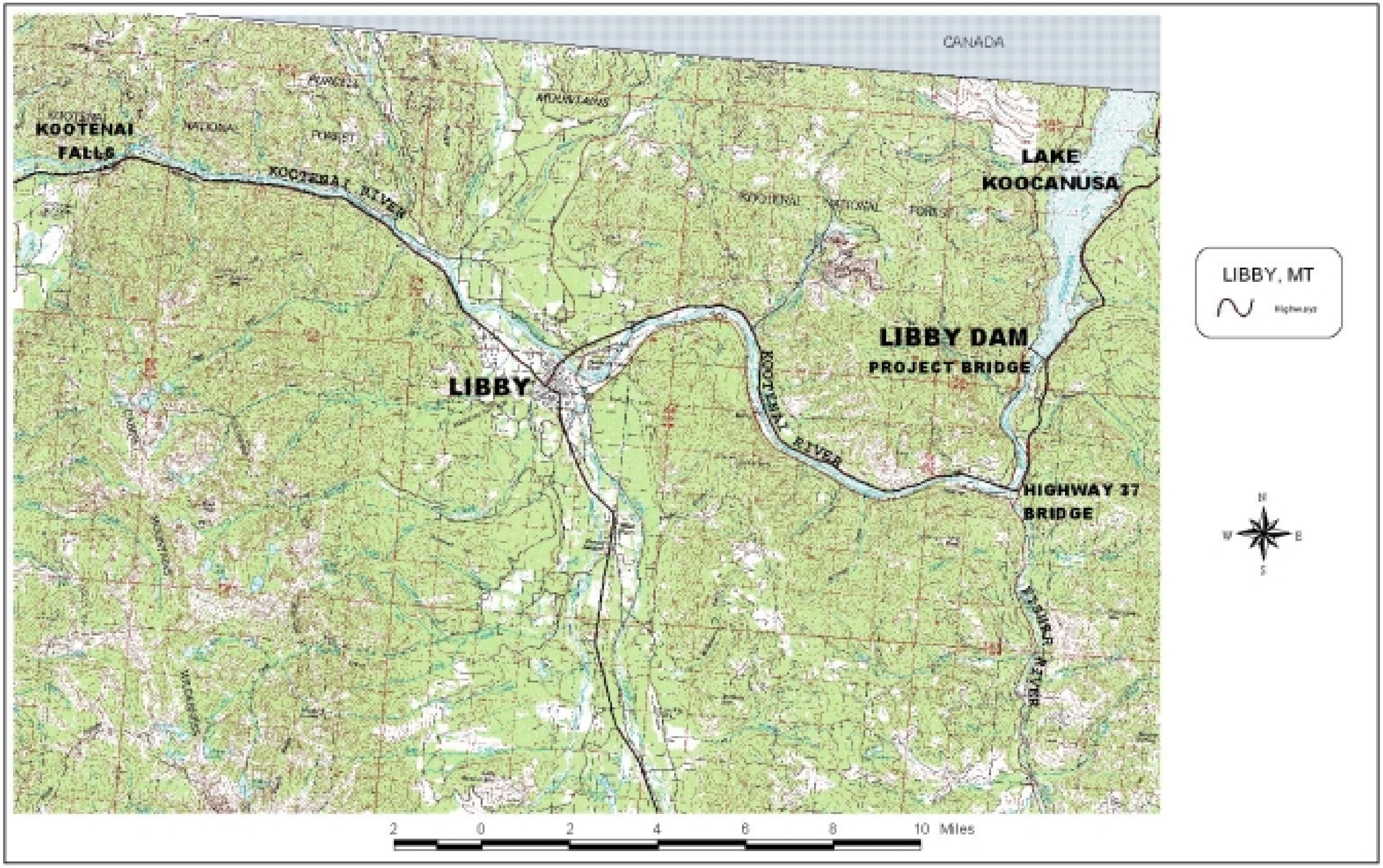

Figure 2. Map of Lake Koocanusa, Libby Dam, and Kootenai River in northwest Montana.

Figure 3. Aerial view of the downstream face of Libby Dam.

Columbia River below Bonneville Dam. During flood season, the RCC operates Libby Dam to minimize downstream flood impacts as much as conditions permit.

Due to concerns about creating damaging levels of dissolved gas downstream of Libby Dam, dam operations have intentionally avoided spill of any water since the mid-1980s,[4] and maximum discharge from the dam has been limited to output from the turbines. The ability to avoid spill at Libby Dam depends on a combination of conservative water management and favorable weather and runoff patterns. For example, in 1996 and 1997, years of high snowpack and subsequent runoff, every other dam in the Northwest was spilling for flood control purposes. Spill was very narrowly averted at Libby due to favorable weather patterns during the crucial time period. 1996 and 1997 will not be the most extreme events that the project will experience. Even considering conservative water management intent on avoiding water spill, the probability of involuntary spill (i.e. passing water over the spillway because the reservoir is full and reservoir inflow exceeds outflow capacity of the powerhouse) is higher in years with unusually high precipitation amounts or runoff events.

Also, use of the spillway would provide some flexibility in maintaining downstream flows for the benefit of fish and recreation. For example, in 1998, during the sturgeon spawning period, a power unit at Libby Dam was down for maintenance. To lower the probability of spill, the Corps supplied only 20,000 cubic feet per second (cfs) for sturgeon (the maximum available powerhouse output with only 4 operable turbines) instead of 25,000 cfs. In another scenario, rare transmission problems could force the Corps to reduce dam outflow to as little as 1,500 cfs for a short period of time. Use of spill would allow us to maintain a higher flow in the river while the problem is fixed.

The potential powerhouse discharge depends on the efficiency and capacity of the turbines and the amount of head difference between the forebay (the reservoir immediately behind the dam) and the tailrace. Under the expected pool conditions during the proposed spill test, maximum powerhouse output at Libby Dam equates to approximately 25,000 cfs. At lower pool levels, maximum powerhouse discharge can exceed 25,000 cfs. For example, powerhouse discharge reached about 28,000 cfs during the high flow year of 1997.[5] Once the powerhouse discharge has been maximized, the only other ways to pass water from the reservoir involve spilling water over the spillway or passing water through the sluiceways. As originally designed, operation of Libby Dam included emergency use of spill under rare conditions when the reservoir is full and reservoir inflow exceeds outflow capacity of the powerhouse. The proposed action would provide valuable information on the potential water quality effects of spill that may influence future dam operations for both flood hazard reduction and fish habitat purposes. More detailed background information is found in Appendix A.

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[4] The most recent opening of the sluices occurred in September 1985 for a test of the emergency closure gates, during which fish with GBD symptoms were observed downstream of the dam.

[5] Maximum powerhouse discharge is a function of turbine efficiency, which is a function of head difference between the forebay and the tailrace. The highest possible powerhouse discharge occurs with a combination of lower pool levels (less than 2437 feet) and maximum power production.

2.4. Dissolved Gas in the Kootenai River

Atmospheric air contains a mix of nitrogen, oxygen, carbon dioxide, and gas. Gas in the atmosphere dissolve into lakes, rivers, and oceans and collectively make up the total dissolved gas (TDG) concentration. In the absence of biological, physical, or chemical activity that can affect dissolved gas concentrations, TDG concentrations in water are generally in equilibrium with the atmosphere; in which case the water contains 100 percent TDG saturation.

TDG saturation can exceed 100 percent under certain circumstances. For example, a high energy plunge of water can carry large amounts of air to depth where high water (hydrostatic) pressures dissolve high amounts of gas, creating a TDG saturation greater than 100 percent, known as supersaturated conditions. At Libby Dam in the early 1970s, water spill falling into the stilling basin forced so much gas into the water that TDG saturation of greater 120 percent was commonly observed downstream of the dam. Environmental phenomena such as photosynthesis by aquatic plants or natural cascades can also create TDG saturation in excess of 100 percent.

As the water flows downstream from a source of TDG supersaturation, supersaturation persists, sometimes for many miles, until the water re-equilibrates by releasing excess gas to the atmosphere. The rate of this de-gassing is dependent on a variety of factors including water depth and agitation (i.e. in waterfalls or rapids). Actions that increase the surface area of the water, such as those that create bubbles or spray, allow more gas to come out of solution and re-enter the atmosphere, thereby decreasing the level of TDG saturation in the water.

In the Kootenai River downstream of Libby Dam, Kootenai Falls (RM 195) agitates the cascading water and effectively “re-sets” the TDG saturation to about 111 percent just downstream of the falls. For instance, from 1972 to 1975, the TDG saturation below the falls measured between 111 and 114 percent regardless if the TDG saturation just above the falls was 130 percent[6] or 110 percent[7] (Graham, 1979). Accordingly, elevated TDG levels generated by Libby Dam are of concern in the reach of the Kootenai River between the dam and Kootenai Falls, but not below the falls.

2.5. Effects of Dissolved Gas on Aquatic Organisms

TDG supersaturation in water can have harmful effects on fish and aquatic insects. Terrestrial organisms breathe air to obtain oxygen and to exhale carbon dioxide. Similarly, aquatic organisms obtain their oxygen and release carbon dioxide by exchanging dissolved gas with the surrounding water via their gills and, in some cases, their skin. This gas exchange allows the dissolved gas to enter their blood and body tissues.

TDG supersaturation in the water causes supersaturation of the blood and body tissues of the organism. The same way the supersaturated water will eventually de-gas to return to equilibrium conditions, supersaturated blood and tissues can de-gas inside an organism under certain conditions. As gas leaves solution in blood vessels, it can block them, restricting blood flow in a condition similar to decompression sickness or “the bends” in human divers. Gas may also come out of solution in other tissues, such as skin, eyes, or swim bladder. Such bubble formation causes tissue damage and may make the organism buoyant, increasing their susceptibility to

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[6] Discharge from Libby Dam via sluiceways only.
[7] Discharge from Libby Dam via turbines.

predation or allowing them to be swept out of their normal habitat. Fish are particularly susceptible to GBD resulting from internal degassing.

TDG supersaturation can also adversely affect aquatic insects. In the Kootenai River, Fickeisen and Montgomery (undated-1976?) found buoyancy from external bubble adherence to insects caused them to float uncontrollably at a surface TDG saturation of 129 percent for several hours. Such flotation may be one mechanism that caused observed changes in the aquatic insect community in the Kootenai River soon after Libby Dam began spilling in 1972.

The degree of the biological effects caused by TDG supersaturation depends on the level of saturation; the type, size, depth, behavior, and health of the organism; the water temperature; and the length of the organism's exposure to supersaturated conditions (Fidler *et al.* 1999). Increased depth in the water column allows water pressure to equal or compensate the added gas pressure from supersaturation. Each 1 meter in depth compensates for an additional 10 percent over the 100 percent TDG saturation. Even at 120 percent TDG saturation, a fish located at the compensation depth of 2 meters will not experience ill effects from GBD. However, if the same fish moves toward the surface, it may begin to experience GBD symptoms since the hydrostatic pressure of the water is no longer sufficient to counteract the TDG gas pressure, allowing gas in the fish's blood and tissues to bubble out of solution, which may injure or kill the organism. Again, this is similar to "the bends" in human divers resulting from a rapid ascent after an extended dive at depth. Another comparison is the sudden bubble formation when a container of carbonated beverage, supersaturated with carbonation, is opened. Opening the bottle suddenly lowers the bottle's internal pressure and allows the dissolved gas (in this case, carbon dioxide) to come out of solution in the form of small bubbles.

