1. Subbasin Assessment – Watershed Characterization

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. Currently this list must be published every two years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards. (In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.) This document addresses the water bodies in the King Hill-C.J. Strike Reservoir Subbasin that have been placed on Idaho's current §303(d) list.

The overall purpose of the subbasin assessment (SBA) and TMDL is to characterize and document pollutant loads within the King Hill-C.J. Strike Reservoir Subbasin. The first portion of this document, the SBA, is partitioned into four major sections: watershed characterization, water quality concerns and status, pollutant source inventory, and a summary of past and present pollution control efforts (Sections 1–4). This information will then be used to develop a TMDL for each pollutant of concern for King Hill-C.J. Strike Reservoir Subbasin (Section 5).

1.1 Introduction

In 1972, Congress passed the Federal Water Pollution Control Act, more commonly called the Clean Water Act. The goal of this act was to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Water Environment Federation 1987, p. 9). The act and the programs it has generated have changed over the years as experience and perceptions of water quality have changed.

The CWA has been amended 15 times, most significantly in 1977, 1981, and 1987. One of the goals of the 1977 amendment was protecting and managing waters to insure "swimmable and fishable" conditions. This goal, along with a 1972 goal to restore and maintain chemical, physical, and biological integrity, relates water quality with more than just chemistry.

Background

The federal government, through the U.S. Environmental Protection Agency (EPA), assumed the dominant role in defining and directing water pollution control programs across the country. The Department of Environmental Quality (DEQ) implements the CWA in Idaho, while the EPA oversees Idaho and certifies the fulfillment of CWA requirements and responsibilities.

Section 303 of the CWA requires DEQ to adopt water quality standards and to review those standards every three years (EPA must approve Idaho's water quality standards). Additionally, DEQ must monitor waters to identify those not meeting water quality standards. For those waters not meeting standards, DEQ must establish a TMDL for each pollutant impairing the waters. Further, the agency must set appropriate controls to restore water quality and allow the water bodies to meet their designated uses.

These requirements result in a list of impaired waters, called the "§303(d) list." This list describes water bodies not meeting water quality standards. Waters identified on this list require further analysis. A SBA and TMDL provide a summary of the water quality status and allowable TMDL for water bodies on the §303(d) list. The *King Hill-C.J. Strike Reservoir Subbasin Assessment and TMDL* provides this summary for the currently listed waters in the King Hill-C.J. Strike Reservoir Subbasin.

The SBA section of this document (Sections 1–4) includes an evaluation and summary of the current water quality status, pollutant sources, and control actions in the King Hill-C.J. Strike Reservoir Subbasin to date. While this assessment is not a requirement of the TMDL, DEQ performs the assessment to ensure impairment listings are up-to-date and accurate. The TMDL is a plan to improve water quality by limiting pollutant loads. Specifically, a TMDL is an estimation of the maximum pollutant amount that can be present in a water body and still allow that water body to meet water quality standards (water quality planning and management, 40 CFR Part 130). Consequently, a TMDL is water body- and pollutant-specific. The TMDL also allocates allowable discharges of individual pollutants among the various sources discharging the pollutant.

Some conditions that impair water quality do not receive TMDLs. The EPA does consider certain unnatural conditions, such as flow alteration, human-caused lack of flow, or habitat alteration that are not the result of the discharge of a specific pollutants as "pollution." However, TMDLs are not required for water bodies impaired by pollution but not by specific pollutants. A TMDL is only required when a pollutant can be identified and in some way quantified.

Idaho's Role

Idaho adopts water quality standards to protect public health and welfare, enhance the quality of water, and protect biological integrity. A water quality standard defines the goals of a water body by designating the use or uses for the water, setting criteria necessary to protect those uses, and preventing degradation of water quality through antidegradation provisions.

The state may assign or designate beneficial uses for particular Idaho water bodies to support. These beneficial uses are identified in the Idaho water quality standards and include the following:

- Aquatic life support–cold water, seasonal cold water, warm water, salmonid spawning, modified
- Contact recreation–primary (ingestion likely), secondary (ingestion not likely)
- Water supply–domestic, agricultural, industrial
- Wildlife habitats
- Aesthetics

The Idaho legislature designates uses for water bodies. Industrial water supply, wildlife habitats, and aesthetics are designated beneficial uses for all water bodies in the state. If a water body is unclassified, then cold water and primary contact recreation are used as additional default designated uses when water bodies are assessed.

A SBA entails analyzing and integrating multiple types of water body data, such as biological, physical/chemical, and landscape data to address several objectives:

- Determine the degree of designated beneficial use support of the water body (i.e., attaining or not attaining water quality standards).
- Determine the degree of achievement of biological integrity.
- Compile descriptive information about the water body, particularly the identity and location of pollutant sources.
- Determine the causes and extent of the impairment when water bodies are not attaining water quality standards.

1.2 Physical and Biological Characteristics

Describing physical and biological parameters of the subbasin aids assessing characteristics relevant to pollutants impairing beneficial uses. To begin evaluating the King Hill-C.J. Strike subbasin for sensitivity to activities that may impair beneficial uses of its waterbodies, the climate, hydrology, geology, soils, vegetation, and assemblages of aquatic life are identified and described.

The King Hill-C.J. Strike subbasin lies mainly in plains and low hills of the western Snake River plain. Figure 1 shows the location of the subbasin within Idaho. The climate is very arid. The Snake River is the primary drainage with most tributaries intermittent or dry. Irrigation is highly developed in this area. Geology is mainly sedimentary and volcanic rocks. Potential natural vegetation is sagebrush (*Artemisia*) steppe with some saltbush (*Atriplex*) communities where fine, high-mineral soils occur.

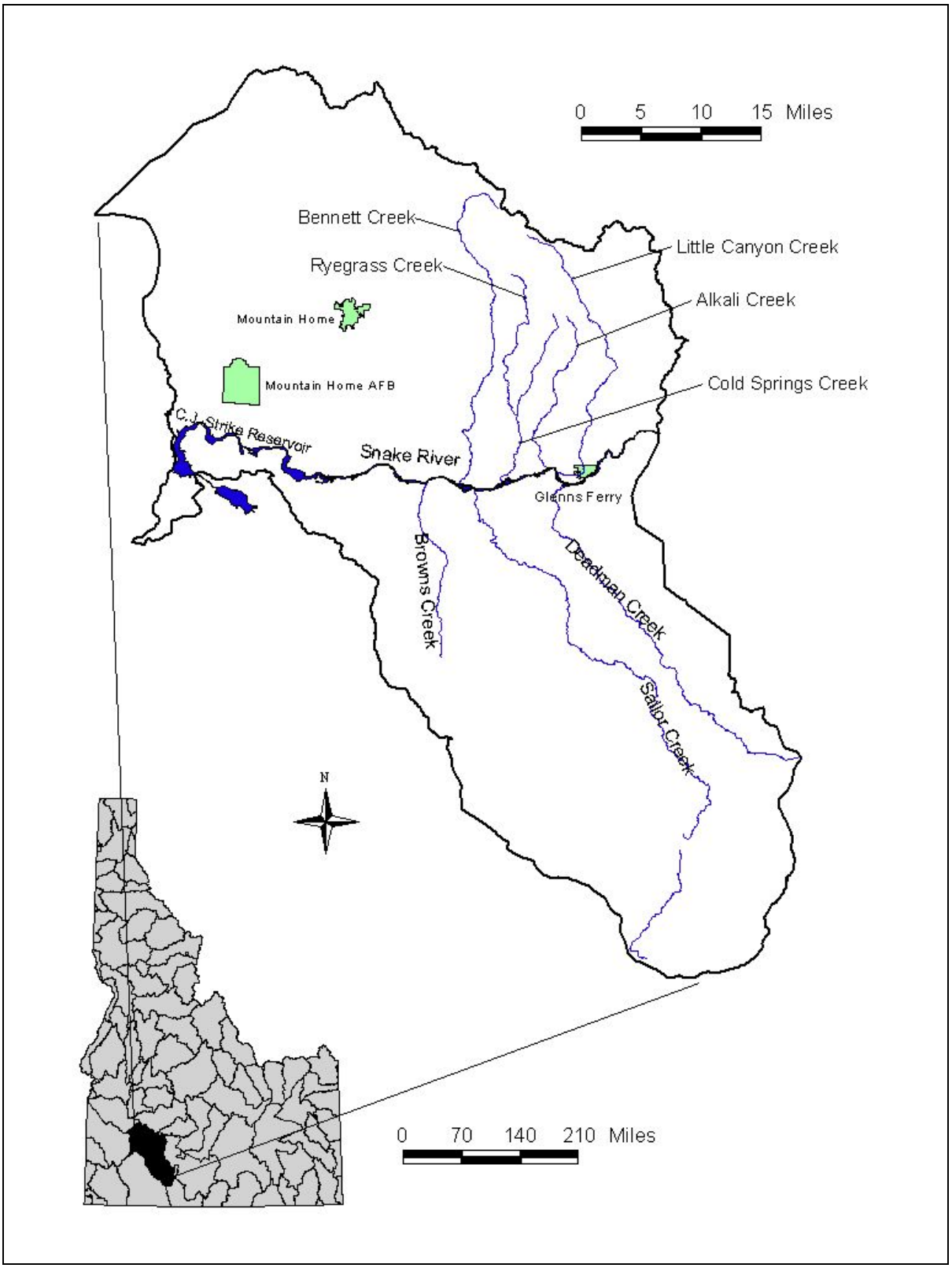


Figure 1. Location of King Hill-C.J. Strike Watershed within Idaho

Climate

The climate of the King Hill-C.J. Strike watershed is dry and temperate. Precipitation values over the Snake River plain as a whole are low because the region is in a large structural depression between two mountain ranges. To the west, the Cascade Mountains capture much of the moisture from oceanic air masses moving east. To the east, the Rocky Mountains shield the Snake River plain from continental cold air masses that sweep from Canada to the Gulf of Mexico (IDWR 1985, Abramovich et al. 1998). Overall, climate differences result more from changes in elevation and aspect rather than latitude.

