# LOWER BEAR RIVER WATER QUALITY MANAGEMENT PLAN

*Prepared By*
**ECOSYSTEMS RESEARCH INSTITUTE**
**and**
**BEAR RIVER RC&D**

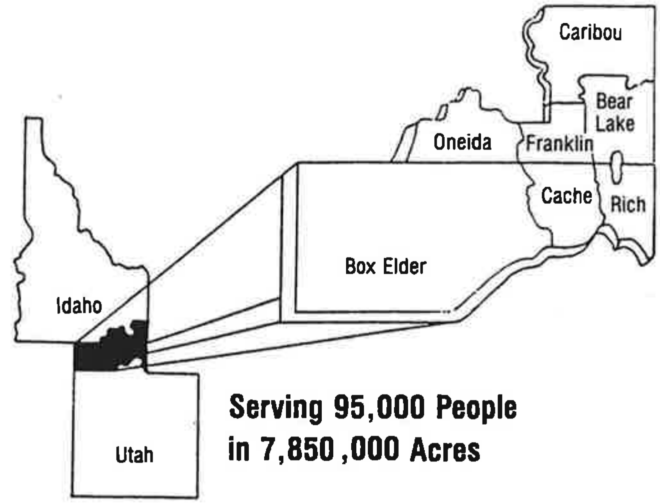
*Prepared For*
**DEPARTMENT OF ENVIRONMENTAL QUALITY/ DIVISION OF WATER QUALITY**

**and**
**DEPARTMENT OF NATURAL RESOURCES/ DIVISION OF WATER RESOURCES**

*Funded in part by*
*the Utah Division of Water Resources and*
*the U.S. Environmental Protection Agency.*

**November 1995**

BEAR RIVER
RC&D

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**Resource Conservation & Development Project** • 1260 North 200 East, Suite 2
Logan, Utah 84321 • (801) 753-3871

TO: Department of Environmental Quality
Division of Water Quality

Department of Natural Resources
Division of Water Resources

A Bear River Water Quality Management Plan was recently completed by Ecosystems Research Institute and Bear River RC&D. This monitoring study and management plan has much local support.

The initial project came about because of the concerns of the Cache County Water Quality Taskforce. At the start of the study a Lower Bear River RC&D Water Quality Steering Committee was organized. This committee helped to develop the initial proposal. They reviewed the project as it was underway. Later they helped to prioritize and target problems.

As the project came to a close, public meetings were held to review the draft and get public comments.

This study has also been reviewed by Utah State University and Federal and State Water Quality experts. The study document was also given to Industry Stake Holders for review. These agencies and stake holders feel that the study has accurately identified problem areas in the Lower Bear River.

We would like to add our support for the management plan and encourage the implementation of this plan.

Sincerely,

M. Lynn Lemon, Chairman
Lower Bear River RC&D
Water Quality Steering Committee

# CACHE COUNTY
CORPORATION

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**November 16, 1995**

**Barbara Hoffman, Coordinator**
**Bear River Resource Conservation & Development**
**1260 North 200 East, Suite 4**
**Logan, UT 84321**

**Reference: Bear River Water Quality Plan**

**Dear Barbara,**

**On October 10, 1995, the Cache County Council passed a motion in support of the Bear River Water Quality Plan.**

**A copy of the minutes reflecting that support is enclosed.**

**Sincerely,**

**M. Lynn Lemon**
**County Executive**

**enclosure**

*COUNCIL MEETING*
*MINUTES 10/10/95*

*BEAR RIVER WATER QUALITY: RECOMMENDATIONS*

*Vice Chairman Anhder told the Council that the County Water Policy Board are supporting water quality recommendations for the Bear River and are asking the Council to support the recommendations.*

*Vice Chairman Anhder moved that the Council support the recommendations of the Water Policy Board. It was seconded and carried unanimously.*

## ACKNOWLEDGEMENTS

The Bear River Water Quality Management Plan, conducted by Ecosystems Research Institute under contract to the Bear River RC&D, is a product of technical assistance and support of a large number of people, not all of whom are mentioned below.

The support and insights of Jim Christensen, Mike Reichert, Tom Toole, Bill Moellmer and others in the Utah Division of Water Quality is greatly appreciated. The monitoring program conducted during this project was a cooperative effort between ERI and the Utah Division of Water Quality. We wish to extend a special thanks to Richard Denton for guidance in establishing monitoring sites and parameters and the help of his staff in conducting a monitoring program of high standards and for providing us with the data in a timely manner. Thanks in particular to Arni Hoelquist for cheerfully fielding countless data requests.

Thanks to Ken Short, Craig Miller and others in the Utah Division of Water Resources for guidance throughout this process. Staff at the U.S. Geological Survey, in particular David Allen, were very helpful in providing flow and sediment data and Tom Pettingill and Kent Sorenson of the Utah Division of Wildlife Resources provided useful fisheries data and expertise. Lee Baxter of the Bureau of Reclamation has been an extremely helpful participant in this project.

A special thanks is extended to Don Huber and Mike Allred of Cache County Extension, as well as Bob Clark, Brock Benson, Jeff Barnes, Karl Kler and many others in the U.S. Soil Conservation Service for their time and expertise. A special thanks to Barbara Hoffman, Jay Bankhead and Kent Hortin of the Bear River RC&D for help in moving the document to the public. For their support and technical assistance, thanks to Mike O'Neill, Kitt Farrell-Poe, Richard Peralta, Howard Deer and Steve Poe of the Utah State University Extension Office. Much appreciation is extended to Nick Galloway of the Bear River Health Department, who provided technical and monitoring support. Thanks to Ron Ryel, Cindy Johnson of NR Systems and Ramona Rukavina for invaluable technical help.

A very special thank you is extended to Sherm Jensen and Ted Dean of White Horse Associates who spent countless hours and silently suffered through short deadlines to provide among many other items, technical maps and landuse statistics.

We recognize and appreciate the interest and support of Bruce Zander and Doug Lofstedt (U.S. Environmental Protection Agency, Region VIII) and other USEPA and Utah Division of Water Quality staff for their guidance and general support of a project aimed at improving the quality of water within the lower Bear River basin. Finally, a sincere thank you to all the private citizens and agency personnel who gave freely of their time to serve on the steering committee, to comment on the draft document, and to offer suggestions and insights into water quality problems in the lower basin. This is a much improved document because you cared enough to spend the time.

## EXECUTIVE SUMMARY

### Introduction

As water resources become increasingly scarce in the Bear River basin, concerns have increased about the quality of the river's water. This document is a water quality management plan for the lower Bear River in Cache and Box Elder Counties, Utah. Objectives of the plan are:

1) To serve as a tool for local officials to improve or protect water quality;
2) To provide a mechanism for implementing water quality improvement projects;
3) To develop long-term monitoring plan to determine the effectiveness of the plan; and
4) To serve as a model in using a watershed based approach to water quality planning.

### Project Area

The Bear River originates in the Uinta Mountains in northeastern Utah and travels through parts of Wyoming and Idaho before returning to Utah. The basin area encompasses 4.8 million acres, of which 1.7 million acres are in the project area. Much of the upper basin flow is diverted into Bear Lake and released throughout the summer for irrigation needs. The average annual discharge as the river re-enters Utah is 750,000 acre-feet. The Cub, Blacksmith Fork, Logan and Little Bear rivers enter the Bear River in the Cache Valley. The Malad River enters the Bear River below Cutler Reservoir, a large shallow reservoir located in Cache Valley.

About 30 percent of the project area is privately held agricultural lands, concentrated in the valley bottoms, with rangelands in the upland areas. Almost half of the project area is public land.

Cache and Box Elder counties had a combined 1990 population of over 100,000 with a projected 2020 population of over 150,000. Manufacturing accounts for one-third of the employment in the local economy. Agriculture accounts for less than 10 percent of the employment, although many of the businesses are agricultural-related. Tourism is an increasingly important part of the local economy.

Water quality studies on the Bear River date back to the 1940s. The Utah Division of Water Quality has monitored sites in the basin since 1976. Work in the 1970s concentrated on municipal and industrial effluent entering the river. More recently studies have concentrated on nonpoint pollutants, particularly nutrients, bacteria and sediments.

Impoundments in the basin include Cutler, Hyrum, Newton and Porcupine reservoirs. The first three are eutrophic, impacted by high nutrient and sediment loadings. In addition, modeling on the proposed Honeyville Reservoir downstream of Cutler predicted very poor water quality in this reservoir under current conditions.

Macroinvertebrates in rivers and streams provide information on long-term conditions in those waterbodies. Samples collected in the Bear River since the 1960s have had poor macroinvertebrate diversity and were dominated by sediment and organic tolerant species.

The Logan and Blacksmith Fork rivers are high quality fisheries, the Little Bear River drainage is considered a good fishery, while the Cub and Bear rivers have average to poor fishery resource value. High sediment concentrations affect both feeding and spawning in these rivers, and are the primary factor limiting fishery potential.

**Current Water Quality Status**

An intensive water quality monitoring program was conducted from October 1992 through 1993 to determine the current water quality status in the lower Bear River basin. Thirty-seven river sites and seven point sources were sampled routinely and analyzed for nutrients, bacterial contamination, field oxygen, temperature and pH. Metals were analyzed quarterly.

Flows in the Bear River in 1993 were lower than the period of record mean flows. Average sediment loads increased from 107,000 kg/day at the stateline to 277,000 kg/day near Corinne. Concentrations were highest during early runoff, and were higher during the irrigation season than during winter baseflows. Total phosphorus (TP) concentrations on the mainstem Bear River averaged 0.105 mg/liter at the stateline, increasing to 0.211 mg/liter at Corinne.

The Cub River contributed substantial sediment, phosphorus and inorganic nitrogen loads to the Bear River. Sediment concentrations were closely associated with flow, with Idaho contributing the largest portion, while nutrients entered disproportionately from the Utah portion of the drainage.

As the river passed through Cutler Reservoir, phosphorus and inorganic nitrogen increased significantly.

The Logan Lagoons contributed substantial loads of dissolved total phosphorus (DTP) and ammonia ($NH_3$). Spring Creek, a tributary of the Little Bear River, accounted for just six percent of the flow entering the Bear River as it passes through Cutler Reservoir, but accounted for over 25 percent of the increased TP and DTP loads and almost 50 percent of the increase in nitrate ($NO_3$) and $NH_3$ loads in this reach. Coliform concentrations were extremely high. This subdrainage is impacted by heavy inputs from both point and nonpoint sources.

The Little Bear drainage showed signs of water quality deterioration both above and below Hyrum Reservoir. Hyrum Reservoir acted as a sink for total suspended solids (TSS), TP and nitrate, but functioned as a substantial source of DTP.

The Logan River and the Blacksmith Fork River had very good water quality as they left U.S. Forest Service lands. Concentrations of TSS and nutrients increased as the Logan River moved across the valley to Cutler Reservoir, although water quality remained relatively good. On average, water quality in the Blacksmith Fork River remained high throughout the valley.

Hopkins Slough had extremely poor water quality, with high nutrients and high coliform concentrations. Clay Slough had high conductivity and extremely high phosphorus and nitrate concentrations.

Macroinvertebrate samples from the Bear River above Cutler Reservoir had few taxa and were dominated by sediment and organic tolerant species. Samples from the Little Bear had fair to good diversity, indicating a fair fishery potential due to limited substrate. The Cub River at the stateline, Worm Creek, and Hopkins Slough were dominated by pollution tolerant species while the Cub River above the Bear River, the Logan River and the Blacksmith Fork River had good abundance, high number of taxa and high diversity indices.

**Beneficial Uses, Standards and the TMDL Process.**

The beneficial uses supported by lakes, reservoirs and rivers in Utah include domestic water supplies, recreation and aesthetics, wildlife habitat, and irrigation and other agricultural use. Low dissolved oxygen, high ammonia concentrations and excessive sediments impact fisheries. Nutrients (phosphorus and nitrate) cause increased plant growth, creating aesthetic problems, low dissolved oxygen, and taste and odor problems. Bacterial contamination is a human health concern. Instream standards for various water quality parameters and an anti-degradation policy have been established by the state to protect these beneficial uses.

Water quality concerns arise directly from loss of beneficial uses. From 1976 through 1992 the greatest number of violations were due to high bacterial concentrations. Violations of the dissolved oxygen standard have occurred within the Little Bear River drainage. Phosphorus concentrations exceeded the pollution indicator concentration at almost all the sites, except those very high in the mountains.

The current study found similar patterns in addition to ammonia violations and very high nitrate concentrations at several sites in the Spring Creek drainage. Again, TP and DTP frequently exceeded the indicator concentration at all sites except those high in the drainage.

Total Maximum Daily Loads (TMDLs) are a means of evaluating and protecting waters based on mass loads of pollutants to the water bodies, rather than just concentrations of pollutants. Using this approach, all point and nonpoint sources can be compared according to their relative contributions, and impacts throughout the entire watershed can be estimated. Similarly, improvements in water quality can be evaluated in terms of their impacts throughout the drainage. Total maximum daily loads for nutrients and suspended and dissolved solids were established for specific reaches of the Bear River, and for each of the major tributaries entering the Bear River above Cutler Reservoir. In addition, a phosphorus TMDL was calculated for Cutler and Hyrum reservoirs. Dissolved total phosphorus loads from the 1993 monitoring found the lower Bear River, the Cub River and Spring Creek all far exceeded the TMDL for DTP and TP. The Cub and Spring Creek loads exceeded the nitrate TMDL. Total suspended solids loads exceeded the TMDLs at all Bear River sites except at the stateline.

**Ranking and Targeting Problem Areas**

Nonpoint and point sources entering each reach of the Bear River, and all tributary inputs were ranked according to the magnitude of TSS, TP and DTP loads entering from each source. Other factors were considered in ranking, but total magnitude was given the most weight. These targeted areas, agreed upon by the Bear River Water Quality Monitoring Plan (BRWQMP) steering committee, are:

1) Spring Creek drainage;

2) The Utah portion of the Cub River;

3) Sources in Cutler Reservoir from Benson to Cutler Dam; and

4) The Bear River corridor from Richmond to Benson.

Each targeted area was evaluated separately and sources of nutrients and sediments were identified. In the Spring Creek drainage, manure management is a critical issue. Runoff from fields spread with manure during the winter and direct runoff from feedlots are serious problems in this subdrainage. Point sources also contribute substantially to nutrient loadings. In the Cub River drainage, impacted riparian areas and stormwater runoff from a fertilizer distributor appear to be the major problems. Work is already underway in the reach of the Bear River through Cutler to stabilize banks and improve grazing practices. This work must be continued as well as restoration of riparian areas currently being overgrazed. Sediment problems in the Bear River corridor below the stateline arise from exposed banks, irrigation return flows and several severely degraded riparian areas.

The potential for reducing pollutant loadings by various remediation activities was evaluated and specific recommendations were made for each of these targeted subdrainages. It was predicted that with a medium to high level of remediation effort in the four targeted areas, TP and DTP loads can be reduced substantially, and the TMDL for DTP could be met in the mainstem Bear River.

**Recommendations**

Following meetings with the BRWQMP steering committee and a comment period on the draft plan, the following set of recommendations were set forth in this plan.

1. Establish target TMDLs for dissolved total phosphorus through voluntary compliance with established time frames. These TMDLs will be refined at the end of this period. The TMDLs are calculated for specific reaches of the mainstem Bear River and tributaries to the Bear River.

2. Use the TMDLs calculated for suspended solids and nitrates as nonenforceable guidelines. Use existing enforceable standards for dissolved oxygen, ammonia and coliforms.

3. Develop Project Implementation Plans for improving water quality in the following subwatersheds:

a) Spring Creek (tributary to Little Bear)

b) The Cub River in Utah. Work with Idaho on that portion of the drainage in Idaho

c) The Bear River from Benson to below Cutler Dam, including Cutler Reservoir

d) The Bear River above Benson to the site near Richmond.

4. Encourage those wastewater treatment plants (WWTPs) in the lower Bear River basin with significant phosphorus loading impacts to determine if changes in operations are possible which would reduce dissolved phosphorus loads from these sources. If operational changes are not possible, tertiary treatment for phosphorus removal may be necessary. To increase the existing database on phosphorus concentrations in the effluent, Utah Division of Water Quality (UDWQ) should add DTP analysis to the samples they collect at regular intervals.

5. Develop a long-range monitoring program to document water quality improvements during and after project implementation plan (PIP) implementations. Integrate water quality sampling and biomonitoring programs. Continued water quality monitoring will determine whether TMDLs are being met. Monitoring of riparian areas, macroinvertebrate populations and fisheries will help determine the true health of these areas, and more directly evaluate the gains in beneficial uses as water quality improves with improved landuse practices.

6. Continue working with existing local agencies and extension services to encourage best management practices (BMPs) in all agricultural lands in the valley. In addition, increase awareness on urban contributions to water pollution and educate the public on measures that can be taken to reduce this problem. There is a need for a coordinator to oversee the existing and new efforts in the lower basin. The existing BRWQMP steering committee will continue to function in an advisory capacity.

7. Work with Idaho and Wyoming to develop an integrated water quality plan for the entire Bear River basin.

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4) **To serve as a model in developing and implementing a watershed based approach to water quality planning.**

Specific tasks conducted during the course of this study include:

- **Review historic water quality conditions including a determination of water quality exceedences and target contaminants.**

- **Conduct an intensive monitoring program to identify the current water quality problems, their magnitude and location.**

- **Determine which water bodies within the basin are currently not supporting their designated beneficial uses.**

- **Develop TMDLs for water bodies within the lower Bear River basin. These TMDLs will serve as the basis for waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources.**

- **Compile a point source and landuse database to help identify sources of water pollution relative to target contaminants.**

- **Prioritize the identified impaired reaches based upon the magnitude of impact.**

- **Develop a database for Project Implementation Plans (PIPs) to secure funding for the correction of nonpoint source pollution problems in the prioritized reaches.**

## 2.0 PROJECT AREA

The project area is part of the Bear River basin, which encompasses 4.8 million acres including parts of Utah, Wyoming and Idaho (Figure 2-1). The Bear River begins at about 13,000 feet in the Uinta Mountains in northeastern Utah. It flows north into Wyoming, crosses into Utah and back into Wyoming before entering Idaho northeast of Bear Lake. A canal has linked the Bear River and Bear Lake since 1911. Prior to the canal construction, the river and lake had been separated for approximately 11,000 years (since the Pleistocene). About three-fourths of the annual flow of the upper Bear River (300,000 acre-feet) is diverted into Bear Lake for storage and is released throughout the summer for irrigation with power generation as a secondary benefit. From Bear Lake, the river flows northwest towards Soda Springs, Idaho. Until about 34,000 years ago, the upper Bear River continued northward to the Snake River (Morrison 1965). When a volcanic debris slide blocked the northward course, the river turned south, overtopped the southern edge of Gem Valley, cut through a narrow basalt canyon (Oneida Narrows) and entered Cache Valley.

Average annual discharge is about 750,000 acre-feet at the Utah-Idaho border. The Cub, Blacksmith Fork, Logan and Little Bear rivers converge with the Bear River near the middle of Cache Valley, augmenting its flow by about 50 percent. Before leaving Cache Valley, the Bear River is impounded in Cutler Reservoir, located in the gap between the Clarkston and Wellsville mountain ranges. The reservoir has a surface area of over 7,000 acres and a mean depth of only three feet. The height of Cutler dam is 110 feet, but the reservoir has filled with sediment over the last 70 years and has a current depth of only 15 feet at the dam. The storage capacity of Cutler Reservoir has been reduced to about 10,000 acre-feet at elevation 4406.63 since construction in the 1920s. Cutler Reservoir sustains over 1,700 acres of emergent wetland vegetation. After leaving Cache Valley through Cutler Reservoir, the Bear River then turns south into Salt Lake Valley and meets with the Malad River before ending in the Great Salt Lake. The Bear River contributes about 1.2 million acre-feet per year to the Great Salt Lake.

The Bear River drops almost 9,000 feet along its 500 mile course from the Uinta Mountains to the Great Salt Lake, a distance of only 75 air miles. Throughout its main course, the Bear is impounded in five reservoirs, completely diverted in three reaches and generates electricity for six hydroelectric plants.

The project area (Figure 2-2) is the lower Bear River basin between Oneida Reservoir in the upper part of Oneida Narrows and the Bear River Migratory Bird Refuge near the shore of the Great Salt Lake, encompassing about 1.7 million acres. Major tributaries include the Cub, Little Bear, Logan, and Blacksmith Fork rivers in Cache Valley and the Malad River in Salt Lake Valley.

## 2.1 Climate

Average annual precipitation in Cache Valley from 1968-1992 was 18.23 inches (Ashcroft et al. 1992). This area is typical of much of the intermountain west, where precipitation is highly seasonal, mostly falling as snow. The average annual snowfall from 1968-1992 was 50.9 inches with an average water content of 10 percent. Snowmelt runoff is a major source of river flow. Typically, runoff in the lower Bear River basin is bimodal with the first peak correlating with snow melt from the valley bottoms and the second peak from snowmelt in the higher parts of the basin. The typical growing season is May through September. Average temperatures are -13°C to -1°C in the winter and 3°C to 11°C in the summer. The frost free period is 40 to 140 days.

## 2.2 Geology/Geomorphology

The Bear River project area straddles two physiographic provinces. The Bear River Range on the east is the western extent of the Middle Rocky Mountain Physiographic Province. Extending west from the base of the Bear River Range to the Sierra-Nevada Mountains is the Great Basin Section of the Basin and Range Physiographic Province (Hunt 1974), which is characterized by nearly parallel, north-south trending, fault-block mountain ranges separated by broad basins, many of which lack external drainage and held extensive lakes in Pleistocene time. This topography is the result of block faulting and the accompanying deposition of mineral debris. An east-to-west cross-section through the Great Basin Section resembles a broad, partially collapsed arch (Morrison 1965), having its highest part in eastern Nevada and dipping towards both the east and west. To the north of the Bear River project area lies the Columbia-Snake River Plateau Physiographic Province, a broad lava plateau separating the Great Basin from the Northern Rocky Mountains.

The geology of the Bear River, Wellsville and Bannock mountain ranges consists primarily of

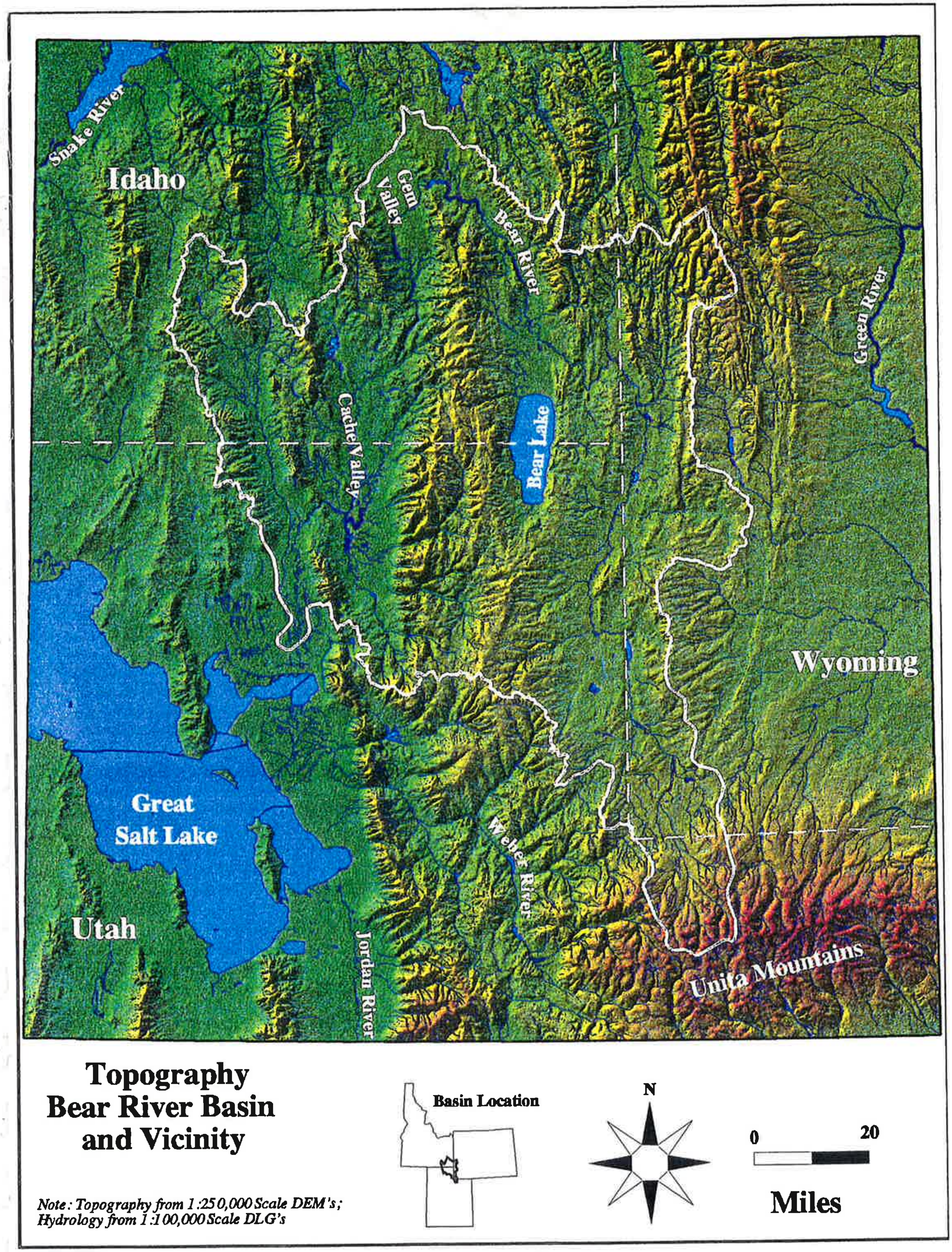


FIGURE 2-1. The entire Bear River basin.

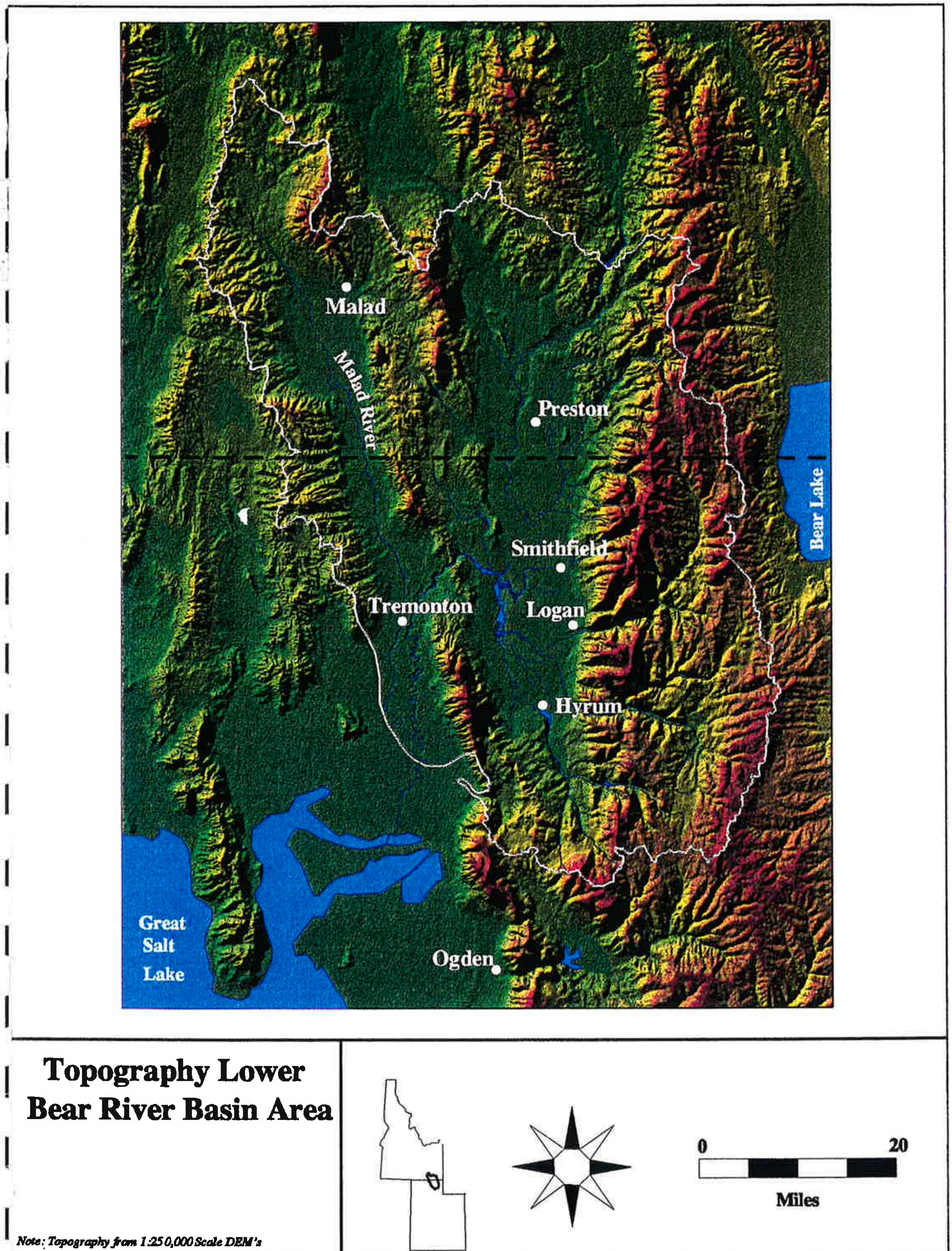


**Figure 2-2. Project Area, lower Bear River Basin**

Paleozoic marine sedimentary rocks overlying a core of Precambrian quartzite. Volcanic rocks are common along the footslopes of ranges in the northern part of the Bear River project area adjacent to the Snake River Plain. Valleys are filled with Tertiary deposits overlayed by Quaternary lake sediments.

Mountain ranges of the Bear River project area are mostly dissected by V-shaped, fluvial canyons. U-shaped, glacial valleys are also present in the Bear River Range and, to a much more limited extent, the Wellsville Range. Glacial features are most evident along the upper part of the Logan River (Figure 2-2). Major streams discharging from canyons have typically dissected into broad alluvial deltas remnant of Lake Bonneville. Terraces denoting relatively stable levels of Lake Bonneville follow the perimeter of both Cache and Salt Lake valleys. While short reaches of contemporary alluvial valley-bottoms are common along the flanks of the valleys, streams meandering through the middle of both Cache and Salt Lake Valleys are confined by high terraces reflecting lacustrine origin.

Valley bottom types (VBTs) are portions of the valley bottom distinguished by mode of genesis and consequent geomorphic attributes. Major VBTs associated with major tributaries of the lower Bear River watershed include:

**Fluvial Canyons:** V-shaped canyons formed by fluvial processes in mountainous areas. Fluvial canyons can be further divided as V-shaped erosional canyons, characterized by narrow bottoms confined by steep residual slopes, and V-shaped depositional canyons, characterized by wider bottoms and flanked by more gentle mountain slopes. Substrates are typically boulder and rubble and stream grades are relatively steep.

**Alluvial Canyons:** Formed at the mouths of canyons draining from mountain fronts. Alluvial valleys can be further divided as confined, where narrow bottoms are abruptly confined by alluvial slopes, and unconfined, characterized by wider bottoms. Substrates are typically gravel and stream grades are moderate.

**Lacustrine Basins:** Formed in nearly level lake sediments remnant of Lake Bonneville. Lacustrine basins can be further divided as confined, where bottoms are relatively narrow and confined by lake terraces, and unconfined, characterized by very wide bottoms. Substrates are typically sand/silt and stream grades are very low.

## 2.3 Soils

In the mountain ranges, slopes are typically steep and soils formed in residuum, colluvium, or alluvium derived from the mixed Paleozoic parent materials. These soils are generally deep to very deep and well to somewhat excessively drained. Runoff is moderate-to-rapid and the water erosion hazard is moderate-to-high. Lake terraces flanking Cache and Salt Lake Valleys are well drained, very deep, and formed in alluvium. Slopes are low-to-moderate and the water erosion hazard is moderate-to-low. Downcutting by the Bear River and its tributaries, resulting from the lowering of the hydrologic base level as Lake Bonneville receded, have resulted in massive erosion from these deltaic deposits where they are adjacent to stream channels. In particular, Battle Creek, Weston Creek, and Fivemile Creek are characterized by high sediment yields due to erosion of the terrace deposits (ERI 1991).