Studies on the effects of TDG supersaturation on fish typically have been performed in controlled laboratory settings where the depth, TDG concentration, temperature, fish health, and duration of exposure are tightly controlled. These studies have documented biological effects from TDG supersaturation in shallow water but do not account for non-steady state exposure caused by spatial and temporal changes in TDG concentration and fish movement in the river (Fidler *et al*., 1999).

In the Pacific Northwest, state water quality standards typically limit TDG saturation to 110 percent at all water depths[8]. However, annual waivers allow TDG saturation of 120 percent in the tailrace for some Columbia and Snake River dams where voluntary spill operations are routinely conducted to facilitate downstream passage of juvenile salmon. The regulatory standards for TDG may be overly conservative in some situations (i.e. where fish spend long periods below the compensation depth) or not conservative enough in some situations (i.e. when elevated water temperatures and shallow water depths may exacerbate swim bladder overinflation in small fish; Fidler *et al.*, 1999).

Laboratory experiments documented high mortality rates for Kootenai River mountain whitefish and cutthroat trout held at TDG saturations greater than 116 percent for more than 3 days. Largescale suckers and torrent sculpins were more tolerant of high TDG saturation but exhibited signs of GBD (i.e. formation of gas bubbles on the skin) that may result in mortality in the

[8] The Montana State water quality standard for TDG saturation is also 110 percent.

natural environment (Fickeisen and Montgomery, undated). In laboratory experiments, 20 percent of juvenile steelhead and chinook died within 35 and 120 hours, respectively, of exposure to a constant 120 percent TDG, while no chinook or steelhead died after 22 days of exposure to 110 percent TDG (Mesa *et al.*, 2000).

Observations at different Columbia River dams have documented GBD symptoms during spill events in the natural riverine environment. Juvenile salmonids in the Columbia River typically began to exhibit signs of GBD when the 24-hour average TDG saturation approached and exceeded 120 percent (Fish Passage Center, 2000). In the Columbia River, TDG supersaturation can persist from the tailrace of an upstream dam to the forebay of the next dam downstream, leading to persistent TDG saturation of 120 percent or higher, the very conditions that have been observed and predicted to cause GBD symptoms in up to 16 percent of fish (Backman *et al.*, 1999).

In studies on mid-Columbia River dams, large or adult fish appear to be more tolerant of higher TDG saturation than juvenile or smaller fish (Backman *et al.*, 1999), possibly because larger fish are more likely to spend more time in water deeper than the compensation depth. Field studies of juvenile salmonids and resident fish have measured lower rates of GBD at high TDG saturation than would be expected based on controlled laboratory experiments (Weitkamp, 2000). The lower rate of GBD in natural conditions may be the result of fish moving up and down in the water column and spending time below the compensation depth where hydrostatic pressure counteracts the TDG gas pressure. Essentially, fish living under high TDG levels may effectively decrease their "dose" of harmful TDG levels by moving from shallow to deeper waters.

The effective "dose" of TDG supersaturation can also be decreased by controlling the duration that TDG supersaturation is generated. Bennett *et al.* (1999) found no external symptoms of GBD among fish below Lower Granite Dam on the Snake River in conjunction with spill tests where TDG levels exceeded 115 percent but the tests lasted no more than 3 hours at a time. GBD is not inevitably fatal. If TDG saturation falls to lower levels or if fish move deeper in the water column and below the hydrostatic compensation depth, the fish can recover from even severe symptoms of GBD.

To summarize, TDG supersaturation can cause physical injury or death in aquatic organisms via GBD. The rate of GBD symptoms is related to the TDG supersaturation level, the size and type of the organism, and the duration of the exposure of the organism to harmful levels of TDG supersaturation. The dynamics of the natural riverine environment complicate an accurate prediction of the effects of a given level of TDG supersaturation, but creation of TDG levels at or above 120 percent saturation should be avoided for all but short periods of time.

2.6. Fish Entrainment at Libby Dam

Since the mid-1980s, only the powerhouse has been used to pass water from the reservoir to the river downstream. Libby Dam utilizes a selective water withdrawal system on the penstock intakes to the powerhouse turbines. The selective withdrawal system consists of up to 22 10-foot-high steel bulkheads that can be stacked into concrete guides over the penstock intakes on the upstream face of the dam. The bulkheads are stacked by a gantry crane into the guide slots until the water from the desired depth is diverted over the top of the stacked bulkheads and into the penstock intakes. The deepest depth at which water can be withdrawn is 2222 feet elevation (the elevation of the reservoir at full pool is 2459 feet). To prevent hydraulic problems, the bulkheads must not be stacked closer than 20 feet from the reservoir surface. During recent years as specified by an agreement with the State of Montana, water typically is drawn from 50 feet from the reservoir surface from May to mid-July. The rest of the year, water is typically withdrawn from deeper than 50 feet below the reservoir surface.

Kokanee were introduced to Lake Koocanusa in the late 1970s and now support a popular sport fishery. Studies have documented kokanee, largescale sucker, burbot, and cutthroat trout passing through turbines in Libby Dam (known as entrainment; Skaar *et al.*, 1996). Kokanee are particularly vulnerable to entrainment through hydropower dams since they are pelagic, spending much of their lives within 70 feet of the water surface.

The vast majority of entrained fish at Libby Dam are kokanee. Skaar *et al.* (1996) found that kokanee comprised 97.5 percent of the fish caught in nets at the turbine outlets. The next most abundant fish were largescale suckers, comprising 1.1 percent of the catch. Together, bull, cutthroat, and rainbow trout made up less than 0.2 percent of the catch and some of the captured fish likely entered the nets from downstream areas rather than passing through the turbines. Accordingly, the analysis of fish entrainment will focus on kokanee.

At Libby Dam, the discharge volume, depth of withdrawal, and forebay fish density all influence the rate of entrainment (Skaar *et al.*, 1996). On a seasonal basis, kokanee entrainment rates are highest in the spring (late April-early July) when dam discharge and forebay fish densities are high and withdrawal depth is the shallowest of the year (Skaar *et al.*, 1996). Bull trout feed on kokanee in Lake Koocanusa and may be entrained as they follow kokanee into the turbine intakes. The Corps is investigating fish entrainment at Libby Dam and hopes to have better data concerning bull trout entrainment from future studies.

While entrained fish may be killed or injured as they pass through the turbines, many survive. For example, since their introduction into Lake Koocanusa, entrained kokanee have colonized the Kootenai River downstream of Libby Dam. Entrained kokanee are also a food source for resident fish downstream of the dam (such as bull trout, pikeminnow, and rainbow trout).

3. EXISTING CONDITIONS

3.1. Physical Characteristics

Libby Dam is located on the Kootenai River in Lincoln County, Montana, about 40 miles south of the international boundary between the United States and Canada (Figures 1 and 2). The dam is approximately 48 miles west of Kalispell, Montana; 11 miles east of the town of Libby, Montana; and 219 river miles upstream from the confluence of the Kootenay[9] River with the Columbia River in British Columbia. Behind Libby Dam, Lake Koocanusa is 90 miles long at full pool (48 miles within the U.S.), extends north into the Canadian province of British Columbia, and has a useable storage capacity of 4.98 acre-feet.

The Kootenay River originates in British Columbia, flowing southward into northwestern Montana. Libby Dam is located in the Kootenai River Valley, within the Kootenai National

[9] The American spelling is Kootenai. The Canadian spelling is Kootenay.

Forest. The area is characterized by high, rugged, forested northwest-trending mountain ranges separated by narrow linear valleys. The elevation of many of the peaks in the Purcell Mountains, west of Lake Koocanusa, exceed 6,000 feet above sea level. Downstream from Rexford, Montana, Lake Koocanusa occupies a narrow gorge, averaging 1 mile in width, between steep, coniferous forest-covered mountains with flat benches at the mouths of tributary streams. Above Rexford to the Canadian border, the reservoir is approximately 2 miles wide and the character of the shoreline changes to generally sloping, rolling terrain with extensive flat areas at or above pool level. Full pool elevation of Lake Koocanusa is 2459 feet.

Downstream of Libby Dam, the Kootenai River follows a free-flowing course, dropping about 5 feet per mile. The stilling basin below the spillway is approximately 60 feet deep, with thalweg depth decreasing to about 23 feet near the bridge for the powerhouse access road (the David Thompson Bridge) downstream of the dam. Nine miles west of the town of Libby, Montana, the river passes over scenic Kootenai Falls. The area downstream of Libby Dam is characterized by relatively flat terraces which lie at intervals between the riverbanks and steep mountain slopes.

The Kootenai River Canyon continues downstream from Kootenai Falls to about RM 161, at the river's confluence with the Moyie River, upstream of the town of Bonners Ferry, Idaho (RM 153). From the lower end of the canyon to the town of Bonners Ferry, the floodplain opens up and is used for agriculture. The river bottom is gravelly, with meandering channels and bars exposed in "braided" configuration at low flows.

The river gradient flattens beginning at about Bonners Ferry, then meanders north in a sinuous pattern through a narrow, flat floodplain bounded by mountains, crossing the Canadian border, and forming a delta as it enters Kootenay Lake at Creston, British Columbia. The Kootenai River floodplain downstream of Bonners Ferry, commonly known as Kootenai Flats, is farmed, and the river confined by nearly continuous levees which extend beyond the Canadian border. The river is deep and slow-moving here, with very little gradient, and its surface elevation is directly affected by the elevation of Kootenay Lake, which backs up as far as Bonners Ferry. Kootenay Lake level is controlled by Corra Linn Dam, where the Kootenay (Canadian spelling) River leaves the lake at the end of its West Arm near Nelson, British Columbia. After exiting Kootenay Lake, the Kootenay enters the Columbia River in Canada. The Columbia flows south and ultimately west into the Pacific Ocean.

3.1.1. Geology

The drainage area of the Kootenai River lies in the Northern Rocky Mountain physiographic province, an uplifted, naturally dissected, and heavily glaciated area. Topography is primarily controlled by bedrock structure modified by glacial erosion and sedimentation. The project area is characterized by high, rugged, forested northwest-trending mountain ranges separated by narrow linear valleys. Bedrock of the Precambrian Belt Series underlies the entire area, composed principally of fine-grained metasedimentary quartzite, argillite, and impure limestone deposited as sand, silt, and clay in a broad and shallow basin. A relatively few igneous intrusive bodies are found scattered within the drainage basin.