Primary weather stations (Table 1) in the King Hill-C.J. Strike watershed are located at Glenns Ferry and Mountain Home (Western Regional Climate Center 2004).

Table 1. Summary of monthly data from 1948 through 2003 for Glenns Ferry and Mountain Home weather stations.

Period	Glenns Ferry			Mountain Home		
	Temperature °F		Precipitation	Temperature °F		Precipitation
	Mean Maximum	Mean Minimum	Mean Total (in.)	Mean Maximum	Mean Minimum	Mean Total (in.)
Jan.	39.2	20.3	1.47	38.2	20.4	1.34
Feb.	47.9	24.9	0.98	45.1	24.2	0.86
March	56.8	29.1	0.87	53.7	28.8	1.06
April	66.8	34.9	0.68	63.1	34.4	0.84
May	76.4	42.7	0.82	72.8	42.2	0.87
June	85.5	50.0	0.68	83.0	49.9	0.73
July	95.9	55.4	0.20	93.0	56.4	0.27
August	93.4	52.5	0.26	91.5	54.2	0.28
Sept.	82.6	43.5	0.42	80.9	45.1	0.51
Oct.	69.4	33.4	0.55	67.3	35.1	0.63
Nov.	52.6	27.2	1.24	50.0	27.3	1.19
Dec.	41.2	21.7	1.26	39.3	21.3	1.29
Annual	67.3	36.3	9.43	64.8	36.6	9.87

On average between the two weather stations, monthly mean maximum temperatures climb to the mid 90s (°F) on average during summer months with the highest maximum temperatures occurring in July and August, while mean minimum temperatures can drop as low as 20 °F in the winter. The annual average maximum temperature is 66 °F and the annual average minimum temperature is 36 °F for the region. Total mean annual precipitation averages less than 10 inches for the region (Western Regional Climate Center 2004).

Solar radiation values are highest during July. Cloud cover varies throughout the year, but there are an overall high proportion of sunny days in this subbasin. Winter is only moderately sunny, with cloudiest conditions in December and January. Clear, sunny skies are common throughout the summer (IDWR 1985).

Relative humidity is low and evaporation is rapid. Because of the low relative humidity, sensible temperatures are low. Where irrigation occurs throughout the growing season, humidity is several percent above the generally arid summer conditions (IDWR 1985).

Subbasin Characteristics

Ecoregion divisions can provide an overall picture of the King Hill-C.J. Strike watershed. Ecoregions are used by scientists to classify areas with similar climate, vegetative cover, geology, soils, and land use. The King Hill-C.J. Strike subbasin lies mainly within the Snake River Plain ecoregion, a dry area with low hills and plains. This ecoregion generally contains low-gradient streams with warmer temperatures and finer substrates than in more mountainous regions (McGrath 2001).

Geology

The Snake River plain characterizes the King Hill-C.J Strike subbasin. A topographic lowland filled with sedimentary and volcanic deposits, the western Snake River plain is, like most of the Basin and Range province, a *graben*—a block of the Earth's crust that has dropped.. This fault-bounded basin, about 70 kilometers wide by 350 kilometers long, separates the granitic Idaho batholith of west central Idaho from similar granitic rock in the Owyhee highlands to the south. Further east, volcanism and its associated tectonism forms the central Snake River plain similar to the processes shaping the landscape of northern Nevada, southern Idaho, and Yellowstone National Park. The area from Bruneau to Mountain Home is near the intersection of the western graben-type landscape and the central Snake River plain northeast-trending volcanism (Jenks and Bonnichsen 1989).

Much of the King Hill-C.J. Strike subbasin lies within the boundaries of the Lake Idaho basin, a large Tertiary age lake. The approximate shoreline of Lake Idaho follows a major topographic break, following the 3,800-foot elevation contour line (Figure 2). While Lake Idaho was full of water, thick layers of sediment were deposited in a wide area at the edges of the lake. In the Glenns Ferry vicinity, the thick lacustrine (of, or relating to lakes) layers can be seen today. These formations are part of the "Idaho Group" of lacustrine, fluvial, and flood plain sediments that were deposited from late Miocene through early Pleistocene time as the western Snake River plain subsided. Through much of this time, small volcanoes episodically erupted on the western Snake River Plain and deposited thick sequences of basalt in many areas. When volcanic eruptions contacted the margin of Lake Idaho, the lava cooled quickly to form characteristic basaltic formations that can be seen today along much of the 3,800-foot elevation contour line (Jenks and Bonnichsen 1989). In the late Pleistocene, the catastrophic outflow of Lake Bonneville scoured and shaped the current channel formation of the Snake River, breaking the dam for Lake Idaho. Then, a succession of lava flows deflected the Snake River channel into its current course along its south bank.

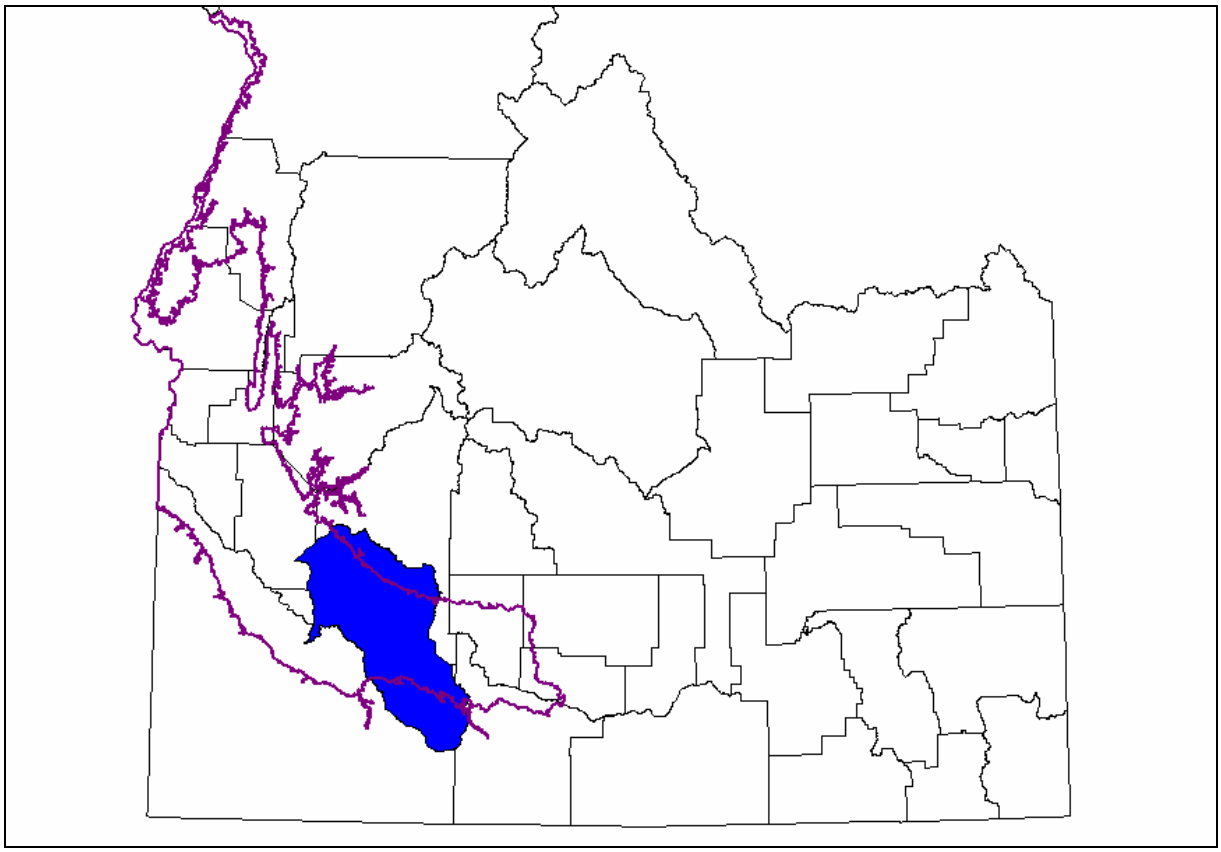


Figure 2. Boundary of Lake Idaho.

Surficial features of the King Hill-C.J. Strike subbasin are all fairly young in geologic age (Figure 3). Most of the lava flows and sedimentary deposits filling the Snake River valley are from the late Tertiary to early Quaternary age. See Table 2 for a review of the geologic timescale. The oldest formations are along the northern boundary of the watershed (Maley 1987). Bowns Creek, Ditto Creek, and the headwaters of Canyon Creek flow from the Danskin Mountains, which have the oldest rock in the subbasin with outcroppings of Cretaceous plutons—igneous bodies crystallized slowly, deep underground. In the Mount Bennett Hills to the southeast are igneous outcrops of the Eocene age. Mount Bennett Hills and part of the Danskin Mountains in the north of the King Hill-C.J. Strike subbasin represent the southernmost extent of the Idaho batholith, a huge mass of granitic plutons covering most of central Idaho (Maley 1987).