Soils on old lake bottoms in the middle of Cache and Salt Lake Valleys are nearly level, moderately well to poorly drained, very deep, and derived from lacustrine and alluvial deposits. They include silt loam to silty clay loam texture with finer textures more prevalent towards the middle of the valleys. Saline/sodic soils are also common. Runoff is slow and in low gradient areas the hazard of water erosion is slight.

## 2.4 Landuse

Over 1.7 million acres drain into the Bear River and its tributaries from Oneida dam to the Great Salt Lake. Of this area, 45 percent is public land, administered by the Bureau of Land Management (BLM) or the U.S. Forest Service (USFS) and almost 30 percent of the land is in agricultural use on private lands. Irrigated lands in the project area typically are used for grains or hay production or for pastureland. Irrigation has traditionally been by flooding, but many fields have converted to sprinkler systems over the past 20 years. In 1994, 57 percent of the irrigated land in Cache Coutny and 20 percent in Box Elder County were in sprinkler systems. Rangelands are typically in upland areas away from valley bottoms. Conditions of these lands range from poor to good, with a few areas considered excellent. Generalizations about rangeland conditions are difficult because conditions are extremely dependant on individual management by landowners. Portions of the public lands and the areas without an identified landuse are probably also used for grazing or other dryland agricultural purposes. Urban development comprises less than 1.5 percent of the total area in the lower Bear River basin. Most of this urban development in the lower basin occurs within Utah (Table 2-1). The major landuses within the lower basin are shown in Figure 2-3 and summarized in Table 2-1. Contained animal feeding operations (CAFOs) are typically clustered along waterways in the valleys of the project area. Over 200 CAFOs, averaging about 65 animals, are identified in the portion of the project area above Cutler Dam (Figure 2-4).

About 16 percent of the total watershed drains to the Bear River before it crosses the Utah-Idaho stateline. Approximately half of the total watershed (890,000 acres) drains to the Bear River as it moves through Cache Valley from the Utah-Idaho stateline to Cutler dam. Almost two-thirds of this land is National Forest, and about 22 percent is in identified agricultural uses. About 543,000 acres drain to the Bear River below Cutler dam, most of which enters through the Malad River drainage.

The corridor of the mainstem Bear River passes through broad floodplains dominated by grazing, pasture lands and dairy operations. About 50 percent of the land is in agricultural use, of which two-thirds are irrigated. Throughout the entire reach, irrigation return flows drain back to the river. Point sources along the mainstem Bear River include seasonal effluent from a cannery just north of the Utah-Idaho border, and effluent from Logan's wastewater treatment facility, which discharges into a slough upstream of Cutler Reservoir. The towns of Logan, Smithfield, Hyde Park, North Logan, Providence and River Heights send sewage to this facility, representing 70 percent of the population in the valley. In addition, all septic tanks in the county are hauled to the lagoons. Current capacity is expected to handle demands until approximately 2007 (Logan City Engineering Office).

The Cub River drains 142,000 acres, most of which are National Forest lands. About one-third of the drainage is in agricultural land, of which 80 percent is irrigated. As it flows southward, the Cub receives agricultural return flows and waste effluent from Franklin, Idaho and Richmond, Utah and several small industries. As the Cub enters Utah, it is joined by Worm Creek, which drains an area to the north and receives the effluent from the Preston, Idaho wastewater treatment plant (WWTP). Within Utah, several tributaries join the Cub River from the east, including High Creek, Spring Creek and Cherry Creek.

Summit Creek drains an area of approximately 16,500 acres, south of the High Creek drainage. Almost 70 percent of the area is National Forest lands, and only two percent is identified as being in agricultural use. The stream is diverted at the mouth of Smithfield canyon and below this point is

TABLE 2-1. Summary of major landuses (in acres) in the lower Bear River basin. Landuses within major subdrainages and reaches of the Bear River are identified. Data were collected in 1986 (Utah Division of Water Resources 1991; Idaho Department of Water Resources; Idaho Geographic Information Center).

| | PUBLIC LANDS | | PRIVATE LANDS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bureau of Land Mgmt * | Forest Service ** | Irrigated Agriculture | Non-irrigated Agriculture | Open Spaces | Other | Unknown | Urban | Water | Wetlands | TOTAL | PERCENT OF TOTAL BASIN |
| **MAINSTEM BEAR RIVER** | | | | | | | | | | | | |
| below Cutler | 0 | 35,026 | 19,147 | 7,471 | 18,229 | 337 | 2,951 | 2,844 | 2,380 | 4,534 | 92,921 | 5.4% |
| Utah above Cutler | 0 | 18,080 | 47,906 | 29,883 | 15,510 | 7,203 | 16,795 | 6,616 | 7,524 | 5,287 | 154,804 | 9.1% |
| Idaho | 3,293 | 67,643 | 44,690 | 63,577 | 813 | 89,872 | 1,232 | 572 | 644 | 4,103 | 276,439 | 16.2% |
| **TRIBUTARIES** | | | | | | | | | | | | |
| Cub River | 1,021 | 53,781 | 37,507 | 9,112 | 976 | 26,177 | 8,236 | 2,221 | 677 | 2,441 | 142,150 | 8.3% |
| Logan River | 0 | 153,597 | 2,572 | 543 | 488 | 130 | 2,409 | 2,734 | 85 | 89 | 162,648 | 9.5% |
| Blacksmith River | 0 | 177,325 | 2,928 | 491 | 331 | 25 | 1,349 | 902 | 13 | 308 | 183,672 | 10.7% |
| Little Bear River | 0 | 121,923 | 21,024 | 13,837 | 1,470 | 2,066 | 16,701 | 2,443 | 923 | 1,767 | 182,155 | 10.7% |
| Spring Creek | 0 | 369 | 10,328 | 513 | 647 | 455 | 531 | 1,491 | 66 | 157 | 14,558 | 0.9% |
| Summit Creek | 0 | 11,408 | 852 | 282 | 112 | 11 | 3,177 | 608 | 11 | 0 | 16,460 | 1.0% |
| Hopkins Slough | 0 | 5,488 | 6,019 | 2,165 | 785 | 333 | 2,817 | 1,609 | 1 | 181 | 19,398 | 1.1% |
| Clay Slough | 0 | 0 | 6,677 | 438 | 1,164 | 1,075 | 0 | 233 | 268 | 1,669 | 11,524 | 0.7% |
| Malad River | 66,774 | 81,668 | 76,000 | 82,566 | 0 | 72,903 | 64,144 | 3,740 | 617 | 5,189 | 453,599 | 26.5% |
| TOTAL | 71,088 | 726,307 | 275,649 | 210,877 | 40,527 | 200,586 | 120,344 | 26,013 | 13,210 | 25,725 | 1,710,327 | 100.0% |
| % of Total Basin | 4.2% | 42.5% | 16.1% | 12.3% | 2.4% | 11.7% | 7.0% | 1.5% | 0.8% | 1.5% | 100.0% | |

* *Landuses include watershed protection, recreational, livestock grazing, wildlife habitat, hunting, mining, logging*

** *Landuses include watershed protection, recreational, livestock grazing, wildlife habitat*

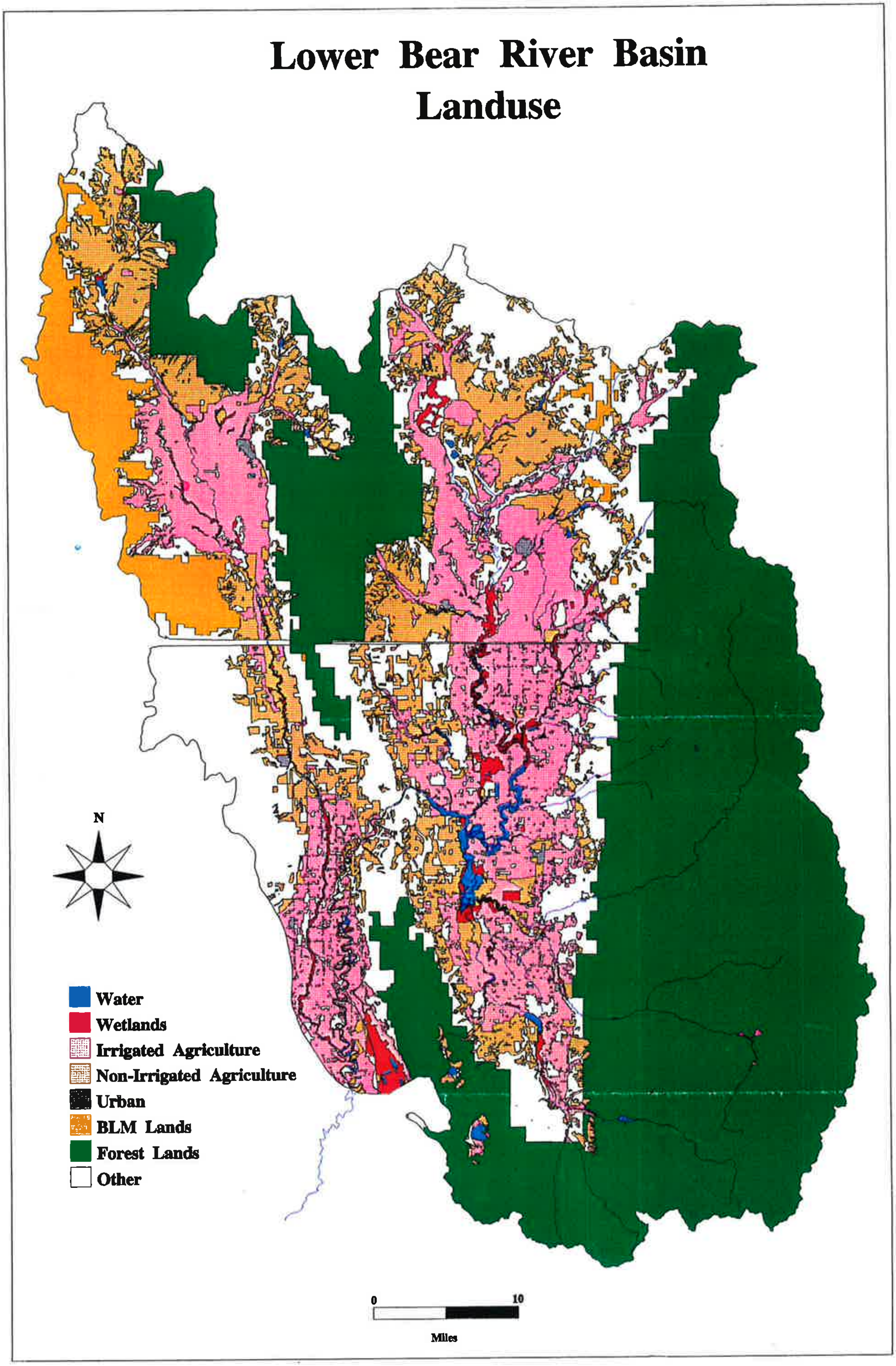


FIGURE 2-3. Lower Bear River basin landuse.

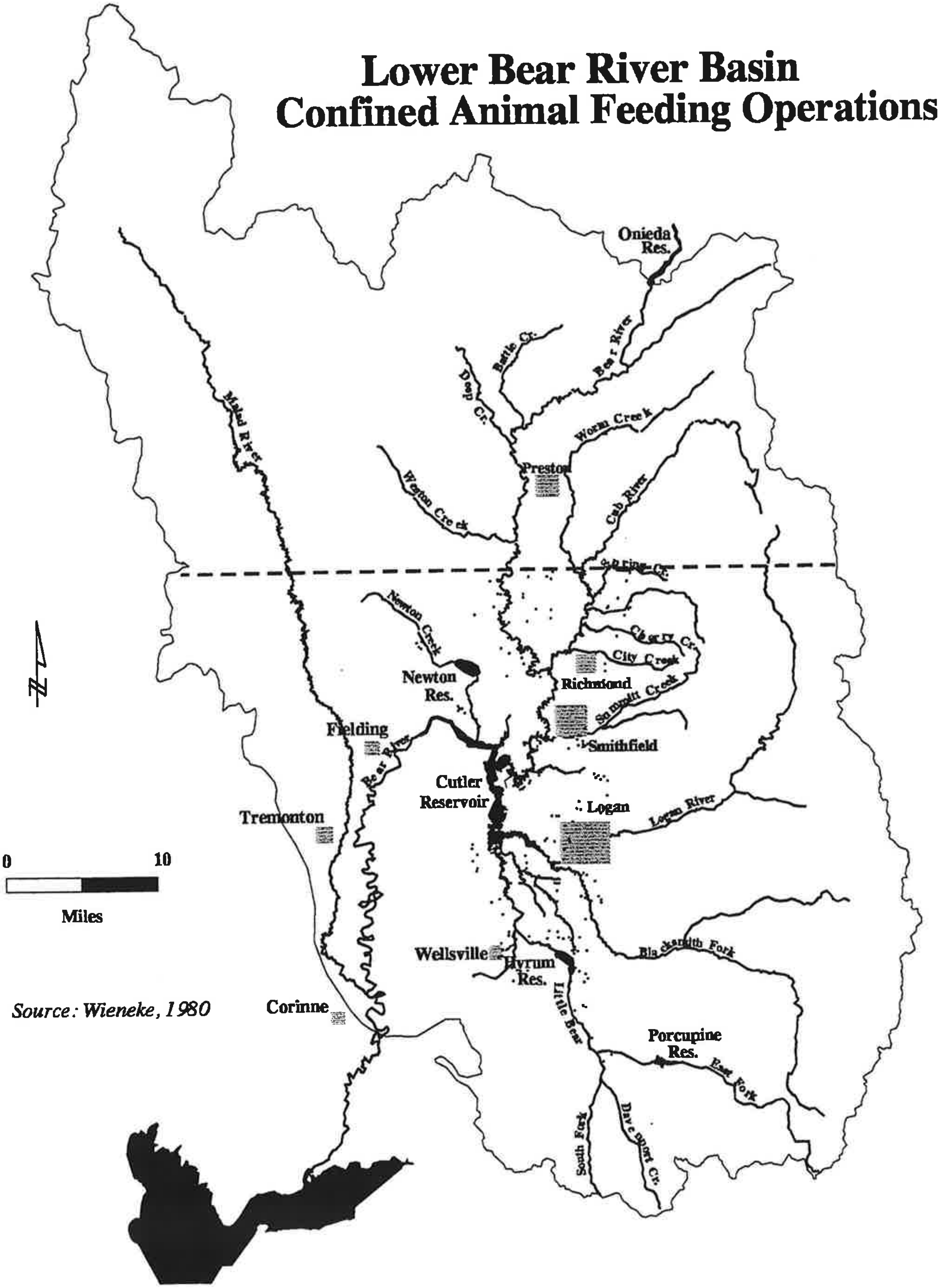


FIGURE 2-4. Lower Bear River CAFOs.

ephemeral. It runs through the town of Smithfield, then through low gradient agricultural lands before draining into the Bear River above Cutler Reservoir. Most of the flow that reaches the Bear River occurs during runoff.

The Logan River subdrainage is approximately 163,000 acres. It leaves the Wasatch National Forest as it enters the city of Logan, then passes through residential and agricultural areas comprised mainly of cattle feed lots and dairy operations before reaching Cutler Reservoir. About 95 percent of the drainage is in the National Forest. The Logan River receives the storm drainage from the town of Logan. Irrigation diversions at the mouth of Logan Canyon divert a large percentage of the flow during summer months.

The Blacksmith Fork River has a drainage area of 184,000 acres, of which 97 percent is in the Wasatch National Forest. Once the river leaves the mountain canyon, it flows through agricultural land to eventually join the Logan River just southwest of the city of Logan. During the growing season, the Blacksmith Fork is diverted for irrigation purposes at a point near the National Forest boundary. Flows in the lower valley during the summer and fall are from local accrual and return flows.

The Little Bear River drains 182,000 acres and has two main subdrainages. The South Fork originates in the low elevation foothills of the Wellsville Mountains and the Bear River range. The East Fork drains a relatively extensive area of National Forest land, and is stored in the upper basin behind Porcupine Reservoir. Porcupine Reservoir's outflow is regulated for irrigation and flood control. Only about two percent of the area above the confluence of the two rivers is agricultural. Below their confluence, about 40 percent is agricultural. In the relatively short stretch between the confluence of the two streams and Hyrum Reservoir there are considerable inputs of pollutants, mostly nutrients from agricultural activities, a trout farm, and erosion from unstable streambanks. Hyrum Reservoir was originally constructed for irrigation and flood control. The Little Bear River below Hyrum dam conveys mainly irrigation return flow in the summer, but may receive high flushing flows in the spring and early summer during runoff events. About 52 percent of the drainage below Hyrum Reservoir is in agricultural use. The river passes through the towns of Hyrum, Wellsville and Mendon, and receives the effluent from the Wellsville Sewage Lagoons.

A small area (approximately 14,600 acres) in the southern portion of Cache Valley drains to Spring

Creek, which enters the Little Bear just above Cutler Reservoir. Much of the runoff from Hyrum drains into this creek and the area is heavily used for agricultural activities. About 75 percent of the drainage is agricultural, of which 95 percent is irrigated. In addition, several agricultural-related industries (feedlots, rendering plants and packing plants) are located within this drainage. The southern fork of Spring Creek receives the effluent from Hyrum's WWTP, a meat packing plant and a large feedlot operation. Effluent from a small trout farm enters the northern fork of Spring Creek.

Several additional small tributaries to the Bear River in Cache Valley include Clarkston Creek and several sloughs which drain the low gradient areas surrounding Cutler Reservoir.

A number of springs enter the Bear River below Cutler dam, and account for much of its summer flow. Box Elder Creek enters the river near the town of Brigham City. Brigham City effluent discharges into this creek. The only other major tributary below Cutler Dam is the Malad River, which enters the Bear River about 20 miles above the Great Salt Lake. The Malad River originates in Idaho and drains about 480,000 acres to the west of Cache Valley. This subdrainage accounts for about 26 percent of the entire lower Bear River basin area and almost 90 percent of the area draining to the river below Cutler Reservoir. The Malad River originates in the lower elevation Malad ranges and the basin is heavily used for grazing and agriculture.

## 2.5 Demographics and Recreation

The 1990 census determined the population in Cache County to be 70,183, with a projected population of 102,431 by the year 2020 (BRAG 1990). Box Elder County had a 1990 population of 36,485 and a projected population of 53,300. These growth rates are typical of much of the Wasatch Front. Within Cache and surrounding counties, 31 percent of the population is employed in manufacturing, 19 percent in government, 14 percent in trades and 13 percent as proprietors. Agriculture accounts for 7.6 percent of the employment within the local economy, although many of the businesses in the project area are also agriculture related. The highest projected growth areas are construction and management, with projected significant increases in all other sectors except agriculture and mining.

Tourism is an increasingly important factor in the local economy. Water related recreational activities are important to the Utah economy, usually ranking in the top 12 of outdoor recreation activities

(UDWR 1992). Within the lower Bear River basin, the four reservoirs provide fishing opportunities, as do the Blacksmith, Little Bear and Logan rivers. Wildlife habitat is currently managed by the state of Utah along portions of the mainstem Bear River. In addition, Utah Power and Light is engaged in substantial recreation and habitat development around Cutler Reservoir and surrounding wetland areas as a result of the recent FERC relicensing of Cutler dam (PacifiCorp Electric Operations 1991).

**2.6 Hydrology**

The Bear River drainage basin (Figure 2-5) has been divided into ten hydrologic subbasins (Haws & Hughes 1973). The study area includes the Cache subbasin (number 8) which extends from below Oneida Reservoir to Cutler dam, subbasin 9 which drains the Idaho portion of the Malad River drainage, and subbasin 10 which includes the Utah portion of the drainage from Cutler dam to the Great Salt Lake. Snowmelt provides most of the water in the drainage, resulting in peak flows during spring runoff and low base flows for the remainder of the year. Water management for irrigation has somewhat altered these historic hydrologic patterns. Runoff is stored in four reservoirs in the study area and released during the growing season. In addition, irrigation releases from Bear Lake supplement the mainstem Bear River flows throughout the summer. Water is removed from the river via pumps and diversions throughout the basin. Power peaking at the Oneida and Cutler dams also result in highly variable flows in the downstream reaches of the Bear River.

The Cache subbasin is almost twice the size and produces more than twice the runoff of any of the other nine basins. It has the highest runoff to precipitation ratio, and includes most of the major tributaries in the study area, including the Cub River, Logan River, Blacksmith Fork River and Little Bear River. The Cache subbasin receives approximately 561,800 acre-feet of inflow water from the Bear River, and produces a net outflow of 1,129,000 acre-feet (Haws & Hughes 1973). The peak net outflow from this basin occurs during May (159,000 acre-feet), with minimum outflows in July, August and September (61,000 to 64,000 acre-feet).

Almost all of the water used for irrigation in the study area is surface water, originating within the Bear River basin. About 709,200 acre-feet annually is diverted in Cache and Box Elder counties, representing a depletion of about 422,600 acre-feet annually (UDWR 1992). Major diversions in the study

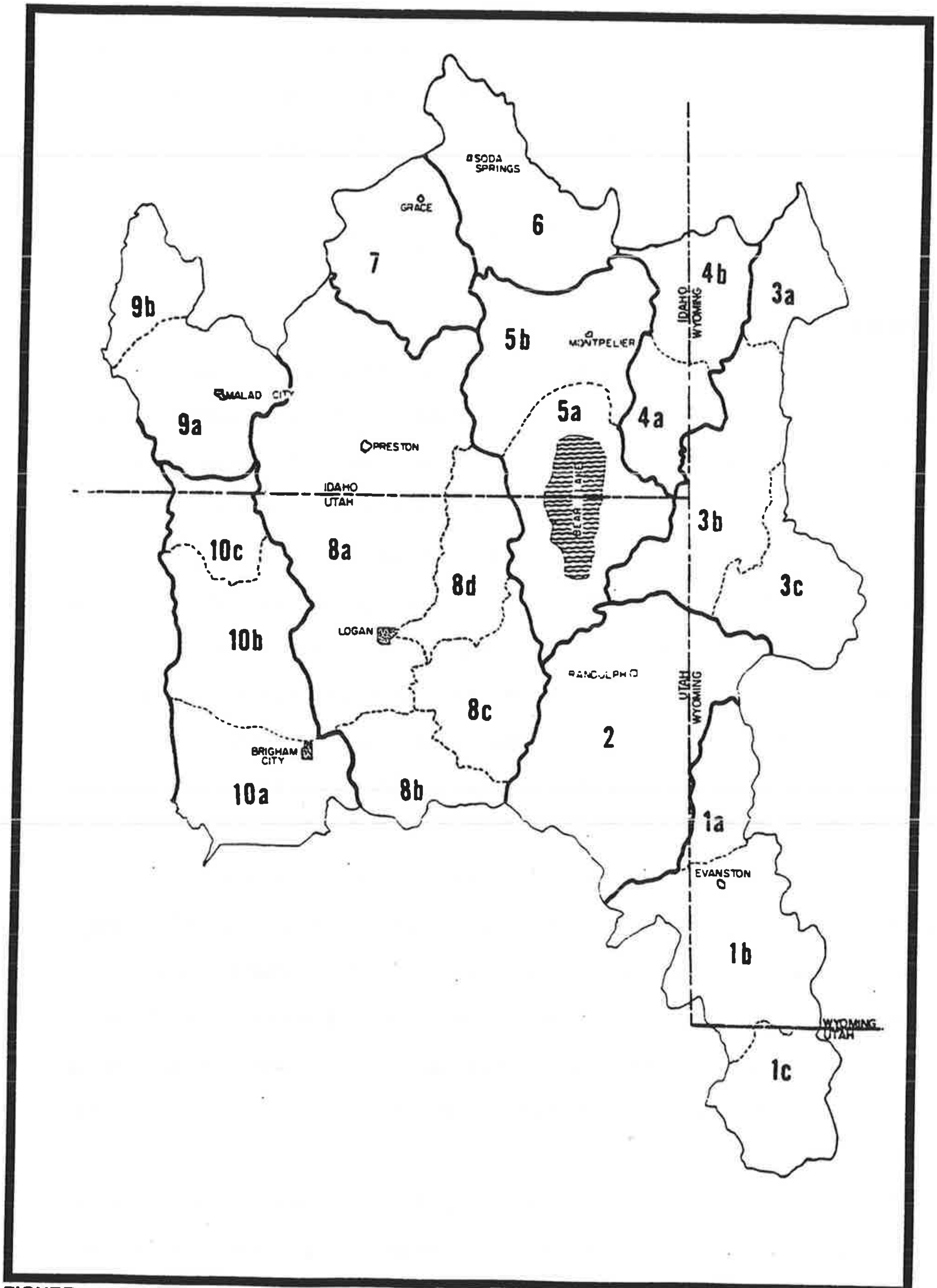


FIGURE 2-5. Hydrologic subbasins within the Bear River basin (from Hawes & Hughes 1973).

area occur on the mainstem Bear River near the Utah-Idaho stateline and below Cutler dam, below Porcupine and Hyrum dams on the Little Bear River, below Newton dam on Clarkston Creek, and near the Forest Service boundary on the Logan River, Blacksmith Fork and Summit Creek. In Cache County, more than 70 irrigation companies provide water to over 120,000 acres of irrigated land. In Box Elder County, over 105,800 acres are irrigated, with about 100 irrigation companies and private users involved in delivering the water. The Bear River Canal Company alone maintains over 120 miles of canals and laterals in Box Elder County (UDWR 1992).

### 2.7 Historic Water Quality

Water quality studies on the Bear River date back to the 1940s. Most of the early work focused on salinity and sediments. Within the past 20 years, concerns over nutrient and bacterial problems have dominated most of the water quality investigations. Table 2-2 summarizes the water quality studies which have been conducted on the Bear River.

Salinity was found by Waddell (1970) to increase from about 100 mg/liter near the headwaters to an average of 560 mg/liter as the river re-enters Utah from Idaho. Water below Cutler dam averaged between 800 and 900 mg/liter, increases associated with spring inputs and the Malad River. The highest salinity in the basin occurred in the Malad River, which averaged over 1,600 mg/liter from 1977-1992 (UDWQ unpublished data).

Changes in the geomorphology of the Bear River were noted in a study by Clyde (1953), which documented an increase in bed elevation of over six feet near the Utah-Idaho stateline from 1920 to 1948. This was attributed to massive inputs of sediments in the reach below Oneida Reservoir. In subsequent studies, large increases in sediment concentrations within that reach have been identified (Waddell 1970; Heimer 1978). Waddell (1970) noted mean total suspended solids (TSS) increased from 35 to 100 mg/liter from Oneida to Cutler reservoirs. Heimer (1978) determined sediment loads increased from an average of 68 tons/day (69,000 kg/day) below Oneida to over 350 tons/day (360,000 kg/day) near Preston, Idaho.

The USGS measured sediment concentrations in the Bear River at the Utah-Idaho border and below Cutler dam from 1987 through 1992. Their data at the stateline shows average daily sediment loads ranging from 6,600 kg/day in 1987 to 3,500,000 kg/day in 1989. The remaining four years were less

**TABLE 2-2. A summary of water quality investigations conducted on the Bear River.**

| | | LOCATIONS | | | PARAMETERS | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Author | Data date | BR UT | BR ID | BR WY | Flow | Nutrients | TSS | Salts | Metals | Bacteria | Biological |
| Thorne & Thorne 1951 | 1949 | X | | | X | | | X | | | |
| Clyde 1953 | 1953 | X | X | | X | | X | | | | |
| Ward & Skoubye 1959 | 1958-59 | X | | | X | X | X | X | X | X | |
| Bangerter 1965 | 1963-67 | X | | | | | | | | | X |
| Waddell 1970 | 1952-68 | X | X | X | X | | X | X | | | |
| Hill et al. 1973 | 1971-72 | X | X | X | X | | | X | | | |
| Israelson et al. 1975 | 1973-74 | X | | | | X | | | | | |
| UWRL 1974a | 1974 | X | | | | X | | | | X | |
| UWRL 1974b | 1974 | X | | | | X | | | | X | |
| Drury et al. 1975 | 1972-73 | X | | | | X | | | | | |
| UWRL 1976 | 1975-76 | X | X | X | X | X | X | X | X | X | |
| Perry 1978 | 1978 | | X | | | | X | X | | X | X |
| Heimer 1978 | 1975-76 | | X | | | | X | | | | |
| Lamarra 1979 | 1977-78 | X | | | | X | | | | | |
| Lamarra & Adams 1980 | 1980 | X | | | X | X | X | | | X | |
| Wienecke et al. 1980 | 1976-77 | X | | | | X | X | | | | |
| Messer et al. 1981 | 1980 | X | X | | X | | X | | | | |
| Rupp & Adams 1981 | 1979-80 | X | | | X | | | | | | |
| UBWPC 1982 | 1975-82 | X | | | | X | X | X | | X | |
| Messer et al. 1984 | 1979-84 | X | | | X | X | | | | | |
| Montgomery 1984 | 1984 | X | | | X | | X | | | | |
| Sorensen et al. 1984 | 1977-83 | X | | | | X | X | X | | | |
| UBWPC 1984 | 1982-84 | X | | | | X | X | X | | X | X |
| Grenney et al. 1985 | 1976-82 | X | | | | X | | | | | |
| UDPC 1985 | 1985 | X | | | | | | | | | X |

TABLE 2-2 (continued). A summary of water quality investigations conducted on the Bear River.

| | | LOCATIONS | | | PARAMETERS | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Author | Data date | BR UT | BR ID | BR WY | Flow | Nutrients | TSS | Salts | Metals | Bacteria | Biological |
| Sorensen et al. 1986 | 1984-85 | X | X | | | X | X | X | X | | |
| UBWPC 1986a | 1984-86 | X | | | | X | X | X | | X | |
| UBWPC 1986b | 1986 | X | | | | | | | | | X |
| Sorensen et al. 1987 | 1985-86 | X | X | | X | X | | | | | |
| UBWPC 1987 | 1987 | X | | | | | | | | | X |
| UBWPC 1988 | 1986-88 | X | | | | X | X | X | | X | |
| Barker et al. 1989 | 1987 | X | X | | X | X | | X | | | |
| UBWPC 1990 | 1988-90 | X | | | | X | X | X | | X | |
| ERI 1991 | 1990-91 | X | X | | X | X | X | X | | X | |
| PacifiCorp Electric Operations | 1991 | X | | | | | | | | | X |
| UBWPC 1991a | 1988-89 | X | | | | | | | | | X |
| UBWPC 1991b | 1889-90 | X | | | | | | | | | X |
| UDWQ 1992a | 1990-92 | X | | | | X | X | X | | X | |
| BLRC & ERI 1993 | 1991 | | | X | X | X | X | X | | | X |
| UDWQ 1993a | 1990-91 | X | | | | | | | | | X |
| UDWQ 1993b | 1991-92 | X | | | | | | | | | X |
| UDWQ 1993c | 1990-91 | X | | | | | | | | | X |
| UDWQ 1993d | 1991-92 | X | | | | | | | | | X |
| ERI 1994 | 1992-93 | X | | | X | X | X | | X | X | X |
| UDWQ 1994a | 1992-93 | X | | | | | | | | | X |
| UDWQ 1994b | 1992-93 | X | | | | | | | | | X |
| UDWQ 1995 | 1993-94 | X | | | | | | | | | X |

variable, averaging 238,000 kg/day. Maximum loads occurred in March from 1987 through 1989 and were associated with runoff events, while peak loads from 1990 through 1992 occurred in June or July and were associated with Bear Lake releases. Sediment loads below Cutler dam ranged from 103,000 kg/day in 1990 to 325,000 kg/day in 1991. While mean daily TSS concentrations are correlated with mean daily flow at both sites, the TSS data were only collected twice daily and are therefore not at a fine enough resolution to evaluate the impacts on TSS of flow fluctuations resulting from power peaking. Daily fluctuations at the Utah-Idaho stateline in stage averaged 2.5 feet and may contribute to maintaining exposed vertical banks along the Bear River.