3.1.2. Climate and Hydrology

The climate of the Kootenai River basin is a combination of a modified west coast marine and continental climate. Summers are sometimes hot and dry and winters are cold. Mean annual precipitation averages approximately 30 inches for the basin, generally increases with increasing altitude, and varies from 14 inches at Cranbrook, British Columbia, to an estimated 60 inches on some of the higher mountains. Annual snowfall varies from about 40 inches in the lower valleys to an estimated 300 inches in some mountain areas. Most of the snow falls during the November-March period, but heavy snowstorms can occur as early as mid-September or as late as early May.

Much of the annual runoff occurs in spring with the snowmelt. The annual pre-dam hydrograph for the Kootenai River at the town of Libby, Montana (Figure 3) shows a distinct peak in the April-July time period. Relatively low runoff predominates the rest of the year, especially in the dry late summer, and in winter when much of the precipitation falls as snow and remains frozen. Thus, flood control operations at Libby Dam are formulated to allow for maximum flood storage by the end of the winter, to control excessive spring runoff.

3.1.3. Water Quality

The state of Montana considers water the mainstem Kootenai River to be class B-1, suitable for drinking after conventional treatment, recreational use, growth and propagation of aquatic organisms (including salmonids), and agricultural and industrial uses. In the winter, water temperatures in Lake Koocanusa and the river generally range between 36°F (2°C) and 46°F (8°C). In the summer, Lake Koocanusa stratifies with the upper layers reaching temperatures up to 68°F (20°C). The temperature of water released by Libby Dam is controllable within a range that varies over the year in agreement with the State of Montana. Dissolved oxygen levels are generally ample for aquatic life and pollutant levels low. Inflow from the Fisher River, with higher loads of suspended sediment and summer temperatures resulting from intensive logging activities in the basin, adversely affects overall Kootenai River water quality.

TDG levels in Lake Koocanusa are generally about 100% saturation. Since the early 1980s, all water from Libby Dam has been discharged solely via the powerhouse, resulting in TDG levels in the Kootenai River just below the dam at about 100% saturation. Prior to installation of the turbine units in the mid-1970s, Libby Dam commonly spilled water via the sluiceways and spillway, resulting in TDG saturations up to 140% immediately downstream of the dam. Because of the adverse environmental effects caused by such high TDG supersaturation, Libby Dam has been carefully managed to avoid spill since the last turbine became operational in 1984. See Paragraphs 3.2.2 (Fish) and 3.2.3 (Aquatic Insects) for more discussion of TDG issues.

TDG levels in Lake Koocanusa are generally about 100% saturation. Since the early 1980s, all water from Libby Dam has been discharged solely via the powerhouse, resulting in TDG levels in the Kootenai River just below the dam at about 100% saturation. Following closure of the dam in 1972 and prior to installation of the turbine units in the mid-1970s, Libby Dam commonly spilled water via the sluiceways and spillway, resulting in TDG saturations up to 140% immediately downstream of the dam. Because of the adverse environmental effects caused by such high TDG supersaturation, Libby Dam has been carefully managed to avoid spill

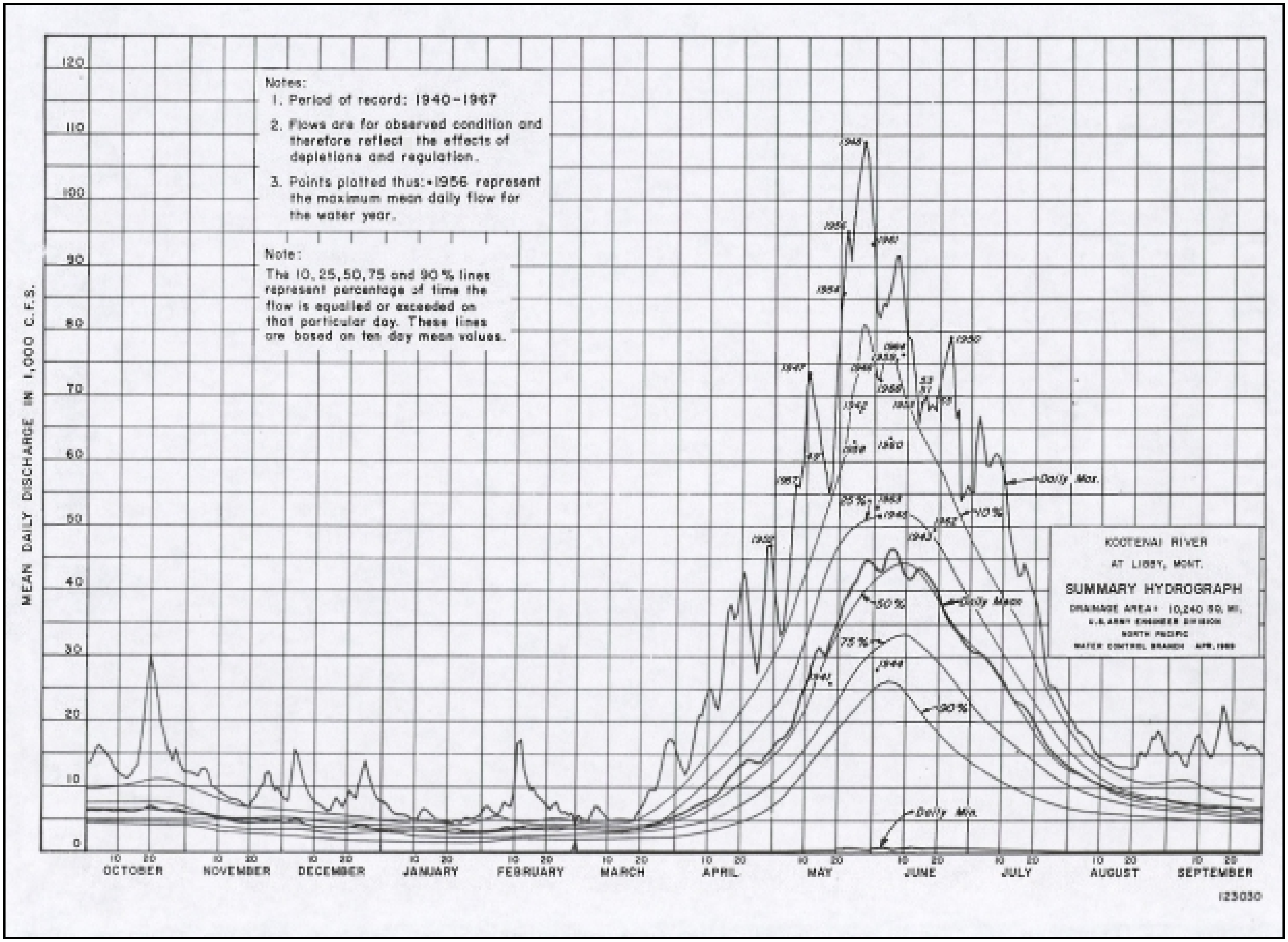

Figure 4. Summary hydrograph for the Kootenai River at Libby, Montana (1940-1967).

since the last turbine became operational in 1984. See Paragraphs 3.2.2 (Fish) and 3.2.3 (Aquatic Insects) for more discussion of TDG issues.

3.2. Natural Resources

3.2.1. Vegetation

The Kootenai River basin in the vicinity of project lands is characterized primarily by coniferous forests. Dominant vegetation in the areas are various conifers such as ponderosa pine (*Pinus ponderosa*), Douglas fir (*Pseudotsuga menziesii*), western larch (*Larix occidentalis*), and spruce (*Picea* spp.). Riparian communities (narrow belts of vegetation along the margins of waterbodies which are adapted to relatively wet conditions) include cottonwood (*Populus balsamifera*), willow (*Salix* spp.), red-osier dogwood (*Cornus stolonifera*), mountain alder (*Alnus tenuifolia*), birch (*Betula* spp.), serviceberry (*Amelanchier alnifolia*), ninebark (*Physocarpus capitatus*), and rose (*Rosa* spp.). These riparian areas are important not only for the variety of food and cover they provide for wildlife, but also because they provide an important link between aquatic and terrestrial ecosystems.

3.2.2. Fish

The Kootenai River serves as habitat for a number of native and nonnative species of fish (Table 1). All are resident (meaning they reside in the Kootenai basin for their entire life cycle), including white sturgeon (*Acipenser transmontanus*) and kokanee (*Oncorhynchus nerka*). Both of these species have anadromous counterparts. The kokanee is a smaller, landlocked form of sockeye salmon, and the Kootenai population of white sturgeon has been isolated (above Bonnington Falls, British Columbia) from anadromous white sturgeon in the Columbia River since the last ice age about 10,000 years ago. Both of these species reside part of the time in Kootenay Lake, BC, migrating up the Kootenai River to spawn. Kokanee also reside above Libby Dam in Lake Koocanusa. Other native salmonids are notable, and include bull trout (*Salvelinus confluentus*), rainbow trout (*O. mykiss*), mountain whitefish (*Prosopium williamsoni*), and westslope cutthroat trout (*O. clarki lewisi*). Non-native fish species that occur in the area include brook trout (*Salvelinus fontinalis*) and bullhead (*Ameiurus* spp.).

The free-flowing Kootenai River prior to the construction of Libby Dam provided relatively good recreational fishing. Mountain whitefish and rainbow and cutthroat trout were the primary species taken. The fishing was, however, seasonal due to the turbid high flows which normally characterized the river for about a 3-month period during spring runoff.

Construction of Libby Dam created a complete barrier to upstream fish passage separating two different aquatic environments—a regulated river downstream from the dam and a fluctuating reservoir upstream from the dam, each with its distinctive fish community. Some downstream passage of fish occurs through the powerhouse (see Paragraphs 3.2.2.1—Fish Entrainment at Libby Dam, and 5.2.2.2—Potential Effects from Entrainment, for more details). The Kootenai River downstream of Libby Dam has developed into a good rainbow trout fishery. Although fishing has been frequently restricted by water level fluctuation caused by hydropower peaking at the dam, it has remained productive. Large Gerrard (Kamloops) rainbow trout can be caught below the dam where they feed on kokanee entrained through the penstocks. In 1997, a world-

Table 1. Partial list of fish species present in the Kootenai River, Idaho and Montana (adopted from BPA *et al.*, 1995, Appendix K)

KEY: A—Abundant C—Common U—Uncommon N—Nonexistent R—Rare

Family—Species	Scientific Name	Lake Koocanusa	Kootenai River
Sturgeons—Acipenseridae			
White sturgeon	*Acipenser transmontanus*	N	C
Salmon, Trout, Whitefishes—Salmonidae			
Cutthroat trout	*Oncorhynchus clarki*	C	C
Rainbow trout	*O. mykiss*	C	C
Kokanee	*O. nerka***	A	C
Bull trout	*Salvelinus confluentus*	C	C
Brook Trout	*S. fontinalis**	U	C
Mountain whitefish	*Prosopium williamsoni*	C	C
Pikes—Esocidae			
Northern pike	*Esox lucius**	U	N?
Minnows—Cyprinidae			
Lake chub	*Couesius plumbeus*	C	N
Peamouth	*Mylocheilus caurinus*	C	C
Northern pikeminnow	*Ptychocheilus oregonensis*	C	C
Longnose dace	*Rhinichthys cataractae*	R	C
Redside shiner	*Richardsonius balteatus*	C	C
Suckers—Catostomidae			
Longnose sucker	*Catostomus catostomus*	C	C
Largescale sucker	*C. macrocheilus*	C	C
Catfish—Ictaluridae			
Bullhead	*Ameiurus* spp.*	C	C
Cods—Gadidae			
Burbot	*Lota lota*	C	U
Troutperches—Percopsidae			
Sandroller	*Percopsis transmontana*	U	U
Sunfishes—Centrarchidae			
Pumpkinseed	*Lepomis gibbosus**	U	U
Largemouth Bass	*Micropterus salmoides**	U	U
Perches—Percidae			
Yellow perch	*Perca flavescens**	U	U
Sculpins—Cottidae			
Slimy sculpin	*Cottus cognatus*	C	C
Torrent sculpin	*C. rhotheus*	U	C

* Not native to Columbia basin.