At lower elevations north of the Snake River, young Pleistocene lava flows and sedimentary deposits overlay the older igneous outcroppings. The Pleistocene water laid detritus shown in Figure 3 are sedimentary deposits that form the relatively featureless landscape on both sides of Interstate 84 northwest of Mountain Home. Surrounding Mountain Home and reaching nearly to Hammett, the middle Pleistocene plateau and canyon-filling basalts can be seen from Interstate 84. The rest of the landscape north of the river is composed mainly of middle Pleistocene lava-dammed Snake Plain lakebeds near the river and upper Pleistocene lava flows (USGS 1978).

Table 2. Geologic Time Scale

Geologic Time Scale			
Era	Subdivisions		Approximate age before present, millions of years
	Period	Epoch	
Cenozoic	Quaternary	Holocene (Recent)	0.011
		Pleistocene	1.8-0.011
	Tertiary	Pliocene	5-1.8
		Miocene	24-5
		Oligocene	38-24
		Eocene	54-38
		Paleocene	65-54
Mesozoic	Cretaceous		146-65
	Jurassic		208-146
	Triassic		248-208
Paleozoic	Permian		280-248
	Pennsylvanian		325-280
	Mississippian		360-325
	Devonian		408-360
	Silurian		438-408
	Ordovician		505-438
	Cambrian		540-500
Precambrian	No subdivisions recognized worldwide		3,500-540

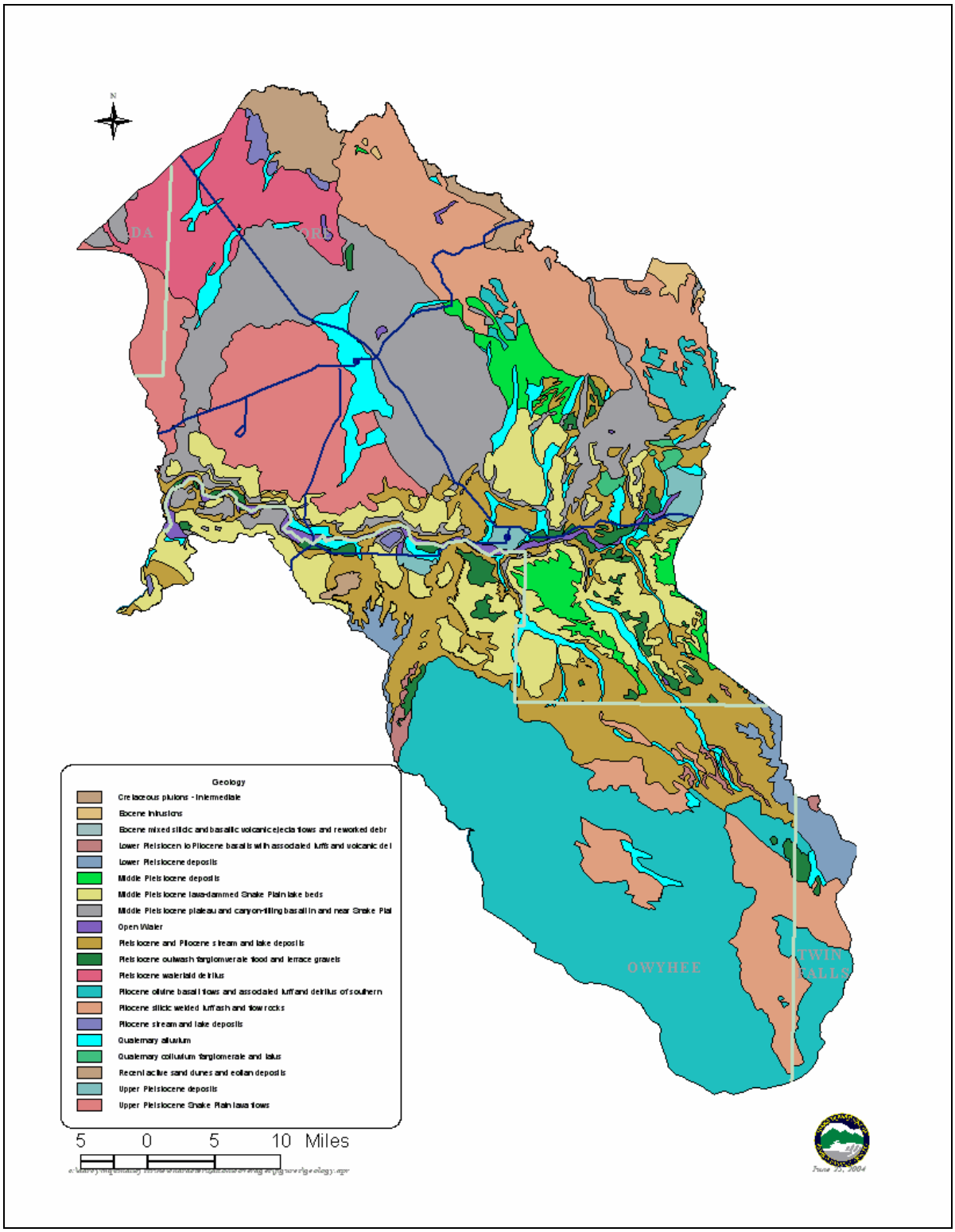


Figure 3. King Hill-C.J. Strike Subbasin Geological Data

Most of the geology south of the Snake River, in the King Hill-C.J. Strike subbasin, is from volcanic activity a little older than that north of the river. From the Saylor Creek Air Force Range, south through the Bruneau desert, the landscape is formed by Pliocene olivine basalt flows, with more silicic welded tuff ash to the east at the headwaters of Rosevear, Sailor, and Pothole Creeks. This is the type of landscape that formed Balanced Rock, because these basalts and welded tuffs are harder and more resistant to weathering (USGS 1978).

The Idaho Geological Survey has surveyed eastern Owyhee County and the proposed expansion of the Saylor Creek Bombing Range for mineral resources. Mineral resources include metallic mineral deposits and industrial materials, such as limestone, sand, and gravel.

Extended periods of volcanic activity provided heat and rare metals to the groundwater. When hot water circulated along fractures in rocks near the surface, gold and silver deposited in thick veins or hairline fractures. This type of epithermal gold and silver deposit has been discovered in western Owyhee County at DeLamar Mine. A rich source of gold has been found in eastern Oregon near Lake Owyhee where the gold is in sandy sediments interbedded with basalt. The geology in the current Saylor Creek Bombing Range is similar to this eastern Oregon site. The proposed expansion to the south of the present bombing range is underlain by basaltic rocks, which would mainly be a source of building materials, like flagstones and gravels (Idaho Geological Survey 2004).

From the legend in Figure 3, the “recent active sand dunes and eolian deposits” have been designated as the Bruneau Sand Dunes State Park. These dunes are unique in the Western Hemisphere. Other dunes in the Americas form at the edges of natural basins; these form near the center. The combination of a source of sand, a relatively constant wind activity, and a natural trap has caused sand to collect in this semicircular basin for over 20,000 years. Geologists believe the dunes seen today may have started with sands from the Bonneville Flood.

Unlike most dunes, these do not drift far. The prevailing winds blow from the southeast 28 percent of the time and from the northwest 32 percent of the time, keeping the dunes fairly stable. Two prominent dunes cover approximately 600 acres and rise 470 feet above ground level. The westernmost dune is reported to be the largest single-structured sand dune in North America (Digital Atlas of Idaho 2004).

Soils

The King Hill-C.J. Strike subbasin contains unconsolidated materials, including windblown dust, river sands and gravels, and talus. Soils derived from these unconsolidated materials range from silty clay loams to gravelly loams. Soils derived mainly from volcanic parent rock often have a stony surface above a hardpan horizon. Other finer-grained, poorly drained soils scattered throughout the region rise from the sedimentary deposits (Gehr et al. 1982).

Soils vary according to ecoregion, as shown in Figure 4. In the northernmost portion of the subbasin in the Danskin Range, the foothill shrublands-grasslands of the Idaho Batholith have mollisol and incepticol soil types with a xeric soil moisture regime. Mollisols are

mineral soils that have developed under grasslands. Xeric mollisols have a soil moisture regime with cool moist winters and warm dry summers. Some water is present in the soil but not at optimum times for plant growth.