The Utah Division of Water Quality (UDWQ) has been monitoring the Bear River basin since 1976. Baseline monitoring at several sites has continued uninterrupted since that time, while more intensive monitoring associated with individual water quality programs has been conducted for shorter periods, These data have been used in the biannual assessments produced since 1975 (Utah Div. of Health 1975; Utah Dept. of Health 1982, 1984, 1986, 1988, 1990; UDWQ 1992a, 1994). In addition, a series of studies evaluated water quality in the Bear River below Oneida Reservoir with the intent of developing a management plan for the lower basin (Thomas et al. 1971; Renk et al. 1973; Hill et al. 1973; UWRL 1974b; Drury et al. 1975; Israelson et al. 1975; UWRL 1976). The 1979 Water Quality Management Plan (BRAG 1982) identified the following primary concerns on the mainstem Bear River: coliform bacteria contamination, high biochemical oxygen demand (BOD) associated with some of the wastewater dischargers, and high phosphorus concentrations. Total dissolved solids (TDS) was only considered a problem in the Malad River. Nonpoint sources identified at the time included erosion from irrigated and dry cropland, runoff from dairies, inappropriate disposal of animal waste and construction activities. Point sources consisting primarily of municipal and industrial effluent were identified as the most significant contributors to water quality problems. In most cases, these point sources were subsequently treated in order to be in compliance with Utah discharge permit requirements. At the time, it was noted, however, that primary and secondary treatment for compliance with discharge requirements would have no bearing on nutrient loadings to the system (UWRL 1974a).

Sorenson et al. (1984, 1986, 1987) and Barker (1989) studied phosphorus dynamics in the lower basin. These studies characterized most of the phosphorus entering the system as nonpoint in source, primarily from watershed and streambank erosion. Approximately 20 percent of the total phosphorus (TP) entering Cutler Reservoir was estimated to be from point sources. It was noted, however, that this portion was more likely to be available for algal uptake, and thus have more potential for degrading water quality.

A study in 1990-91 (ERI 1991) on the Bear River below Oneida Reservoir found similar patterns to those seen in other studies. The Cub River had very poor water quality, as did small tributaries above the Utah-Idaho border. Phosphorus was highest below Cutler Reservoir, although substantial increases occurred within the valley above Cutler as well.

Herbicides and pesticides were evaluated by the UDWR in 1989-1990 and were found to be below detection limits. No information on herbicides or pesticides in river sediments is available.

Reservoirs within the lower basin are impacted by the high sediment and nutrient loadings in the area. A Trophic State Index (TSI) combines data about phosphorus concentrations, water transparency and algal abundance in a lake or reservoir into a single value which allows different waterbodies to be compared (Carlson 1977). A TSI greater than 50 indicates a eutrophic (over-enriched) waterbody (Cooke et al. 1993). Cutler Reservoir, with its high phosphorus concentrations and very low visibility, has a mean TSI of 73.6 (Pacificorp Electric Operations 1991; UDHW 1982). In 1990-91, Cutler appeared to function as a nitrogen and sediment sink for most of the year. Hyrum Reservoir has a history of high nutrients, leading to algal blooms, floating mats of debris and low dissolved oxygen with associated fisheries problems (Lynn & Murray 1972; ERI 1994). Newton Reservoir is also eutrophic, with a TSI of 67.7, based on 1980 data (UDHW 1982). Small impoundments along the Logan River have not experienced eutrophication problems, but do receive substantial sediment loads which can be delivered downstream under drawdown conditions. Porcupine Reservoir on the east fork of the Little Bear River is relatively high in the drainage, with little development in its watershed, and a mean TSI of 48.9 based on 1978-1979 data (UDHW 1982). Mechanistic modeling conducted on seven proposed reservoirs in the lower basin predicted moderate to poor water quality in all reservoirs except for those located high in the Little Bear drainage (ERI 1991). The proposed Honeyville Reservoir was predicted to have the most impaired water quality and to be nitrogen limited, thus leading to potential blue-green algal blooms.

## 2.8 Trends in Historic Water Quality

Long-term water quality trends were evaluated at five sites in the lower Bear River basin: Bear River at Corinne (490110), Bear River below Cutler Dam (490198), Bear River at the Utah-Idaho stateline (490610), Little Bear River above Cutler Dam (490500) and Little Bear River above Avon (490570). These sites were chosen because they had an adequate long-term data set. Sampling began in 1983 at site 490500 and dates back to 1976 at the other sites. Total suspended solids, total phosphorus, orthophosphorus, and nitrate were evaluated. At each site, flow was regressed against each parameter and the residuals of predicted to actual values were determined. An ANOVA was then conducted on the residuals to look for differences between years with the effects of flow removed. No significant trends were seen at the Bear River sites at the stateline and below Cutler Dam and no trends were seen for orthophosphorus or TSS at the other sites. A significant year effect was seen for nitrate at site 490110 near Corinne ($P<0.0079$). The Student-Neuman-Keuls multiple comparison test, used to evaluate which years were significantly different, found that 1981 was significantly different from all other years. While concentrations appeared to be lowest in the late 1970s and since the mid-1980s, no obvious trends by year were seen.

ANOVAs of total phosphorus residuals against year were significant at both sites on the Little Bear ($P<0.0191$ at site 490500 and $P<0.0088$ at site 490570). In both cases, total phosphorus appears to have decreased in recent years. At the upper site near Avon, years 1989 through 1991 and 1983 clustered and were significantly lower than the other years. At the lower site, 1987 through 1991 were significantly lower than the other years.

## 2.9 Macroinvertebrates

Macroinvertebrate samples have been collected throughout the Bear River basin since the early 1960s. Samples collected in the 1960s and the early 1970s in the Bear River near Cornish showed the lowest abundances in the Bear River basin (Bangerter 1965, UWRL 1974b). Annelids and chironomids dominated. The low abundance and poor diversity was attributed to silt and poor habitat. The Utah Division of Water Quality has monitored this site since 1977. Most samples have been categorized as fair, with good biomass but dominance by sediment and organic tolerant taxa. Again, poor spawning substrate was noted (UDPC 1985; UBWPC 1986b, 1987, 1990, 1991a, 1991b; UDWQ 1993a, 1993b).

Samples collected near Corinne also found low biomass, with dominance by sediment tolerant taxa and few cleanwater species (UDPC 1985; UBWPC 1986b, 1987, 1990, 1991a, 1991b). The highest abundance and diversity has been observed below Cutler, and attributed to good substrate, the high productivity of Cutler and good dissolved oxygen (UWRL 1974b). Samples from Cutler Reservoir itself, however, have found low macroinvertebrate numbers, dominated by chironomids and oligochaetes (Bangerter 1965, ERI 1991).

In 1974, the Cub River had low diversity, species richness and abundance. The Logan River had good macroinvertebrate indicators at upstream sites, with some deterioration in lower stream segments, apparently due to increased sediments (UWRL 1974b).

The Little Bear River has shown similar trends to the Logan river. Above Hyrum Reservoir, samples had good diversity and biomass, with the presence of cleanwater taxa (UWRL 1974; UDWQ 1993c, 1993d). Since 1990, samples at sites above Hyrum Reservoir have shown some evidence of stress conditions. Below Hyrum Reservoir, conditions are more stressed, with macroinvertebrate communities indicative of high organic loading and sediment intolerance.

## 2.10 Fisheries

Fisheries data in the lower Bear River basin have been collected infrequently and at varying intensities in different reaches. The mainstem Bear River and several tributaries were evaluated for fish, macroinvertebrates, and habitat in the early 1960s (Bangerter 1965). This remains the most recent fisheries work conducted on portions of the mainstem Bear River. More recent sampling has been conducted on most of the other reaches of fishable waters in the lower drainage, with emphasis on those rivers which are able to support or be stocked with game fish.

The Utah Division of Wildlife Resources (UDWR) has categorized streams in Utah into six general categories, ranging from top quality fishing streams (Class I) to streams with no fishery resource value (Class V). Class VI streams are dewatered for some portion of the year. The mainstem Bear River has been classified by the UDWR as Class III from the Bear River refuge to Cutler Reservoir and Class IV from Cutler to the Idaho stateline. Class III waters are considered of average quality as a fishery, while Class

IV are waters with limited fishery habitat. In both cases, the strategy of the UDWR is to enhance the fisheries when possible. Sampling on the mainstem Bear River in the 1960s by the UDWR found Utah sucker, green sunfish, black crappie and walleye, both above and below Cutler Reservoir. Brown trout, channel catfish and largemouth bass were only found below Cutler, while albino rainbow trout, carp and yellow perch were only collected above the reservoir (Table 2-3). The river is stocked every other year with channel catfish, but is otherwise not managed very closely for fisheries. Fisheries problems in the mainstem Bear River derive primarily from the high sediment load, which interferes with visual feeding fish, destroys spawning habitat, and negatively impacts macroinvertebrates. Accurately sampling the fish population is also complicated by the extreme turbidity of the water (Tom Pettingill, UDWR, pers. comm.).

Bangerter (1965) found a fishery in Cutler Reservoir dominated by carp but with moderate species richness. In the 1970s, carp appeared to become less abundant and largemouth bass percentages increased. Black bullhead numbers also increased in the 1970s. Fathead minnows appeared for the first time in the 1970s (Helms unpub. 1977), representing an important new forage fish in the reservoir. Sampling of fish and habitat was conducted throughout the reservoir in the spring and summer of 1990 (Pacificorp Electric Operations 1991). Spring surveys indicated carp were dominant throughout the reservoir, in addition to high numbers of fathead minnows and green sunfish. Channel catfish were sampled sporadically. Summer samples were also dominated by carp and higher abundances of black crappies, largemouth and smallmouth bass than were seen in the spring. Species richness in 1990 was lower than 1965 in the Bear River above the marsh, below the dam and in Spring Creek and the Little Bear just above the reservoir. Rainbow trout, walleye and sculpin were all sampled in 1965 but not in 1990, while smallmouth bass, channel catfish and bluehead sucker were found only in 1990. A single logperch was found in 1990 below the dam. The reduced richness was attributed to poor habitat, eroded streambanks, unstable substrates and poor water quality (Pacificorp Electric Operations 1991). Species richness in the canyon section of Cutler Reservoir and in the Benson area were greater in 1990 than in 1965.

The Logan and Blacksmith Fork rivers contain Class I and Class II reaches. Tributaries to these rivers are in general categorized Class III, primarily because of the lower flows in these smaller streams. Fish sampled in these rivers include rainbow, cutthroat and brown trout, mottled sculpin, and mountain

**TABLE 2-3. Historical fisheries data for the lower Bear River basin (SOURCE: Stream Inventory File Reports, Utah Division of Wildlife Resources and Kent Sommers, pers. comm).**

| RIVER Reach | MILES | CLASS | RATING | YEAR | FISH SAMPLED (SEE KEY AT END OF TABLE) | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | * | * | | 1 | 2 | 3 | 6 | 7 | 8 | 12 | 14 | 15 | 17 | 18 | 21 | 22 | 26 | 28 | 36 | 38 | 40 | 41 | 42 | 43 | 58 |
| BEAR RIVER | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Refuge to Cutler | 61.0 | 3 | 18 | 62 | | | X | | X | X | | | X | | | | | X | | X | X | X | | X | | |
| Cutler to stateline | 39.0 | 4 | 17 | 64 | | | | | | X | X | X | | | | | | X | | | X | X | X | X | | |
| NEWTON CREEK | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BR confl to res | 5.0 | 4 | 14 | 71 | | | | | | | | | | | | | | X | | | | | | | | |
| CLARKSON CREEK | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Res to HW | 7.8 | 3 | 16 | 78 | X | | X | | | | | | | | | X | | | X | | | | | | X | |
| BOX ELDER CREEK | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BR confl to res | 8.1 | 5 | 11 | 72 | | | X | | | | | | | | | | | | | | | | | | | |
| Res to HW | 3.0 | 3 | 21 | 92 | X | | X | | | | | | | | | | | | X | | | | | | X | |
| MALAD RIVER | 45.0 | 4 | 12 | 73 | | | | | X | | | X | X | | X | | X | X | | | X | | | | X | |
| SWIFT SLOUGH | 3.5 | 4 | 14 | 81 | | | | | | | | X | | | | | | | | | | | | | | |
| HOPKINS RIVER | 4.0 | 4 | 13 | 81 | | | | | | | | X | | | | | | | | | X | | | | | |
| LOGAN RIVER | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cutler to BS Fk | 9.5 | 3 | 20 | 87 | | | X | | | | | X | | | | | | X | | | | | | | X | X |
| BS Fk to Little Logan Div | 3.2 | 2 | 25 | 91 | X | | X | | | | | X | | | | | | | | | | | | | X | X |
| 1st dam to 2nd dam | 3.0 | 3 | 23 | 87 | X | | X | | | | X | | | | | | | | | | | | | | X | X |
| 2nd dam to 3rd dam | 2.5 | 2B | 28 | 91 | X | X | X | | | | | | | | | | | | | | | | | | X | X |
| 3rd dam to RH Fk | 6.0 | 1B | 34 | 91 | X | X | X | | | | | | | | | | | | | | | | | | X | X |
| RH Fk to Temple Fk | 6.0 | 2B | 30 | 91 | | X | X | | | | | | | | | | | | | | | | | | X | X |
| Temple Fk to ID SL | 11.5 | 2B | 30 | 91 | | X | X | | | | | | | | | | | | | | | | | | X | X |
| CUB RIVER | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BR confl to stateline | 15.0 | 4 | 12 | 63 | | | X | | | X | | X | X | | | | | X | | X | X | | X | | | X |
| LITTLE BEAR RIVER | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cutler to Wellsville Cr | 25.5 | 3 | 21 | 54 | X | | X | | | X | | X | X | | X | | X | X | | X | X | X | X | X | X | |

**TABLE 2-3 (continued). Historical fisheries data for the lower Bear River basin.**

| RIVER<br>Reach | MILES | CLASS<br>* | RATING<br>* | YEAR | FISH SAMPLED (SEE KEY AT END OF TABLE) | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 2 | 3 | 6 | 7 | 8 | 12 | 14 | 15 | 17 | 18 | 21 | 22 | 26 | 28 | 36 | 38 | 40 | 41 | 42 | 43 | 58 |
| LITTLE BEAR RIVER (continued) | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Wellsville Cr to Hyrum res | 6.0 | 2 | 25 | 93 | X | X | X | | | | | | | | X | X | X | X | X | | X | | X | | X | |
| Hyrum res to WTF outfall | 2.5 | 2 | 25 | 91 | X | X | X | | | | | | | X | X | X | | X | | | | | | | X | X |
| WTF inflow to outfall | 1.0 | 6 | 7 | 78 | | | | | | | | | | | | | | | | | | | | | | |
| WTF inflow to EFK/SFK | 3.0 | 2 | 27 | 91 | X | X | X | | | | | | | | | | | X | | | | | | | X | X |
| Spring Creek | 9.0 | 3 | 20 | 75 | X | | X | | | | X | X | | | | | | X | | | X | | | | | X |
| East Fk to Porcupine | 4.0 | 2 | 27 | 92 | X | X | X | | | | | | | | | | | | | | | | | | X | |
| East Fk frm Porcupine to HW | 7.0 | 3R | 24 | 71 | X | X | X | X | | | | | | | | | | | | X | | | | | X | |
| South Fk to HW | 3.0 | 3B | 21 | 91 | X | X | X | | | | | | | | | | | | | X | | | | | X | X |
| Davenport to HW | 3.0 | 3 | 20 | 85 | | X | X | | | | | | | | | | | | | | | | | | X | |
| BLACKSMITH FORK | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Logan R to Ballard Spr | 1.0 | 2 | 25 | 87 | X | X | X | | | | | | | | | | | | | | | | | | X | X |
| Ballard Spr to Nibley Div | 5.0 | 6 | 12 | 87 | | X | X | | | | | | | | | | | | | | | | | | X | X |
| Nibley Div to 1st dam | 3.5 | 3 | 24 | 87 | X | X | X | | | | | | | | | | | | X | | | | | | X | X |
| 1st dam to Hyrum Power | 3.2 | 1 | 31 | 87 | | X | X | | | | | | | | | | | | X | | | | | | X | X |
| Hyrum Power to 2nd dam | 0.8 | 3 | 32 | 87 | X | X | X | | | | | | | | | | | | | | | | | | X | X |
| 2nd dam to Anderson ranch | 9.5 | 1B | 35 | 91 | | X | X | | | | | | | | | | | | | | | | | | X | X |
| Anderson ranch to HW | 2.5 | 1 | 31 | 91 | | | X | | | | | | | | | | | | | | | | | | X | |

1 rainbow trout (*Oncorhynchus mykiss*)
2 cutthroat trout (*Oncorhynchus clarkii bouvieri*)
3 brown trout (*Salmo trutta*)
6 kokanee (sockeye) (*Oncorhynchus nerka*)
7 channel catfish (*Ictalurus punctatus*)
8 black bullhead (*Ictalurus melas*)
12 albino rainbow trout (*Oncorhynchus mykiss*)
14 carp (*Cyprinus carpio*)
15 Utah chub (*Gila atraria*)
17 leather side chub (*Gila copei*)
18 redside shiner (*Richardsonius balteatus*)
21 speckled dace (*Rhinichthys osculus*)
22 longnose dace (*Rhinichthys cataractae*)
26 Utah sucker (*Catostomus ardens*)
28 mountain sucker (*Catostomus platyrhinchus*)
36 largemouth bass (*Micropterus salmoides*)
38 green sunfish (*Lepomis cyanellus*)
40 black crappie (*Pomoxis nigromaculatus*)
41 yellow perch (*Perca flavescens*)
42 walleye (*Stizostedion vitreum*)
43 mottled sculpin (*Cottus bairdi*)
58 mountain whitefish (*Prosopium williamsoni*)

* Rating is the weighted sum of three individual ratings, based on aesthetics, availability and productivity. The individual ratings are weighted by 1, 2 and 4, respectively. Classes range from I to VI, with Class I being the highest quality fishery to Class V, with no fishery value. Class VI is dewatered for part of the year.

whitefish (Table 2-3). Both rivers are stocked throughout the summer with catchable trout, and the Logan River is stocked annually with fingerling brown trout.

The Little Bear River is a Class II river, except for a short Class III reach near Cutler Reservoir and a short dewatered reach above Hyrum Reservoir. The tributaries are all rated Class III. Rainbow, cutthroat and brown trout, redside shiner, speckled dace, Utah sucker, mottled sculpin and Utah chub have been sampled throughout the Little Bear drainage (Table 2-3). Leatherside chub and mountain whitefish have been collected only above Hyrum Reservoir and sockeye occur only above Porcupine Reservoir on the East Fork. Black bullhead, carp, black crappie and walleye have been found only in the Class II reach near Cutler Reservoir.

The Cub River is a Class IV fishery from the Bear River confluence to the Idaho stateline. Spring Creek, a tributary to the Cub River, is considered a Class V fishery. Fish sampled within the Cub include brown trout, black bullhead, carp, Utah chub, Utah sucker, largemouth bass, green sunfish, yellow perch and mountain whitefish (Table 2-3).

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## 3.0 CURRENT WATER QUALITY STATUS

An intensive water quality monitoring program was conducted from October 1992 through 1993 to determine the current water quality status in the lower Bear River basin. This section is a summary of the results of that monitoring program. A complete writeup of the monitoring results is included in Appendix I of this document. A complete listing of all water quality data collected is included in Appendix II. Macroinvertebrate data is listed in Appendix III, and quality assurance/quality control results are included in Appendix IV.

The intent of the monitoring program was as follows:

1) **Determine current loadings within the lower Bear River and its tributaries.**

2) **Distinguish between point and nonpoint sources.**

3) **Determine where within the local watershed the current loads exceed criteria or standards for total maximum daily loads (TMDL).**

4) **Recommend where reductions to the loads can be made to achieve the TMDL in the most cost effective manner possible.**

Sample collection and analysis was a cooperative effort between the Monitoring Section of the Utah Division of Water Quality and Ecosystems Research Institute. Thirty-seven river sites and seven point sources were sampled routinely. Sample locations are shown in Figure 3-1. Tables 3-1 and 3-2 list each site, and include a description, river mile location, and identification of who sampled each site. Point sources in the project area are identifed in Table 3-3 by their UPDES permit number and discharge location. Site numbers are also given for those sampled as part of this project. Table 3-4 lists all water quality parameters that were evaluated, including the methods, detection limits, and the labs used for the analyses.

### 3.1 Monitoring Results

Unless otherwise stated, results refer to samples collected during the 1993 water year (October 1992 through September 1993). Average flows in the Bear River increased from 720 cfs at the stateline to 1,410 cfs at the most downstream site (near Corinne), compared to historic mean flows of 1,239 and 1,837 cfs, respectively. Average suspended solids (TSS) concentrations were 57 mg/liter at the stateline, fell to 38 mg/liter below Cutler and increased to 72 mg/liter at Corinne. Concentrations were highest during early runoff, and were higher during summer baseflows (the irrigation season) than during winter baseflows. Total suspended solids loads increased from 107,000 kg/day at the stateline to 277,000 kg/day near Corinne. Total phosphorus (TP) concentrations on the mainstem averaged 0.105 mg/liter at the stateline, increasing to 0.211 mg/liter at Corinne. Dissolved total phosphorus (DTP) averaged 0.039 mg/liter above Cutler and 0.107 mg/liter below the reservoir. Phosphorus loads showed large increases at the Cub River confluence and as the river passed through Cutler Reservoir. Similar patterns were seen for nitrate ($NO_3$) and ammonia ($NH_3$). The increases as the river passed through Cutler were due in part to ungaged flows entering within the Cutler reach. Spring Creek and the Logan Lagoons, however, contributed disproportionately to the DTP and $NH_3$ load compared to their flow inputs.

The Logan River and the Blacksmith Fork River had very good water quality as they left Forest Service lands. Concentrations of TSS and nutrients increased as the Logan River moved across the valley to Cutler Reservoir, although water quality remained relatively good. On average, water quality in the Blacksmith Fork remained high throughout the valley.

The Little Bear drainage showed signs of water quality deterioration both above and below Hyrum Reservoir. Sediment loads increased in both reaches, entering primarily from nonpoint sources. Nonpoint sources of TP and $NO_3$ also caused increased loads above Hyrum Reservoir. Below Hyrum reservoir, Wellsville lagoons were responsible for most of the increase in TP loads, while nonpoint inputs accounted for $NO_3$ increases. Hyrum Reservoir acted as a sink for TSS, TP and $NO_3$, but functioned as a substantial source of DTP.

Spring Creek is a tributary of the Little Bear, entering just above Cutler Reservoir although all sample sites were above the confluence of the two. Spring Creek accounted for just six percent of the increased flow entering the Bear River as it passes through Cutler Reservoir, but accounted for over 25 percent of the increased TP and DTP loads and almost 50 percent of the increase in $NO_3$ and $NH_3$ loads in this reach. Within this drainage, South Fork Spring Creek and Hyrum Slough were the most impacted, from a combination of high point source and nonpoint inputs of nutrients. Total phosphorus and DTP averaged 12 and 7.9 mg/liter respectively at the most upstream site on the South Fork. Nitrate concentrations averaged 3.2 mg/liter. In these tributaries, coliform concentrations were extremely high and dissolved oxygen fell below coldwater standards.

# Lower Bear River Basin Monitoring Sites

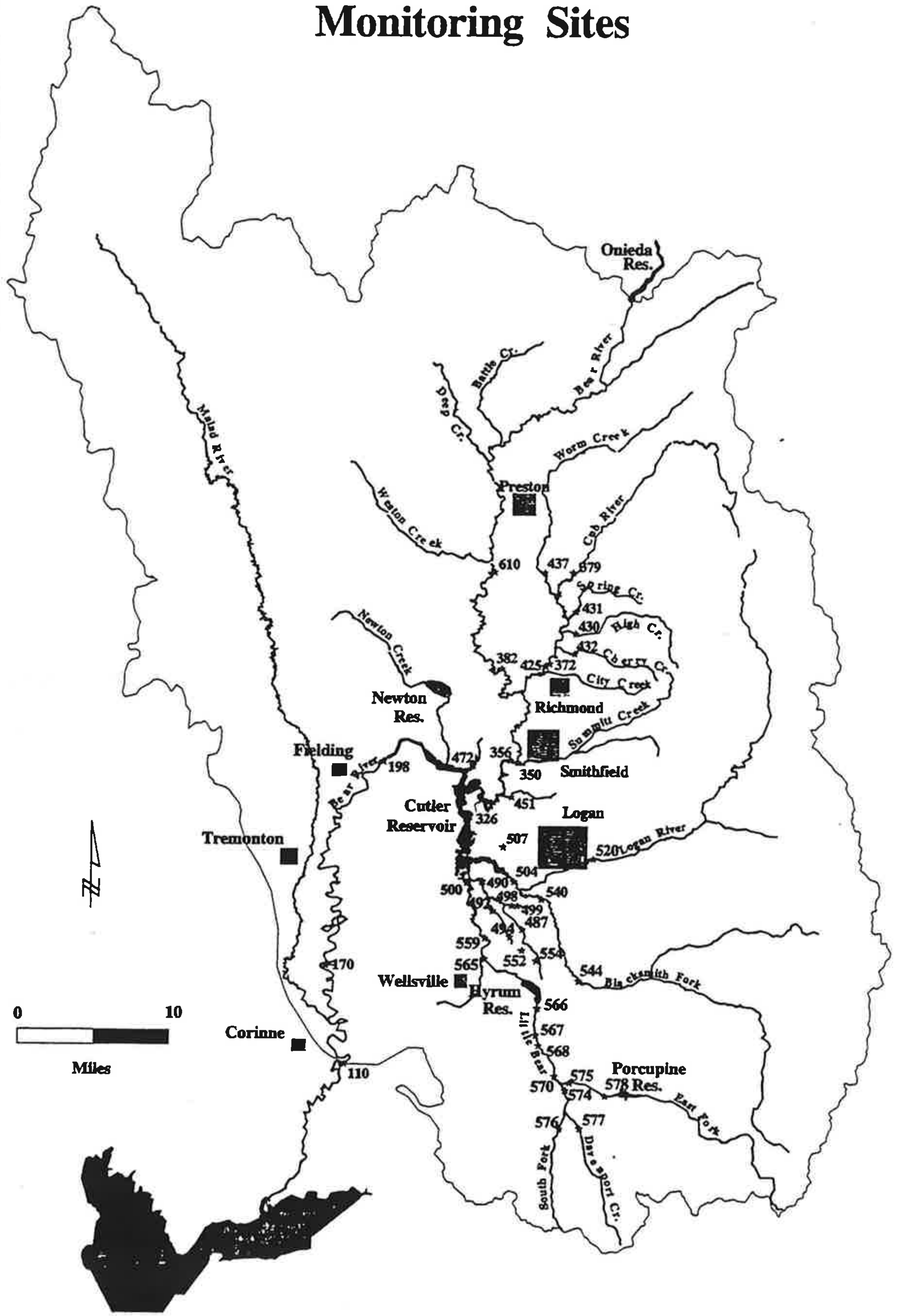


FIGURE 3-1. Lower Bear River basin monitoring sites. All numbers indicate the last three digits of the six digit STORET sample site number assigned by the state of Utah, UDWQ. All site numbers in the lower Bear River basin begin with the basin number 490.

**TABLE 3-1. Location of each sample site on the mainstem Bear River and its tributary confluences. All distances are given in river miles above the Bear River Bird Refuge. The site numbers are STORET numbers assigned by the Utah Division of Water Quality. The first three numbers (490) are the basin code and are the same for all river and tributary sites in this study. To save space, these first three numbers are not included in many of the tables and figures. (SOURCE: 1:100K DLGs)**

| SITE NUMBER | DESCRIPTION | DISTANCE (river miles) | SAMPLER |
|---|---|---|---|
| **Mainstem Bear River (miles above the Bear River Bird Refuge)** | | | |
| 490110 | Bear River at Corinne at U83 xing | 16.7 | UDWQ |
| 490170 | Bear River below Honeyville on I-15 | 31.8 | UDWQ |
| 490198 | Bear River below Cutler at UPL bridge | 61.1 | UDWQ |
| 490326 | Bear River above Cutler at Benson bridge | 71.9 | UDWQ |
| 490356 | Bear River at Amalga | 79.3 | ERI |
| 490382 | Bear River at Richmond | 92.5 | ERI |
| 490610 | Bear River west of Fairview, ID | 106.4 | UDWQ |
| **Tributary Confluences (miles above the Bear River Bird Refuge)** | | | |
| 490119 | Box Elder Creek | 11.9 | ERI |
| | Malad River | 24.7 | Not sampled |
| 490310 | Newton Creek | 66.8 | UDWQ |
| 490472 | Clay slough | 68.1 | ERI |
| 490451 | Hopkins Slough | 75.8 | ERI |
| 490490 | Spring Creek at south end of Cutler Reservoir | 76.5 | UDWQ |
| 490500 | Little Bear at south end of Cutler Reservoir | 77.1 | UDWQ |
| 490350 | Summit Creek | 79.6 | ERI |
| 490504 | Logan River above Little Bear River | 85.1 | UDWQ |
| 490540 | Blacksmith Fork above Logan River | 86.1 | ERI |
| 490425 | Cub River | 87.0 | ERI |

**TABLE 3-2. Location of each sample site in the Bear River tributary confluences. All distances on the mainstem Bear River are given in river miles above a reference point given in the table. For an explanation of the site numbers, see Table 3-1. (SOURCE: 1:100K DLGs)**

| SITE NUMBER | DESCRIPTION | DISTANCE (river miles) | SAMPLER |
|---|---|---|---|
| **Little Bear River Drainage (distance from south end of Cutler - Mendon Road)** | | | |
| 490500 | Little Bear above Logan River | 0.0 | UDWQ |
| 490559 | Little Bear above Wellsville | 7.5 | UDWQ |
| 490565 | Little Bear one mile below Hyrum Reservoir | 9.7 | UDWQ |
| 490165 | Hyrum Reservoir | 13.6 | ERI |
| 490566 | Little Bear above Hyrum Reservoir | 16.7 | ERI |
| 490567 | Little Bear below Trout of Paradise fish hatchery | 18.7 | ERI |
| 490570 | Little Bear west of Avon | 22.1 | ERI |
| 490574 | South Fork Little Bear above East Fork | 23.4 | ERI |
| 490576 | South Fork Little Bear above Davenport Creek | 26.2 | ERI |
| 490577 | Davenport Creek above South Fork Little Bear | 26.6 | ERI |
| 490585 | Davenport Creek above Wellsville | 32.6 | ERI |
| 490575 | East Fork Little Bear above South Fork | 23.5 | ERI |
| 490578 | East Fork Little Bear below Porcupine Reservoir | 26.2 | ERI |
| **Spring Creek Drainage (distance from south end of Cutler - Mendon Road)** | | | |
| 490490 | Spring Creek at Mendon Road | 0.0 | UDWQ |
| 490499 | Spring Creek 1.3 miles north of College Ward | 4.2 | UDWQ |
| 490487 | Hyrum Slough at Nibley/College Ward | 5.6 | UDWQ |
| 490492 | South Fork Spring Creek west of Pelican Pond | 2.8 | UDWQ |
| 490494 | South Fork Spring Creek at US89 Xing | 5.1 | UDWQ |
| **Logan River Drainage (distance above south end of Cutler Reservoir - Mendon Road)** | | | |
| 490504 | Logan River above Little Bear River | 0.0 | UDWQ |
| 490520 | Logan River at mouth of canyon | 7.2 | UDWQ |
| **Blacksmith Fork Drainage (distance above confluence with the Logan River)** | | | |
| 490540 | Blacksmith Fork above Logan River | 0.0 | ERI |
| 490544 | Blacksmith Fork at mouth of canyon | 9.7 | UDWQ |

**TABLE 3-2 (continued). Location of each sample site in the Bear River tributary confluences. All distances on the mainstem Bear River are given in river miles above a reference point given in the table. For an explanation of the site numbers, see Table 3-1. (SOURCE: 1:100K DLGs)**

| SITE NUMBER | DESCRIPTION | DISTANCE (river miles) | SAMPLER |
|---|---|---|---|
| **Cub River Drainage (distance above confluence with the Bear River)** | | | |
| 490425 | Cub River | 4.4 | ERI |
| 490432 | Cherry Creek confluence | 6.2 | ERI |
| 490430 | High Creek confluence | 7.6 | ERI |
| 490431 | Spring Creek confluence | 9.0 | ERI |
| 490437 | Worm Creek confluence | 11.6 | ERI |
| 490379 | Cub River at Utah-Idaho stateline | 15.5 | ERI |

**TABLE 3-3. Facilities discharging into state waters in the Lower Bear River basin. All sites were sampled by the Utah Division of Water Quality.**

| DISCHARGER | UPDES # | STORET # | DISCHARGE LOCATION |
|---|---|---|---|
| Logan Lagoons | UT0021920 | 490507 | Cutler Reservoir |
| Gossner Foods | UT0024309 | | Blue Springs above Cutler |
| Brigham City | UT0022365 | | Box Elder Creek |
| Richmond Lagoons | UT0020907 | 490372 | Cub River |
| Wellsville Lagoons | UT0020371 | 490560 | Little Bear River |
| Trout of Paradise 001 | UTG130015 | 490568 | Little Bear River |
| Trout of Paradise 002 | UTG130015 | 490571 | Little Bear River |
| Hyrum WWTP | UT0023205 | 490552 | Spring Creek (Little Bear) |
| EA Miller effluent | UT0000281 | 490554 | Spring Creek (Little Bear) |
| Magic Valley effluent | UT0024872 | 490562 | Wellsville Creek above Little Bear |
| Whites College Ward fish Hatchery | UTG130015 | 490562 | North Fork Spring Creek |
| Silicone Plastics | UT0025186 | | Mill Creek |
| Silicone Plastics | UT0025160 | | Mill Creek |

**TABLE 3-4. Water quality parameters evaluated for the Bear River Water Quality Management Plan.**

| Parameter | Units | Method * | Detection Limit | Labs (B) |
|---|---|---|---|---|
| pH | S.U. | Hydrolab | 0.1 | ERI/UT SHL |
| Conductivity | µmhos/cm | Hydrolab | 1.0 | ERI/UT SHL |
| Dissolved Oxygen | mg/l | Hydrolab | 0.1 | ERI/UT SHL |
| Temperature | °C | Hydrolab | 0.1 | ERI/UT SHL |
| Nitrate | mg/l | 353.3 | 0.005 | ERI/UT SHL |
| Nitrite | mg/l | 354.1 | 0.0005 | ERI/UT SHL |
| Ammonia | mg/l | 350.3 | 0.01 | ERI/UT SHL |
| Orthophosphorus | mg/l | 365.2 | 0.001 | ERI/UT SHL |
| Dissolved Total Phosphorus | mg/l | 354.2 | 0.002 | ERI/UT SHL |
| Total Phosphorus | mg/l | 354.2 | 0.002 | ERI/UT SHL |
| Alkalinity | mg/l as $CaCO_3$ | 310.1 | 5 | ERI/UT SHL |
| Volatile Total Suspended Solids | mg/l | 160.4 | | ERI/UT SHL |
| Residual Total Suspended Solids | mg/l | 160.1 | 1 | ERI/UT SHL |
| Calcium | mg/l | 215.2 | 1 | ERI/UT SHL |
| Magnesium | mg/l | (A) | 1 | ERI/UT SHL |
| Hardness | mg/l | 130.2 | 3 | ERI/UT SHL |
| Chloride | mg/l | 325.3 | 2 | ERI/UT SHL |
| Sulfate | mg/l | 375.4 | 0.001 | ERI/UT SHL |
| Potassium | mg/l | 200.7 | 1 | UT SHL |
| Sodium | mg/l | 200.7 | 1 | UT SHL |
| Fecal Strep (C) | #100/ml | 9230C | | ERI/UT SHL |
| Total Coliforms | #100/ml | 9222B | | BRHD/UT SHL |
| Fecal Coliforms | #100/ml | 9222D | | BRHD/UT SHL |
| Chlorophyll *a* | µg/l | 1002G | | ERI/UT SHL |
| Arsenic (dissolved) | µg/l | 200.9 | 5 | UT SHL |
| Barium (dissolved) | µg/l | 200.7 | 5 | UT SHL |
| Cadmium (dissolved) | µg/l | 200.9 | 1 | UT SHL |
| Chromium (dissolved) | µg/l | 200.9 | 5 | UT SHL |
| Copper (dissolved) | µg/l | 200.7 | 20 | UT SHL |
| Iron (dissolved) | µg/l | 200.7 | 20 | UT SHL |
| Lead (dissolved) | µg/l | 200.9 | 3 | UT SHL |
| Manganese (dissolved) | µg/l | 200.7 | 5 | UT SHL |
| Selenium (dissolved) | µg/l | 200.9 | 2 | UT SHL |
| Silver (dissolved) | µg/l | 200.9 | 2 | UT SHL |
| Mercury (dissolved) | µg/l | 245.1 | 0.2 | UT SHL |

(A) Magnesium hardness calculated by ERI as a difference between total hardness and calcium hardness.
(B) ERI: Ecosystems Research Institute Laboratory; UT SHL: Utah State Health Laboratory; BRHD: Bear River Health Department
(C) ERI does not maintain USEPA certification for fecal strep. The analyses was conducted at ERI's lab for all samples collected by ERI because all certified labs were too far away to deliver samples within the required holding times. All normal microbiological QA/QC procedures were followed by ERI.