** Kokanee are native to Kootenay Lake but did not occur in the Kootenai River above Kootenai Falls until their introduction to Lake Koocanusa in the late 1970s.

record rainbow was taken from the river below Libby Dam. Kootenai Falls constitutes a barrier to most upstream fish migration. Some downstream fish movement past the falls does occur.

3.2.3. Aquatic insects

Aquatic insects occurring in the project area include mayflies, caddisflies, stoneflies, and chironomids. Aquatic insects occupy a range of habitats ranging from turbulent flowing water to shallow, slower flowing areas. Insects form an important part of the diet of a variety of fish species, forming a vital link between energy produced by plant photosynthesis and higher levels of the food chain.

Libby Dam regulates flow in the Kootenai River. In the fall and winter, hydropower operations cause fluctuations in dam discharge and resulting river flow. In the past, rapid flow fluctuations in the Kootenai River have had an adverse effect on aquatic insect abundance and community composition (Hauer and Stanford, 1997). In an effort to protect downstream aquatic ecosystems, in recent years the Corps has moderated the rate at which it changes dam discharge (the ramping rate). While moderation of ramping rates will likely benefit aquatic insects, the current river level fluctuations may still exceed the ability of the insect community to adapt.

3.2.4. Wildlife

Wildlife in the area include white-tailed and mule deer (*Odocoileus virginianus* and *O. hemionus*, respectively), moose (*Alces alces*), elk (*Cervus elaphus*), black bear (*Ursus americanus*), beaver (*Castor canadensis*), muskrat (*Ondatra zibenthica*), mink (*Mustela vison*), river otter (*Lutra canadensis*), bobcat (*Lynx rufus*), mountain lion (*Felis* concolor), and coyote (*Canis latrans*). Bald eagles (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), several species of grouse, a variety of waterfowl, and passerine birds all occur in or along the reservoir and river corridor. The Kootenai River basin is located in the Pacific flyway for migrating birds. Factors influencing wildlife distribution include forestry practices, dam operation, lake management (primarily water level), transportation corridors, recreational use, and natural disturbances (i.e. wildfire).

3.2.5. Sensitive, Threatened and Endangered Species.

Kootenai River white sturgeon are listed as endangered, bull trout and bald eagle are listed as threatened, and burbot are candidates for listing under the Endangered Species Act. Kootenai River flows affect aquatic species and their habitat downriver in the Columbia River where a variety of salmon and steelhead species are listed as threatened or endangered.

3.2.5.1. Kootenai River White Sturgeon

Kootenai River white sturgeon were listed as endangered in September 1994. In 2001, the Kootenai River between RM 141.4 (below Shorty's Island) and RM 152.6 (above the Highway 95 bridge at Bonners Ferry) was designated as critical habitat for Kootenai River white sturgeon. Since the early 1990s, spring flows from Libby Dam have been increased in an effort to benefit spawning and larval sturgeon. In 1999, the U.S. Fish and Wildlife Service and the Kootenai River White Sturgeon Recovery Team released the final recovery plan for the Kootenai River white sturgeon (USFWS, 1999).

A primary reason for the protection of white sturgeon is lack of recruitment of young fish to the adult population. Lower spring flows since the construction of Libby Dam may not be sufficient to trigger successful sturgeon spawning and egg survival. Also, control of floods, aided by construction of the levee system and Libby Dam, has resulted in an overall loss of off-channel and side-channel aquatic habitat which historically was provided by annual spring flooding in the valley, primarily from the Bonners Ferry area downstream to Kootenay Lake. This habitat is thought to be important for rearing of juvenile white sturgeon, and its loss may be a factor in the lack of recruitment of young sturgeon to adulthood. Other factors may include predation, lack of nutrients, and contaminants (USFWS, 1997a)

3.2.5.2. Columbia River Bull Trout

Bull trout of the Columbia River distinct population segment (DPS, which includes Kootenai River bull trout) was listed as threatened in 1999 (USFWS, 1999). In general, bull trout populations in the upper Columbia River have declined from historic levels. The sub-population below Libby Dam appears to number a few hundred adults and is considered to utilize a fluvial life history[10]. The adfluvial[11] Lake Koocanusa sub-population represents one of the strongholds of the Columbia River DPS (USFWS, 2000; BPA, *et al*, 1999).

3.2.5.3. Bald Eagle

The bald eagle is listed as threatened. Bald eagle populations have recovered to the extent that they have been proposed to be removed from the list of endangered and threatened species. Recent estimates count 10 pairs of nesting eagles downstream of Libby Dam in Montana. Migratory and wintering bald eagles occur downstream of Libby Dam primarily in late fall to early spring (BPA *et al.*, 1995, Appendix N, Wildlife).

3.2.5.4. Anadromous Fish

In total, 12 threatened or endangered evolutionarily significant units (ESUs) of salmon and steelhead occur in the mainstem Columbia River downstream of Chief Joseph Dam in Washington. Historically, natural barriers blocked anadromous fish passage to the Kootenai River and no anadromous fish are present or have ever been present in or upstream of Kootenay Lake. Currently, fish passage to the upper Columbia River is blocked at Chief Joseph Dam near Bridgeport, Washington. However, Libby Dam stores a large quantity of water, the release of which influences migration of juvenile and adult salmon in the mainstem Columbia River downstream of Chief Joseph Dam. Use of water stored in headwaters reservoirs like Lake Koocanusa forms an important component in plans designed to conserve and recover populations of Columbia River anadromous fish.

3.2.5.5. Burbot

Burbot are of concern because of population declines in the Kootenai river below Libby Dam. Current burbot abundance has been estimated at 10 percent of pre-Libby Dam abundance (Dalbey and Marotz, 1997). Recently, the USFWS started a status review of burbot for potential

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[10] Fluvial bull trout rear in tributary streams as juveniles, migrate downstream to live in larger rivers as sub-adults and adults, and return to tributary streams to spawn.

[11] Adfluvial bull trout rear in tributary streams as juveniles, migrate downstream to live in lakes as sub-adults and adults, and return to tributary streams to spawn.

listing as threatened or endangered. Burbot migrate upriver to spawn in the winter. High flows caused by power generating discharges from Libby Dam during the winter months may adversely affect burbot by impeding their spawning migration (Paragamian, 1995b; Paragamian and Whitman, 1998). Alteration of water temperatures and decreased nutrient input in areas downstream of Libby Dam since its construction may also be a factor in the decline of burbot abundance (Paragamian, 1995a and b).

3.2.5.6. Westslope Cutthroat Trout

Westslope cutthroat trout were the subject of a petition for listing in May 1997 but the petition was denied in 1999 when the USFWS concluded that westslope cutthroat are not likely to become threatened or endangered within the foreseeable future (USFWS, 2000, 1999b). This determination is based on a finding that westslope cutthroat are widely distributed, there are numerous robust populations throughout its range, and imminent threats to extant stocks are small. The state of Montana classifies westslope cutthroat trout as a Class A species of special concern.

3.3. Native American and Cultural Resources Sites

The Kootenai Indian people historically lived within the area of Libby project lands. Today, the Confederated Salish and Kootenai Tribes of the Flathead Reservation at Pablo, Montana, are among the group of Federally recognized treaty Indians which claims the area of Libby project lands as part of their former territory. The Kootenai Tribe of Idaho headquarters and other tribal facilities and residences are located on the Kootenai River a short distance downstream of Bonners Ferry, Idaho. The facilities there include the Kootenai Tribal Hatchery, an important part of Kootenai River white sturgeon research and recovery. The Kootenai Tribe of Idaho and Canadian Kootenay bands have also periodically expressed interest in cultural resource sites at the Libby Dam-Lake Koocanusa Project.

Seventeen known cultural resource sites located on project lands downstream from Libby Dam have been determined eligible for the National Register of Historic Places. These sites have been evaluated and are part of the Libby-Jennings Archeological District. About 300 cultural resource sites have been identified within the drawdown area of Lake Koocanusa. These compose the middle Kootenai River Archeological District, which has been determined eligible for listing in the National Register of Historic Places.

3.4. Socio-Economic Resources

3.4.1. Land Use

The towns of Libby (population 2,626) and Troy (population 957), Montana, and Bonners Ferry, Idaho (population 2,515) lie along the Kootenai River downstream of Libby Dam. Land use in the valley in general consists primarily of timber harvest in Montana and timber and agriculture in Idaho. Cattle are pastured and a variety of crops are cultivated; the harvest crops include wheat, barley, hops, clover seed, timothy seed, and hay. An extensive levee system lines the river in both the U.S. and in Canada (extending into the Kootenay delta where the river enters Kootenay Lake).

3.4.2. Flood Hazards

The floodplain between Bonners Ferry and Kootenay Lake comprises about 72,000 acres. There are about 190 acres of land in the town of Bonners Ferry within the Kootenai flood plain, including 106 homes, 66 commercial establishments, and 12 public facilities. The floodplain is flat and relatively narrow, with mountainsides rising up along either side. The river meanders considerably within these confines. Historical spring flooding was sometimes extensive. A total of about 100 miles of levees have been built on both sides of the U.S. portion of the river in Idaho, protecting about 35,000 acres of land. Levees have also been constructed on the Canadian portion, protecting additional acreage between the border and Kootenay Lake. This system was started in the 1890s in Canada, and in the 1920s in the US. In the U.S., diking districts under county jurisdiction are responsible for dike maintenance, which has been performed to varying degrees of effort and effectiveness. The Corps provides emergency flood assistance if requested by the counties under Public Law 84-99, and otherwise assesses flood control capabilities as necessary.

Libby Dam and Lake Koocanusa provide approximately 4.98 million acre-feet of usable storage for the purpose of flood hazard reduction. In the Kootenai watershed, spring runoff from snowmelt is the primary cause of flooding. To reduce the risk of spring flooding, drawdown of Lake Koocanusa begins in late August or early September, reducing the pool surface elevation to reach 2,411 feet on January 1. The lowered lake provides 2 million acre-feet of storage space for inflow. Through the winter, snowpack is regularly checked, and monthly runoff forecast updates are used to determine drafting limits (i.e. how low to draw the lake down) before spring runoff begins. The higher the spring runoff forecast, the deeper the ultimate draft point on March 15. Through the spring and early summer, snowmelt and rain gradually fills Lake Koocanusa, typically to the highest elevation of the year by July.