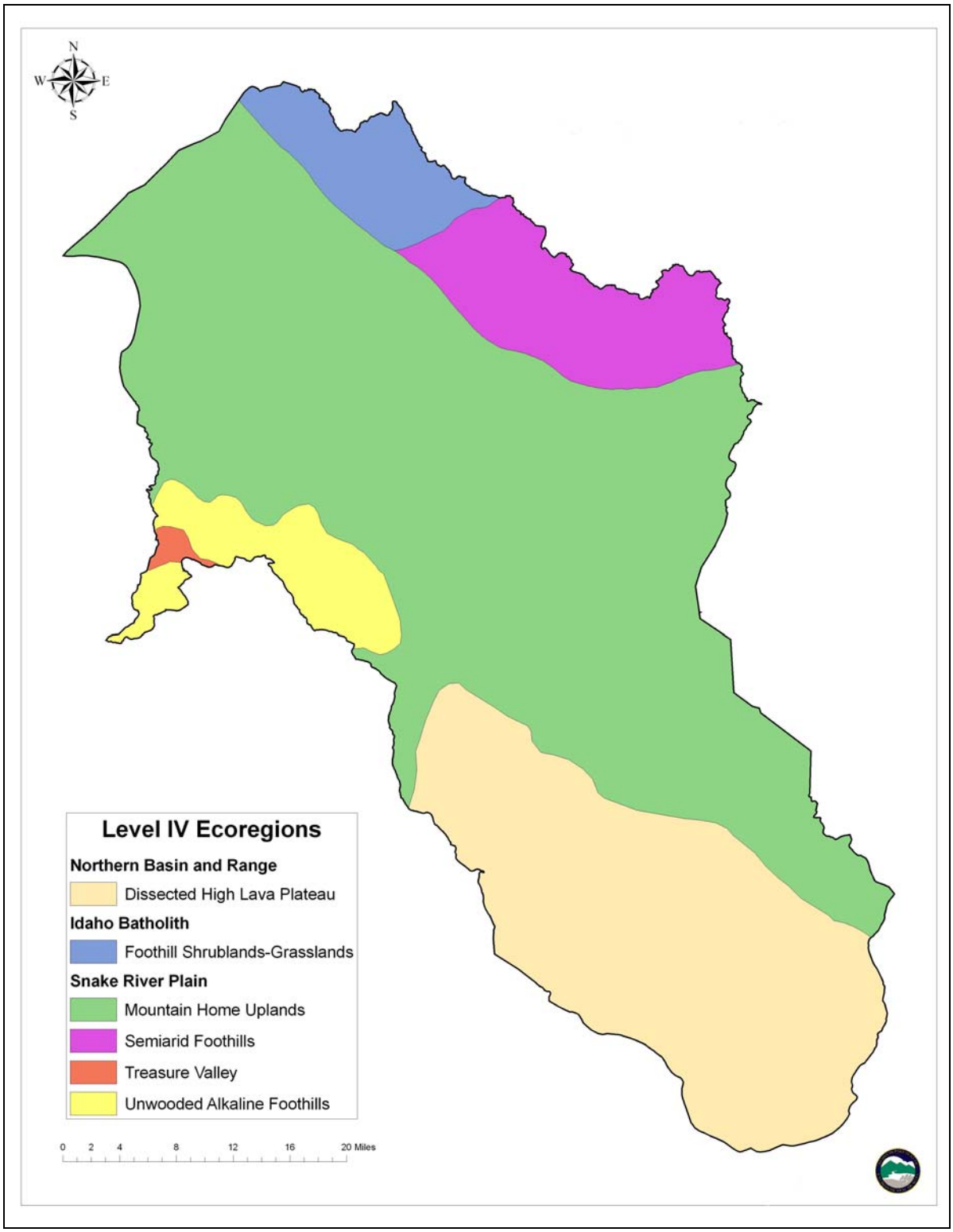


Figure 4. Ecoregions in the King Hill-C.J. Strike Subbasin

To the southeast of the Idaho batholith, in the Mount Bennett Hills, the semi-arid foothills of the Snake River Plain ecoregion contain mollisol and incepticol soil types with a xeric soil moisture regime. The incepticols are only in the steepest portions of this ecoregion.

Most of the King Hill-C.J. Strike subbasin is in the Snake River plain ecoregion, classified as the Mountain Home uplands, with aridisol soil types. Aridisols are mineral soils with an aridic moisture regime, which means that in average years, no water is available for plants for more than half the growing season. Aridisol soils are too dry for most plants. Plants growing in aridisols have to have some special adaptation for drought-tolerance, such as deep taproots or waxy leaf and stem surfaces to conserve water from evaporation. Some aridisols in the area have a salic horizon, which is an enrichment of a mineral soil with secondary salts that are soluble in cold water.

The unwooded alkaline foothills along the Snake River corridor have sandy, alkaline lacustrine deposits with three different soil types occurring in this ecoregion: aridisols, mollisols, and entisols with aridic and xeric moisture regimes. Entisols are characteristic of flood plains, having no diagnostic horizons because these soil types have been so recently deposited. As discussed previously, aridic regimes have water available for only half of the typical growing season; xeric moisture regimes have cool, moist winters with warm, dry summers, so that some water is present in the soil, but not at optimum times for plant growth.

To the south of the subbasin is the dissected high lava plateau ecoregion of the Northern Basin and Range. Here, the soils are aridisols and mollisols with aridic and xeric soil moisture regimes.

Vegetation

Just as soil types vary according to ecoregion, so too do plant types vary. In the foothill shrublands-grasslands of the Idaho batholith, potential natural vegetation is shrub-steppe with bluebunch wheatgrass (*Pseudoroegneria spicata*), basin big sagebrush and Wyoming big sagebrush (*Artemisia tridentata* ssp. *tridentata* and *Artemisia tridentata* ssp. *wyomingensis*), Thurber needlegrass (*Stipa thurberina*), Idaho fescue (*Festuca idahoensis*), bitterbrush (*Purshia tridentata*), and mountain snowberry (*Symphoricarpos oreophilus*). In a project that classified current conditions of low-elevation shrub-steppe vegetation (Rust 2003), the present plant associations in this area are as follows:

- Bluebunch wheatgrass-Sandberg bluegrass (*Poa secunda*), balsamroot daisy (*Balsamorhiza sagittata*) association
- Little sagebrush (*Artemisia arbuscula*) series
- Mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*)-mountain snowberry/Idaho fescue association
- Idaho fescue series
- Bitterbrush series

Comparing the potential natural vegetation with the present vegetation, this area has a healthy shrub-steppe with a good perennial understory of native grasses and forbes.

In the Mount Bennett Hills, the semi-arid foothills of the Snake River Plain ecoregion also contain a healthy shrub-steppe with a good perennial understory of native grasses and forbes. Here, the existing plant associations are:

- Little sagebrush-bitterbrush/bluebunch wheatgrass association
- Idaho fescue-Geyer's sedge (*Carex geyeri*)/silvery lupine (*Lupinus argenteus*)
- Needlegrass (*Stipa occidentalis*)/silvery lupine (Rust 2003).

Healthy shrub-steppe conditions in these two ecoregions may be due to the relatively higher altitudes with higher moisture availability. Other reasons may include lighter grazing pressure or inaccessible areas surrounded by difficult topography.

In the Mountain Home uplands ecoregion of the Snake River plain, potential natural vegetation is Wyoming and mountain big sagebrush, alkali sagebrush (*Artemesia longiloba*), and bitterbrush. On salty, high-mineral soils, the natural shrub species will be four-wing saltbrush and greasewood. Current conditions over most of this ecoregion are a desertified shrub-steppe (West 1999) where existing shrubs have introduced, weedy annuals in the understory. The weedy annuals are dominated by cheatgrass (*Bromus tectorum*), which has been introduced since the 1870s. Native plant regeneration is limited by low available moisture. Livestock can be used in the spring to reduce cheatgrass, but grazing at that time may also reduce any chance the native understory has of recovering (West 1999).

In the unwooded alkaline foothills of the Snake River plain, the potential natural vegetation is greasewood (*Sarcobatus vermiculatus*), shadscale saltbush (*Atriplex confertifolia*), inland saltgrass (*Distichlis spicata*), and desert seepweed (*Suaeda suffrutescens*) on the salty, high-mineral soils. On the sandy sediments that are not so alkaline, Wyoming big sagebrush can potentially occur with bluebunch wheatgrass, Thurber needlegrass, and Indian ricegrass (*Oryzopsis hymenoides*) in the understory. Current conditions have more weedy annual cheatgrass in the understory with some crested wheatgrass (*Agropyron spicatum*) introduced to increase forage production.

Introducing perennial grasses is a common management practice to rehabilitate shrub-steppe areas. Rehabilitation of burned rangeland and land treatments for forage production are successful with nonnative perennial grasses, such as crested wheatgrass or intermediate wheatgrass (*Agropyron intermedium*) because these nonnative species can germinate and survive with less than 12 inches of annual precipitation. However, areas with introduced perennial grasses may have less wildlife diversity than shrub-steppe with native grasses and forbes. If rehabilitation efforts are planned, including seed for native grasses and forbes is advisable.

The dissected high lava plateau of the Northern Basin and Range ecoregion to the south of the subbasin has been extensively rehabilitated with either crested wheatgrass in monocultural grasslands, or as an understory to the native Wyoming big sagebrush. Naturally, the understory in this region would have included Thurber needlegrass, bluebunch wheatgrass, and western wheatgrass.

Aquatic Life

Sensitive species in the King Hill-C.J. Strike subbasin include the white sturgeon (*Acipenser transmontanus*) and the Idaho Springsnail (*Pyrgulopsis idahoensis*). The white sturgeon is listed as a species of special concern by the State of Idaho (Idaho Conservation Data Center 2004) and a species of concern by the U.S. Fish and Wildlife Service. Most of the white sturgeon in this subbasin are in the reservoir, with the highest population in the upper reaches at river miles 504 and 505. Idaho Power Company has indicated that the viability of this population is dependant on the canyon reach of the Snake River from Bliss Dam to King Hill-Glenns Ferry. The Idaho Springsnail is listed as endangered under the Endangered Species Act. It has been found in both the Snake River and Bruneau River arms of the C.J. Strike Reservoir. Even though it is identified as a cold water species, Idaho Power has found the Idaho Springsnail in water temperatures greater than 22°C (Idaho Power 1998). The Idaho Springsnail once occupied the ancient Lake Idaho, so its habitat has been reduced since the ancient lake was drained by the Bonneville flood. In recent times, its habitat may be further reduced by hydroelectric facilities (although this is currently being evaluated) and degraded water quality creating a loss of habitat. This species feeds on plant debris and microorganisms.