* APHA et al. 1981, USEPA 1979

The Cub River accounted for 100 percent of the increase in $NO_3$ load as the Bear River passed from Richmond to Amalga. The Cub River contributed substantial loads of sediments and other nutrients as well. The major sources within the Cub River are Worm Creek, the Cub entering from Idaho, and drainage directly to the Cub River within Utah. Sediment inputs were closely associated with flow, with Idaho contributing the largest load, while nutrient inputs came disproportionately from the Utah portion of the drainage.

Other Bear River tributaries sampled in 1993 included Summit Creek, Hopkins Slough, Clay Slough and Newton Creek. Summit Creek was sampled only during runoff and during this time showed no evidence of impaired water quality. Hopkins Slough had extremely poor water quality, with high nutrients and high coliform concentrations. Hopkins Slough has a minor impact on Bear River water quality only because of its low average flows. Clay Slough had high conductivity and extremely high phosphorus concentrations. It accounted for five percent of the total and dissolved phosphorus increases in Cutler and over nine percent of the increased nitrate. Because Newton Reservoir did not spill during the monitoring period, Newton Creek had very low or no flows through most of the monitoring period.

Metals were measured quarterly. All concentrations were low, with no violations of state standards.

### 3.2 Biological Monitoring

Total coliform concentrations were elevated at four of the five sites in the Spring Creek drainage, in the Little Bear River below a fish hatchery and below the Wellsville sewage lagoons, in Hopkins Slough and Worm Creek (Figure 3-2). Violations of state standards for fecal coliform were more frequent, occurring sporadically along the mainstem Bear River and within each of the subdrainages except the Blacksmith Fork (Figure 3-3). Again, the highest concentrations occurred in the Spring Creek drainage, in Worm Creek and Hopkins Slough. The ratio of fecal coliform to fecal streptococcus was used to identify sources of fecal contamination. The site at Worm Creek above the Cub River had the highest ratios, suggesting a possible human source of contamination at this site.

Macroinvertebrates were sampled at 13 sites in the drainage in late summer. Samples from the Bear River at the stateline and near Richmond had few taxa and were dominated by sediment and organic

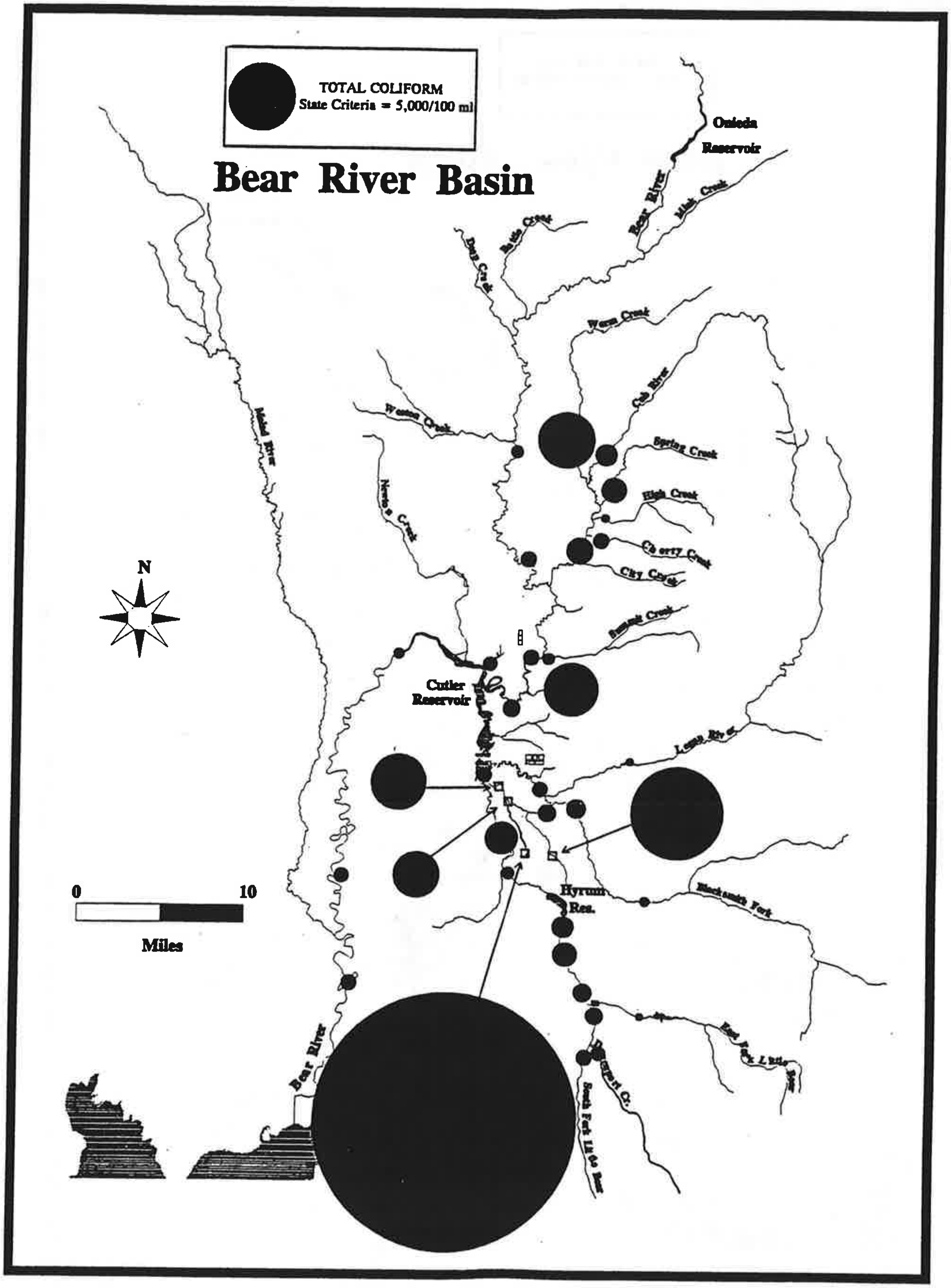


FIGURE 3-2. Total coliform concentrations from October 1992 through September 1993 at each sample location. The area of the circle is proportional to the geometric mean concentration.

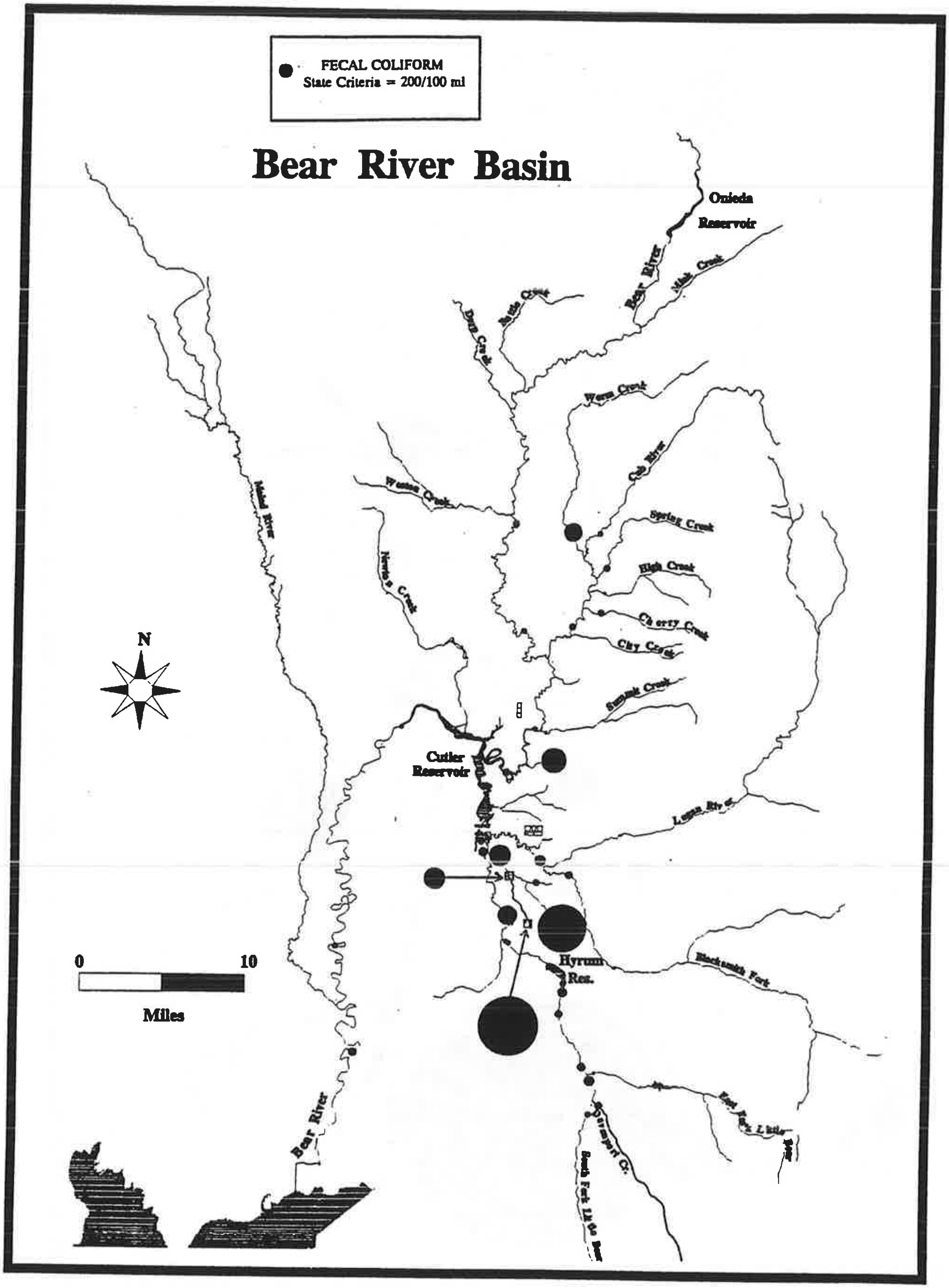


**FIGURE 3-3. Fecal coliform concentrations from October 1992 through September 1993 at each sample location. The area of the circle is proportional to the geometric mean concentration.**

tolerant species. More species were found at the site near Corinne, but the fishery potential at all these sites was considered low due to poor substrate. The site below Cutler had greater diversity and species richness, with the species present indicative of improved substrate.

Sites in the Little Bear drainage indicated fair to good diversity with a fair fishery potential due to limited substrate. Spring Creek was only sampled at a point high in the drainage and the samples were dominated by amphipods. The Cub at the stateline, Worm Creek, and Hopkins Slough were dominated by pollution tolerant species. The Cub above the Bear River had higher diversity and species richness, possibly because of microhabitat formed in the hard clay substrate from hoof prints. The Logan River and the Blacksmith Fork had good abundance, high number of taxa and high diversity indices.

### 3.3 Basin Wide Water Quality Patterns

Utilizing the mainstem and tributary data for average daily mass loadings, a comprehensive picture can be obtained for the water quality conditions within the Bear River watershed relative to the TMDL process. Figures 3-4 through 3-6 present annual average daily loadings of TSS, TP and DTP throughout the lower Bear River drainage. The width of the line in these figures is proportional to the loading. Point source inputs are shown, as are reach gains and losses. Reach gains which are not attributable to point sources are assumed to be nonpoint in origin.

The general patterns are different for particulate and dissolved pollutants. The Bear River entered the state with an annual average TSS load almost half the size of the load at Cutler (Figure 3-4). Large gains were recorded along all but one of the Bear River reaches. Tributaries and point sources were, by comparison, relatively small contributors to the total TSS load.

In contrast to TSS, the DTP loads at the stateline were relatively small. Major inputs occurred from the Cub River, and again within Cutler Reservoir. The high relative inputs of Spring Creek and the point sources are apparent (Figure 3-5).

Total phosphorus is a combination of dissolved and particulate phosphorus (Figure 3-6). The loading patterns for total phosphorus reflect the combination of these two forms. The TP load crossing the stateline was about one third of the TP load observed at Cutler. Point and tributary inputs were significant for TP as well.

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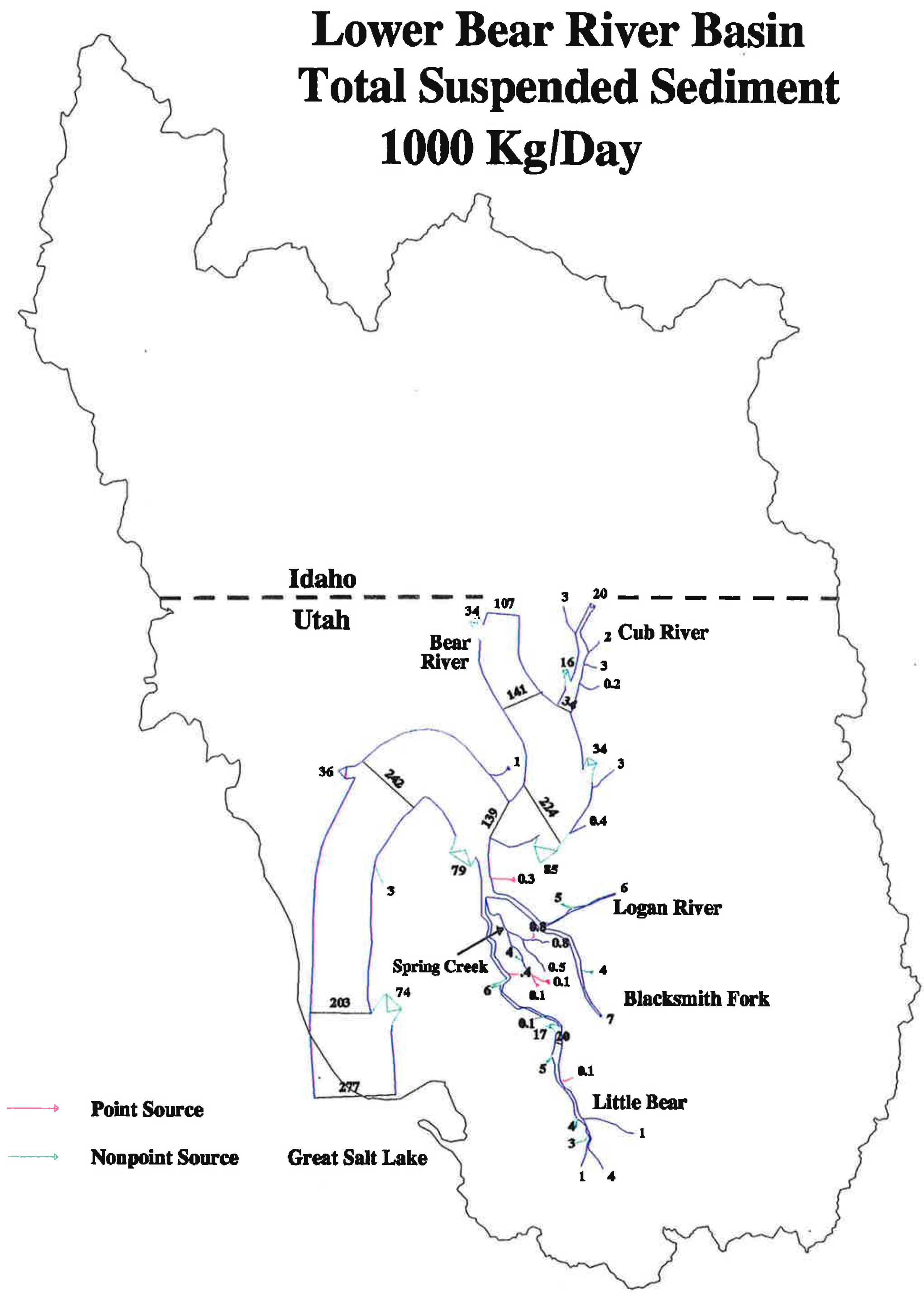



**FIGURE 3-4. Average daily loadings of total suspended solids in the lower Bear River basin.**

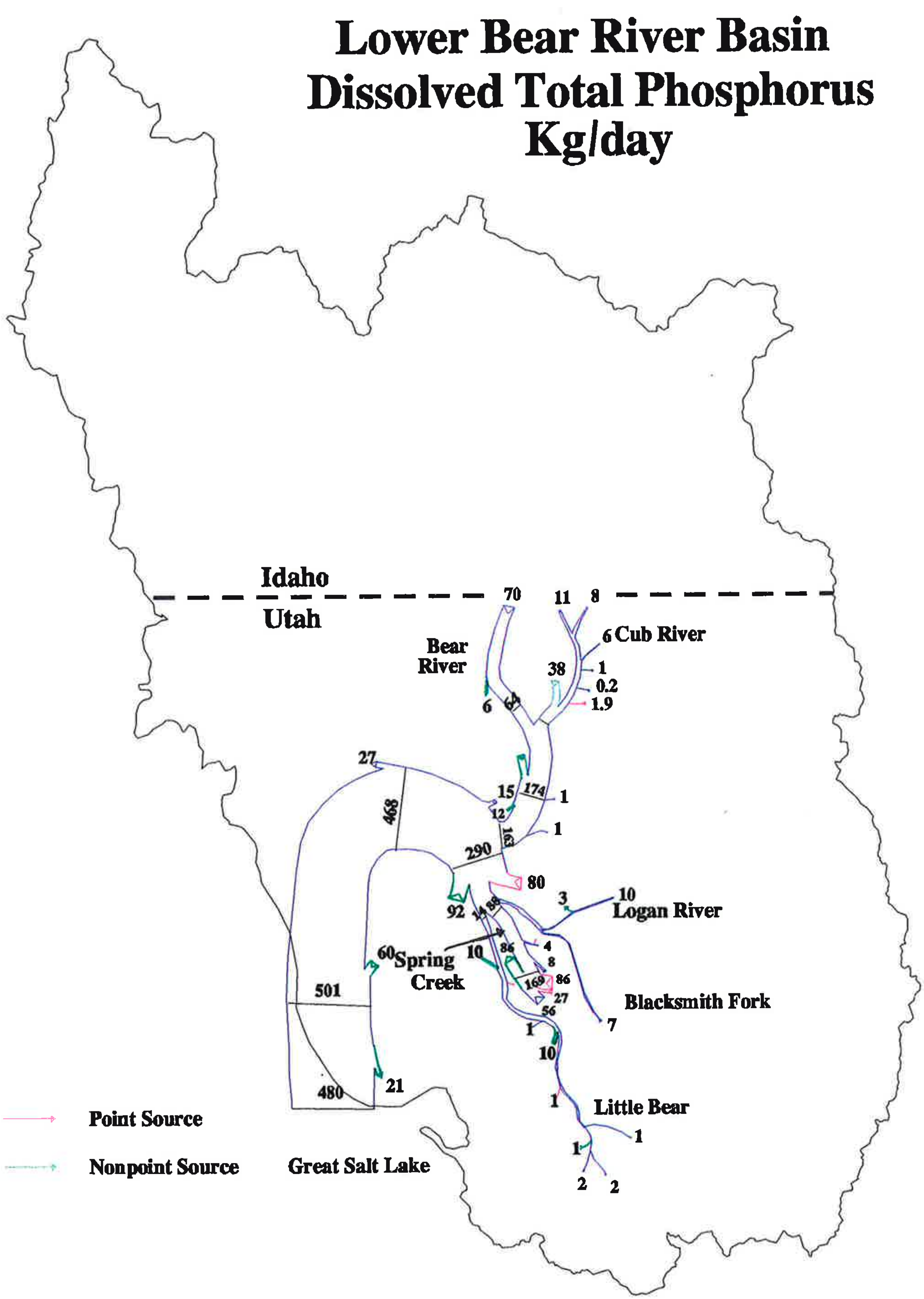



FIGURE 3-5. Average daily loadings of dissolved total phosphorus in the lower Bear River basin.

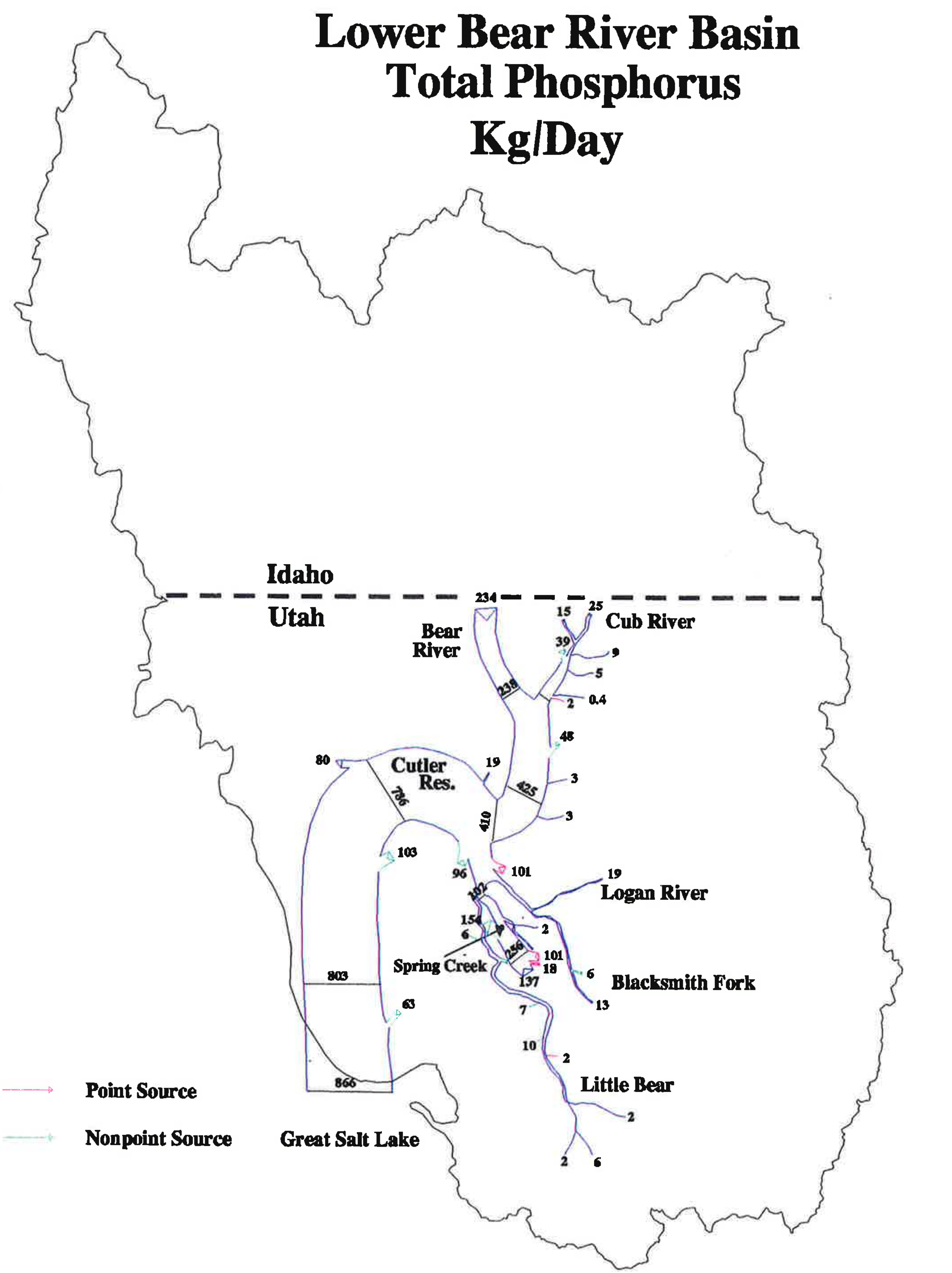



**FIGURE 3-6. Average daily loadings of total phosphorus in the lower Bear River basin.**

## 4.0 BENEFICIAL USES, STANDARDS AND THE TMDL PROCESS

This plan is intended to be used as a tool for local officials to help protect and improve the many beneficial uses provided by our local waterbodies. This plan is also to be used as a guide by UDWQ in carrying out its water quality program in the Bear River basin. All existing programs, tools and regulations now available to UDWQ would be used in this process.

The Bear River Water Quality Plan is being developed as part of a consensus process. Granting the plan sufficient authority to focus the use of program resources, influence internal planning, and exercise the agency's mandate to manage the resource is a direct extension of UDWQ's commitment to the consensus process.

The rational for watershed plans is to consolidate and fulfill as many requirements as is possible within one product. This has significant efficiency and effectiveness ramifications for the agency. Giving sufficient recognition to the plan is also consistent with guidance from several state and federal statutes, including but not limited to the following:

> Utah Code 19-5 Water Quality Act contains adequate authority to carry out this process. Section 19-5-104(m) states: "***(The Board shall) establish and conduct a continuing planning process for control of water pollution including the specification and implementation of maximum daily loads of pollutants.***" Other specific statements in Powers and Duties of the Board related to the Watershed Approach are 19-5-104(a), (b), (c), (d), and (j).
>
> Clean Water Act, Section 303(e) (1) states: "***Each State shall have a continuing planning process approved under paragraph (2) of this subsection which is consistent with this Act.***" Section 303(e)(3) states: "***The Administrator shall approve any continuing planning process submitted...which will result in plans for all navigable waters within such State, which include...(A) effluent limitations and schedules of compliance...(B) the incorporation of all elements of any applicable areawide waste management plans under section 208, and applicable basin plans under section 209 of this Act.***"

## 4.1 Public Involvement

A local steering committee for the Bear River Water Quality Management Plan (BRWQMP) was formed at the initiation of this project. This committee is composed of representatives of local user groups, communities, agencies and private entities concerned with water quality. The committee has met four times for updates on the plan, and has supplied valuable insights on local concerns. Issues addressed by the public steering committee were the criteria to be used in setting total maximum daily loads, ranking problem reaches and reservoirs, targeting specific reaches for additional work and review of draft plans.

As part of this project, a symposium on Bear River Water Quality was held in Logan, Utah on April 6-8, 1993. The symposium was an attempt to pull together policy makers and researchers to discuss water quality concerns, research results and policy issues in the Bear River basin. Panel sessions included elected government and agency representatives from Utah, Idaho and Wyoming as well as representatives from the U.S. Environmental Protection Agency, U.S. Geological Survey,and U.S. Forest Service. In addition, a total of 31 technical papers were presented. The symposium was attended by over 200 people. Out of this symposium, a tri-state committee was formed to address water quality issues throughout the entire Bear River basin.

Information about the current project has been presented to a number of different local groups. These include Box Elder County and Cache County mayor's associations, the steering committee for the Little Bear Hydrologic Project, the Bear River tri-state water quality committee, the Cache County water quality committee, a Utah State University (USU) sponsored symposium on nonpoint issues, and the local Audubon Society. In addition, articles have appeared in the local daily and weekly newspapers about the Bear River project. A public meeting presenting preliminary results was held June 15, 1994. At this meeting, comments were solicited and a questionnaire was distributed. Responses were incorporated into the final draft plan.

Several other projects are also underway in the lower Bear River basin. The Soil Conservation Service (SCS) began a demonstration nonpoint project (Little Bear Hydrologic Unit Project) in 1992. There has been considerable interest by local farmers and property owners in the project area, and there has been good media coverage and reporting to various sectors of the local government. Within the Little

Bear watershed, the SCS has spent over $175,000 on BMPs (fencing, off-river watering, riparian revegetation and bank stabilization, manure bunkering) by the end of 1994, as well as disseminating information of no-till agriculture, fertilizer management and other management issues. Other public concerns in the basin have included a highly visible effort by citizens in Box Elder County to initiate garbage cleanup along the shores of the Bear River below Cutler Reservoir.

## 4.2 Designated Beneficial Uses of the Bear River and its Tributaries

The beneficial uses supported by lakes, reservoirs and rivers in Utah are broken down into several general categories (UDWQ 1992b). These include uses for domestic water supplies, recreation and aesthetics, providing an adequate habitat for aquatic wildlife and providing irrigation waters for agriculture (Table 4-1). The state of Utah has determined uses and classifications of each of the rivers, lakes and reservoirs in the state. All waterbodies in the lower Bear River basin are protected for boating, wading and other light-contact recreation, for agricultural uses and for aquatic wildlife. The Little Bear River, Blacksmith Fork, Logan River and several smaller streams and their tributaries are considered cold water fisheries, while the remainder of the waterways are protected for warm water fisheries. Table 4-2 summarizes the beneficial use designations for the lower Bear River and its tributaries.