Kootenai River elevations from Bonners Ferry to Kootenay Lake are controlled by two factors: total river discharge, and elevation of Kootenay Lake. Kootenay Lake backs up nearly to Bonners Ferry. Peak Kootenay Lake elevations tend to occur in June, usually slightly after the peak of spring runoff. The maximum levels of Kootenay Lake are established by the International Joint Commission (IJC) Order of 1938.

During flood season, Corps reservoir regulators operate Libby Dam to minimize flood impacts and to protect the Bonners Ferry area from river stages in excess of elevation 1764 feet. In addition to overbank flooding, other effects of prolonged high river levels include velocity-related bank erosion, elevated water tables, and seepage into agricultural lands (as high river flows elevate the water table near the river).

3.4.3. Dam Safety

Libby Dam is safe and is fully capable of continued operation. In the past, concrete patch repairs were made to portions of the spillway face. These repairs were made under the assumption that, in order to avoid the harmful levels of dissolved gas downstream of the dam, the spillway would be infrequently used. Careful operation of the dam has successfully avoided any major spills in over 20 years. The patched areas of the spillway face have reached the end of their design life and must be repaired. Engineers will evaluate the areas needing repairs during and after the spill test and will design repairs to assure that they will sustain more frequent spillway use, and other aspects of the spillway system will also be evaluated at that time to assure minimum maintenance under more frequent spilling.

3.4.4. Recreation

Recreational use in the Kootenai River corridor includes fishing, hunting, camping and other outdoor pursuits. Commercial marinas along Lake Koocanusa are dependent on the reservoir filling to within 10 feet of full pool elevation of 2459 feet. Marinas in Montana and British Columbia cater to boaters and anglers during the summer operating season. Average annual visitation for 1987-1993 was 593,200 recreation days (BPA *et al.*, 1995, Appendix J, Recreation). Economic value of these activities in the basin is considerable, as underscored by concerns voiced by local citizens at annual public meetings concerning Libby project operations.

4. ALTERNATIVES

4.1. Description of the Proposed Action

We propose to conduct a comprehensive test of the TDG levels resulting from a range of spill releases at Libby Dam. The proposed testing would be directed at describing the spatial (how far) and temporal (how long) dynamics in TDG levels in the Kootenai River from Libby Dam (RM 219) to below Kootenai Falls (RM 194).

The proposed test would consist of systematic variations in spillway discharge in conjunction with pre-determined powerhouse discharge (Table 2). At no time would total discharge from the dam exceed 28,000 cfs, a volume of water similar to that discharged in high flow years such as 1997. Additionally, spillway flows would cease if measured TDG concentrations reach specified thresholds (see Paragraph 5.1.3—Water Quality).

4.1.1. Water Quality Monitoring

Water quality would be monitored throughout the study. Parameters of interest include depth, water temperature, TDG gas pressure, dissolved oxygen concentration, and internal battery voltage of the gas sensors. These data would be collected automatically at 15-minute intervals during the study. Manual sampling would be used where and when necessary to supplement the automated measurements. In addition, barometric pressure and air temperature would be similarly monitored to allow calculation of percent TDG saturation. Real-time TDG measurements would be taken from at least one mid-river station within 1 mile of the dam to and compared to specified thresholds which, if exceeded, would signal the end of the test at that spill volume.

An array of automated remote logging water quality instruments would be deployed on 2 transects; the first located immediately downstream of the tailrace at the bridge for the powerhouse access road (RM 221.6), the second at the Highway 37 Bridge just upstream of the mouth of the Fisher River (RM 218.5). Each transect would consist of 3 to 5 instruments deployed on the bottom of the river. The deployment array would provide direct assessment of the lateral and longitudinal gradients and dynamics in TDG concentrations in the study area.

Additional TDG instruments would be deployed in a longitudinal series at approximately 5-mile intervals to RM 194. Auxiliary instruments or manual water quality profile sampling would be conducted in the Lake Koocanusa forebay.

4.1.2. Fish Monitoring

In addition to measurement of water quality parameters, observations of fish would be used as a kind of biological sensor of TDG concentrations. Live fish (most likely mountain whitefish or rainbow trout) would be held captive in the upper water column, where aquatic organisms are most vulnerable to GBD. Locations for the captive fish would likely mirror the most upstream water quality sampling locations. Trained personnel from Montana Department of Fish, Wildlife, and Parks would observe these fish for signs of GBD. During the spill tests, fish would also be sampled with electroshocking equipment and examined for signs of GBD. Also, movements of radio-tagged fish would be tracked during the spill test. At least one Corps fish biologist would also be on-site during the test. Observations of fish condition would occur during and after conclusion of the spill test and be timed to account for water travel time from Libby Dam. For example, electroshocking and fish observations would extend into the evening hours after the end of a day's test until water spilled during the test flows past the monitoring locations. The spill test would cease if GBD symptoms are observed in any fish and observations would then continue to document any further symptoms, mortalities, or recovery.

The planned fish monitoring would add another safeguard to protect aquatic life during the spill test. Fish monitoring is <u>not</u> intended or designed as a bioassay to obtain data on the response of aquatic organisms to varying TDG concentrations. The captive fish would be held in areas most vulnerable to elevated TDG concentrations and fish sampling would occur in shallow margins where symptoms of GBD would be expected to manifest first. Electroshocking will occur throughout the day and into the evening to look for potential GBD symptoms as fish move into shallow water at dusk (past experience in the Kootenai River has found that electroshocking is most effective during the evening and night when fish move from deep parts of the river and into the shallow river margins; J. Dunnigan, Montana Dept. of Fish, Wildlife, and Parks, pers. comm..). Ending the spill test at the first sign of TDG-related trauma provides a biological failsafe that will complement the other automated water quality monitoring. Tracking of radio-tagged fish will be done for primarily for informational purposes and is not expected to provide a trigger to end the test in the event of unexpected or unusual movement patterns.

4.2. No Action Alternative

No spill has occurred at Libby Dam since 1985. Without the spill test, we would not obtain data that would allow us to more accurately predict how spill affects downstream water quality and we would continue to manage the reservoir to avoid spill at the dam. Involuntary spill as a result of high runoff or unplanned powerhouse outages may occur in the future, with unknown consequences to downstream ecosystems. The no-action alternative would not accomplish the project purpose but will serve as a point of comparison to evaluate the effects of the proposed action.

4.3. Alternatives Not Considered in Detail

4.3.1. Numerical Modelling

Numerical modelling would involve calculation of the levels of pertinent downstream water quality parameters using mathematical formulas and relationships. The numerical model would be developed using a combination of measured physical attributes of Libby Dam and the

Kootenai River, and the behavior of certain parameters during spill tests at other dams.[12] Uncertainties in the model input would result in magnified error or uncertainty in the model output. Experience with spill tests at other Northwest dams has demonstrated that predictions by numerical model are not very accurate. Direct measurement of actual spill provides much more certain and accurate results that can be better used to manage the risks and opportunities of future spill events. Numerical modelling of spillway use would not fulfill the project purpose and this alternative will not be considered further.

4.3.2. Physical Modelling

For physical modelling, a scale model of Libby Dam and the Kootenai River would be constructed and tested under varying flows simulating conditions of interest. Measurements of the behavior of the physical model would then be applied on a larger scale to predict circumstances at the actual project. In essence, the physical model would recreate the real Libby Dam in miniature. While physical models can provide valuable information on certain variables such as water velocity, scour and cross-current stress, some physical parameters, including bubble formation, are not scalable. Accordingly, a physical model would not produce valid information on the dynamics of TDG levels at the Libby Dam-Lake Koocanusa project. Physical modelling would not fulfill the project purpose and this alternative will not be considered further.

4.3.3. Use of Data from Past Spill Events

While no spill of any kind has occurred at Libby Dam since 1985, spill routinely occurred from 1972, when operation of the dam's sluiceways commenced, until 1984 (when the fifth turbine was installed). If they existed, data from spill during the 1972-1984 time period could be used to determine how much spill can occur at Libby Dam without generating harmful levels of total dissolved gas. However, while we do possess some water quality data that document very high TDG levels resulting from spill, we do not have the corresponding data describing the source of dam discharge (i.e. the powerhouse, sluiceways, and spillways). We also do not have detailed water quality characterization in downstream areas. Together, these data gaps make it impossible to define the relationship between spillway flow and downstream TDG levels. Due to the lack of complete data, use of past spill events to predict TDG levels is not possible and therefore does not fulfill the project purpose.

5. EFFECTS OF THE PROPOSED ACTION

The effects of the proposed spill test are compared against the baseline conditions associated with the no-action alternative. Unless indicated in discussion below, the no-action alternative would not affect the physical, natural, cultural, or socioeconomic resources in the project area.

5.1. Physical Characteristics

5.1.1. Geology

Other than placement of monitoring instruments, no construction is required to perform the proposed spill test. During the spill test, flows from the dam would not exceed full powerhouse discharge. No impacts to the geology of the project area are anticipated.

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[12] Spill tests have already been conducted at most other dams in the Federal Columbia River Power System.

5.1.2. Climate and Hydrology

During the spill test, flows from the dam would not exceed full powerhouse discharge during high flow years (about 28,000 cfs). The spill test would coincide with fish flow discharges that require the dam to increase output to more closely approximate natural spring runoff patterns. These fish flows have been implemented since the early 1990s as part of efforts to recover Kootenai River white sturgeon. Also, in years with high runoff (i.e. 1996 and 1997), the normal flood control operation of Libby Dam requires full powerhouse discharge for as long as several weeks during the spring and early summer. Spring or early summer flows in the Kootenai River would not exceed those experienced during normal dam operations for fish or flood control. The Corps and Reclamation are currently preparing an environmental impact statement on VARQ which will include an analysis of the effects of fish flows.

Careful water management at Libby Dam accounts for the water required for the fish flows, with the goal to bring Lake Koocanusa to full pool elevation by early July. The spill test would not affect the probability of reservoir refill, only the path by which water exits the reservoir into the river downstream.

5.1.3. Water Quality

The proposed spill test is intended to quantify how spill is related to TDG levels downstream of Libby Dam. Experience with the Libby Dam spillway indicates that spill has the potential to cause TDG levels up to 140%. For the proposed test, we plan to stop the spill test under the following conditions:[13]

- Sensors measure an average of 125 percent TDG saturation for 1 hour;
- The 12-hour average TDG saturation is equal to or greater than 120 percent; or
- Any symptoms of gas bubble disease are observed in fish (see Paragraph 4.1.2—Fish Monitoring, for more details on the proposed biological monitoring).