Idaho Power Company has entered into agreements with the U.S. Fish and Wildlife Service for management of these sensitive species in the following documents:

- *Mid Snake River Offer of Settlement*—directs that additional studies and analysis are needed for Idaho Springsnail.
- *Snake River White Sturgeon Conservation Plan*, with both U.S. Fish and Wildlife Service and Idaho Department of Fish and Game—outlines management of population.

C.J. Strike Reservoir is utilized as a sport fishery, with smallmouth bass (*Micropterus dolomieui*) being the most abundant game fish sampled. The Bruneau arm of the reservoir is dominated by game fish species and has a higher concentration of fishes. The Idaho Department of Fish and Game and Idaho Power Company stock the reservoir with rainbow trout. There is no known suitable spawning habitat available in the reservoir for naturally-reproducing populations of rainbow trout (Idaho Power 1998).

In the Snake River, the U.S. Geological Survey (USGS) has collected fish species data at King Hill in an on-going study for the last nine years. These data show that main stem Snake River populations are dominated by native, non-game, cool-water species (Table 3 and Figure 5).

Table 3. Fish species data collected by USGS, Snake River at King Hill.

King Hill Fish Population						
USGS data						
Total individuals from 1993-2002						
Scientific Name	**Common name**	**Count**	**Native**	**Tolerance**	**Temperature preference**	**Habitat type**
Oncorhynchus mykiss	Rainbow trout	3	Native	S	Cold	hider
Prosopium williamsoni	Mountain whitefish	22	Native	I	Cold	benthic
Acrocheilus alutaceus	Chiselmouth	252	Native	I	Cold	benthic
Cyprinus carpio	Common carp	225	Alien	T	Warm	benthic
Mylocheilus caurinus	Peamouth	25	Native	I	Cool	water column
Ptychocheilus oregonensis	Northern pikeminnow	480	Native	T	Cool	water column
Rhinichthys cataractae	Longnose dace	6	Native	I	Cool	benthic
Rhinichthys falcatus	Leopard dace	6	Native	I	Cool	benthic
Rhinichthys osculus	Speckled dace	127	Native	I	Cool	benthic
Richardsonius balteatus	Redside shiner	390	Native	I	Cool	water column
Catostomus columbianus	Bridgelip sucker	54	Native	T	Cool	benthic
Catostomus macrocheilus	Largescale sucker	1276	Native	T	Cool	benthic
Micropterus dolomieu	Smallmouth bass	41	Alien	I	Cool	water column
Micropterus salmoides	Largemouth bass	5	Alien	T	Warm	water column
Pomoxis annularis	White crappie	55	Alien	T	Warm	water column
Pomoxis nigromaculatus	Black crappie	8	Alien	T	Warm	water column
Perca flavescens	Yellow perch	7	Alien	I	Cool	water column
Cottus bairdi	Mottled sculpin	140	Native	I	Cool	benthic

S: sensitive, T: tolerant, I: intolerant

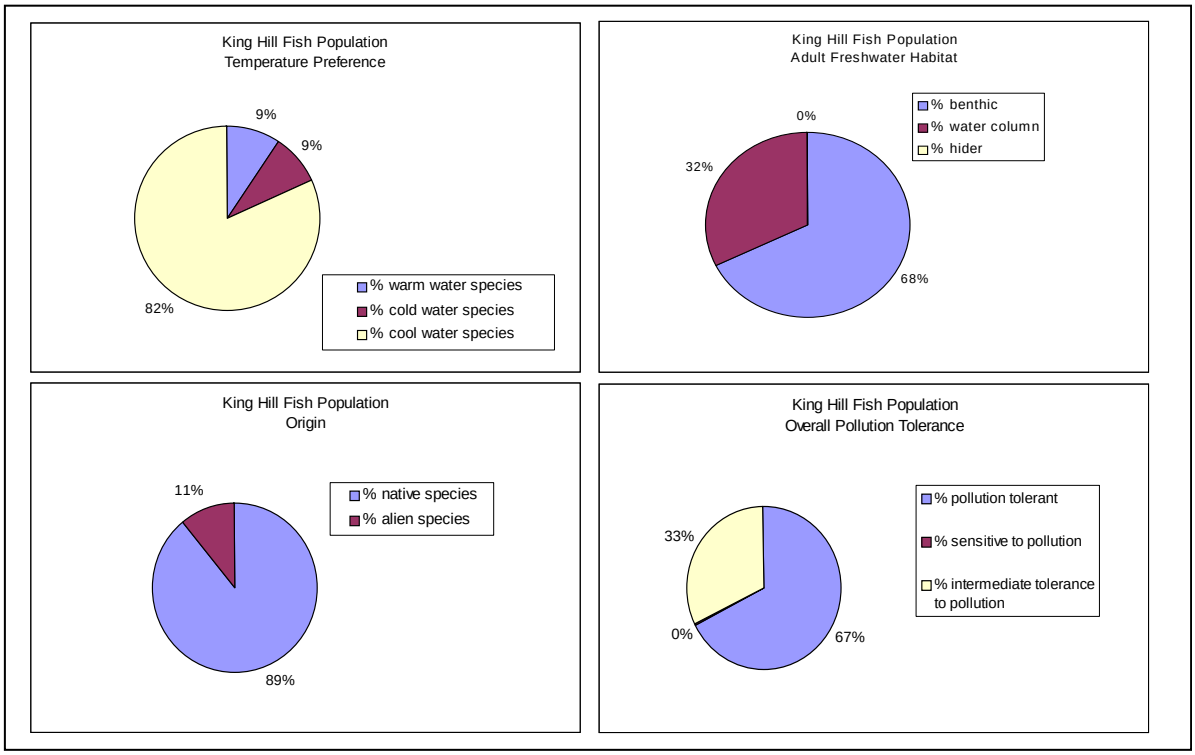


Figure 5. Categorization of fish species at King Hill.

In the tributaries of the King Hill-C.J. Strike subbasin, the only salmonid generally present is redband trout. Redband trout are a variety of rainbow trout that are adapted to the warmer waters of desert watersheds. Although exceedances in the salmonid spawning criteria of Idaho's water quality standards may occur, redband trout are successfully propagating. Figure 6 shows the tributaries where populations of redband trout occur.

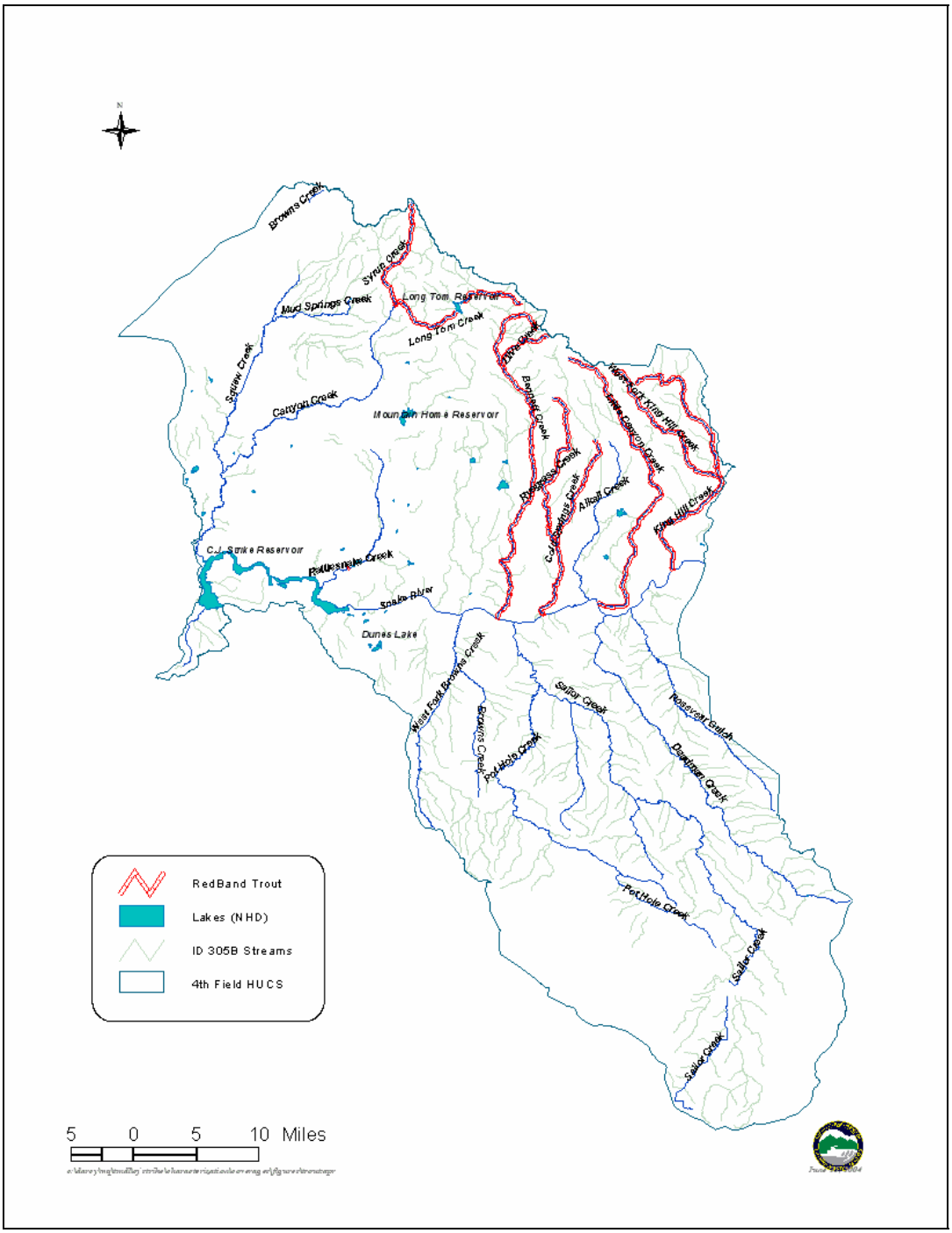


Figure 6. Redband trout distribution.