Instream standards for various water quality parameters are established by the state to protect these specific designated uses (UDWQ 1992b). Table 4-3 is a partial summary of these standards and Appendix V includes a complete listing of all standards and classifications for all lower Bear River waters. In addition to the enforceable criteria, the state of Utah has established several water quality indicators. As the name suggests, high concentrations of these parameters (e.g. total phosphorus) indicate potential water quality problems and the need for additional information.

Several non-numeric standards also exist to protect water quality (UDWQ 1992b). The anti-degradation policy states that when water quality is better than the state standard, it should be maintained at that higher quality unless there are compelling economic or social reasons to allow it to deteriorate, although at no time may water quality deteriorate to below the water quality standard. Narrative standards written into the code further state that no discharges may be made which would result in deteriorated conditions or would adversely affect desirable aquatic life.

**TABLE 4-1. Designated use classifications for waters in the state of Utah. (From State of Utah Water Quality Assessment for 1992, Section 305b).**

| BENEFICIAL USE CLASSIFICATIONS FOR WATER IN THE STATE OF UTAH | |
|---|---|
| Class 1 | Protected for use as a raw water source for domestic water systems. |
| Class 1A | Reserved. |
| Class 1B | Reserved. |
| Class 1C | Protected for domestic purposes with prior treatment processes as required by the Utah Department of Health. |
| Class 2 | Protected for in-stream recreational use and aesthetics. |
| Class 2A | Protected for recreational bathing (swimming). |
| Class 2B | Protected for boating, water skiing, and similar uses, excluding recreational bathing (swimming). |
| Class 3 | Protected for in-stream use by aquatic life. |
| Class 3A | Protected for cold water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain. |
| Class 3B | Protected for warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food. |
| Class 3C | Protected for nongame fish and other aquatic life, including the necessary aquatic organisms in their food chain. |
| Class 3D | Protected for waterfowl, shore birds, and other water-oriented wildlife not included in Classes 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain. |
| Class 4 | Protected for agricultural uses including irrigation of crops and stockwatering. |
| Class 5 | Reserved. |
| Class 6 | Water requiring protection when conventional uses as identified in Section 2.6.1 through 2.6.5 do not apply. Standards for this class are determined on a case-by-case basis. |

**TABLE 4-2. Designated use classification of river sections in the Bear River drainage.**

| LOCATIONS | Domestic Source | Recreation & Aesthetics | | Aquatic Wildlife | | | | Agricultural |
|---|---|---|---|---|---|---|---|---|
| | (1C) | (2A) | (2B) | (3A) | (3B) | (3C) | (3D) | (4) |
| Mainstem Bear and tributaries, except where listed below | | | X | | X | | | X |
| Blacksmith Fork and tributaries with Logan River | | | X | X | | | | X |
| Cub River, except High Creek from confluence with Cub River to headwaters | | | X | | X | | | X |
| Little Bear and tributaries from Cutler Reservoir to headwaters | | | X | X | | | X | X |
| Logan River and tributaries from Cutler Reservoir to headwaters | | | X | X | | | | X |
| Spring Creek | | | X | X | | | | X |
| Cutler | | | X | | X | | X | X |
| Hyrum Reservoir | | X | X | X | | | | X |
| Newton Reservoir | | | X | | X | | | X |
| Porcupine Reservoir | | | X | X | | | | X |

TABLE 4-3. State water quality standards and pollution indicator values for water quality parameters evaluated in the historical data set.

| PARAMETER | Domestic Source | Recreation & Aesthetics | | Aquatic Wildlife | | | | Agricultural |
|---|---|---|---|---|---|---|---|---|
| - | (1C) | (2A) | (2B) | (3A) | (3B) | (3C) | (3D) | (4) |
| BACTERIOLOGICAL | | | | | | | | |
| Maximum Total Coliforms | 5,000 | --- | 5,000 | --- | --- | --- | --- | --- |
| Maximum Fecal Coliforms | 2,000 | --- | 200 | --- | --- | --- | --- | --- |
| PHYSICAL | | | | | | | | |
| Minimum Dissolved Oxygen (mg/l) | 5.5 | --- | 5.5 | | | | | |
| 30-day average dissolved oxygen | | | | 6.5 | 5.5 | 5.0 | 5.0 | |
| 2-day average dissolved oxygen | | | | 9.5/5.0 | 6.0/4.0 | | | |
| 1-day average dissolved oxygen | | | | 8.0/4.0 | 5.0/3.0 | 3.0 | 3.0 | |
| pH (units) | 6.5-9.0 | --- | 6.5-9.0 | 6.5/9.0 | 6.5/9.0 | 6.5/9.0 | 6.5/9.0 | 6.5/9.0 |
| Turbidity increase (NTU) | | | | 10 | 10 | 15 | 15 | |
| Temperature (°C) | | | | | | | | |
| Maximum | | | | 20 | 27 | 27 | | |
| Maximum temperature change | | | | 2 | 4 | 4 | | |
| INORGANICS (mg/l) | | | | | | | | |
| Ammonia ($NH_3$) | | | | | | | | |
| 4-day average | | | | *** | *** | *** | *** | |
| 1-hour average | | | | *** | *** | *** | *** | |
| Nitrates | 10 | | | | | | | |
| Total Dissolved Solids | | | | | | | | 1200 |
| POLLUTION INDICATORS (mg/l) | | | | | | | | |
| Nitrate (mg N/l) | | | 4 | 4 | 4 | --- | --- | --- |
| Phosphate (mg P/l) | | | 0.05 | 0.05 | | --- | --- | --- |

*** *Dependent upon temperature and pH.*

An important part of the water quality regulations of the state is the UPDES program. Those responsible for point sources which discharge into a waterbody are required to obtain a State of Utah discharge permit. The state determines the maximum allowable discharges of various pollutants from each source, and establishes a monitoring and reporting program for these different sources.

Many of the enforceable criteria are for hazardous substances such as metals and organic pesticides and are intended to protect human health. Bacterial contamination is controlled because it represents possible fecal contamination and thus is also a health hazard. Additional standards such as dissolved oxygen, pH, temperature and $NH_3$ are established to protect fisheries and other aquatic wildlife.

Limits on nutrients (phosphorus and nitrates) are suggested because of the secondary impact these can have in waterbodies. Just as on land, these function as plant foods and can cause increased growth of large aquatic plants, periphyton (mats of small plants attached to rocks and other surfaces) or microscopic algae. In many cases, the primary concern is algal growth in reservoirs. Excessive plant growth leads to reduced dissolved oxygen and increased pH, due in part to plant respiration at night and to decay of dead plant materials. In rivers, dissolved oxygen sags can impact fisheries, restricting spawning areas and altering macroinvertebrate communities. Excessive nutrients in reservoirs result in algal blooms, and ultimately low dissolved oxygen, which again leads to fish kills or altered fish and macroinvertebrate communities. In addition, some types of algae may form floating mats of debris, causing noxious odors and other aesthetic problems. In extreme cases, noxious algal blooms are toxic to cattle and other mammals.

Suspended solids are not controlled by numeric criteria, but fall within the non-degradation clauses of the Utah code. Apart from an aesthetics problem, silts cover spawning areas and adversely affect aquatic food chains and fisheries. Turbidity can greatly limit the feeding and survival of many fish (Newcombe 1986). Sediments can fill reservoirs to the point that storage capacity is greatly reduced, limiting the usefulness of the reservoirs for all beneficial uses.

### 4.3 Exceedences of Historic Water Quality Standards as They Relate to Beneficial Uses

The State of Utah Division of Water Quality (UDWQ) maintains a monitoring program on waters of the state to determine whether the designated beneficial uses for these waters are being supported.

Water quality monitoring within the Bear River basin has been conducted since the mid-1970s, and several stations have continuous databases since that time. Since 1988, the monitoring has typically been every six weeks, except when special studies such as this one called for more frequent sampling. The UDWQ has defined full and partial support of beneficial uses (UDWQ 1992b). Conventionals (dissolved oxygen, temperature, pH, total dissolved solids) are defined as fully supporting when standards were exceeded in less than 10 percent of the samples, as partially supporting when 25 percent or fewer of the samples exceed standards, and as non-supporting when standards are exceeded in more than 25 percent of the samples. For priority pollutants (e.g. un-ionized ammonia), full support is defined as two or fewer exceedences over three years of quarterly samples.

Table 4-4 lists all historic water quality stations and the percent of samples which have exceeded criteria over the sampling period. Because of the variable sampling periods, comparisons between sites are difficult. In summary, dissolved oxygen exceedences have been a problem in the Spring Creek, Little Bear, Logan and Blacksmith Fork drainages. Ammonia, temperature, pH, and TDS have not been consistent problems at any sites. Coliform contamination has occurred throughout the basin, although at several sites (e.g. the Blacksmith Fork sites) these data were collected only during the late 1970s, and do not reflect more recent conditions. Total phosphorus has exceeded the pollution indicator concentration throughout the lower Bear River, the Cub drainage, the lower Little Bear drainage, and the Spring Creek drainage. Nitrate concentrations have exceeded the indicator level far less frequently, and in general appear to have been a problem only in the Spring Creek drainage.

The Bear and Cub rivers have historically had high concentrations of suspended solids. Concentrations have exceeded 40 mg/liter in over half of all samples collected since the 1970s. In 20 percent of all samples TSS was greater than 100 mg/liter (Figure 4-1). In contrast, the Logan and Blacksmith Fork drainages have had very low TSS concentrations most of the time, with concentrations exceeding 35 mg/liter in only 10 percent of the samples. The Little Bear and Spring Creek drainages have intermediate suspended solids concentrations. Over 70 percent of all samples collected in the Little Bear had TSS concentrations less than 25 mg/liter. Spring Creek had higher TSS, with 70 percent of the samples greater than 55 mg/liter. During low flow periods, Spring Creek TSS concentrations were twice those of the Little Bear River.

**TABLE 4-4. Percent of historic water quality samples which exceeded state standards or water quality indicator concentrations from 1976 to 1992. The state considers sites where more than 25 percent of the samples exceed the standard as non-supporting. These cases are in bold.**

| LOCATION | DATES | # OF SAMPLES | Enforceable Standards | | | | | | | | Water Quality Indicators | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | TDS | Temp | DO | pH | $NH_3$ | | COLIFORMS** | | TP* | $NO_3$* |
| | | | | | | | 4-day | 1-hour | Total | Fecal | | |
| Mainstem Bear River | | | | | | | | | | | | |
| 610 - west of Fairview | 1976-92 | 126-170 | 0 | 0 | 0 | 2 | <1 | 0 | 3 | **38** | 72 | 0 |
| 382 - west of Richmond | 1982-92 | 14-38 | 0 | 0 | 0 | 4 | 3 | 0 | 0 | 14 | 79 | 0 |
| 326 - above Cutler | 1982-92 | 13-71 | 0 | 0 | 3 | 3 | 1 | 0 | 0 | 15 | 79 | 0 |
| 198 - below Cutler | 1977-92 | 30-121 | <1 | 0 | <1 | 0 | 2 | 0 | 6 | **30** | 92 | 0 |
| 110 - near Corinne | 1976-92 | 126-146 | 20 | <1 | 2 | 2 | 2 | 0 | 10 | **44** | 100 | 0 |
| Cub Drainage | | | | | | | | | | | | |
| 379 - at stateline | 1977-92 | 31-59 | 0 | 0 | 6 | 0 | 0 | 0 | 3 | **48** | 89 | 0 |
| 425 - U142 Xing | 1976-92 | 31-94 | 0 | 4 | 13 | 4 | 3 | 0 | 0 | 0 | 94 | 0 |
| Spring Creek | | | | | | | | | | | | |
| 487 - Hyrum slough | 1992 | 10 | ND | 0 | 20 | 0 | 20 | 10 | **60** | **80** | 80 | 0 |
| 490 - Mendon xing | 1992 | 9-11 | ND | 9 | **36** | 0 | 9 | 0 | **60** | **89** | 100 | 45 |
| 492 - west of Pelican Pond | 1992 | 11 | ND | 0 | ND | 0 | 9 | 9 | **64** | **73** | 100 | 76 |
| 494 - US 89 xing | 1992 | 11 | ND | 9 | **64** | 0 | 18 | 9 | **82** | **73** | 100 | 82 |
| 499 - n. of College Ward | 1992 | 1-13 | 0 | 0 | 23 | 0 | 0 | 0 | 0 | 17 | 38 | 0 |
| Logan River | | | | | | | | | | | | |
| 520 - mouth of canyon | 1977-92 | 12-116 | 0 | <1 | 11 | 0 | 0 | 0 | 0 | 25 | 19 | 0 |

**TABLE 4-4 (continued). Percent of historic water quality samples which exceeded state standards or water quality indicator concentrations from 1976 to 1992. The state considers sites where more than 25 percent of the samples exceed the standard as non-supporting. These cases are in bold.**

| LOCATION | DATES | # OF SAMPLES | Enforceable Standards | | | | | | | | Water Quality Indicators | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | TDS | Temp | DO | pH | $NH_3$ | | COLIFORMS** | | TP* | $NO_3$* |
| | | | | | | | 4-day | 1-hour | Total | Fecal | | |
| Logan River (continued) | | | | | | | | | | | | |
| 504 - abv. conf. with LB | 1976-92 | 19-23 | 0 | 4 | 22 | 0 | 0 | 0 | ND | ND | 23 | 0 |
| Blacksmith Fork | | | | | | | | | | | | |
| 544 - mouth of canyon | 1977-92 | 15-117 | 0 | 0 | 20 | 4 | 0 | 0 | 0 | **30** | 27 | 0 |
| 540 - above Logan River | 1977-92 | 18-44 | 0 | 3 | 25 | 0 | 3 | 3 | **28** | **94** | 44 | 0 |
| Little Bear | | | | | | | | | | | | |
| 576 - above Davenport Crk | 1990-92 | 9-27 | ND | 11 | **26** | 0 | 0 | 0 | 4 | 11 | 8 | 0 |
| 577 - Davenport abv S. Fork | 1990-92 | 11-26 | ND | 8 | 15 | 4 | 0 | 0 | 4 | 14 | 8 | 0 |
| 578 - below Porcupine | 1976-79, | 15-40 | 0 | 0 | 8 | 0 | 0 | 0 | 4 | 14 | 18 | 0 |
| 575 - above conf. w/S. Fork | 1990-92 | 7-23 | ND | 9 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 574 - above conf. w/E. Fork | 1990-92 | 8-25 | ND | 12 | 12 | 0 | 0 | 0 | 0 | 25 | 17 | 0 |
| 570 - west of Avon | 1977-92 | 40-120 | 0 | 3 | 14 | 5 | 0 | 0 | 3 | 7 | 31 | 0 |
| 567 - below White Trout farm | 1977-92 | 22-48 | 9 | 2 | 17 | 0 | 0 | 0 | **35** | **48** | 80 | 0 |
| 565 - below Hyrum reservoir | 1976-92 | 17-63 | 0 | 11 | 8 | 0 | 0 | 0 | 7 | **37** | 61 | 0 |
| 559 - below Wellsville | 1992 | 1-15 | ND | 9 | **36** | 0 | 0 | 0 | **27** | **55** | 88 | 0 |
| 500 - above Logan River | 1977-92 | 45-131 | <1 | 7 | **37** | 0 | 2 | 0 | 20 | **57** | 66 | 2 |

* *TP and $NO_3$ are non-enforceable pollution indicator levels.*

** *In general, coliform samples were collected far less frequently than other parameters and represent the low end of the range.*

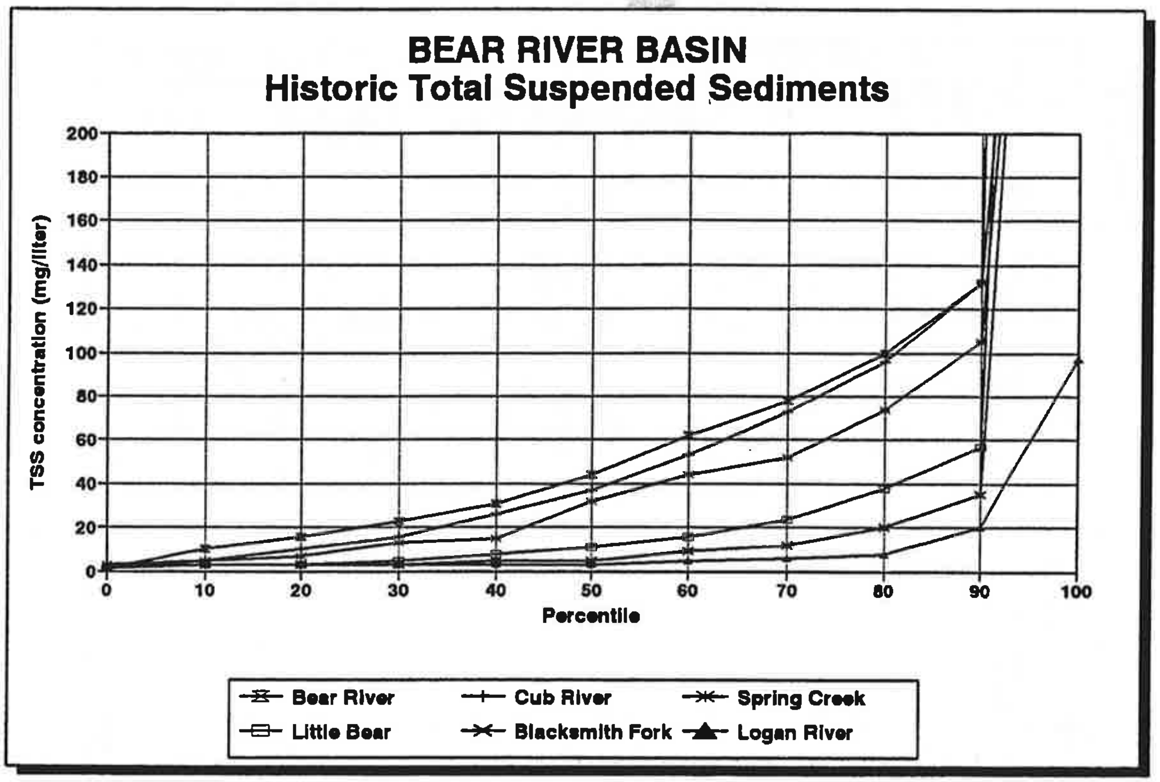



**FIGURE 4-1. Total suspended sediments concentrations in all samples taken in the lower Bear River basin since 1970.**

### 4.4 Standards Exceedences In Current Study

Table 4-5 summarizes the percentage of state of Utah's water quality standards violations seen in the water quality data collected during the 1993 water year. Impacts are described separately for streams and reservoirs in the system.

#### *4.4.1 River and Stream Impacts*

Violations of conventional criteria (dissolved oxygen, pH, temperature) and four-day ammonia standards were observed throughout the basin, but were seen at higher frequencies in the Little Bear and Spring Creek drainages (Table 4-5). Coliform violations also occurred throughout the Bear River basin, but were most frequent in the Spring Creek drainage, the Cub drainage and portions of the Little Bear drainage.

The Spring Creek drainage south of Cutler Reservoir had the most frequent and severe violations observed during the monitoring program. Ammonia concentrations violated 4-day criteria in eight of 14

**TABLE 4-7. Summary total phosphorus loads for Bear River basin. TMDLs chosen for the Lower Bear River basin are based on median flows (shaded values).**

| | TMDL (kg/day) based on 0.05 mg/liter concentration | | HISTORIC LOADS (kg/day) * | | | THIS STUDY (kg/day) | Exceedence of 1993 load over recommended TMDL (kg/day) |
|---|---|---|---|---|---|---|---|
| | 10th Percentile Flow | Median Flow | Median | Minimum | Maximum | 1993 Mean | |
| Bear River | | | | | | | |
| Stateline | 40 | 121 | 162 | 67 | 2,500 | 234 | 113 |
| Smithfield | 53 | 136 | | | | 425 | 289 |
| Collinston | 3 | 154 | 335 | 174 | 3,770 | 786 | 632 |
| Corinne | 17 | 183 | 509 | 206 | 4,020 | 866 | 683 |
| Logan River | 5 | 13 | 16 | 4 | 116 | 19 | 6 |
| Blacksmith Fork | 7 | 12 | | | | 14 | 2 |
| Cub River | 1 | 9 | 40 | 14 | 199 | 136 | 127 |
| Spring Creek ** | | 3 | 46 | | | 102 | 99 |
| Little Bear River | | | | | | | |
| Above Cutler | 3 | 9 | 24 | 7 | 76 | 24 | 15 |
| Above Hyrum | 2 | 6 | 8 | 1 | 44 | 15 | 9 |

** Calculated from UDWQ long-term monitoring data (1970 - 1992).*
*** Spring Creek is a tributary of the Little Bear River.*

**TABLE 4-8. Summary dissolved total phosphorus loads for Bear River basin. TMDLs chosen for the Lower Bear River basin are based on median flows (shaded values).**

| | TMDL (kg/day) based on 0.05 mg/liter concentration | | HISTORIC LOADS (kg/day) * | | | THIS STUDY (kg/day) | Exceedence of 1993 load over recommended TMDL (kg/day) |
|---|---|---|---|---|---|---|---|
| | 10th Percentile Flow | Median Flow | Median | Minimum | Maximum | 1993 Mean | |
| Bear River | | | | | | | |
| Stateline | 40 | 121 | 51 | 14 | 17,900 | 70 | -51 |
| Smithfield | 53 | 136 | | | | 174 | 38 |
| Collinston | 3 | 154 | 139 | 38 | 2,680 | 468 | 314 |
| Corinne | 17 | 183 | 188 | 45 | 3,240 | 480 | 297 |
| Logan River | 5 | 13 | 7 | 2 | 28 | 10 | -3 |
| Blacksmith Fork | 7 | 12 | | | | 7 | -5 |
| Cub River | 1 | 9 | 18 | 12 | 198 | 68 | 59 |
| Spring Creek ** | | 3 | | | | 89 | 86 |
| Little Bear River | | | | | | | |
| Above Cutler | 3 | 9 | 7 | 4 | 59 | 13 | 4 |
| Above Hyrum | 2 | 6 | 2.5 | 0.4 | 10 | 7 | 1 |

** Calculated from UDWQ long-term monitoring data (1970 - 1992).*
*** Spring Creek is a tributary of the Little Bear River.*

**TABLE 5-1. Highest pollutant ranked reaches of the Bear River.**

| | TOTAL PHOSPHORUS | | DISSOLVED TOTAL PHOSPHORUS | | TOTAL SUSPENDED SOLIDS | |
|---|---|---|---|---|---|---|
| | RANK | AVG ANNUAL LOAD (kg/day) | RANK | AVG ANNUAL LOAD (kg/day) | RANK | AVG ANNUAL LOAD (kg/day) |
| Bear River at Idaho Border | 1 | 264 | 4 | 70 | 1 | 107,000 |
| Cub River | 2 | 136 | 5 | 68 | 4 | 43,100 |
| Cutler Reservoir | 3 | 130 | 1 | 119 | 2 | 78,300 |
| Spring Creek | 4 | 102 | 2 | 89 | 9 | 3,630 |
| Logan Lagoons [a] | 5 | 101 | 3 | 80 | 10 | 351 |
| Bear River at Honeyville | 6 | 97 | 6 | 60 | 11 | -2,500 |
| Bear River at Corinne | 7 | 62 | 11 | -21 | 3 | 7,410 |
| Bear River from Richmond to Amalga | 8 | 48 | 7 | 42 | 5 | 36,100 |
| Logan River | 9 | 34 | 8 | 14 | 7 | 11,700 |
| Little Bear River | 10 | 24 | 9 | 14 | 8 | 8,150 |
| Bear River from Idaho to Richmond | 11 | 3.7 | 10 | -5.9 | 6 | 34,200 |

[a] *This is end-of-pipe value*

**TABLE 5-2. Rankings of reaches and subbasins in the lower Bear River basin.**

| REACH | LOAD | LOAD/FLOW | LOAD/AREA | POSITION IN BASIN |
|---|---|---|---|---|
| **TOTAL PHOSPHORUS RANKING** | | | | |
| Cub River in Utah | 1 | 4 | 4 | 3 |
| Cutler (Benson to Cutler Dam) | 2 | 1 | 3 | 5 |
| Spring Creek | 3 | 3 | 1 | 4 |
| Logan Lagoons | 4 | 2 | NA | 4 |
| BR from Richmond to Benson | 5 | 5 | 2 | 2 |
| Logan River | 6 | 8 | 7 | 4 |
| Little Bear River | 7 | 7 | 5 | 4 |
| BR from stateline to Richmond | 8 | 6 | 6 | 1 |
| **DISSOLVED TOTAL PHOSPHORUS RANKING** | | | | |
| Cub River in Utah | 4 | 4 | 4 | 3 |
| Cutler (Benson to Cutler dam) | 1 | 1 | 3 | 5 |
| Spring Creek | 2 | 3 | 1 | 4 |
| Logan Lagoons | 3 | 2 | NA | 4 |
| BR from Richmond to Benson | 5 | 5 | 2 | 2 |
| Logan River | 6 | 7 | 6 | 4 |
| Little Bear River | 7 | 8 | 5 | 4 |
| BR from stateline to Richmond | 8 | 9 | 7 | 1 |
| **TOTAL SUSPENDED SOLIDS RANKING** | | | | |
| Cub River in Utah | 2 | 4 | 4 | 3 |
| Cutler (Benson to Cutler dam) | 1 | 1 | 3 | 5 |
| Spring Creek | 7 | 5 | 5 | 4 |
| Logan Lagoons | 8 | 8 | NA | 4 |
| BR from Richmond to Benson | 3 | 3 | 1 | 2 |
| Logan River | 5 | 7 | 7 | 4 |
| Little Bear River | 6 | 6 | 6 | 4 |
| BR from stateline to Richmond | 4 | 2 | 2 | 1 |

Other variables can be incorporated into ranking. These include the population size contributing to the pollutant load, the willingness of citizens in a targeted area to pay or be involved in mitigation activities, the cost of mitigation, and the ease of instituting different types of implementations. These were all considered by the BRWQMP steering committee. The committee, however, decided to rank targeted subdrainages based only on the magnitude of the pollutant load. Other factors may be included in ranking individual projects within targeted subdrainages.

Other water quality problems such as coliform contamination and violation of conventional or toxic standards were not formally incorporated into the ranking system, but were considered in the final ranking decisions. In particular, the high frequency of criteria violations in the Spring Creek basin was of concern and was responsible for this drainage being given the highest ranking.

The final ranking agreed upon by the BRWQMP steering committee was:

1) **Spring Creek drainage**
2) **The Utah portion of the Cub River corridor**
3) **Nonpoint sources in Cutler Reservoir from Benson to Cutler dam**
4) **Bear River corridor from Richmond to Benson.**

Figure 5-1 shows the areas represented by prioritized drainages.

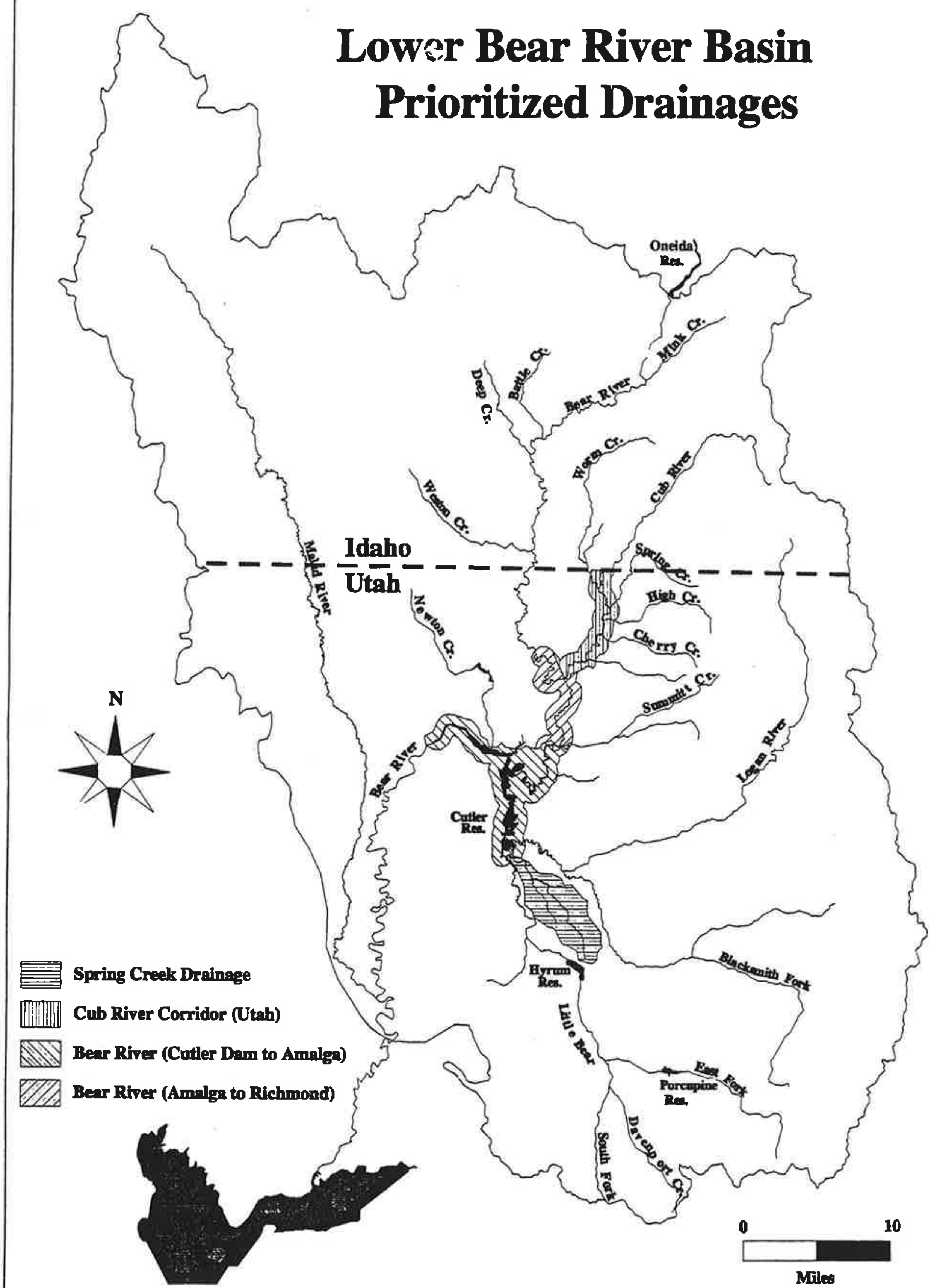



**FIGURE 5-1. Lower Bear River prioritized drainages.**

## 5.1 Targeted Watersheds for Project Implementation Plans (PIPs)

The following section describes specific conditions in each of the targeted subdrainages. Each section covers the current water quality and landuse conditions in that targeted subdrainage. The sources of pollutant loads in each of the targeted subdrainages are identified in as much detail as possible. In most cases, point sources were measured directly. The relative importance of pollutant loads from nonpoint sources was estimated by applying nutrient export coefficients to the areas of different landuses in a specific subdrainage. Literature values for these export coefficients were used (Table 5-3). Typically, a range of coefficients are available, arising from different studies in different geographic areas and under different conditions. When available, coefficients meeting mountain west conditions were used. To estimate nonpoint loadings, an average loading coefficient was chosen, along with a high and low value to provide a range. Once the pollutant sources under current conditions were evaluated, the potential reduction in these nutrient loads through various remediations was calculated. These nutrient reduction activities range from changes in treatment processes in the wastewater treatment facilities to additional best management practices (BMPs) in agricultural fields and feedlots. Table 5-4 lists a wide range of remediation activities and BMPs, the effectiveness of each of these actions in reducing nutrient or sediment inputs to waterways and, when available, typical costs associated with each practice.

The ability to reduce pollutant inputs is largely a function of the amount of effort and money available for the task. Because of this, a range of nutrient reductions were calculated assuming low, medium and high levels of effort. Table 5-5 summarizes the percent reduction of pollutants assumed for these different levels of effort.