Measurements from the sensor transect within 1 mile of the dam would be used to determine when the physical water quality criteria for test cut-off are met. The cut-off criteria are the same as used for other spill tests at hydropower dams in Idaho, Oregon, and Washington and would require a waiver of the Montana TDG standard of 110 percent.

Elevated TDG saturation would persist downstream of Libby Dam for some distance, likely to Kootenai Falls. Downstream of Kootenai Falls, TDG saturation will be 110-113 percent regardless of the TDG level above the falls. Potential biological effects of the TDG supersaturation and their relation to the spill test are discussed in Paragraphs 5.2.2 (Fish), 5.2.3 (Insects), and 5.2.5 (Sensitive, Threatened, and Endangered Species).

According to early March, 2002, forecasts, the most probable reservoir elevation when the spill test begins is 2440 feet. Water flowing over the spillway flows over the spillway crest at elevation 2405 feet. At a reservoir elevation of 2440 feet, water for powerhouse is withdrawn from an elevation of 2390 feet. Since the depth difference between the spillway crest and the powerhouse withdrawal is only 15 feet, we expect that the temperature of water withdrawn for

[13] These criteria may be revised pending full coordination with the Montana Department of Environmental Quality.

the spillway flows will be no more than 2°F warmer (M. Valentine, internal Corps memorandum, April 1996) than the temperature of water withdrawn for powerhouse use. Considering the small temperature difference between spillway and powerhouse withdrawals and that no more than 35 percent of the total dam discharge would come over the spillway, water temperature downstream of the dam is not expected to be affected by use of the spillway during the spill test. In the event of a warm spring and lower-than-expected pool elevation, we will investigate using the dam's selective powerhouse withdrawal system to compensate for the warmer water being discharged via the spillway.

5.2. Natural Resources

5.2.1. Vegetation

Land-based activities for the spill test would take place primarily on roads and other developed areas. Minor cutting of shrubs or other vegetation in areas adjacent to the river may be required to provide access to some monitoring locations. No other vegetation disturbance is anticipated.

5.2.2. Fish

5.2.2.1. Potential for Effects from High Levels of Dissolved Gas

As discussed in Paragraph 2.5 (Effects of Dissolved Gas on Aquatic Organism), prolonged high levels of TDG saturation above 110% can have adverse impacts of fish and other aquatic organisms in surface waters. Because every 3 feet of water depth allows water pressure to compensate for about 10 percent of the gas saturation, at a depth greater than about 3 feet and with a TDG saturation of 120 percent, aquatic organisms experience the equivalent "dose" of 110 percent TDG saturation. Organisms along the shallow margins of the river, in the upper water column, or surfacing from deeper waters are most vulnerable to GBD during high TDG supersaturation events.

The proposed spill test is geared to avoid harmful biological effects by limiting TDG saturation to a maximum of 125 percent at any one reading or a maximum 12-hour average of 120%. For any given day during the test, spill would be intermittent, occurring for 12 hours during daylight hours (see Appendix A). For the remaining hours each day, all discharge would pass via the powerhouse and TDG levels would return to near 100% saturation shortly after termination of spill at the dam. Between episodes of TDG supersaturation during spill events, organisms near the water surface would have about 12 hours to re-equilibrate and recover.

Based on previous studies, fish exposed to short durations (less than 24 hours) of 115 to 120 percent TDG saturation in the natural environment are unlikely to be adversely affected (Fish Passage Center, 1999; Bennett, *et al.* 1999; Ryan and Dawley, 1998). However, the duration of exposure is critical, as juvenile salmonids in the Columbia River typically begin to exhibit signs of GBD when the 24-hour average TDG saturation approaches and exceeds 120 percent (Fish Passage Center, 2000).

Monitoring of large adult rainbow trout at Keenleyside Dam on the Columbia River in British Columbia during a 3-day spill event in 1997 with dissolved TDG levels of 130 percent showed no behavioral response in the trout, and no signs of GBD or mortality (during the event or delayed) in the trout or other aquatic organisms in the vicinity (C. Powell, BC Hydro, pers. comm., 2002). The proposed spill test will generate lower levels of TDG for shorter duration.

Rainbow and cutthroat trout spawning periods overlap the timing of the proposed spill test. These fish typically spawn in tributary streams or the mainstem river. Some redds may have already been established in the Kootenai River downstream of Libby Dam before the spill test occurs. The relatively high flow during the spill test should minimize the chances of adverse effects. While TDG supersaturation has the potential to adversely affect redds located in shallow waters (less than about 1 foot deep), spawning likely will have occurred at lower flow levels than that experienced during the spill test. Water depth over any redds would be at least 1 foot deeper during the spill test than when spawning occurred. Each additional 1 foot of depth would provide a margin of safety for the redds during the spill test since the added depth would compensate for some portion of the predicted TDG supersaturation. Also, Weitkamp and Katz (1980, as cited in Venditti *et al.*, 2001) found that fish eggs are more tolerant of high TDG levels than larval, juvenile, and adult fish. Given the short duration of the proposed test periods, the water depth over any redds in the mainstem river, the tolerance of eggs to high TDG levels, and the physical and biological cut-off criteria, adverse effects to redds and the eggs in them are not expected.

TDG levels would not approach the combination of duration and magnitude that would be expected to cause signs of GBD. The tests would never run for more than 12 continuous hours each day and spill would cease at thresholds for fish harm as observed in other studies or in the planned biological monitoring. When TDG levels equilibrate after a period of exposure to TDG supersaturation, even fish exhibiting GBD symptoms recover (Mesa *et al.*, 2000) and do not experience delayed onset of GBD . During the night, TDG supersaturation would dissipate completely in both the river and the tissues of aquatic organisms. The biological effects of TDG supersaturation are not accumulative. Accordingly, both the magnitude and duration of the effective TDG "dose" experienced by fish populations would not reach that expected to cause adverse effects.

5.2.2.2. Potential Effects from Entrainment

Two spillway tainter gates control discharge via the spillway. The spillway crest is at elevation 2405 feet (full pool elevation is 2459 feet). During the spill test, the tainter gates would open to allow the specified discharge to flow down the spillway bays (Appendix A). Water would be drawn from the reservoir at the spillway crest elevation. The depth of the spillway crest below the surface would be determined by the pool elevation at the time of the test.

Fish entrainment is dependent on rate of discharge, depth of water withdrawal, and forebay fish density. Skaar *et al.* (1996) found that spring entrainment rates of kokanee are typically the highest of the year since rates of discharge are high, withdrawal depth tends to be relatively shallow, and forebay fish densities are high in the upper water column. In the spring, fish densities are highest in the top 33 feet (10 meters) of the water column and decrease as depth increases. As shown in Skaar *et al.* (1996), as the withdrawal depth decreases, kokanee entrainment rates would be expected to increase.

Since the elevation of the forebay water surface is not constant, the difference between the turbine withdrawal elevation and the spillway crest is not constant. When the forebay water surface elevation is higher, the 50-foot withdrawal depth (as measured from the elevation of the forebay water surface) is closer to the spillway crest. In most years, the elevation of the spillway crest is 5 to 30 feet higher than the shallowest powerhouse withdrawal depth. While turbine withdrawal depth in the spring are the shallowest of the year, in comparison the spillway crest elevation more closely matches the depth of peak fish densities in the spring. As a result, during the spring time frame when the spill test is planned, more fish entrainment would be expected during discharge of water over the spillway crest than through the powerhouse.

Over the 3 day test period, the volume of discharge over the spillway would gradually increase from 2,000 cfs to 10,000 cfs. Throughout the spill test, total dam discharge will be maintained between 27,000 and 28,000 cfs. At 2,000 cfs, the spillway flow equates to about 7 percent of total dam discharge. At 10,000 cfs, spillway flow contributes 36 percent of total dam discharge.[14] At the beginning of the test, few fish would likely be entrained in the spillway flow since the volume of discharge is low. As high volumes of spill are released, proportionately greater numbers of fish would likely be entrained.

Clearly, fish, primarily kokanee, would be entrained in greater numbers than expected under normal dam operations. Although some may survive, large numbers of the fish passing over the spillway may be injured or killed. In any event, entrained fish would be lost from the Lake Koocanusa fishery.

For the spill test, it is difficult to accurately quantify the increased entrainment. Overall, kokanee entrainment by Libby Dam can have a substantial effect on the age and size composition of reservoir kokanee (from Skaar *et al.*, 1996; Maiolie and Elam, 1998). Using previous data on from Skaar *et al.* (1996), the mean daytime fish density in the upper 33 feet (10 meters) of the Libby Dam forebay is about 1.5 fish per 10,000 cubic feet of water. With an estimate of the fish density in the upper water column of the forebay, we can conservatively estimate the number of fish that might pass over the spillway during the spill test (Table 2).

Table 2. Estimated fish entrainment via spillway during the proposed spill test

Day of Test*	Spill Rate (cfs)	Duration (hours)*	Total Spill Volume (cu.ft.)	Fish Density in Forebay (# per 10,000 cu.ft.)	No. of Entrained Fish
2	2000	4	28800000	1.5	4320
2	3000	4	43200000	1.5	6480
2	4000	4	57600000	1.5	8640
3	5000	4	72000000	1.5	10800
3	6000	4	86400000	1.5	12960
3	7000	4	100800000	1.5	15120
4	8000	4	115200000	1.5	17280
4	9000	4	129600000	1.5	19440
4	10000	4	144000000	1.5	21600
				TOTAL	**116640**

[14] Higher volumes of spill may not be released if lower volumes cause TDG levels to exceed the test criteria of a 12-hour average of 120 percent or a point reading of 125%.

*Flow via the spillway will be done during daylight hours only for 12 hours during every 24 hour period. For the remaining 12 hours each day, no spillway flow would occur and all water discharged from Libby Dam would be via the powerhouse

The entrainment estimate in Table 2 is very conservative and we expect the number of entrained kokanee to be substantially less than our estimate. The mean number of fish in the upper feet of the water column includes both day and night data. The test would be conducted during daylight hours when fish density in the upper water column and entrainment rates tend to be lower than that observed during sunrise, sunset, or night periods (Skaar *et al.*, 1996).

Kokanee comprise the bulk (97.5 percent in Skaar *et al.*, 1996) of the entrained fish. The estimated kokanee population in Lake Koocanusa is about 4.5 million fish (Skaar *et al.*, 1996). The conservatively high estimate of 116,640 fish entrained via the spillways during the proposed spill test represent 2.6 percent of the total kokanee population in the lake. While some entrainment of kokanee is unavoidable, we do not expect losses to adversely affect kokanee populations (or other fish stocks) Lake Koocanusa or the Kootenai basin.

5.2.3. Aquatic insects

Aquatic insects appear to be very tolerant to onset of GBD (Fickeisen and Montgomery, undated). However, at high TDG supersaturation, bubbles can adhere to the exterior of aquatic insects and float them to the water's surface. When Libby Dam spilled water in the early 1970s, the aquatic insect community downstream of the dam experienced drastic changes due to, in part, prolonged high TDG supersaturation of 130 to 140 percent.