Subwatershed Characteristics

The primary stream in the King Hill-C.J. Strike subbasin is the Snake River. The importance of the river is enhanced because tributaries contribute very minor stream flow to the watershed. Commonly, water flowing from the mountain valleys does not reach the Snake River in tributary drainages but disappears from the surface and enters the aquifer (Gehr 1982). See Figure 7 for the watersheds in this subbasin.

In cooperation with other agencies, the Idaho Department of Water Resources (IDWR) is currently in the process of updating the numbering system and boundaries of the watersheds in this subbasin. Any discrepancies in the current numbering system of the 5th and 6th field watersheds will be resolved in this review and revision process. The topographic statistics for the watersheds are given in Table 4, which shows fifth level hydrologic unit codes (HUCs) for the watersheds in the subbasin.

Table 4. Characteristics of the major HUC 5 watersheds in the King Hill-C.J. Strike Subbasin.

HUC 5 code	HUC 5 name	Area (square miles)	Stream miles	Mean elevation (ft)	Minimum elevation (ft)	Mean stream gradient (%)
1705010101	Lower C.J. Strike Reservoir	144.92	290.12	4232.84	3158.64	2
1705010102	Fraser Reservoir	111.90	207.45	4219.72	3739.20	2
1705010103	Bowns Creek	191.84	390.48	3665.40	2486.24	2
1705010104	Ditto Creek	167.90	299.26	4498.52	2469.84	5
1705010105	Long Tom Reservoir	196.54	355.72	3409.56	2469.84	3
1705010106	Mountain Home Reservoir	187.60	463.72	4931.48	2463.28	6
1705010107	Middle C.J. Strike Reservoir	214.95	419.65	4895.73	2460.00	5
1705010108	Dry Creek	271.76	321.93	3926.16	2446.88	3
1705010109	Browns Creek	198.57	463.95	4114.76	2935.60	3
1705010110	Bennett Creek	122.41	99.48	2907.72	2450.16	2
1705010111	Sailor Creek	203.03	312.10	4465.06	2453.44	5
1705010119	Pot Hole Creek	74.46	137.69	4529.68	4014.72	1

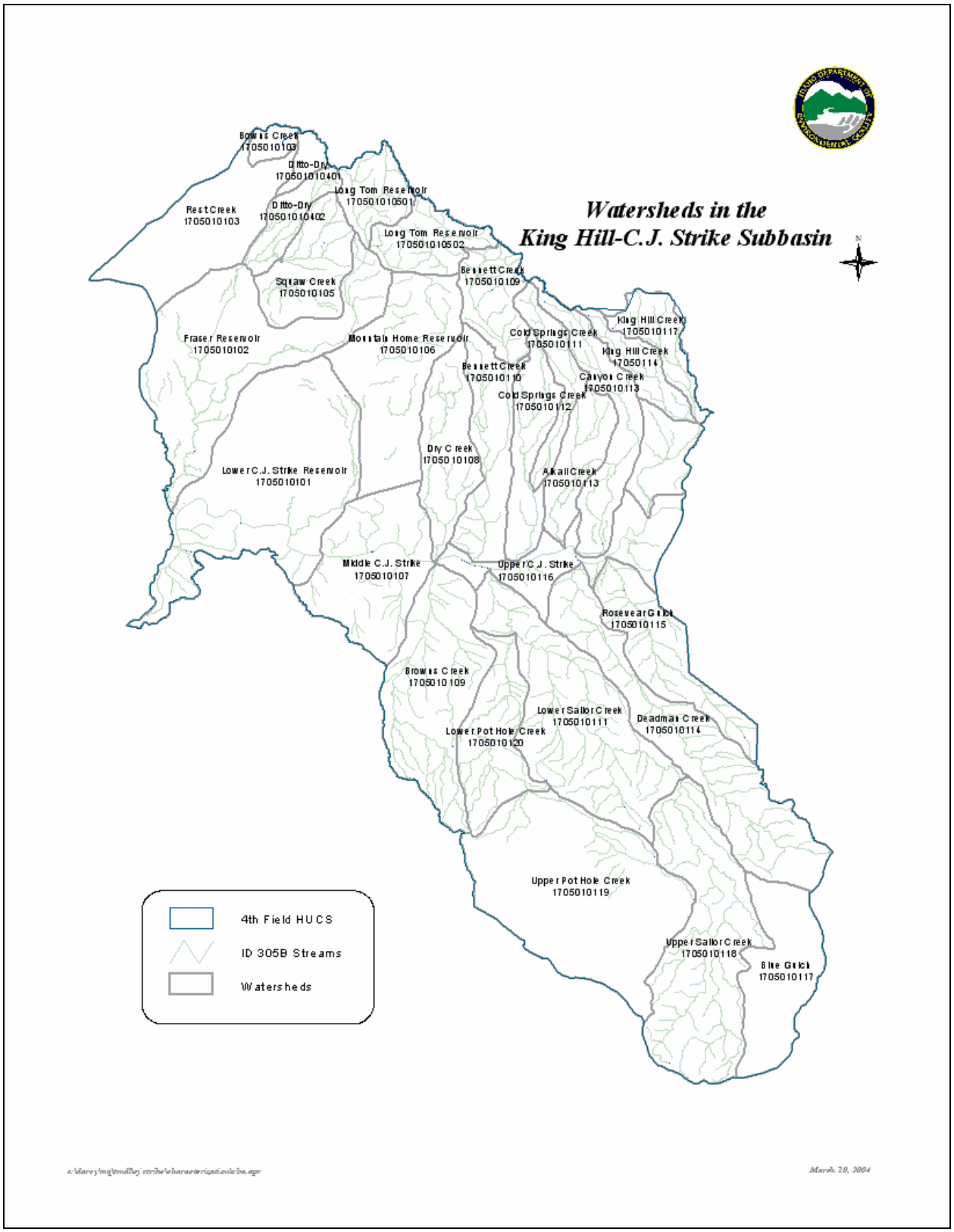


Figure 7. Watersheds in the King Hill-C.J. Strike Subbasin

Stream Characteristics

Snake River

The Snake River originates at 9,500 feet, along the continental divide in Wyoming, and flows 1,038 miles to the confluence with the Columbia River in Pasco, Washington. The King Hill-C.J. Strike reach begins at river mile 547 at King Hill and ends at river mile 494 at the C.J. Strike Dam for a total length of 53 river miles. The Snake River is a large volume, n^{th} order (greater than fifth order) river that is one of the most important water resources in the state. The King Hill-C.J. Strike reach is an important agricultural, recreational, and wildlife resource as well as a hydroelectric power source. In this reach, the river flows through basalt canyons, rangeland, and agricultural land. The channel shape varies from being confined in the canyons to wide single channel areas with extensive floodplains and meandering channels with island complexes.

The USGS stream gauging program has continually collected streamflow data at King Hill, from 1910 to the present time. Figure 8 shows the mean monthly flows from 1992-2002. A coarse water balance can be also computed from the major irrigation withdrawals and tributary flows from the most recently gauged data (Figure 9.)