**TABLE 5-3. A range of phosphorus loading coefficients for different landuses. Rates used in loading calculations compiled from Reckhow et al. 1980.**

| | TOTAL PHOSPHORUS (KG/ACRE/DAY) | | |
|---|---|---|---|
| | LOW | MEDIUM | HIGH |
| Nonpoint Source: | | | |
| Irrigated agriculture | 0.00100 | 0.00243 | 0.00588 |
| Nonirrigated agriculture | 0.00011 | 0.000832 | 0.00177 |
| Open/unknown | 0.00011 | 0.000889 | 0.00294 |
| Urban | 0.00011 | 0.00122 | 0.00299 |
| Public lands | 0.00011 | 0.00022 | 0.00033 |
| Feedlots | 0.177 | 0.277 | 0.471 |
| Cows (kg/cow/day) | 0.0008 | 0.018 | 0.032 |

| | DISSOLVED TOTAL PHOSPHORUS (KG/ACRE/DAY) | | |
|---|---|---|---|
| | LOW | MEDIUM | HIGH |
| Nonpoint Source: | | | |
| Irrigated agriculture | 0.000240 | 0.000583 | 0.00141 |
| Nonirrigated agriculture | 0.0000561 | 0.000424 | 0.000903 |
| Open/unknown | 0.0000726 | 0.000587 | 0.00194 |
| Urban | 0.0000715 | 0.000793 | 0.00194 |
| Public lands | 0.0000737 | 0.000147 | 0.000221 |
| Feedlots | 0.0797 | 0.125 | 0.212 |
| Cows (kg/cow/day) | 0.00036 | 0.0081 | 0.0144 |

TABLE 5-4. Literature review of remediations and their effectiveness.

| POTENTIAL SOURCES OF POLLUTION | REMEDIATION | PERCENT REDUCTION | COST | IMPACT |
|---|---|---|---|---|
| Feedlots (manure management) | | | | |
| | Structural | | | Reduce runoff of nutrients, fecal coliform and total suspended solids from animal waste into adjacent waterways |
| | Holding Ponds | 50-70% | $25,000 | |
| | Lagoons | 75-100% | $25,000-$85,000 | |
| | Bunkers | * | $10,000-$50,000 | |
| | Tanks | * | | |
| | Composting | | | |
| | Operational | | | |
| | Total animal waste management | | | |
| | Hook into MWWTF | * | | |
| Agriculture | Structural | | | These practices reduce soil erosion and therefore, decrease the transport of sediments and associated nutrients (soluble and insoluble) into adjacent waterways |
| | Sprinkler systems | | | |
| | Operational (BMPs) | | | |
| | Conservation tillage | full strip 40-90% (1)<br>wide strip 40-60% (1)<br>narrow strip 50-95% (1) | | |
| | Contour farming | 50% max (1) | | |
| | Strip cropping | 75% max (1) | | |
| | Cover crops | 40-60% (1) | | |
| | Terrace | 95-98% (1) | | |
| | Grade stabilization | 75-90% (1) | | |
| | Water sediment control | 40-60% (1)<br>60-80% (1) | | |
| | Filter strips (10-25 m width) | 35-40% (general) (2)<br>70% (nutrients) (1)<br>80-90% (feedlots) (1) | 0.18-1.92/$m^2$ (2) | |

**TABLE 5-4 (continued). Literature review of remediations and their effectiveness.**

| POTENTIAL SOURCES OF POLLUTION | REMEDIATION | PERCENT REDUCTION | COST | IMPACT |
|---|---|---|---|---|
| Agriculture (cont.) | Nutrient Management | | | |
| | Livestock Management | | | Reduce streambank erosion, reduce the transport of animal waste and associated pollutants (nutrients, fecal coliform and total suspended solids) into adjacent waterways |
| | Exclusion | * | | |
| | Rest-rotation | * | | |
| | Mgmt + reveg | groundcover >30% (1) | | |
| | Mgmt w/o reveg | groundcover >10% (1) | | |
| | Fencing | * | $2-$2.50/ft (1) | |
| | Constructed wetlands | ? | $5,000 and up | |
| Streambank | Non-structural | | | These practices stabilize streambanks and reduce soil and streambank erosion. |
| | Revegetation | | | |
| | Trees | 15-50% | $1-$2/ft for willows (1) | |
| | Brush | 50-60% | $0.18-1.92/m^2$ (2) | |
| | Grass | up to 90% (2) | $55 and up/acre (1)<br>$1.50-$3.50/ft (1) | |
| | Snag removal and clearing | * | $1/ft (1) | |
| | Structural | | | |
| | Flow regulation | | Up to $5,000 depending on size, length, etc. | |
| | Drop structures | * | | |
| | Rock Pools | * | up to $20-placed rock | |
| | Wire structures | | $500/ea | |
| | Revetments | | | |
| | Conifer | ** (1) | $12/ft (3) | |
| | Rock | ** (1) | $200-$400/ft | |

## TABLE 5-4 (continued). Literature review of remediations and their effectiveness.

| POTENTIAL SOURCES OF POLLUTION | REMEDIATION | PERCENT REDUCTION | COST | | IMPACT |
|---|---|---|---|---|---|
| Streambank | Structural (continued) | | | | |
| | Deflectors | | | | |
| | Single | 75% [1] | $500/ea | | |
| | Irrigation management (offsite watering, pipelines) | 25-75% [1] | $400/trough + $?/pump + $2/ft for pipe [1] | | |
| Open Channel | Meander Reconstruction | ** [1] | $50/ft [2] | | Reduce streambank erosion |
| | | | COST PER MGD | | |
| | | | CONSTRUCTION [4] | MAINTENANCE [4] | |
| Wastewater | Hook into MWWTF | | | | Reduce total phosphorus |
| | Land treatment option | 80-90% [3] | $980,000-1,200,000 | $44,000-64,000 | |
| | Rapid infiltration (underdrained or not) | 80-90% [3] | $34,000-44,000 | $25,000-47,000 | |
| | Overland flow | 30-60% [3] | | | |
| | Activated sludge | >90% [3] | $160,000-820,000 | $10,000-64,000 | |
| | Alum | 94% [3] | $18,000-48,000 | $40,000-55,000 | |
| | Ferric chloride | 56-97% [3] | $16,000-46,000 | $28,000-40,000 | |
| | Lime clarification of raw wastewater | 75% [3] | $21,000-47,000 | $20,000 | |

**TABLE 5-4 (continued). Literature review of remediations and their effectiveness.**

| POTENTIAL SOURCES OF POLLUTION | REMEDIATION | PERCENT REDUCTION | COST | IMPACT |
|---|---|---|---|---|
| Wastewater (cont.) | Primary treatment | | | Reduce total suspended solids |
| | With mineral addition | 60-75% [(3)] | | |
| | Without mineral addition | 40-70% | | |
| | Secondary treatment | | | |
| | Trickling filter | | | |
| | With mineral addition | 85-95% [(3)] | | |
| | Without mineral addition | 70-92% | | |
| | Activated sludge | | | |
| | With mineral addition | 85-95% [(3)] | | |
| | Without mineral addition | 85-95% | | |

(1) Utah Little Bear River Hydrologic Unit Plan 1992
(2) Water Quality Investigations - Lower Bear River and Hyrum Reservoir; ERI 1991
(3) Process Design Manual for Phosphorus Removal; USEPA 625/1-76-0019
(4) Barker et al. 1989

**TABLE 5-5. Percent reductions in predicting phosphorus loads in this report.**

| SOURCE | LEVEL OF EFFORT | | |
|---|---|---|---|
| | LOW | MEDIUM | HIGH |
| Nonpoint | 40 | 50 | 90 |
| Point | 50 | ** | 90 |
| Feedlots | 50 | 75 | 90 |

** *Calculate load based on a 5 mg/liter effluent standard.*

### *5.1.1 Spring Creek Drainage*

Landuse in the Spring Creek subbasin is illustrated in Figure 5-2. Valley bottom vegetation and bank conditions are illustrated in Figures 5-3 and 5-4, respectively. Attributes of the Spring Creek subbasin are summarized in Table 5-6.

The Spring Creek subdrainage includes three small tributaries: 1) North Fork Spring Creek; 2) South Fork Spring Creek; and 3) Hyrum Slough. Table 5-7 summarizes nutrient and sediment loadings and flows from each of these subdrainages. Evaluating the drainage is complicated by irrigation diversions and return flows. Both South Fork Spring Creek and Hyrum Slough are entirely channelized and diverted for irrigation water. Ditches allow point sources and irrigation return flow to move in several directions, which complicates determining sources within a subdrainage. In addition, diversions may result in lower flows downstream than upstream on a given day, which can distort calculated loading patterns and may not be representative of the total loading within the drainage.

The North Fork of Spring Creek originates in a small spring/wetlands area near Young Ward, Utah. This stream drains about 840 acres and had an average flow of about 14 cfs which remained relatively constant throughout the 1993 water year. This portion of Spring Creek had the best water quality in the subdrainage. Total phosphorus averaged about 0.052 mg/liter and DTP averaged 0.029 mg/liter. In both cases, concentrations did not vary much throughout the sample year. A small fish hatchery above this sample site appeared to have no measurable impact on water quality.

In contrast, Hyrum Slough and South Fork Spring Creek had impaired water quality. Hyrum Slough drains into the North Fork of Spring Creek (Figure 5-3). The slough drains about 4,700 acres south of the North Fork subdrainage. Nutrient concentrations in Hyrum Slough were high throughout much of the year. Total phosphorus averaged 1.45 mg/liter, DTP averaged 0.72 mg/liter and nitrate averaged 2.8 mg/liter. Flows averaged 5.3 cfs and were highest in the mid to late summer.

Most of the impacts to Spring Creek occurred in the upper portion of the South Fork drainage (above Highway 89/91). Site 490494 drains approximately 1,030 acres, and collects drainage from Hyrum WWTP, EA Millers WWTP, and a large (over 3,000 head) feedlot. Winter land application of manure is widespread and intense, due to the high concentration of animals throughout this relatively small area, and runoff of manure directly into the waterways is also a problem. Flows were erratic in the stream, but

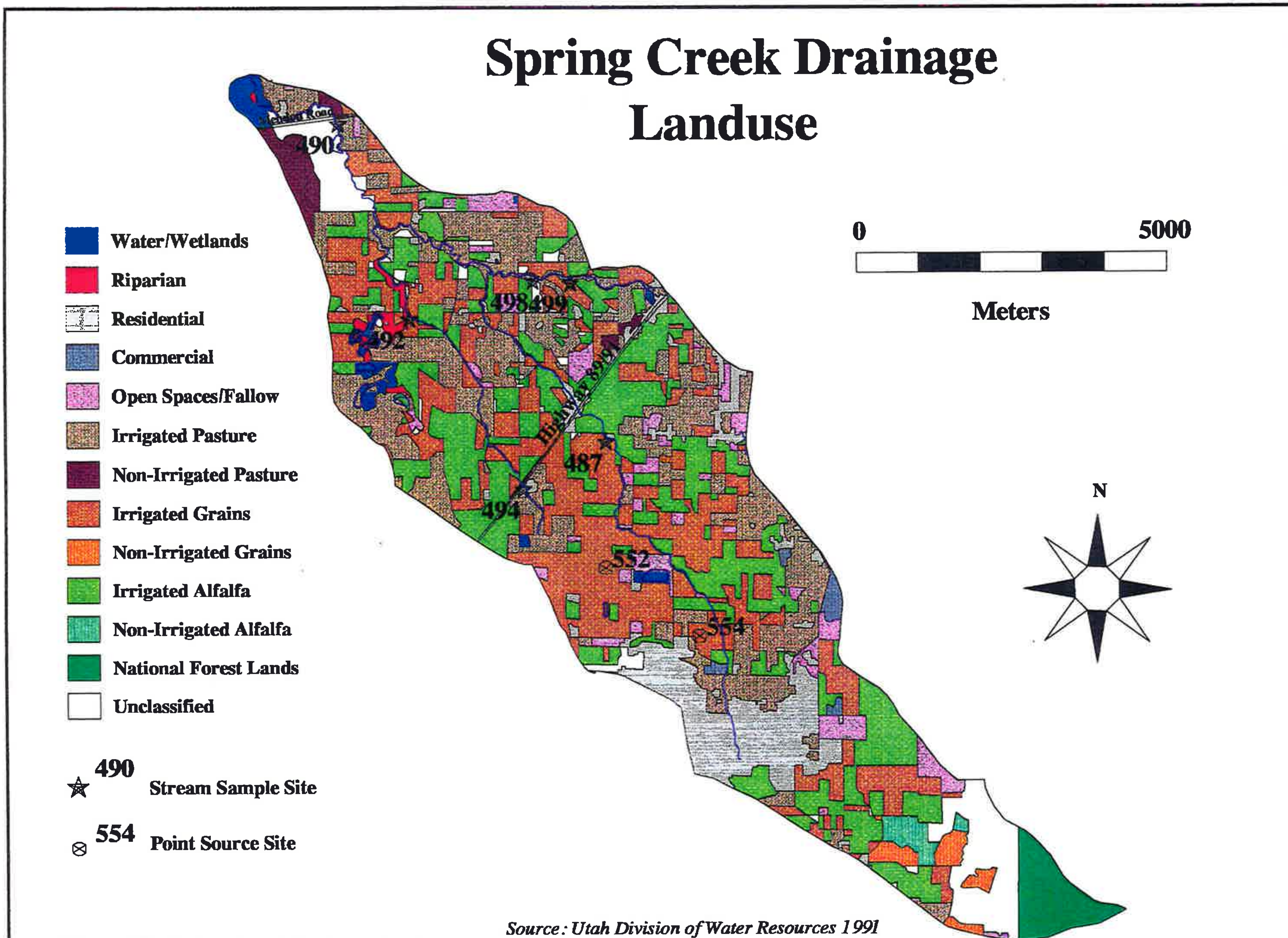



Figure 5.2. Spring Creek Drainage landuse.

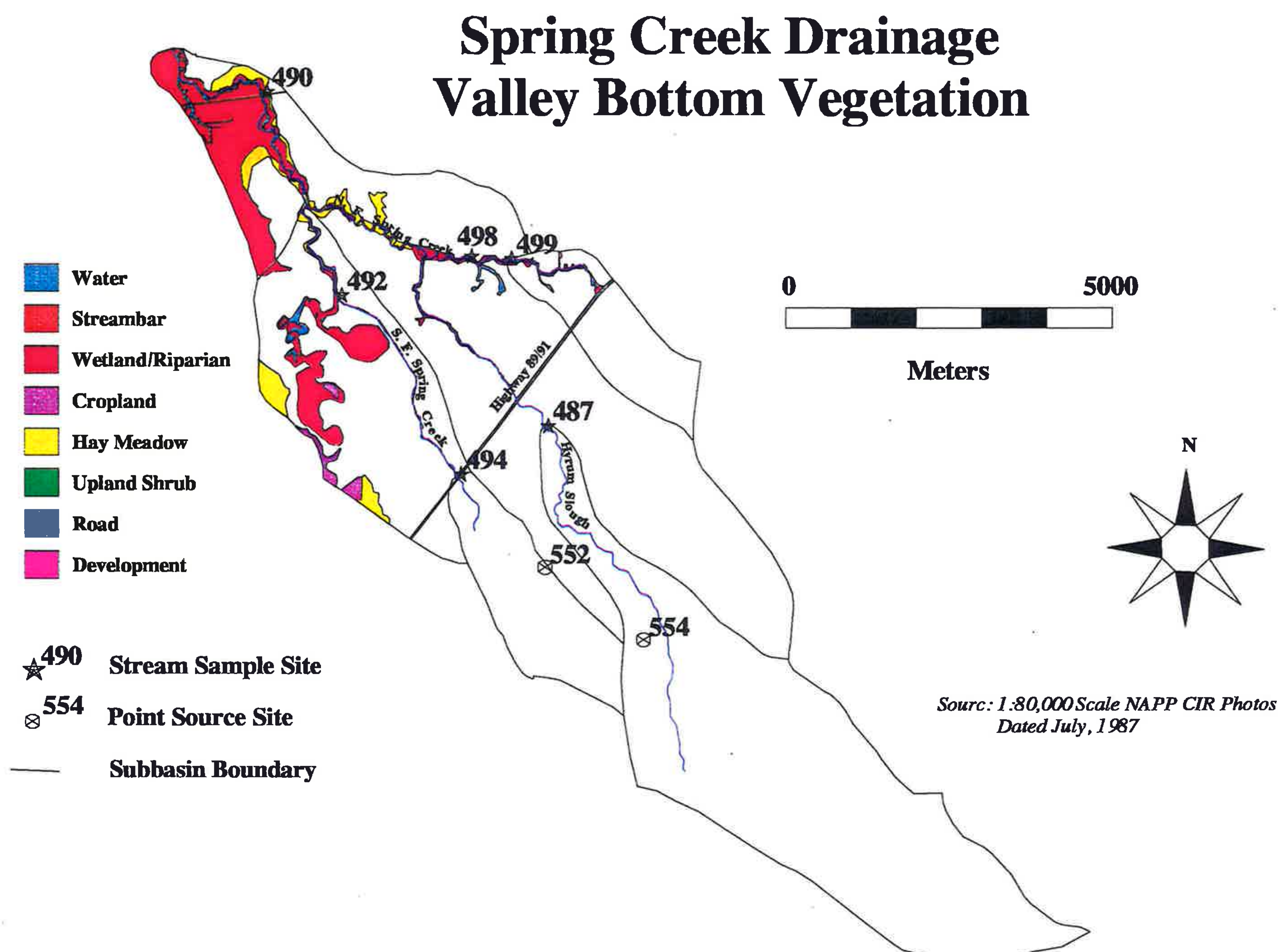



FIGURE 5-3. Spring Creek Drainage valley bottom vegetation.

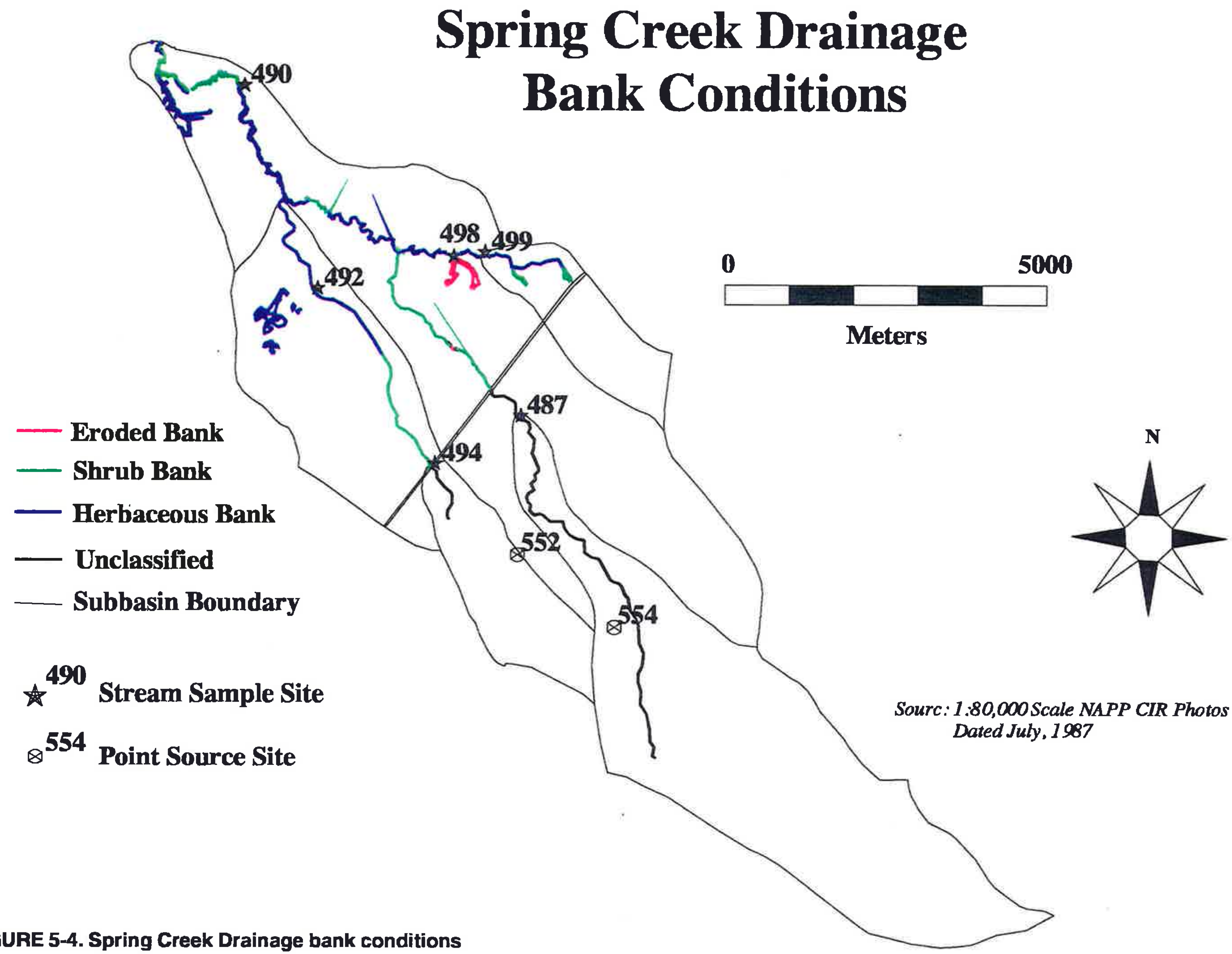



FIGURE 5-4. Spring Creek Drainage bank conditions

**TABLE 5-6. Attributes of Spring Creek basin.**

| | ACRES | PERCENT |
|---|---|---|
| **UPLAND LANDUSES** | | |
| irrigated agriculture | 10,328 | 71 |
| non-irrigated agriculture | 513 | 4 |
| open/unknown | 1,637 | 11 |
| urban | 1,490 | 10 |
| water/wetlands | 222 | 2 |
| National Forest | 369 | 2 |
| **TOTAL** | **14,559** | **100** |
| **VALLEY BOTTOM VEGETATION TYPES *** | | |
| cropland | 216 | 16 |
| hay meadow | 107 | 8 |
| road/development | 47 | 3 |
| water | 87 | 6 |
| wetland | 938 | 67 |
| **TOTAL** | **1,395** | **100** |

| | METERS | PERCENT |
|---|---|---|
| **VALLEY BOTTOM TYPE *** | | |
| alluvial confined | 19,036 | 76 |
| lacustrine unconfined | 5,913 | 24 |
| **TOTAL** | **24,949** | **100** |
| **VALLEY BOTTOM STATE *** | | |
| graded, stable banks | 15,044 | 60 |
| impounded | 5,015 | 20 |
| channelized | 4,865 | 20 |
| **TOTAL** | **24,949** | **100** |
| **BANK CONDITION *** | | |
| exposed | 873 | 2 |
| herbaceous | 16,630 | 33 |
| shrub | 32,395 | 65 |
| **TOTAL** | **49,898** | **100** |

* *These values for the portion of the drainage area northwest of Highway 89/91.*

**TABLE 5-7. Pollutant loads and flows contributed from different sources within Spring Creek drainage.**

| | SITE NUMBER | Basin Area Acres | AVERAGE WATER YEAR LOADS (kg/day) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | TP | DTP | TSS | $NH_3$ | $NO_3$ | FLOW (cfs) |
| Spring Creek above Cutler | 490490 | 12,244 | 102 | 89 | 3,630 | 134 | 532 | 41 |
| **Contributions from subdrainages** | | | | | | | | |
| North Fork Spring Creek | 490499 | 836 | 1.9 | 1.1 | 856 | 1.7 | 44 | 14 |
| Hyrum Slough | 490487 | 4,682 | 11 | 8 | 513 | 19 | 30 | 5.3 |
| Upper South Fork Spring Creek | 490494 | 1,028 | 256 | 169 | 4,470 | 183 | 723 | 9.5 |
| Lower S. Fork Spring Creek, w. of Pelican Pond | 490492 | 2,314 | 11 | 10 | 100 | 14 | 32 | 1.0 |
| **Point source inputs:** | | | | | | | | |
| **Within Upper South Fork subdrainage** | | | | | | | | |
| EA Miller | 490554 | | 101 | 86 | 147 | 17.5 | 707 | 2.3 |
| Hyrum WWTP | 490552 | | 18 | 16 | 35 | 3 | 27 | 1.1 |
| **Within North Fork subdrainage** | | | | | | | | |
| College Ward fish hatchery | 490498 | | 0.7 | 0.4 | 80 | 0.7 | 4.1 | 3.2 |
| **TOTAL:** | | | **119.7** | **102.4** | **262** | **21.2** | **738.1** | **6.6** |

were highest in the late summer due to irrigation flows. As stated in Section 4.4, numerous violations of state water quality standards were recorded at this site, including coliforms, ammonia and dissolved oxygen. Phosphorus concentrations at this site exceeded 10 mg/liter on four sample dates and averaged 21.0 mg/liter during the winter and early spring, but were lower during late summer, averaging 2.1 mg/liter. Dissolved total phosphorus showed a similar pattern, with peak concentrations in the winter and during runoff. During the winter, DTP averaged 14.7 mg/liter, while late summer concentrations averaged 1.2 mg/liter. These patterns were similar to those recorded in the previous year. On average, DTP accounted for 75 percent of the TP at this site, higher than observed through much of the study area. Nitrate exceeded 30 mg/liter on seven occasions, and exceeded the state water quality pollution indicator on all but three dates.

Below Highway 89/91, the South Fork drains into an area edging a substantial wetlands complex (Figure 5-3). This was the location of the downstream sample site on the South Fork (490492). Measured flows at this site were lower than those measured upstream (490494) or downstream (490490), and did not vary with season, suggesting that flows in the South Fork may disperse through the wetland, making it impossible to measure total water movement past this point. Nutrient concentrations measured at this site were also considerably lower than either the upstream or downstream sites.

Both Hyrum Slough and North Fork join the South Fork below site 490492. Local drainage in this lowest part of the Spring Creek basin drainage is from about 5,700 acres. By the time Spring Creek reached Cutler Reservoir, it had extremely large nutrient loads which could only be accounted for by loadings from the upper portion of the South Fork. With an average flow of 41 cfs, Spring Creek represented about six percent of the average annual accrual of the Bear River as it moved through the Cutler reach, but accounted for 27 percent of the TP, 29 percent of the DTP and 47 and 49 percent of $NO_3$ and $NH_3$ respectively.

As mentioned above, the biggest pollutant problems appear to be within the upper South Fork Spring Creek subbasin (above Highway 89/91). Major landuses and sources in this subbasin are listed in Table 5-8. Total phosphorus and DTP loads measured from point sources in 1993 and calculated nonpoint loads for given landuses are also presented. Potential loads under improved operations or following implementation of mitigation measures are listed in Table 5-9. Nonpoint sources to the stream

**TABLE 5-8. Allocation of total phosphorus and dissolved total phosphorus loads to different sources in the upper South Fork Spring Creek drainage.**

| | AREA (acres) | TOTAL PHOSPHORUS LOADS (kg/day) RATE OF LOADING * | |
|---|---|---|---|
| | | MEDIUM | RANGE (Low-High) |
| Point Source: | | | |
| EA Miller | | 101 | |
| Hyrum WWTP | | 18 | |
| Miller Brothers Feedlot ** | | 54 | |
| Nonpoint Source: | | | |
| Irrigated agriculture | 756 | 1.8 | 0.8-4.5 |
| Nonirrigated agriculture | 0 | 0 | 0 |
| Open/unknown | 84 | 0.08 | 0.01-0.25 |
| Urban | 187 | 0.23 | 0.02-0.56 |
| Public lands | 0 | 0 | 0 |
| Feedlots | 0.5 | 0.14 | 0.09-0.24 |
| Unidentified nonpoint | | 81 | 134-36 |
| **TOTAL 1993 Load:** | | **256** | **256** |
| **TMDL (Target Load):** | | **3** | **3** |

| | AREA (acres) | DISSOLVED TOTAL PHOSPHORUS LOADS (kg/day) RATE OF LOADING * | |
|---|---|---|---|
| | | MEDIUM | RANGE (Low-High) |
| Point Source: | | | |
| EA Miller | | 86 | |
| Hyrum WWTP | | 16 | |
| Miller Brothers Feedlot ** | | 24 | |
| Nonpoint Source: | | | |
| Irrigated agriculture | 756 | 0.44 | 0.18-1.1 |
| Nonirrigated agriculture | 0 | 0 | 0 |
| Open/unknown | 84 | 0.05 | 0.01-0.16 |
| Urban | 187 | 0.15 | 0.01-0.36 |
| Public lands | 0 | 0 | 0 |
| Feedlots | 0.5 | 0.06 | 0.04-0.11 |
| Unidentified nonpoint | | 42 | 66-22 |
| **TOTAL 1993 Load:** | | **169** | **169** |
| **TMDL (Target Load):** | | **3** | **3** |

* *Rates used in loading calculations can be found in Table 5-3.*
** *Assumes 3,000 head of cattle*

**TABLE 5-9. Potential reduction in phosphorus loads in the upper South Fork Spring Creek drainage given different levels of remediation intensity. Reductions are applied to medium loads reported in Table 5-8.**

| | TOTAL PHOSPHORUS POTENTIAL LOADS (kg/day) | | |
|---|---|---|---|
| | LEVEL OF REMEDIATION EFFORT * | | |
| | LOW | MEDIUM | HIGH |
| Point Source: | | | |
| EA Miller | 51 | 28 | 10 |
| Hyrum WWTP | 13 | 9.0 | 1.8 |
| Miller Bros Feedlot | 27 | 14 | 5.4 |
| Nonpoint Source: | | | |
| Irrigated agriculture | 1.1 | 0.92 | 0.18 |
| Nonirrigated agriculture | 0 | 0 | 0 |
| Open/unknown | 0.04 | 0.04 | 0.01 |
| Urban | 0.14 | 0.11 | 0.02 |
| Public lands | 0 | 0 | 0 |
| Feedlots | 0.07 | 0.03 | 0.01 |
| Unidentified nonpoint | 48 | 40 | 8.1 |
| **TOTAL Potential Load:** | **141** | **92** | **26** |
| **TMDL (Target Load):** | **3** | **3** | **3** |

| | DISSOLVED TOTAL PHOSPHORUS POTENTIAL LOADS (kg/day) | | |
|---|---|---|---|
| | LEVEL OF REMEDIATION EFFORT * | | |
| | LOW | MEDIUM | HIGH |
| Point Source: | | | |
| EA Miller | 28 | 43 | 8.6 |
| Hyrum WWTP | 13 | 8.0 | 1.6 |
| Miller Bros Feedlot | 12 | 6.1 | 2.4 |
| Nonpoint Source: | | | |
| Irrigated agriculture | 0.26 | 0.22 | 0.04 |
| Nonirrigated agriculture | 0 | 0 | 0 |
| Open/unknown | 0.03 | 0.02 | 0.005 |
| Urban | 0.09 | 0.07 | 0.01 |
| Public lands | 0 | 0 | 0 |
| Feedlots | 0.04 | 0.03 | 0.01 |
| Unidentified nonpoint | 25 | 21 | 4.2 |
| **TOTAL Potential Load:** | **79** | **78** | **17** |
| **TMDL (Target Load):** | **3** | **3** | **3** |

* *See Table 5-4 for percent reductions assumed for different levels of remediation effort*

appear to be primarily from agricultural activities. As mentioned above, most of the South Fork and Hyrum Slough are channelized, although the banks are vegetated through most of the reach. The proximity to fields covered with manure during winter appears to be a serious problem, with manure entering the stream directly during spring runoff. Manure bunkering would allow manure to be spread after the ice is off the fields, when the manure can be worked into the soil. Improved riparian areas would result in slowing down or trapping the runoff, and incorporating these nutrients ultimately into vegetation, rather than transporting the nutrients downstream. A 10-25 meter green belt has been shown to remove up to 90 percent of dissolved total phosphorus in runoff from a field or feed lot (Vought et al. 1994). In cases where the runoff cannot be contained by improved riparian areas, holding ponds may help to reduce spring runoff. Alternate uses for the manure, such as composting may also reduce the problem.

This subdrainage is also impacted more than any other subdrainage by point source inputs. Two permitted dischargers account for almost half the total phosphorus and almost two-thirds of the DTP which were measured in the upstream South Fork site (Table 5-7). These are both secondary wastewater treatment facilities, which do not typically remove much phosphorus under traditional operating procedures. Revisions in operations and better management of sludge and flow through the plants may greatly improve nutrient removal without costly capital improvements. It is recommended that these facilities be evaluated to determine if they are adequately sized for their current loads. If they are appropriately sized, an additional evaluation of treatment processes may be advisable, to determine what modifications could be made to improve nutrient removal. Although both facilities currently have Utah discharge permits, phosphorus discharge is not controlled. The state can, however, require the plants to remove phosphorus if there is a demonstrated water quality and beneficial use impairment. A review of operations and potential improvements prior to this move by the state is recommended.