The levels of TDG supersaturation that would be generated by the spill test are below those expected to cause insect flotation. As with other aquatic organisms, insects should not experience short or long term harmful effects from the spill test due to the TDG criteria for the test and the test's relatively short and intermittent duration.

Ramping rates in the river downstream of the dam during the spill test would be no different than baseline conditions and therefore will have no effect on aquatic insect communities.

5.2.4. Wildlife

The bulk of activities would occur during daylight hours and from roads or other developed areas. Minor cutting of vegetation in some river-side areas may be necessary for access to more remote monitoring locations. Fish sampling and monitoring would create disturbance in and along the margins of the river. No heavy construction is necessary for the proposed test. The short duration of the test (one week, including equipment installation and removal) would further minimize any adverse impacts to wildlife in the area. Flow fluctuations in the river downstream of the dam would be within normal operating limits and would not result in rapid or unpredictable river level changes. Adverse effects to wildlife are expected to be minimal.

5.2.5. Sensitive, Threatened and Endangered Species.

5.2.5.1. Kootenai River White Sturgeon, Columbia River Bull Trout, and Bald Eagle

Impacts of the spill test on white sturgeon, bull trout, and bald eagle are expected to be minimal. River flows would be maintained in accordance to the river flows designed to benefit white sturgeon and bull trout (USFWS, 2000). Bull trout entrainment is not expected to occur since bull trout entrainment at the dam occurs only very sporadically (Skaar *et al.*, 1996). No construction would be required and spill test activities would not increase disturbance above ambient levels. See Paragraph 8.2 (Endangered Species Act) for details concerning compliance with the Endangered Species Act of 1973.

5.2.5.2. Anadromous Fish

River flows during the spill test would be within the historical operating range for Libby Dam. The spill test would not affect the ability of Libby Dam to provide increased summer flows for anadromous salmonids in the mid- and lower Columbia River. Elevated TDG levels would dissipate at Kootenai Falls, hundreds of miles upstream of areas that support anadromous fish. The spill test is not expected to have any adverse effects on anadromous fish.

5.2.5.3. Burbot

Burbot spawn in the late winter and may make long migrations to spawning areas. The spill test would miss critical burbot life history periods. Burbot typically associate with the river bottom in areas deep enough (generally deeper than 9 feet; Paragamian, 1995b) to allow water pressure to compensate for elevated TDG levels. Flow during the spill test would not exceed normal high flows during the spring and therefore no adverse affects to burbot from high flows are expected.

5.2.5.4. Westslope Cutthroat Trout

The spill test would take place in the middle of the spawning period for westslope cutthroat trout. Careful monitoring of TDG concentrations and for biological effects would prevent occurrence of damaging levels and durations of TDG supersaturation. The standards for TDG saturation have been developed and used in a variety of other spill tests with no apparent ill effects on aquatic communities. Considering both the TDG limits and short duration of the proposed test, adverse effects to westslope cutthroat trout are not expected. See Paragraphs 5.2.2 (Fisheries) and 5.2.3 (Aquatic Insects) for more details about the potential effects of the spill test on salmonids.

5.3. Native American and Cultural Resources Sites

Land-based activities for the spill test would take place primarily on roads and other developed areas. Access to some monitoring locations may require minor cutting of shrubs or other vegetation in riparian areas. Proposed activities would not involve grading, excavation, or other ground disturbance. Also, no activities would take place at identified cultural or historic sites. Accordingly, adverse effects to Native American, cultural, or historic sites are not anticipated.

5.4. Socio-Economic Resources

5.4.1. Land Use

Activities associated with the spill test would take place from roads and other developed areas, with some transit of undeveloped riparian areas. Flows from Libby Dam during the spill test would not exceed full powerhouse output and would stay within normal operating criteria. The spill test would last one week only. Land use impacts are not anticipated.

5.4.2. Flood Hazards

Flows during the spill test would be at the high end of the normal operating range for Libby Dam. Flows in this range have been discharged regularly in the past for flood control and fish flow augmentation. Flows and river levels at Libby and the Kootenai Flats are determined by both dam discharge an runoff from areas downstream from the dam (local inflow). The spill test would take place in the second half of June, after the peak for local inflow. Accordingly, flows at Libby and, in particular, the Kootenai Flats are not expected to be as high or last as long as those experienced in higher runoff years (most recently in 1996 and 1997). Compared to the no-action alternative, adverse effects to floodplains, including seepage, or an increase in flood hazards are not expected to occur.

5.4.3. Dam Safety

Observations made during the proposed spill test will be used to evaluate the spillway face and spillway system (gates, stilling basin, etc) for more frequent spillway use. During the test, it is possible that small chunks of concrete from previously patched areas on the spillway may be dislodged and fall into the stilling basin below. Safety plans and procedures will be in place to minimize safety hazards during the test. Corps personnel, contractors and the public will be kept a safe distance away when water is flowing over the spillway. The analyses of the spillway and spillway system will be accomplished separate from the test and will enable verification that future spilling can be safely accommodated with minimum maintenance. All repairs will be implemented in compliance with applicable laws and regulations.

5.4.4. Recreation

Recreational use of the Kootenai River downstream of Libby Dam is affected by the flow level of the river. Typically, higher flows preclude some on-river activities, such as fishing, until flow decreases and stabilizes.

Flows during the spill test would be at the high end of the normal operating range for Libby Dam. Flows in this range have been discharged regularly in the past for flood control and fish flow augmentation. Since the early 1990's, high flows during a short period in May and June have been released in most years. Compared to normal operations for flood control or fish flow augmentation, the proposed spill test would not substantially change the flow regime. Flow-related impacts to recreation, when compared to the no-action alternative, are not anticipated.

By its nature, the proposed spill test would generate TDG supersaturation which, if it reaches extremely high levels for long duration, could adversely affect aquatic life downstream of Libby Dam. The river reach within 5 miles below Libby Dam hosts a very popular sport fishery for Kamloops rainbow trout. A number of guide services use the Kootenai River in pursuit of rainbow trout, cutthroat trout, and mountain whitefish. The health of the sport fishery is dependent upon the health of the Kootenai River.

As discussed in Paragraphs 4.2.2 (Fisheries) and 4.2.3 (Aquatic Insects), the spill test would be managed to avoid creation of TDG concentrations high enough to harm fish, aquatic insects, or other aquatic organisms. Other than TDG levels, the proposed spill test would not create conditions with the potential to adversely affect fishing or other recreational activities.

6. CUMULATIVE EFFECTS

The NEPA defines cumulative effects as the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-federal) or person undertakes such other actions (40 CFR §1508.7).

This environmental assessment document addresses the potential individual and cumulative effects of the proposed spill test only. The potential future actions described below are related or commonly perceived to be related to the spill test, but, unlike the spill test, would take place over longer time frames or last longer. Accordingly, the potential future actions described in this section will all require additional analysis and study of their potential effects before the Corps reaches a decision on their form and implementation schedule.

The Kootenai River basin changed as a result of the construction of Libby dam in the 1970s. In the case of white sturgeon, the changes likely have not been beneficial. The spill test will provide valuable information that will help the Corps, USFWS, and the States of Montana and Idaho conserve and recover Kootenai River white sturgeon and other native fish populations. The spill test is one component of the larger effort to conserve threatened and endangered fish species in the basin. Even though its incremental effects on species recovery are relatively small, the spill test is an integral component of a comprehensive plan to ensure the continued existence of native fish populations.

The spill test is necessary, in part, to provide information needed to move forward with evaluation of other reasonable and prudent alternatives and measures required by the 2000 USFWS and NMFS biological opinions on the operation of the FCRPS, including Libby Dam. The biological opinions call for implementation of VARQ in order to more reliably provide water for fish augmentation flows below Libby Dam in average to low runoff years. Preliminary information indicates that VARQ may increase the probability and frequency of involuntary spill at Libby Dam.[15] The information obtained during the spill test on the downstream effects of spill on water quality will be used in the NEPA evaluation on VARQ implementation currently underway.

Information obtained concerning downstream water quality effects of spill may be used to investigate future spillway modifications that may require change to the spillway design to minimize the observed water quality impacts during spill. Future design changes intended to mitigate for high TDG levels would likely require substantial spillway modifications and would be subject of separate NEPA documentation to document the potential environmental effects.

The USFWS biological opinion requires the Corps to evaluate use of the spillway, the powerhouse, or some combination thereof, to increase the release capacity of Libby Dam from the current maximum of about 25,000 cfs (at full pool) to 35,000 cfs. The spill test will allow us to reliably predict the potential physical effects of using spill to augment discharge capacity. Additional analysis would be required to predict the potential biological effects of more frequent or more prolonged spill events. The Corps would prepare a separate NEPA evaluation, including

[15] If implemented, the VARQ flood control operation would likely be paired with releases of water during the spring for the benefit of fish populations. Release of the spring fish flows may mitigate for any increased probability and frequency of involuntary spill predicted to result from the VARQ flood control operation alone.

public coordination, to evaluate the potential effects of increased dam discharge capacity on downstream channel capacity, fish populations, and river levels; the costs and benefits of installing another turbine at Libby Dam to increase discharge capacity; and a variety of other matters. The spill test does not, in any way, commit the Corps to or assume future approval and implementation of increased discharge capacity at Libby Dam.

The spill test would be scheduled to coincide with higher Libby Dam discharges that are intended to benefit sturgeon. As such, incremental downstream effects attributable to the spill test are not expected.

7. IRRETRIEVABLE AND IRREVERSIBLE COMMITMENTS OF RESOURCES

No federal resources would be irreversibly and irretrievably committed to the proposed action until this Environmental Assessment is finalized and a "Finding of No Significant Impact" has been signed.

8. ENVIRONMENTAL COMPLIANCE

8.1. National Environmental Policy Act

Section 1500.1(c) and 1508.9(1) of the National Environmental Policy Act of 1969 (as amended) requires federal agencies to "provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact" on actions authorized, funded, or carried out by the federal government to insure such actions adequately address "environmental consequences, and take actions that protect, restore, and enhance the environment". This assessment evaluates environmental consequences from implementation of the proposed spill test at Libby Dam.

8.2. Endangered Species Act

In accordance with Section 7(a)(2) of the Endangered Species Act of 1973, as amended, federally funded, constructed, permitted, or licensed projects must take into consideration impacts to federally listed or proposed threatened or endangered species. The 2000 FCRPS biological opinion from the USFWS requires the Libby Dam spill test as an element of the reasonable and prudent alternatives required to avoid the likelihood of jeopardizing the continued existence of Kootenai River white sturgeon. The USFWS' FCRPS biological opinion also authorizes an indeterminate level of incidental take of bull trout that may result from the activities specified in the biological opinion (including the spill test). Potential effects to bald eagles from FCRPS operations, including Libby Dam, were addressed in the 1995 USFWS biological opinion.[16] Thus, no additional consultation is required under the Endangered Species Ac.