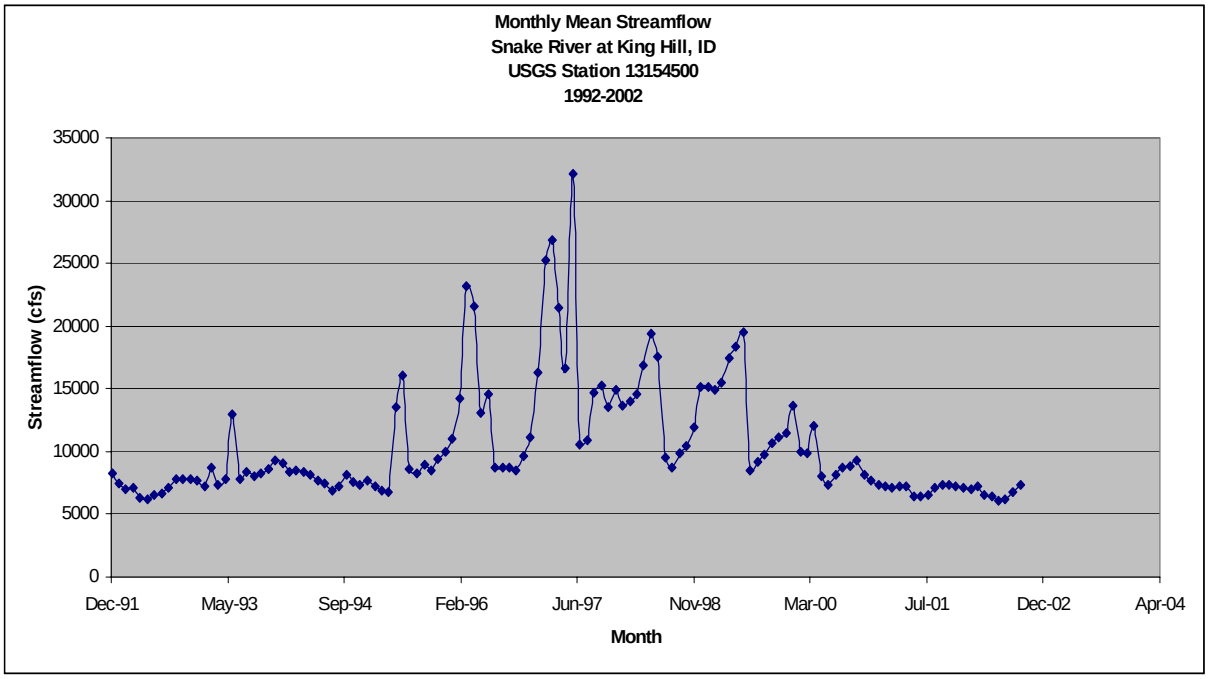
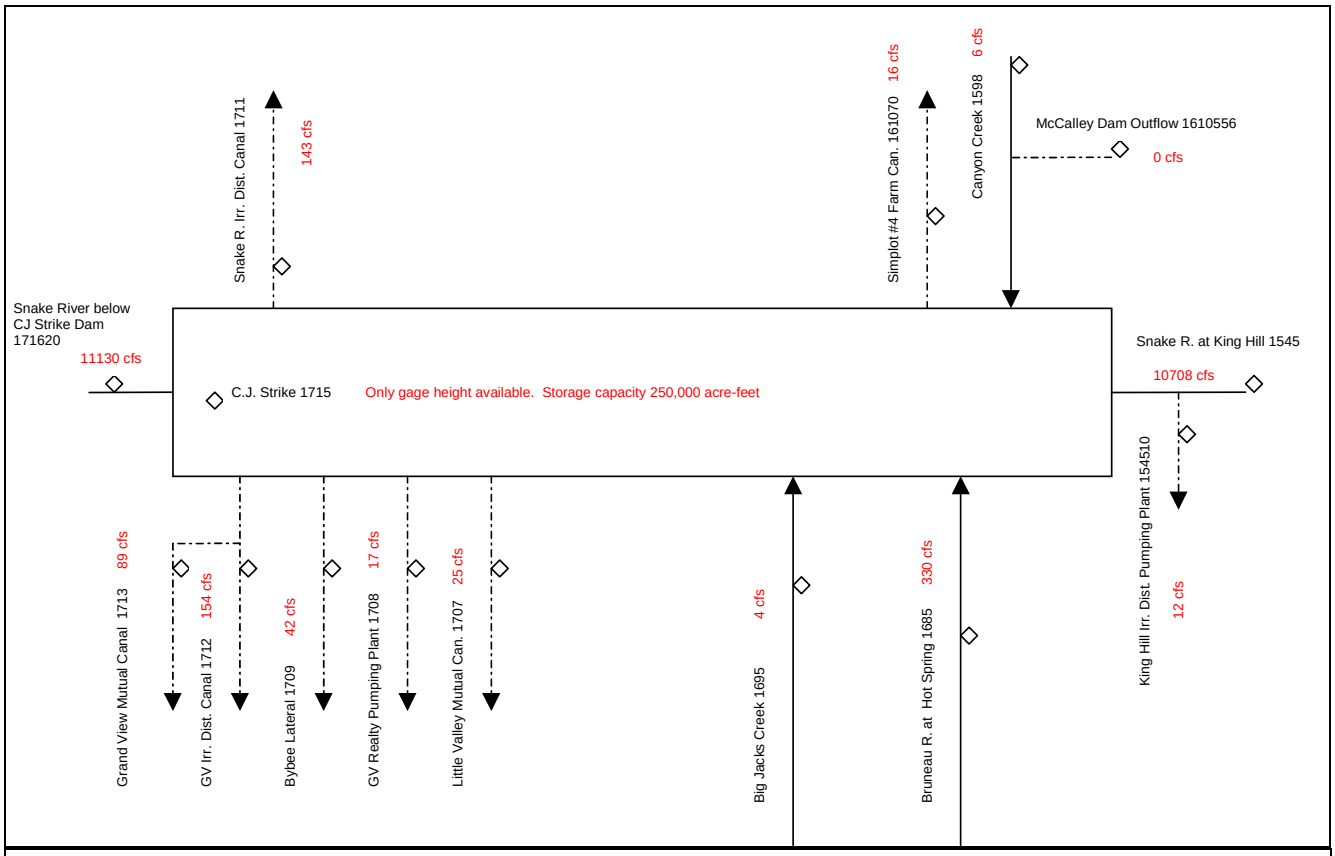


Figure 8. Hydrograph of USGS streamflow data for Snake River at King Hill.



Mean discharge based on yearly average streamflow data for the most recently-recorded 10-year period.

Change in storage = Δin – Δout

Change in storage = (10708 + 36 + 330 + 4) – (0 + 16 + 25 + 17+ 89 + 11130) = 11078-11277 = -199

Net loss of 199 cfs annual average discharge for last 10 years in watershed.

Figure 9. Water balance of the King Hill-C.J. Strike subbasin from USGS stream flow data.

Tributaries

The Idaho DEQ Beneficial Use Reconnaissance Program (BURP) has collected most of the data describing the tributaries in the King Hill-C.J. Strike subbasin. The BURP Data describing some of the stream channels surveyed is given in Table 5. Major streams in the subbasin are shown in Figure 10.

Table 5. Beneficial Use Reconnaissance Program channel characteristics.

Stream Name	BURP Identification Numbers	Dates surveyed	Morphology (Rosgen)	Stream sinuosity	Channel shape
Alkali Creek	1996SBOIA002 1996SBOIA003 1996SBOIA004 2003SBOIA018	6/5/1996 6/5/1996 6/5/1996 (Dry) 7/23/2003 (Dry)	Rosgen D to F	Moderate	Trough-like valley
Bennett Creek	1993SBOIA054 1997SBOIC016 2003SBOIA013 2003SBOIA037	5/23/1993 9/8/1997 (Dry) 7/22/2003 (Dry) 8/26/2003	Rosgen C	Moderate to low	U-shaped
Browns Creek	1995SBOIA061 1998SBOIB002 2003SBOIA011	5/31/1995 (Dry) 6/10/1998 (Dry) 7/21/2003 (Dry)	--	--	--
Canyon Creek	2003SBOIA034	8/20/2003	--	Low	--
Cold Springs Creek	1995SBOIA002 1997SBOIC023 1997SBOIC024 2003SBOIA015 2003SBOIA016	5/30/1995 9/11/1997 (Dry) 9/11/1997 (Dry) 7/22/2003 (Dry) 7/22/2003	Rosgen C	Low to moderate	Trough-like valley
Deadman Creek	1995SBOIA060 1998SBOIB004	5/31/1995 (Dry) 6/10/1998 (Dry)	--	--	--
King Hill Creek	1997SBOIC022 2003SBOIA019	9/11/1997 7/28/2003	Rosgen B	Low to moderate	V-shaped valley
Little Canyon Creek	1993SBOIA044 1993SBOIA045 1997SBOIC017 1997SBOIC018 2003SBOIA002 2003SBOIA034	7/16/1993 7/16/1993 9/8/1997 9/8/1997 7/2/2003 8/20/2003	Rosgen B to E	Moderate	Flat-bottomed valley
Long Tom Creek	2003SBOIA017	7/23/2003	Rosgen B	Low	--
Pony Creek	1998SBOIB019 2003SBOIA036	6/25/1998 8/26/2003 (Dry)	Rosgen B	Moderate	V-shaped valley
Ryegrass Creek	1996SBOIA001 1996SBOIB001 1996SBOIB002 2003SBOIA014	6/4/1996 6/4/1996 6/5/1996 7/22/2003 (Dry)	Rosgen B to D	Moderate	Trough-like valley
Sailor Creek	1995SBOIA063 1998SBOIB003	5/31/1995 (Dry) 6/10/1998 (Dry)	--	--	--
Unnamed tributary to Pot Hole Creek	2003SBOIA012	7/21/2003 (Dry)	--	--	--