A third point source in the valley is a large feedlot (Miller Brothers feedlot) in the South Fork subdrainage. Under conditions of a Notice of Violation and administrative order issued by the Utah Department of Environmental Quality in 1993 and again in 1995, this facility is currently building retention basins to contain runoff (Nathan Gwin, UDWQ, pers. comm). The existing plan for this facility is for solids and liquids to be land-applied. Of concern in this basin, however, is the current overapplication of surrounding lands with manure. Exchanging a point source with an increase in nonpoint source loadings will not improve water quality in the basin. Alternative uses for manure, such as composting, have great potential in this subbasin. A concentrated source of manure exists, some lands currently being used for land application could be converted to a composting operation, and a waste product could be converted into a resource.

Finally, it is recommended that Pelican Pond or the wetlands surrounding this area be evaluated as a location for wetland treatment of the stream. The higher water quality that was recorded at this site may come from springs near the pond, but also may result from some removal of nutrients within the wetlands. By routing more of the South Fork flow through the area, or by generating additional wetlands in the low lying areas near the existing complex, significant seasonal nutrient removal may be possible. Wetland treatment is complex, however, because many of the nutrients (especially phosphorus) which are removed during the growing season can reenter a system as plants decompose in the fall and winter (USEPA 1988; Hammer 1992). Harvesting some of the vegetation is one solution to this. A full evaluation of wetland treatment is not within the scope of this document, but it is recommended that this be evaluated.

**Recommendations:** Concentrate efforts in the South Fork subdrainage southwest of Highway 89/91.

- Improve manure management, reduce winter manure spreading, develop holding ponds to reduce direct spring runoff from manure covered fields.
- Improve and expand riparian areas to provide green belts to filter runoff.
- Evaluate EA Miller's and Hyrum's wastewater treatment processes to determine whether changes or improvements in operations can reduce nutrient concentrations in the effluent. Recommend continued monitoring of DTP in their effluent.
- Continue monitoring below the Miller Brothers feedlot to evaluate success of this new facility. Pursue alternatives to land application of waste such as composting operations.
- Evaluate potential wetland development in the Pelican Pond area to treat South Fork Spring Creek before it reaches Cutler Reservoir.

### *5.1.2 Utah Portion of the Cub River Basin*

Landuse in the Cub River subbasin is illustrated in Figure 5-5. Valley bottom vegetation and bank conditions are illustrated in Figures 5-6 and 5-7, respectively. Attributes of the area draining directly to the Cub River below the Utah-Idaho border are summarized in Table 5-10.

The Cub River is a major contributor of dissolved nutrients and TSS to the Bear River system.

The major contributions of TSS, however, occur in Idaho (Table 5-11) and therefore are not within the scope of this document. This discussion emphasizes those nutrient remediations possible in the Utah portion of the Cub River. Reductions of TSS are secondary benefits of any improvements in agricultural runoff or in riparian areas.

Sources of water and contaminants to the Cub River which were evaluated in this study include Worm Creek and the Cub River entering from Idaho, three streams (Cherry, High and Spring creeks) draining lands to the east in Utah, and the Richmond sewage lagoons (Table 5-11). Local accrual is the difference between what was measured at the site above the Bear River (490425) and all other sources, and represents local drainage along the corridor of the Cub River in Utah (Figure 5-6). Local accrual accounted for about 24 percent of the total flow during the year of sampling, but accounted for 46 percent of the TSS load and about 58 percent of the nutrient loads (Table 5-11). Flows at site 490425 peaked twice, first in late March and later in late May and early June. Flows during early runoff peaked at almost 570 cfs, of which 65 percent was contributed by local runoff. The peak runoff from tributaries and the upper reach of the Cub River occurred in May. During this later runoff, only 20 to 25 percent of the flow at 490425 was contributed by local runoff.

In contrast to flow, local accrual accounted for about 58 percent of the nutrient loading. Concentrations of all nutrients were highest at 490425 in late March. At that time, the concentration of TP increased from 0.231 mg/liter at the stateline to 0.756 mg/liter at the Bear River confluence, a three-fold increase. Dissolved total phosphorus concentrations doubled to a peak concentration of 0.409 mg/liter over the same reach, $NO_3$ increased from 3.61 mg/liter to 5.1 mg/liter, and $NH_3$ increased from 0.103 to 0.321 mg/liter. A second peak in the concentrations of TP and TSS was seen at the stateline during the second peak flow period, but no further increases occurred from that point to the confluence with the Bear River. These patterns resulted in extremely high nutrient loadings during early runoff, which accounted for almost 80 percent of the annual loading. Furthermore, almost all DTP, TP, and $NO_3$ which entered during the peak early runoff loading event entered from local accrual (Table 5-11).

Total suspended solids concentrations and loads showed a different pattern. While about 80 percent of the annual TSS load at 490425 entered during runoff, the largest percentage entered from Idaho, especially during the later May runoff. The highest TSS concentrations in the drainage were

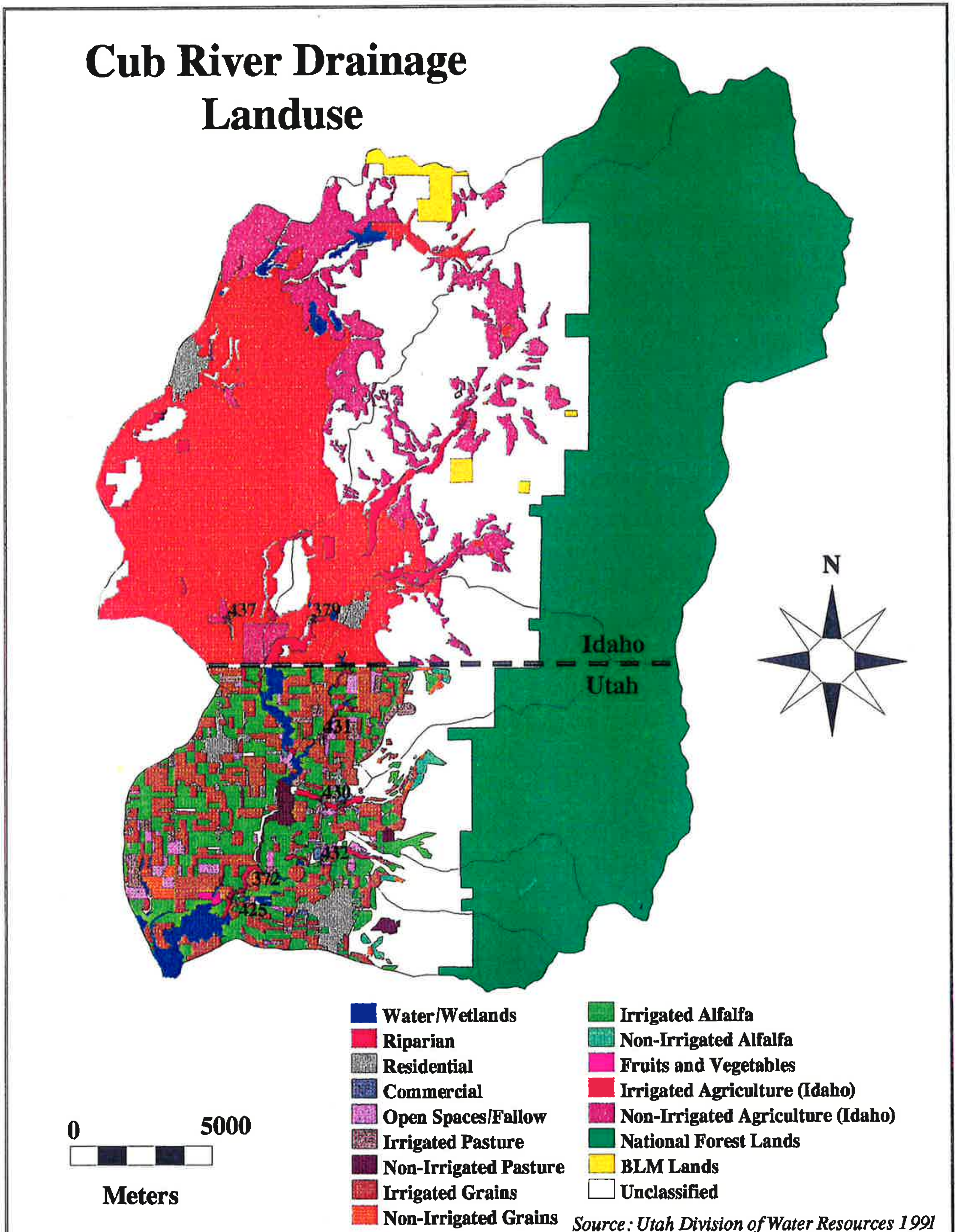



**FIGURE 5-5. Cub River Drainage landuse.**

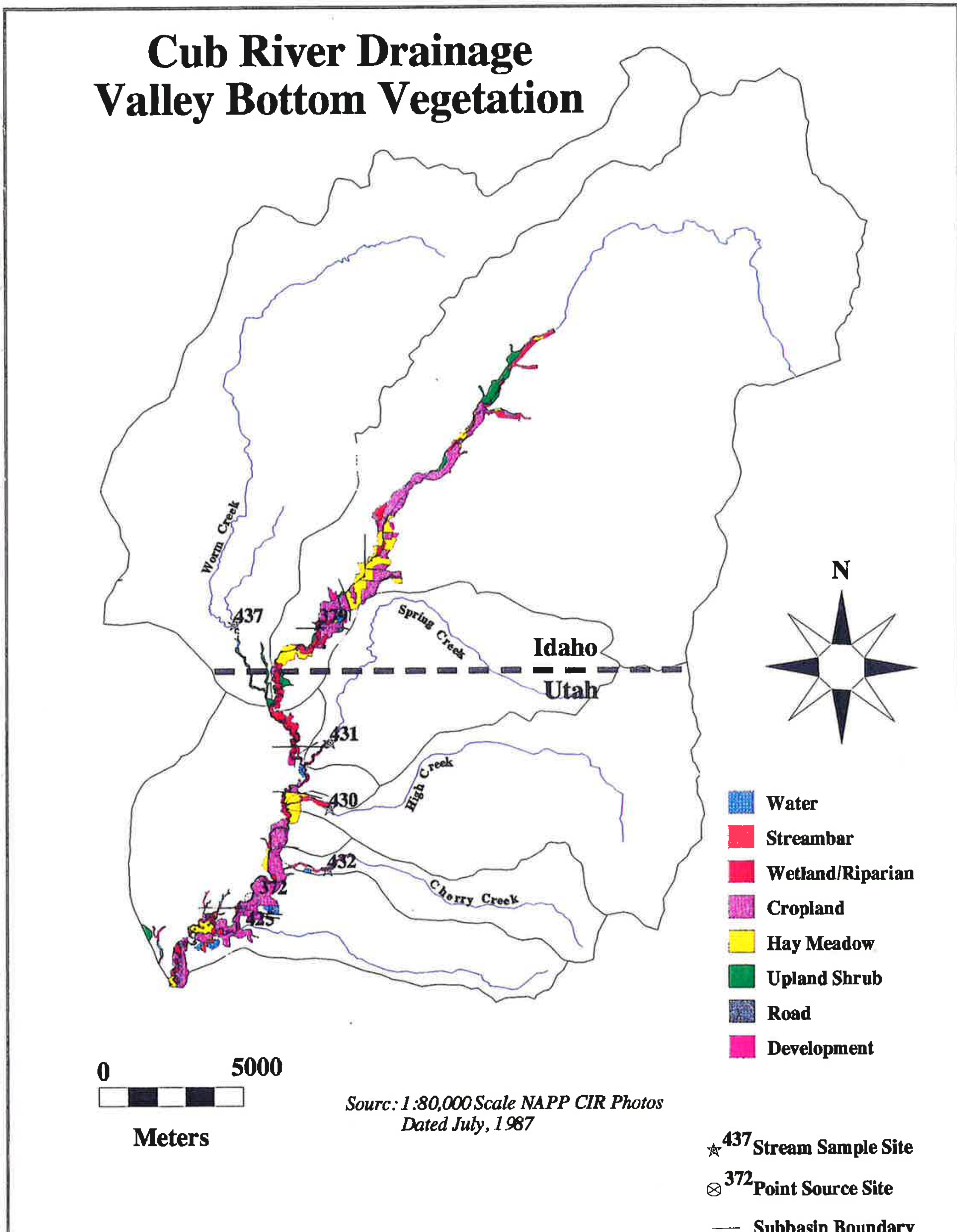



Figure 5-6. Cub River Drainage valley bottom vegetation.

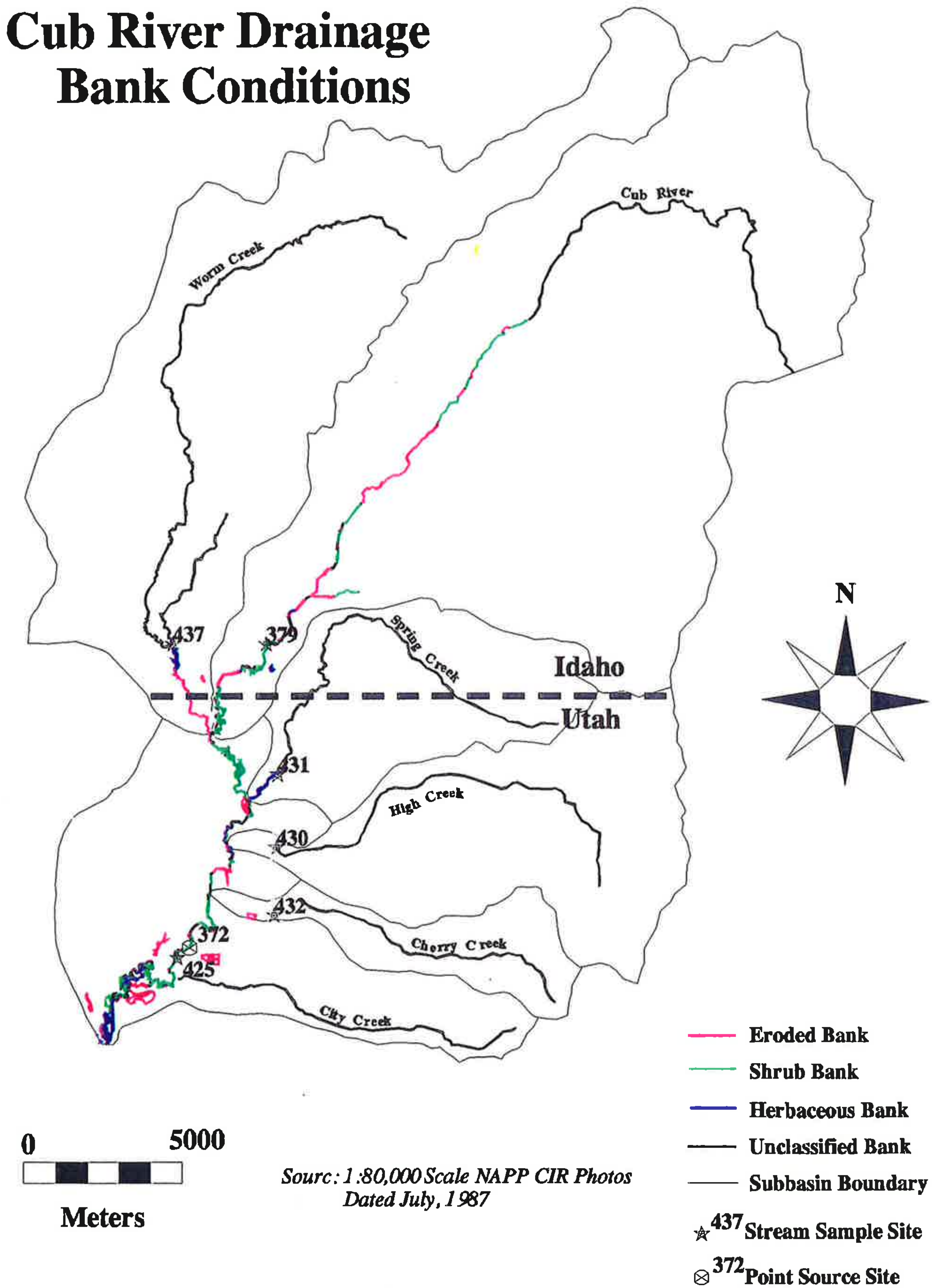



FIGURE 5-7. Cub River drainage bank conditions.

**TABLE 5-10. Attributes of the localized Cub River drainage area in Utah. This area includes lands draining directly to the Cub River from the Idaho stateline to the Bear River confluence.**

| | | ACRES | PERCENT |
|---|---|---|---|
| **UPLAND LANDUSES** | | | |
| irrigated agriculture | | 11,011 | 60 |
| non-irrigated agriculture | | 533 | 3 |
| open/unknown | | 2,910 | 16 |
| urban | | 1,375 | 7 |
| water/wetlands | | 1,165 | 6 |
| National Forest | | 1,480 | 8 |
| | **TOTAL** | **18,474** | **100** |
| **VALLEY BOTTOM VEGETATION TYPES** | | | |
| cropland | | 809 | 46 |
| haymeadow | | 161 | 9 |
| upland | | 142 | 8 |
| roads/development | | 55 | 3 |
| water/wetlands/streambar | | 598 | 34 |
| | **TOTAL** | **1,765** | **100** |

| | | METERS | PERCENT |
|---|---|---|---|
| **VALLEY BOTTOM TYPE** | | | |
| lacustrine confined | | 16,452 | 46 |
| lacustrine unconfined | | 19,236 | 54 |
| | **TOTAL** | **35,688** | **100** |
| **VALLEY BOTTOM STATE** | | | |
| graded | | 22,382 | 62 |
| eroded bank | | 2,536 | 7 |
| incised | | 935 | 3 |
| channelized | | 9,836 | 28 |
| | **TOTAL** | **35,688** | **100** |
| **BANK CONDITION** | | | |
| eroded | | 21,928 | 31 |
| shrubs | | 35,792 | 50 |
| grass covered | | 13,656 | 19 |
| | **TOTAL** | **71,376** | **100** |

observed within the Utah reach. Several animal feeding operations occur about 2.4 river miles above the 490425 site. These sites also have degraded riparian areas, with little or no vegetative buffer between animal operations and the river. Throughout the corridor, however, there are few major animal operations or other practices such as intensive winter manure spreading which could result in a greater increase in dissolved nutrients than in sediment runoff.

Potential point sources in the Cub drainage include the following permitted dischargers: Richmond sewage lagoons, Lewiston sewage lagoons, Presto Products, Preston WWTP, and the Del Monte cannery in Idaho. Non-permitted sources include a small dairy products operation, storm runoff from the towns of Richmond and Lewiston, and a fertilizer distributor on Highway 61 near Lewiston. Effluent from the Richmond lagoons was sampled regularly and found to be a small contributor (Table 5-11). The Lewiston lagoons are contained and may spill briefly during high flow periods, but no overflows during the study period could account for the nutrient gains seen in this study. Preston WWTP discharges into Worm Creek and the Del Monte cannery discharges into the Cub River above the state line. While the Preston WWTP may be a substantial contributor to Worm Creek, this source would not be included in the large increases seen in the Utah reach. Presto Products discharges into the Cub River, but occasional effluent samples evaluated for nutrients indicate very low concentrations.

The fertilizer distributor was not evaluated during this study, so its influence has not been quantified. A site visit in mid-summer found substantial amounts of what appeared to be granular fertilizer in small piles and drifts in the parking and loading areas, apparently from spills during loading. This parking area drains directly into Spring Creek below the Spring Creek sample site, and only a few hundred feet above the Cub River. Vegetation in the ditch downgradient from the parking area appeared "burned", which may indicate a big pulse of intense nutrients during snowmelt or early runoff. There is no way to evaluate an actual load from this site without additional monitoring. Assuming that typical phosphate fertilizer is about 45 percent $P_2O_5$ by weight, over 2,000 kilograms of fertilizer would have to enter the river to account for the entire runoff peak in DTP of 430 kg/day. Existing evidence suggests that substantial amounts of dissolved nutrients may enter from this source but the site needs to be monitored closely during the next runoff to determine the actual magnitude of inputs. In any case, operations need to be improved to contain any spills and to keep these nutrients from entering the river. Table 5-13 summarizes potential reduced TP and DTP loads under a range of remediation intensity.

**TABLE 5-13. Potential reduction in phosphorus loads in the Cub River localized drainage given different levels of remediation intensity. Reductions are applied to the medium loads reported in Table 5-12.**

| | TOTAL PHOSPHORUS POTENTIAL LOADS (kg/day) | | |
|---|---|---|---|
| | LEVEL OF REMEDIATION EFFORT * | | |
| | LOW | MEDIUM | HIGH |
| Point Source: | | | |
| Richmond WWTP | 3.8 | 1.2 | 0.23 |
| Lewiston Lagoons | | | |
| Nonpoint Source: | | | |
| Irrigated agriculture | 16 | 13 | 2.7 |
| Nonirrigated agriculture | 0.27 | 0.22 | 0.04 |
| Open/unknown | 1.6 | 1.3 | 0.26 |
| Urban | 1.0 | 0.84 | 0.17 |
| Public lands | 0.20 | 0.16 | 0.03 |
| Feedlots | 0.53 | 0.44 | 0.09 |
| Unidentifed nonpoint ** | 28 | 24 | 4.7 |
| **TOTAL Potential Load:** | **52** | **41** | **8.2** |
| **TMDL (Target Load):** | **9** | **9** | **9** |

| | DISSOLVED TOTAL PHOSPHORUS POTENTIAL LOADS (kg/day) | | |
|---|---|---|---|
| | LEVEL OF REMEDIATION EFFORT * | | |
| | LOW | MEDIUM | HIGH |
| Point Source: | | | |
| Richmond WWTP | 3.8 | 0.95 | 0.19 |
| Lewiston Lagoons | | | |
| Nonpoint Source: | | | |
| Irrigated agriculture | 3.9 | 3.2 | 0.64 |
| Nonirrigated agriculture | 0.14 | 0.11 | 0.02 |
| Open/unknown | 1.0 | 0.85 | 0.17 |
| Urban | 0.65 | 0.55 | 0.11 |
| Public lands | 0.13 | 0.11 | 0.02 |
| Feedlots | 0.20 | 0.10 | 0.04 |
| Unidentifed nonpoint ** | 17 | 14 | 9 |
| **TOTAL Potential Load:** | **27** | **20** | **4.1** |
| **TMDL (Target Load):** | **9** | **9** | **9** |

** See Table 5-3 for percent reductions assumed for different levels of remediation effort*
*** A larger proportion of the unaccounted for phosphorus may be removed if the source is the fertilizer distributor.*

**Recommendations:**

- Evaluate Intermountain Farmers Association in Lewiston as a source of high nutrient runoff. Help develop a plan to contain spills and reduce runoff to public waterways.

- Improve riparian areas in the reach from 2.4 to 4.3 miles above site 490425. Parts of site 490425 are heavily grazed. Implement a wider buffer zone between the fields and river and plant willows and other vegetation to help revegetate and stabilize the shoreline in this area.

- Educate agricultural users on fertilizer application and other techniques to reduce nutrient and sediment runoff.

- Work with Idaho to reduce incoming TSS.

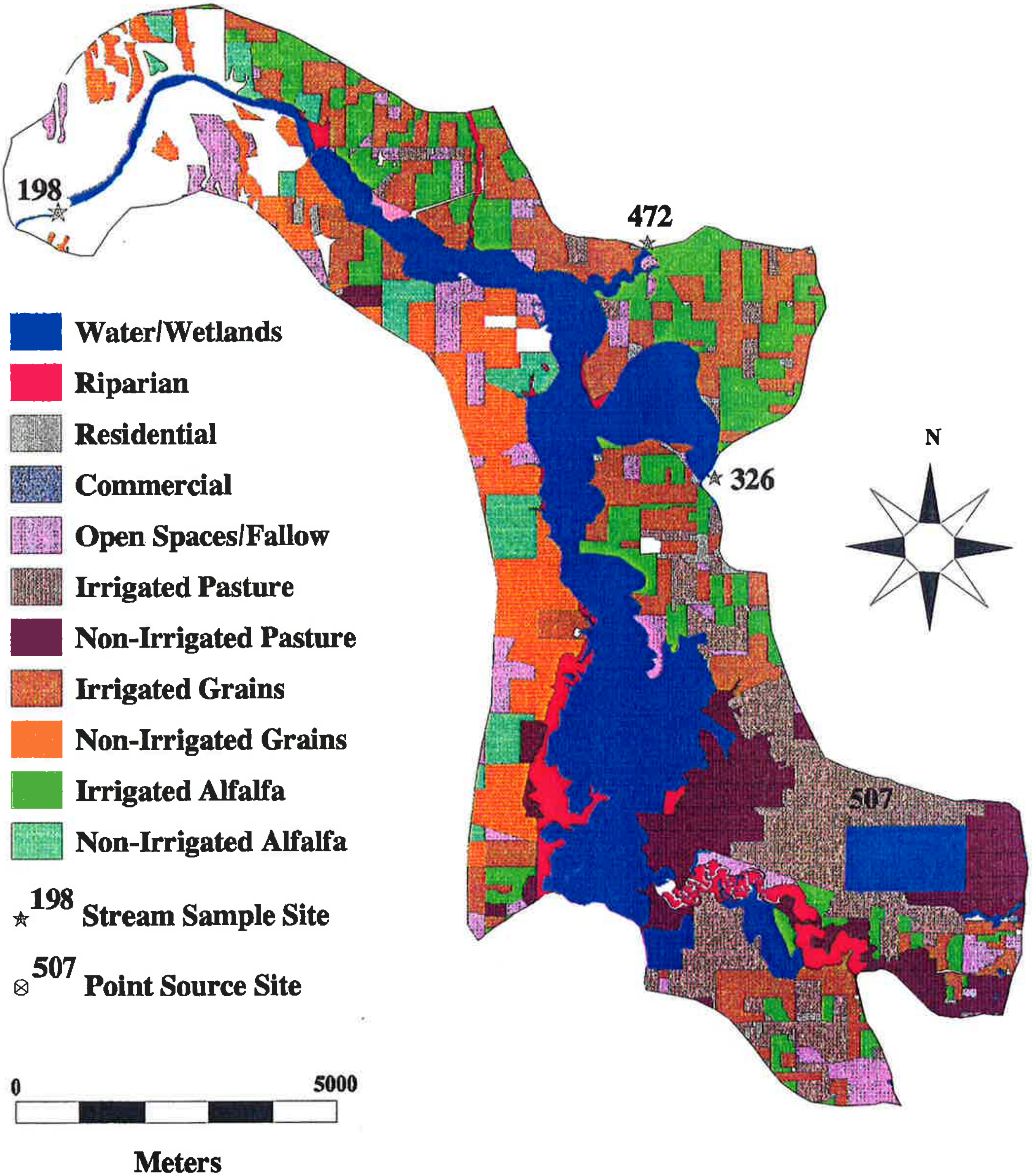
### *5.1.3 Nonpoint Sources in Cutler Reservoir*

Landuse in the vicinity of Cutler Reservoir is illustrated in Figure 5-9. Valley bottom vegetation and bank conditions are illustrated in Figures 5-10 and 5-11, respectively. Attributes of the Cutler Reservoir subbasin are summarized in Table 5-14. About 45 percent of the land draining to Cutler is identified as agricultural, with another 35 percent either open or in public use (Table 5-14). Of the valley bottom about 25 percent is either cropland or haymeadow.

From the site near Benson, the Bear River flows about 2.6 miles before entering Cutler Reservoir proper. This reach above Cutler Reservoir is greatly influenced by reservoir water levels. As mentioned earlier, Cutler Reservoir covers a surface area of about 7,000 acres within Cache Valley. Upstream from the dam, the reservoir is wide and shallow, and deepens only in the canyon section. The valley area north of the reservoir, draining into Clay Slough and the reservoir itself, is low gradient, highly saline, and in part consists of salt barrens. South of the Bear River channel, the reservoir is quite shallow and sustains over 1,700 acres of emergent wetlands. At the south end of the reservoir, the Logan River, Bear River and Spring Creek enter. The Logan Lagoons also discharge into the southern portion of the reservoir, except when the effluent is diverted for irrigation purposes.

The influence of tributaries on Cutler water quality was discussed in Chapter 3. Inputs are summarized in Table 5-15. Total phosphorus and dissolved total phosphorus loadings from point sources and major landuses in the immediate Cutler drainage are summarized in Table 5-16. Flows entering Cutler Reservoir and along the Bear River below Benson were responsible for about 40 percent of the

# Bear River (Cutler Dam to Benson) Landuse




*Source: Utah Division of Water Resources 1991 from data collected in 1986*

FIGURE 5-9. Bear River (Cutler Dam to Benson) landuse.

**TABLE 5-14. Landuses and conditions in the local drainage area within Cutler Reservoir. This includes the area west of the Mendon Road crossing and downstream of site 490326 near Benson to below Cutler Dam.**

| | | ACRES | PERCENT |
|---|---|---|---|
| **UPLAND LANDUSES** | | | |
| irrigated agriculture | | 8,505 | 37 |
| non-irrigated agriculture | | 4,697 | 20 |
| open/unknown | | 3,555 | 15 |
| urban | | 216 | 0.9 |
| water/wetlands | | 6,001 | 26 |
| | **TOTAL** | **22,975** | **100** |
| **VALLEY BOTTOM VEGETATION TYPES** | | | |
| cropland | | 1,557 | 20 |
| haymeadow | | 335 | 4 |
| upland | | 0 | 0 |
| roads/development | | 70 | 1 |
| water | | 3,584 | 47 |
| wetlands | | 2,047 | 27 |
| other | | 25 | 0 |
| | **TOTAL** | **7,618** | **100** |

| | | METERS | PERCENT |
|---|---|---|---|
| **VALLEY BOTTOM TYPE** | | | |
| alluvial confined | | 11,766 | 10 |
| lacustrine unconfined | | 111,792 | 90 |
| | **TOTAL** | **123,588** | **100** |
| **VALLEY BOTTOM STATE** | | | |
| graded | | 11,766 | 10 |
| impounded | | 111,792 | 90 |
| | **TOTAL** | **123,588** | **100** |
| **BANK CONDITION** | | | |
| eroded | | 31,509 | 13 |
| grass covered | | 184,525 | 75 |
| shrubs | | 31,083 | 12 |
| | **TOTAL** | **247,117** | **100** |

**TABLE 5-15. Pollutant loads and flows contributed from different sources within Cutler Reservoir.**

| | SITE NUMBER | AVERAGE WATER YEAR LOADS (kg/day) | | | | | |
|---|---|---|---|---|---|---|---|
| | | TP | DTP | TSS | $NH_3$ | $NO_3$ | FLOW (cfs) |
| Bear River at Collinston | 490198 | 786 | 468 | 241,871 | 497 | 3,553 | 1,608 |
| **Contributions from subdrainages** | | | | | | | |
| Bear River at Benson | 490326 | 410 | 163 | 138,644 | 223 | 2,477 | 969 |
| Spring Creek | 490490 | 102 | 89 | 3,629 | 134 | 533 | 41 |
| Little Bear | 490500 | 24 | 14 | 8,147 | 14 | 128 | 77 |
| Logan River | 490504 | 34.4 | 14 | 11,674 | 38 | 288 | 248 |
| Clay Slough | 490472 | 18.6 | 15.4 | 1,248 | 10.6 | 104.9 | 8 |
| **Point source inputs:** | | | | | | | |
| Logan Lagoons | 490507 | 68 | 54 | 235 | 55 | 22 | 8 |
| **Local accrual within the Cutler Reach** | | 129 | 119 | 78,294 | 22.4 | 0.1 | 257 |

**TABLE 5-16. Allocation of total phosphorus and dissolved total phosphorus loads to different sources in the Cutler localized drainage in Utah.**

| | ACRE (acres) | TOTAL PHOSPHORUS LOADS (kg/day) | |
|---|---|---|---|
| | | RATE OF LOADING * | |
| | | MEDIUM | RANGE (Low-High) |
| Point Source: | | | |
| Logan Lagoons | | 68 | |
| Nonpoint Source: | | | |
| Irrigated agriculture | 8,505 | 21 | 8.7-50 |
| Nonirrigated agriculture | 4,697 | 3.9 | 0.6-8.4 |
| Open/unknown | 3,555 | 3.2 | 0.4-5.6 |
| Urban | 216 | 0.3 | 0.02-0.6 |
| Feedlots | 8 | 2.2 | 1.4-3.8 |
| Unidentified nonpoint | | 98.4 | 191-61 |
| **TOTAL 1993 Load:** | | **197** | **197** |
| **TMDL (Target Load):** | | **18** | **18** |

| | ACRE (acres) | DISSOLVED TOTAL PHOSPHORUS LOADS (kg/day) | |
|---|---|---|---|
| | | RATE OF LOADING * | |
| | | MEDIUM | RANGE (Low-High) |
| Point Source: | | | |
| Logan Lagoons | | 54 | 54 |
| Nonpoint Source: | | | |
| Irrigated agriculture | 8,505 | 5.0 | 2.0-12.0 |
| Nonirrigated agriculture | 4,697 | 2.0 | 0.3-4.3 |
| Open/unknown | 3,555 | 2.1 | 0.3-6.9 |
| Urban | 216 | 0.2 | 0.02-0.4 |
| Feedlots | 8 | 1.0 | 0.64-1.7 |
| Unidentified nonpoint | | 109 | 116-94 |
| **TOTAL 1993 Load:** | | **173** | **173** |
| **TMDL (Target Load):** | | **18** | **18** |

** Rates used in loading calculations can be found in Table 5-3*

FERC application for the relicensing of Cutler Dam (PacifiCorp Electric Operations 1991). Work includes approximately two miles of bank stabilization and revegetation at several sites in the reservoir. Work at the first two sites north and south of the Benson marina has been completed, while work at the northern end of the reservoir will begin in 1995 (Maureen Wilson, UP&L, pers comm.). In addition, landuse practices have been modified on PacifiCorp owned lands around the reservoir area which are leased to farmers. The number of agricultural leases has been reduced and the management of livestock has been modified. Grazing areas have been divided into more manageable pastures, with portable electric fences utilized to subdivide pastures. A short-term intensive rotational grazing system has been initiated rather than continuous grazing over larger areas. Finally, tilling of cropland to the edge of the reservoir will no longer be allowed, in an attempt to let deeper rooted, permanent woody vegetation become established which should help stabilize banks. PacifiCorp will also be establishing grass buffer strips between croplands and the reservoir shoreline.