8.3. Clean Water Act Compliance

The proposed spill test would comply with pertinent state water quality standards (TDG, in particular) to the extent practicable. Short-term exceedances may occur but in-river monitoring

[16] The FCRPS operations addressed by the 2000 USFWS biological opinion will not change in such a way to substantially alter the effects or conclusions regarding bald eagles of the 1995 USFWS biological opinion. Therefore, the 1995 USFWS biological opinion stands for bald eagles.

would detect any exceedance at which time the test would be terminated. Biological monitoring for symptoms of GBD would also be done to provide an additional trigger to terminate the test in the event adverse biological effects are observed. Full coordination with the Montana Department of Environmental Quality is occurring in the planning process for the proposed spill test.

8.4. Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (FWCA, 16 USC 470) requires that wildlife conservation receive equal consideration and be coordinated with other features of water resource development projects. This goal is accomplished through Corps funding of USFWS habitat surveys evaluating the likely impacts of proposed actions, which provide the basis for recommendations for avoiding or minimizing such impacts. A FWCA Report is not required for this work, since the FWCA applies to new projects rather than changes in the operation of existing projects.

8.5. National Historic Preservation Act

The National Historic Preservation Act (16 USC 470) requires that the effects of proposed actions on sites, buildings, structures, or objects included or eligible for the National Register of Historic Places must be identified and evaluated. The proposed spill test would not increase river flows downstream of Libby Dam above that which would normally be provided for flood control or fish flow augmentation. The spill test would not affect drawdown of Lake Koocanusa upstream of Libby Dam. Accordingly, the proposed spill action would not affect cultural resource sites in the vicinity of the Libby Dam.

8.6. Environmental Justice

Executive Order 12898 directs federal agencies to identify and address disproportionately high and adverse human health or environmental effects of agency programs and activities on minority and low-income populations. No tribal resources would be harmed. No adverse effects to minority or low-income populations would result from the implementation of the proposed spill test.

9. CONCLUSIONS

Based on the above analysis, this project is not a major Federal action significantly affecting the quality of the human or natural environment, and therefore does not require preparation of an environmental impact statement.

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Appendix A

Plan of Study
for TDG Field Investigations,
Libby Dam, FY2002

1. **Introduction.** Total dissolved gas (TDG) generated by aerated releases from dams promotes the potential for gas bubble trauma in downstream aquatic biota. Past TDG tests conducted by the Seattle District Corps of Engineers (CENWS) have indicated the potential of high TDG to result from spill at Libby Dam located on the Kootenai River at RM 221.9 (CENWS, 1980). The Corps of Engineers, Engineer Research and Development Center (CEERD), Environmental Laboratory proposes to conduct a comprehensive test of TDG resulting from a range of releases at Libby Dam.

The proposed testing will be directed at describing spatial and temporal dynamics in TDG both near the structure and downstream in the Kootenai river for about 30 miles. The information gained can be used in better understanding the gas exchange processes, particularly dissolved gas production from overflow spill releases and dissolved gas dissipation downstream from the project. Results from these studies will provide information to be used in spill management at Libby and to avoid water quality problems associated with TDG and potential harmful impacts on downstream aquatic life. The degree of mixing between powerhouse and spillway releases will be investigated since this is important to the total flux of TDG introduced into the downstream habitat. In addition, the study will characterize transport, time of travel, mixing, and degassing of dissolved gas that may occur in the Kootenai River downstream to below Kootenai Falls at RM 194.

2. **Objectives.** The purpose of the field study is to more clearly define and quantify processes that contribute to dissolved gas transfer during spill releases at Libby Dam. In general, the transfer of dissolved gas is thought to be a function of the unit spillway discharge, spill pattern, spillway geometry, stilling basin and tailwater depth and flow conditions, forebay TDG concentration, project head differential, and water temperature. This study will focus on resolving questions regarding accurate source and sink descriptions of mass conservation of dissolved gases in the Kootenai River below the dam. TDG time history information as related to specific project operation is of particular interest. The data will be analyzed to provide estimates of the gas transfer throughout the tailwater area that should provide guidance on the relative importance of gas exchange processes within the stilling basin and in the downstream tailrace. The specific objectives of the field investigations are as follows:

- Describe dissolved gas exchange processes (exchange, mixing, transport) in the Libby Dam tailwater for various spillway/powerhouse operational scenarios
- Describe resulting TDG pressures downstream to the Kootenai Falls reach associated with the test spillway/powerhouse operational scenarios
- Provide recommendations for future WQ monitoring as needed
- Provide recommendations for minimizing TDG resulting from Libby Dam project operations

The conclusions drawn from this effort will aid in the identification of operational measures that may reduce TDG super saturation in the Kootenai River, in the event of spill.

3. **Approach.** A single TDG monitoring study will be conducted to address the objectives stated above. This field study will employ an array of automated remote logging water quality instruments which are capable of describing the complete time histories while maintaining the spatial density required to quantify the water quality characteristics of the river/reservoir system. Once the water quality instrumentation is in place the project will be cycled through a series of spill operations of interest combined with constant maximum available powerhouse operation.

Data colleted during the study will include water quality, geographic locations of instruments, plant operations, water elevation, and water discharge. Parameters recorded by the WQ instruments will include date, time, instrument depth, water temperature, TDG gas pressure, dissolved oxygen concentration, and internal battery voltage. The water quality parameter of primary interest is TDG pressure. These data will be collected at fifteen-minute intervals during the deployment period. Manual sampling will be used where and when necessary to supplement the automated approaches. In addition, barometric pressure and air temperature will be monitored near the Libby project at a similar interval to allow the calculation of TDG % saturation.

TDG instruments will be deployed on 2 transects, the first being located immediately downstream of the tailrace at Thompson Bridge, RM 221.6, and the second downstream at the Highway 37 Bridge upstream of the confluence with the Fisher River, RM 218.5. Each transect will consist of 3-5 instruments deployed on the bottom of the river. This deployment array will provide direct assessment of the lateral and longitudinal gradients and dynamics in TDG concentrations throughout study area and subsequently descriptions of the gas exchange characteristics of the existing spillway, sluices, stilling basin, and tailrace.

In order to maintain TDG pressures within 120 % saturation, real time measurements of TDG will be taken from a mid river station within 1 mile of the dam. This real-time data will be used to coordinate or modify testing as required by high TDG pressures.

Additional TDG instruments will be deployed in a longitudinal series downstream of the instrument transect at Highway 37 Bridge and the Fisher River. The deployments will be at approximately 5-mile intervals down to RM 194. Auxiliary instrument placement and/or manual water quality profile sampling will be conducted in the forebay of Lake Koocanusa.

4. **Operating Conditions.** Spillway discharge will be systematically varied while maintaining constant hydropower discharge during the first part of the field study. The test schedule will allow project TDG rating for a range of spills considered for individual and simultaneous operation of the 2 spillway gates. The spillway gates will be cycled through 1000 cfs increments of flow for treatment periods of 4 hours up to the flow corresponding to 120 % TDG saturation is reached at a sensor location within 1 mile of the dam.

Each spill/powerhouse combination discharge or test treatment will last for approximately 4 hours then operation will change to the next combination or treatment pending equilibrated TDG pressures. The TDG testing will require 3-5 days to complete all treatments. Downstream testing will require an additional 2-3 days of instrument logging in those reaches.

5. <u>Fish monitoring.</u> It is intended that no fish will be harmed by the test, and that dissolved gas levels will not exceed levels harmful to aquatic biota. The Montana Dept. of Fish, Wildlife and Parks will assist the study by making personnel and 2 boats available for fish sampling at 2 (unspecified) locations. The object of the fish sampling will be to obtain live specimens in the affected part of the river and to examine them for signs of gas bubble disease (GBD). This will be done by personnel with training or orientation in recognizing external symptoms in fish. Sampling will occur during and after the spill tests, and will be timed to account for water travel time between Libby Dam and the sampling location, as well as for anticipated time for symptoms to occur. All fish captured will be released unharmed by sampling, but some may be held for observation if GBD symptoms are seen. The CENWS fish biologist on site will be present in one of the sampling boats, or at another location nearby if it is the consensus of all involved that that would be more advantageous.

Monitoring personnel will record results of sampling. The spill test will cease if GBD symptoms are observed in any fish. Sampling personnel will inform the Corps fish biologist on site (by radio if necessary), who will then contact the study manager via radio. The study manager will immediately tell Libby Dam operations personnel to cease spill. Further fish sampling will be conducted to ensure subsidence of symptoms in fish, as well as to document any further symptoms, or mortalities if necessary.

6. <u>Deliverables.</u> An interim data and final memo report will be submitted by CEERD to CENWS in accordance with the work schedule given in this proposal. The memo reports should be submitted as a hard copy and in electronic format (pdf files). The report should provide the following information.

- Study review and description complete with study design and methods
- Summary of assumptions made in taking the data
- Statement of data accuracy
- Discussion of the limitations of the data and/or analysis
- Documentation of the field study results including text, tabular data, graphical presentation of the data, and any other pertinent information
- Review and documentation of historical data relevant to the field study and data analysis

7. <u>Scheduling of Study.</u> The CEERD is being contracted to assist with planning, coordination, and conduct of TDG studies as required at Libby Dam by CENWS. The work to be performed during FY00 includes field sampling, data analysis, and reporting. The majority of the fieldwork and data analysis will be conducted during June and July 2002. The work should be completed in accordance with the following schedule. The specific week of the test will be scheduled in coordination with federal, state and tribal fish and water quality agencies.

- Data Collection — June 1 – June 30, 2002
- Data Analysis — July 1 2002 through August 31 2002
- Interim Data Report and Test Results — August 15 2002
- Final Report to NWS — September 15 2002

8. **<u>Points of Contact.</u>** The CEERD primary points of contact for this work are Joe H. Carroll 541.298.6656 and Mike Schneider 601.634.3424. CENWS point of contact is Layna Goodman 206.764.5523.

Table 1. Tentative Test Schedule for TDG Testing at Libby Dam.

Event	Date	Time	Number Hours	Generation Flow (Kcfs)	Spill per Gate (Kcfs)	Number Gates	Total Spill (Kcfs)	Total Release (Kcfs)
Install Equipment	Day 1	All day		25	0	0	0	25
1	Day 2	0700-1100	4	25	1	2	2	27
2	Day 2	1100-1500	4	25	1.5	2	3	28
3	Day 2	1500-1900	4	24	2	2	4	28
	Day 2-3	1900-0700		25	0	0	0	25
Meeting	Day 3	0700-0900						
4	Day 3	0900-1300	4	23	2.5	2	5	28
5	Day 3	1300-1700	4	22	3	2	6	28
6	Day 3	1700-2100	4	21	3.5	2	7	28
	Day 3-4	0700-0900		25	0	0	0	25
Meeting	Day 4	0700-0900						
7	Day 4	0900-1300	4	20	4	2	8	28
8	Day 4	1300-1700	4	19	4.5	2	9	28
9	Day 4	1700-2100	4	18	5	2	10	28
Remove Equipment	Day 5	All day		25	0	0	0	25