The work that is underway in this areas should be viewed as an excellent starting point. Similar modifications in crop and grazing practices on private lands should be encouraged. Reduced grazing intensity and improved vegetation in floodplain areas should improve the ability of these areas to retain sediment during runoff conditions. Trampling of river banks and direct impacts by livestock can be reduced by establishing and improving watering facilities away from the river and fencing riparian areas. Vegetative buffers between crop lands and the river will also reduce runoff into the reservoir and river. Table 5-17 summarizes potential reductions in total phosphorus and dissolved total phosphorus given a range of remediation activities.

**Recommendations:**

- Evaluate Logan Lagoons' treatment processes to determine whether changes or improvements in operations can reduce nutrient concentrations in effluent.
- Continue work begun in Cutler Reservoir by PacifiCorp.
- Fence and revegetate riparian areas to restore severely degraded sites.
- Stabilize banks in the reservoir.

**TABLE 5-17. Potential reduction in phosphorus loads in the Cutler localized drainage given different levels of remediation intensity. Reductions are applied to the medium loads in Table 5-16.**

| | TOTAL PHOSPHORUS POTENTIAL LOADS (kg/day) | | |
|---|---|---|---|
| | LEVEL OF REMEDIATION EFFORT * | | |
| | LOW | MEDIUM | HIGH |
| Point Source: | | | |
| Logan Lagoons | 98 | 34 | 6.8 |
| Nonpoint Source: | | | |
| Irrigated agriculture | 30 | 25 | 5.0 |
| Nonirrigated agriculture | 13 | 11 | 2.2 |
| Open/unknown | 16 | 13 | 2.7 |
| Urban | 3.8 | 3.1 | 0.63 |
| Public lands | 2.3 | 1.9 | 0.38 |
| Feedlots | 1.3 | 1.1 | 0.22 |
| Unidentified nonpoint | 11 | 9.3 | 1.9 |
| **TOTAL Potential Load:** | **175** | **99** | **20** |
| **TMDL (Target Load):** | **18** | **18** | **18** |

| | DISSOLVED TOTAL PHOSPHORUS POTENTIAL LOADS (kg/day) | | |
|---|---|---|---|
| | LEVEL OF REMEDIATION EFFORT * | | |
| | LOW | MEDIUM | HIGH |
| Point Source: | | | |
| Logan Lagoons | 98 | 27 | 5.4 |
| Nonpoint Source: | | | |
| Irrigated agriculture | 7.2 | 6.0 | 1.2 |
| Nonirrigated agriculture | 6.7 | 5.6 | 1.1 |
| Open/unknown | 11 | 8.8 | 1.8 |
| Urban | 2.4 | 2.0 | 0.41 |
| Public lands | 1.5 | 1.3 | 0.26 |
| Feedlots | 0.50 | 0.25 | 0.10 |
| Unidentifed nonpoint | 42 | 35 | 7.1 |
| **TOTAL Potential Load:** | **169** | **86** | **17** |
| **TMDL (Target Load):** | **18** | **18** | **18** |

** See Table 5-4 for percent reductions assumed for different levels of remediation effort*

- Improve grazing management throughout the area, emphasizing short-term, intense rotation grazing rather than continuous contact. ·

- Improve riparian areas in low gradient lands along the Bear River above Cutler Reservoir. Restore and improve vegetation in these areas to allow them to function more effectively as sediment and nutrient traps during high water periods.

- Inventory and quantify unregulated pipe drainage along the Bear River immediately above Cutler Reservoir.

- Evaluate inputs from Newton Reservoir (low flows in 1993 resulted in little data from this drainage).

### *5.1.4 Bear River Corridor from Utah-Idaho Border to Benson*

Landuse in the Bear River subbasin from the Utah-Idaho border to the Benson site is illustrated in Figure 5-13. Valley bottom vegetation and bank conditions are illustrated in Figures 5-14 and 5-15, respectively. Attributes of this Bear River subbasin are summarized in Table 5-18.

The water quality concerns in the Bear River above Benson are primarily sediment inputs (Table 5-19). Nutrient loads are associated mostly with sediment loads. On average, over 70,000 kg/day of suspended solids entered the river between the stateline (490610) and Amalga (490356) during the 1993 water year. A little more than this dropped from the water column between Amalga and the site near Benson (490326). In a 1991 study of the Bear River, however, this lower reach also contributed significant sediment to the river. During the present study, Cutler Reservoir elevations were such that the reach below Amalga functioned as part of the reservoir system. In contrast, Cutler Reservoir was drawn down in 1991, resulting in an increased river gradient with subsequent headcutting and resuspension of previously deposited sediments.

This process of deposition and resuspension occurs throughout any river. In the mainstem Bear River, whose bottom is characterized by fine-grained sediment, the task of distinguishing outside nonpoint inputs from resuspension of bedload is, therefore, complicated. The river can carry heavier loads of TSS at higher velocities, and thus suspended solids increase during runoff, or when changes in reservoir elevations change river gradients. Accounting for the movement and redistribution of bedloads throughout the mainstem river would require an intensive study covering more than a single water year, and is not within the scope of this management plan. It is clear from the increased load in the river as it travels from the stateline to the Great Salt Lake that external loading of sediments to the river occurs,

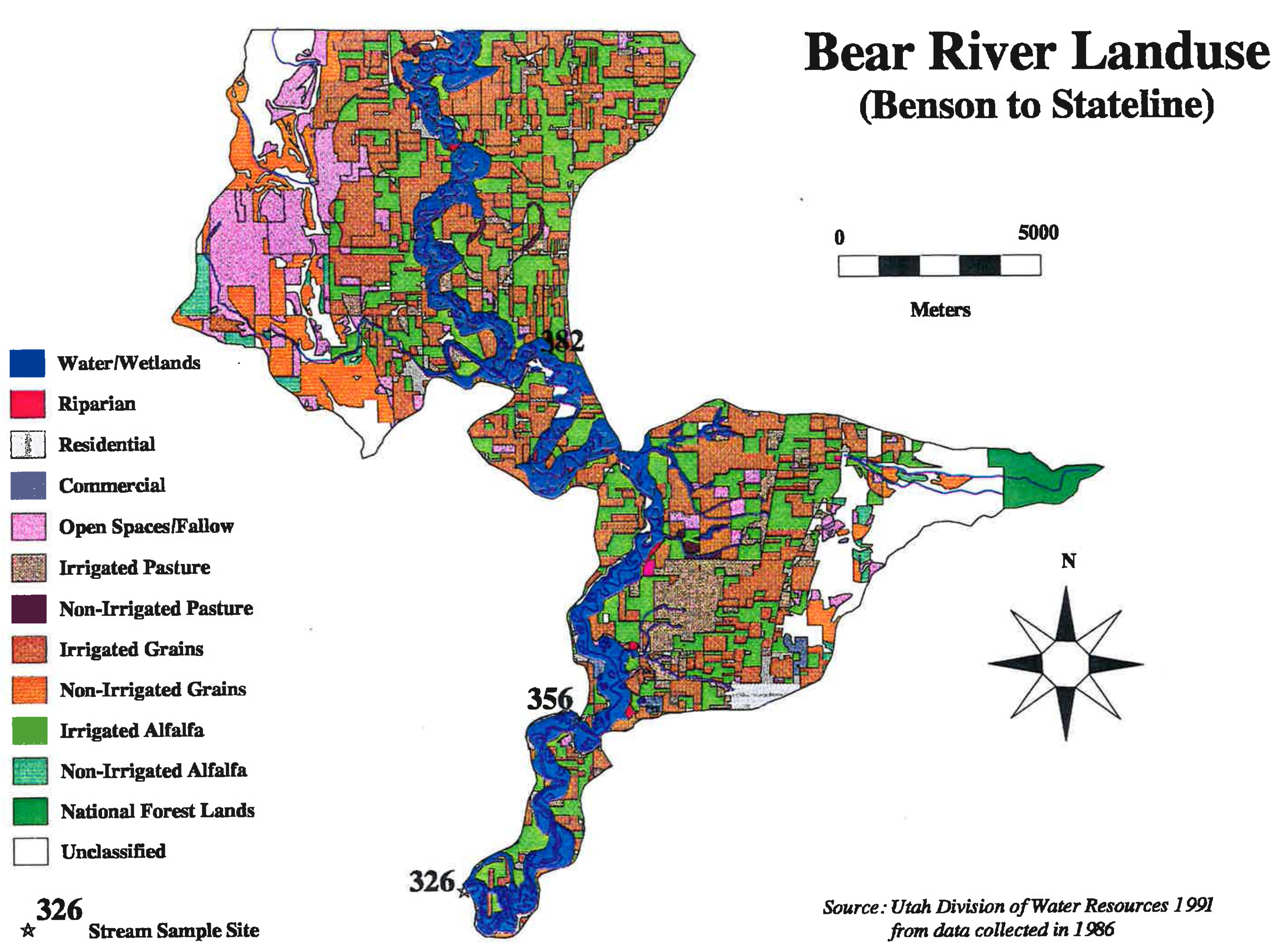



FIGURE 5-13. Bear River (Benson to stateline) landuse.

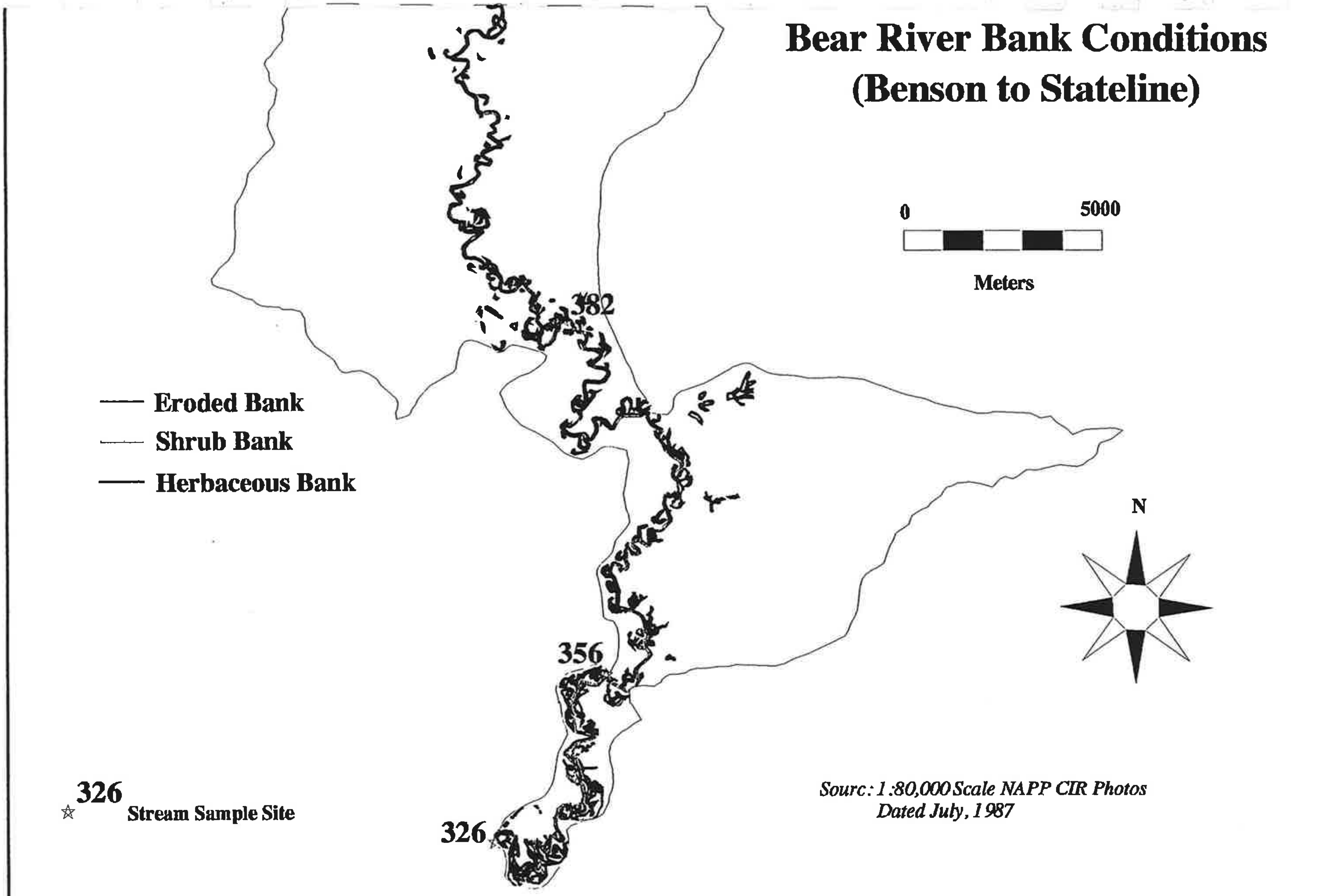



FIGURE 5-15. Bear River (Benson to stateline) bank conditions.

**TABLE 5-18. Attributes of the Bear River, from stateline to Benson.**

| | | ACRES | PERCENT |
|---|---|---|---|
| **UPLAND LANDUSES** | | | |
| irrigated agriculture | | 27,369 | 56 |
| non-irrigated agriculture | | 3,573 | 7 |
| open/unknown | | 9,560 | 20 |
| urban | | 1,485 | 3 |
| water/wetlands | | 6,376 | 13 |
| National Forest | | 637 | 1 |
| | **TOTAL** | **49,000** | **100** |
| **VALLEY BOTTOM VEGETATION TYPES** | | | |
| cropland | | 228 | 4 |
| hay meadow | | 1,648 | 27 |
| road/development | | 159 | 3 |
| water | | 1,513 | 25 |
| wetland | | 2,486 | 41 |
| | **TOTAL** | **6,033** | **100** |

| | | METERS | PERCENT |
|---|---|---|---|
| **VALLEY BOTTOM TYPE** | | | |
| lacustrine unconfined | | 77,480 | 100 |
| | TOTAL | 77,480 | 100 |
| **VALLEY BOTTOM STATE** | | | |
| graded, stable banks | | 26,553 | 34 |
| graded, unstable banks | | 26,868 | 35 |
| incised | | 5,495 | 7 |
| impounded | | 18,562 | 24 |
| | **TOTAL** | **77,480** | **100** |
| **BANK CONDITION** | | | |
| exposed | | 38,729 | 25 |
| herbaceous | | 73,849 | 48 |
| shrub | | 42,381 | 27 |
| | **TOTAL** | **154,959** | **100** |

**TABLE 5-19. Average daily loads for the 1993 water year at Bear River sites and tributaries above Cutler Reservoir.**

| | SITE NUMBER | AVERAGE WATER YEAR LOADS (kg/day) | | | | | |
|---|---|---|---|---|---|---|---|
| | | TP | DTP | TSS | $NH_3$ | $NO_3$ | FLOW (cfs) |
| Bear River at stateline | 490610 | 234 | 70 | 107,000 | 185 | 970 | 720 |
| Bear River at Richmond | 490382 | 238 | 64 | 141,000 | 164 | 1,180 | 720 |
| Cub River | 490425 | 136 | 68 | 43,100 | 58 | 835 | 191 |
| Summitt Creek | 490350 | 3 | 1 | 3,320 | 1 | 23 | 21 |
| Bear River at Amalga | 490356 | 425 | 174 | 224,000 | 271 | 2,010 | 969 |
| Hopkins slough | 490451 | 3 | 1 | 395 | 2 | 44 | 9 |
| Bear River at Benson | 490326 | 410 | 164 | 139,000 | 224 | 2,480 | 969 |
| **Local accrual within the Bear River Corridor** | | | | | | | |
| Stateline to Richmond | | 4 | -6 | 34,153 | -22 | 211 | 0 |
| Richmond to Amalga | | 48 | 42 | 36,118 | 49 | -27 | 36 |
| Amalga to Benson | | -18 | -12 | -85,420 | -50 | 421 | -4 |

and that the sediment loads cannot be entirely accounted for by redistribution of existing bedload. The aim of this management plan is to reduce as much of the external loading of sediments as possible.

The main external sources of sediment to the Bear River are direct erosion of banks and runoff from surrounding lands, which occurs during spring snowmelt and from irrigation return flows. Bank conditions in this reach were mapped from aerial photos. Only one percent of the banks were designated as exposed below Richmond (490382) using this approach. Field verification determined, however, that this is a low estimate. Many banks are cut vertically, with herbaceous vegetation up to the edge of the vertical exposed banks. From Richmond to Amalga, almost 15 percent of the banks were cut, with three to four feet of exposed banks during late summer flows (approximately 700 cfs in 1993). In some cases, slumping and revegetation on the more graded banks has occurred. From Amalga to Benson, about 10 percent of the banks are cut, with one to two feet of exposed banks during late summer flows. These cut banks probably represent typical high water elevations during runoff flows. Most of the cut banks occurred on the outer curves in bends. In these cases, the presence of grazing animals or other agricultural activity was not necessarily associated with the bank erosion. Rather, it appears to result from natural shear forces of river flows acting on the erodible lacustrine soils in the lower Bear River valley. High flows during runoff result in increased shear forces on the river banks. In addition, daily fluctuations occur in the river as a result of power peaking from Oneida Reservoir. River elevations at the stateline vary by two or more feet on a daily basis. This daily change in flow may also contribute to bank instability, increased sloughing, and increased sediment load to the river.

Other areas of streambank erosion are caused by using the riparian area for intense grazing or for feedlot operations. This has caused several areas with severely degraded vegetation, trampling of the banks and erosion problems. At several sites, the riparian area has been completely denuded and severe erosion continues to occur. In these cases, direct inputs of animal waste is an exacerbating problem (Figure 5-14).

The contribution of runoff from agricultural lands to sediment loading is also difficult to determine. The land draining directly to the Bear River from the stateline to the site near Amalga (490356) is mostly in agricultural use (Table 5-18). Downriver from Amalga to the site near Benson (490326), slightly more than 40 percent of the local drainage area is agricultural land, while over 50 percent is wetlands or open water. Vegetation mapping of the valley bottom from the stateline to Benson also indicates a shift in landuses along the river (Figure 5-12). From the stateline to the site near Richmond (490382), 44 percent of the valley bottom is hay meadow and 12 percent is upland shrublands, while just 22 percent was mapped as wetlands. In contrast, almost 60 percent of the valley bottom from Richmond to Benson was mapped as wetlands. It should be noted that these wetland areas are often used for grazing and other agricultural purposes. Seasonal patterns in sediment loading suggest that direct bank erosion from vertical banks and flooded valley bottom areas is most important in the lower gradient reach of the river from Amalga to Benson. Almost 60 percent of the sediment carried in the water column at the site near Benson was transported during runoff, and only 9 percent of the sediment was transported during the summer irrigation season. In contrast, only 40 percent of the sediment carried in the river at the upstream sites was transported during runoff, with about 15 percent carried during the irrigation season. This suggests that irrigation return flows may have a greater impact on total sediment loading in the reach from the stateline to Amalga than in the reach below Amalga. The reach below Amalga contains greater valley bottom areas which may be flooded during runoff. The impact of runoff flows on sediment loading, therefore, is probably more important in this reach.

Much of the sediment loading in the upper portion of this reach appears to be a result of natural actions of the river on the erodible soils of the Bear River basin. Attempting to target a specific reduction in sediment loading, therefore, is impractical. Recommendations in this reach are to improve agricultural practices to reduce sediment runoff and sediment loss during irrigation and to reduce the flushing of animal waste and soil from agricultural areas in the floodplain. These best management practices (BMPs) include conservation tillage (leaving 30% of the soil surface covered with crop residue after planting), establishing no-till agriculture, establishing greenbelts, wetland complexes or sedimentation basins to filter irrigation return flows prior to re-entering the Bear River, and optimizing the volumes of irrigation water used to reduce return flows. In several areas, feedlot activities have seriously impacted the riparian areas. These sites should be restored. Improved operations would include fencing, rotation of animal access sites, and development of off-river watering so riparian areas are not constantly impacted by grazing and trampling. Overgrazing in low-lying valley bottom areas leaves little vegetation to trap sediments during flooding and runoff events. A reduction in the intensity of grazing in these areas would improve vegetation and allow these areas to return to their role as sediment filters.

**Recommendations:**

- Continue implementing BMPs to reduce sediment inputs from agricultural lands. These include no-till agriculture, greenbelts, sedimentation basins or wetland complexes to filter return flows, optimizing fertilizer and irrigation water use.
- Improve the isolated areas where severe overgrazing and trampling in the riparian area has led to serious erosion problems. Fence areas, restrict animal access, provide off-stream watering facilities, restore and revegetate the banks.
- Evaluate the effects of water level fluctuations on exposed, vertical banks.

### 5.2 Potential Reduction in Phosphorus Loadings

Phosphorus loads following improvements in the targeted subdrainages were calculated using percent reductions chosen to represent medium and high levels of effort. In Table 5-20, these predicted loads are compared to the 1993 loads (assumed to be a no action alternative) and to the TMDL for total phosphorus and dissolved total phosphorus.

It is difficult to accurately predict changes in phosphorus loading following improvements in management practices. Uncertainty exists in all elements of the predicted values. The 1993 water year loads contain uncertainty in measurement and in extrapolating from discrete samples to an annual average value. The estimated loadings from nonpoint sources contain uncertainty in the areas of different landuses and in the loading coefficients for those landuses. In addition, no adjustments were made for specific soil types, slope of the land, distance from a waterbody and other factors which affect nonpoint source loadings. Finally, the amount of improvement possible from different remediations is compiled from other studies under a number of different conditions and thus is not an exact prediction. Whenever possible, coefficients and remediation studies which fit the conditions in the Bear River basin were used. The coefficients used and the assumed percent improvement are summarized in Table 5-3.

Given the uncertainty of these predictions, the predicted loads have interesting management implications. Even with an intense level of remediation, predicted TP would remain almost three times the TMDL for TP below Cutler dam. This reflects the high concentrations of TP associated with sediment loads in the Bear River system. Because this sediment-bound phosphorus is fairly non-reactive (not biologically available), this management plan is proposing to regulate DTP, rather than TP. This dissolved

**TABLE 5-20. A summary of the total phosphorus and dissolved total phosphorus TMDLs, 1993 loads and predicted loads at four lower Bear River sites assuming medium and high remediation effort in the four targeted subdrainages. Reduced loads are detailed in Tables 5-9, 5-13, and 5-17.**

| TOTAL PHOSPHORUS | | | | |
|---|---|---|---|---|
| | | | PREDICTED LOAD (kg/day) | |
| BEAR RIVER SITES | TMDL (kg/day) | 1993 LOAD (kg/day) | MEDIUM REMEDIATION EFFORT | HIGH REMEDIATION EFFORT |
| Utah-Idaho stateline | 121 | 234 | 234 | 234 |
| Above Cutler (Smithfield) | 136 | 425 | 366 | 317 |
| Below Cutler (Collinston) | 154 | 786 | 564 | 408 |
| Above the Bear River Bird Refuge (Corinne) | 183 | 866 | 644 | 489 |

| DISSOLVED TOTAL PHOSPHORUS | | | | |
|---|---|---|---|---|
| | | | PREDICTED LOAD (kg/day) | |
| BEAR RIVER SITES | TMDL (kg/day) | 1993 LOAD (kg/day) | MEDIUM REMEDIATION EFFORT | HIGH REMEDIATION EFFORT |
| Utah-Idaho stateline | 121 | 70 | 70 | 70 |
| Above Cutler (Smithfield) | 136 | 174 | 140 | 116 |
| Below Cutler (Collinston) | 154 | 468 | 291 | 172 |
| Above the Bear River Bird Refuge (Corinne) | 183 | 480 | 303 | 184 |

portion of the TP in the Bear River is more biologically available and thus more tightly coupled to the water quality problems which arise from increased nutrients.

Predicted DTP above Cutler dam was reduced to the TMDL load (136 kg/day) with a medium effort. This same level of effort, however, reduced DTP at the site below Cutler by 35 percent (from almost 470 kg/day to 290 kg/day) which is still two times the proposed TMDL for this point in the Bear River drainage (154 kg/day). Downriver DTP was predicted to be quite close to the TMDL from Collinston to Corinne following a high level of effort in reducing sources.

### 5.3 Future Monitoring

Water quality and other monitoring will be necessary to determine the effectiveness of any remediation activities in the project area. Utah's Division of Water Quality will continue their long-term ambient monitoring program in the Bear River basin. They are currently sampling the Bear River at the stateline and above Cutler Reservoir. The Little Bear River drainage is being monitored at the site above Cutler Reservoir, at sites above and below the town of Wellsville, and two sites above Hyrum Reservoir. Sampling sites in the Spring Creek drainage will be the same as those in this study. Finally, the Logan River will be monitored at the mouth of Logan Canyon. Several point sources (Logan Lagoons, Richmond WWTP, Hyrum WWTP, EA Miller WWTP and White's Trout Farm) will also be sampled on a regular basis. In addition to water samples, the state will continue to collect macroinvertebrate samples at several sites in the Bear River and the Little Bear River drainage.

As water quality projects are developed in the targeted subdrainages, additional monitoring will be necessary. Specifics of these monitoring plans will be included in the specific project plans. In general, upstream and downstream water quality sites must be monitored and downstream macroinvertebrate samples collected before and after project implementations. When projects begin in targeted subdrainages, water quality monitoring for TMDL parameters at the TMDL locations must also be conducted. For example, monitoring on the Cub River above the Bear River confluence and at the stateline should be reinstated once projects in this subdrainage begin. Finally, in project areas involving restoration of streambanks and riparian areas, an assessment of the riparian community both before and after implementation should be conducted.

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## 6.0 CONCLUSIONS

Water quality problems in the lower Bear River basin arise primarily from high phosphorus and total suspended sediment concentrations. In particular, DTP contributes to eutrophication of existing reservoirs, and will certainly cause any additional reservoirs in the basin to be eutrophic. Eutrophication causes diminished recreational and fisheries benefits in reservoirs. Other impacts on fisheries arise from violations of state criteria for dissolved oxygen and ammonia, especially in the Spring Creek portion of the Little Bear drainage. High sediment loads in the Cub River and the mainstem Bear River also restrict fisheries in these rivers. Periodic high sediment concentrations in other tributaries stress the coldwater fisheries in these waters. Violations of coliform criteria occurred throughout the basin, but were most severe in the Spring Creek subdrainage and indicate potential public health concerns.

Total maximum daily loads were calculated for nutrients, total dissolved phosphorus and total suspended solids within specific reaches of the mainstem Bear River and its tributaries. These target loads are intended to protect beneficial uses within the rivers and to ultimately attain the TMDLs in the reservoirs in the system.

This project identified specific reaches and tributaries whose contributions to these problems were particularly significant. These include the Spring Creek drainage, entering the Bear River at the south end of Cutler Reservoir, the Cub River within Utah, and the mainstem Bear River from the stateline to below Cutler Reservoir. Cutler Reservoir itself was a major contributor of sediments and phosphorus. Although the Little Bear River did not appear to be among the most serious contributors to the Bear River, problems within this drainage exist as well. As a result, water quality in Hyrum Reservoir is compromised.

Recommendations specific to the top four targeted subdrainages or reaches appear in Section 5.1. In general, these recommendations include improving riparian areas, removing feedlots and other intensive grazing activity from the river corridors, implementing nontill agriculture to reduce sediment inputs from croplands, and improving manure management throughout the watershed. Although most point sources in the drainage are permitted and in general meet their permit requirements, several point sources are significant contributors of phosphorus. To obtain real improvements in dissolved total phosphorus in this drainage, point sources will have to reduce their phosphorus loadings.

### 6.1 Recommendations

Because much of this drainage is currently agricultural, many of the nonpoint problems are attributed to agricultural activities. The large nutrient inputs from the Logan WWTP are the most significant identified source of pollutants from urbanized areas. Stormwater runoff from the towns in Cache Valley were not identified as a major problem in this study. As this valley becomes more urbanized, however, nonpoint inputs from lawns, parking lots and other urban sources will be an increasing problem. It is important that all citizens in the lower Bear River basin understand their individual roles in reducing water pollution. Fertilizer use on lawns, inappropriate dumping and washing household chemicals down drains all contribute to water quality problems and without good educational efforts, these problems will increase over time.

Recommendations approved by BRWQMP Steering Committee, May 10, 1995

1. Establish target TMDLs for dissolved total phosphorus through voluntary compliance with established time frames. These TMDLs will be refined at the end of this period. The TMDLs are calculated for specific reaches of the mainstem Bear River and tributaries to the Bear River.

2. Use the TMDLs calculated for suspended solids and nitrates as nonenforceable guidelines. Use existing enforceable standards for dissolved oxygen, ammonia and coliforms.

3. Develop Project Implementation Plans for improving water quality in the following subwatersheds:
    a) Spring Creek (tributary to Little Bear)
    b) The Cub River in Utah. Work with Idaho on that portion of the drainage in Idaho
    c) The Bear River from Benson to below Cutler Dam, including Cutler Reservoir
    d) The Bear River above Benson to the site near Richmond.

4. Encourage those WWTPs in the lower Bear River basin with significant phosphorus loading impacts to determine if changes in operations are possible which would reduce dissolved phosphorus loads from these sources. If operational changes are not possible, tertiary treatment for phosphorus removal may be necessary. To increase the existing database on phosphorus concentrations in the effluent, UDWQ should add DTP analysis to the samples they collect at regular intervals.

5. Develop a long-range monitoring program to document water quality improvements during and after PIP implementations. Integrate water quality sampling and biomonitoring programs. Continued water quality monitoring will determine whether TMDLs are being met. Monitoring of riparian areas, macroinvertebrate populations and fisheries will help determine the true health of these areas, and more directly evaluate the gains in beneficial uses as water quality improves with improved landuse practices.

6. Continue working with existing local agencies and extension services to encourage BMPs in all agricultural lands in the valley. In addition, increase awareness on urban contributions to water pollution and educate the public on measures that can be taken to reduce this problem. There is a need for a coordinator to oversee the existing and new efforts in the lower basin. The existing BRWQMP steering committee will continue to function in an advisory capacity.

7. Work with Idaho and Wyoming to develop an integrated water quality plan for the entire Bear River basin.

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