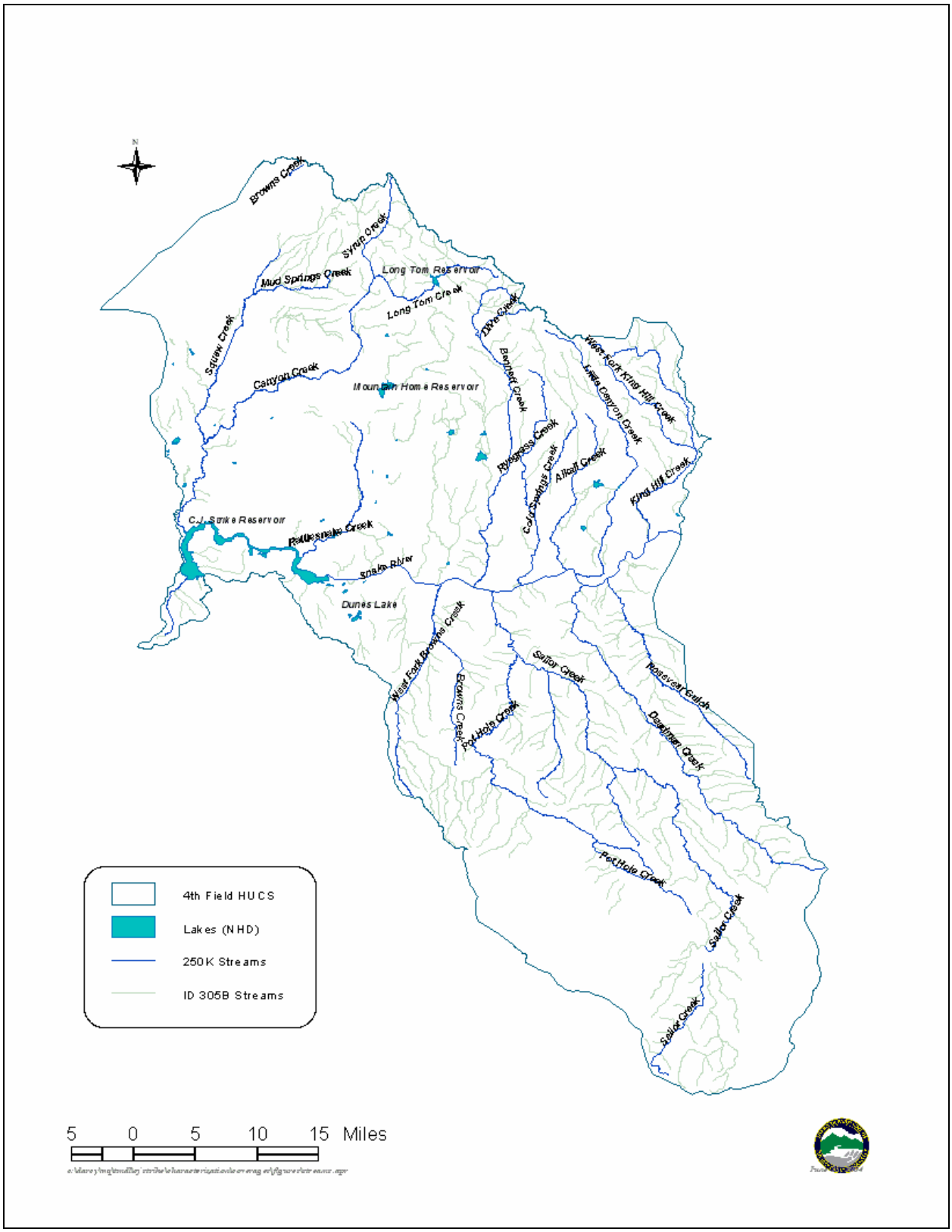


Figure 10. Major Streams in the King Hill-C.J. Strike Subbasin.

Ground Water

The King Hill-C.J. Strike subbasin lies within the Snake River Plain Aquifer, which covers an area over 10,000 square miles and contains over twice the volume of water in Lake Erie. It is the largest aquifer in Idaho and may be one of the most productive in the world, consisting of numerous interconnected ground water systems. In the King Hill-C.J. Strike subbasin, the western Snake River plain aquifer is composed of permeable sand and gravel aquifers overlaid with impermeable clay layers. Water moves through pore spaces of sand or gravel and often exhibits positive pressure, meaning that a well drilled through the confining clay layer will be an artesian well.

In the King Hill-C.J. Strike subbasin, there are three ground water management areas:

1. The Cinder Cone Butte Critical Ground Water Area
2. The Mountain Home Ground Water Management Area
3. The Grand View-Bruneau Ground Water Management Area

Ground water is managed by the Idaho Department of Water Resources (IDWR). *Critical Ground Water Areas* (a portion of the aquifer does not contain enough water for current and projected uses) are designated according to Idaho Code § 42-226 and 42-233a, and *Ground Water Management Areas* (approaching the conditions of a Critical Ground Water Area) are designated according to Idaho Code § 42-233b. Once designated, the Director of IDWR can deny an application for a proposed use and may require diversion and water use reporting within the Critical Ground Water Management Area. A new application for a proposed use will be approved only if the Director of IDWR determines that a sufficient supply of ground water is available for the use of the water (Harrington 1999).

A 1982 IDWR ground water investigation in the Mountain Home plateau determined that a perched aquifer and a larger regional aquifer would not supply sufficient resource for the use of that time. A water budget calculation showed that withdrawals exceeded recharge by 600 acre-feet per year under 1980 conditions. As a result of this study and continued data collection, IDWR recommended that the perched and regional aquifers should be protected by Ground Water Management Area designation (Norton 1982). In 1981, the Cinder Cone Butte Critical Ground Water Area was designated. In 1982, the surrounding aquifer was designated as the Mountain Home Ground Water Area (Harrington 1999).

In the perched aquifer, ground water levels have varied according to the climate and seasonal cycles. Overall, the perched aquifer has been relatively stable. In the regional aquifer, ground water levels have shown the following trends (Harrington 1999):

- Water levels in the southern and eastern portions of the aquifer, near the Mountain Home Air Force Base, have experienced:
  - steep declines in the late 1960s and early 1970s,
  - stability in the mid-1970s to early 1980s, and
  - declines from the mid-1980s through to 1996, the time of the report.
- Water levels in the north central portion of the aquifer have declined since 1976.

- Water levels in the northwest portion of the aquifer have been stable and increased slightly since 1966.

Hydrographs of all monitored ground water levels in these management areas can be found at the IDWR website (www.idwr.state.id.us/hydrologic/projects/gwma).

1.3 Cultural Characteristics

Watersheds are affected by cultural characteristics in that human activities have affected land use. Cultural features include the history of the area, the past and current economic climate, and the distribution of the population within the watershed.

In the King Hill-C.J. Strike subbasin, land is predominantly rangeland managed by the Bureau of Land Management (BLM) Lower Snake River District. Other than the major population centers at Mountain Home and Mountain Home Air Force Base, the subbasin is mainly rural with a very sparse population.

History and Economics

Territories of the Western Shoshone and Northern Paiutes often collectively called the *Bannock Indians*, overlapped in the C.J. Strike area. Archaeological data shows that occupation density was higher in the canyon areas, with winter camps and cache pits. The Snake River Plain had the lowest population density with small, temporary campsites. The Mount Bennet hills show 7,000 years of occupation, mainly for temporary fall use of hunting and gathering, specifically butchering, berry and seed preparation, and hunting complexes.

Here is evidence of open campsites with lithic scatters, a few quarries and rock alignment structures, some rock art, and a few rock shelters. These inhabitants followed the "Desert Culture" way of life, with a sparse population of small groups in a migratory seasonal hunting and gathering pattern. Food collection was non-specialized, with an intensive exploitation of the total environment. Small seeds from sunflower, goosefoot, and Indian ricegrass were harvested and prepared. The inhabitants also collected roots, chokecherries, and service berries. Fishing was seasonal at Glenns Ferry and the Bruneau River with weirs, hooks, nets, and spears. They also hunted deer, elk, and bighorn sheep when available.

Lifestyles changed significantly in the early 1700s, with the introduction of the horse, increasing the effective range of nomadic groups by increasing their mobility. Also at this time, the Bannocks began contacting other groups for trade.

Significant milestones in Idaho history left the King Hill-C.J. Strike subbasin relatively untouched compared to travel centers like Fort Hall and Fort Boise. For instance, the fur trade from 1810 to 1839 had only peripheral contact in this area. During the overland migration and settlement era from 1840 to 1859, southern Idaho was an obstacle to travel rather than a destination. During summer, when emigrant trains passed through the Snake River valley, the native inhabitants were mostly in the mountains for hunting and collecting. The western Shoshone and northern Paiutes feared and avoided the whites, so these populations were not as affected by smallpox and cholera epidemics as other native

populations elsewhere. However, they experienced more starvation because the presence of the emigrants made food collection more difficult.

The Oregon Trail passed through this subbasin, with the most popular campsites mainly outside the watershed boundaries. Stops along the North Trail Segment included the following:

- Salmon Falls Creek
- Salmon Falls
- Big Pilgrim Gulch
- Three-Island Crossing
- Boise Valley

Stops along the Southern Sinker Creek segment of the Oregon Train included these spots:

- Bruneau Crossing
- Castle Creek
- Walter's Ferry
- Givens Hot Springs

Goodale's Cutoff of the Oregon Trail entirely bypassed this subbasin, traveling to the north through the Camas Prairie.

Most of the significant events of the mining frontier and Snake Indian wars of 1860 through 1879 were peripheral to this region. However, the Bannock War of 1878 occurred at Bennett Creek, marking the last major Native American resistance to white settlement in the region, the dispute being mainly over use of the Camas Prairie. The Bannock War resulted in the remaining resistant Bannocks being sent to Fort Hall. Today, the Shoshone-Paiute tribes are consolidated on 289,819 acres of tribal land on Duck Valley Reservation, and the Shoshone-Bannock tribes are on 544,000 acres on Fort Hall Indian Reservation.

After hostilities ceased, farm settlement and development began. The 1877 Desert Land Act enabled agriculture in this area by allowing a resident to file ownership on up to 320 acres and patent the holding when it was developed. Another settlement phase followed railroad building, with town sites growing along the Oregon Short Line. After statehood, in 1890, the Carey Act of 1894 allowed reclamation of desert lands by approving irrigation and reclamation projects. Extensive irrigation projects used the abundant water supply from the Snake River. Agricultural settlements formed around irrigation made possible near creeks or the Snake River. Even the current population centers of Elmore and Owyhee Counties are an intensified pattern of this irrigation-based settlement.

In 1934, the Taylor Grazing Act allowed the management of rangelands to control grazing. Before the Taylor Grazing Act, there was vigorous competition between ranchers and sheepherders for land. The act required a fixed base of operations rather than entirely nomadic herds. The next development in rangeland management came when the Taylor Grazing Service and the General Land Office merged, in 1946, to form the Bureau of Land

Management (BLM). More comprehensive planning for rangelands came in 1976, with the Federal Land Policy and Management Act, which mandated multiple use and sustained yield of resources.

Land Ownership, Cultural Features, and Population

Most of the land in the King Hill-C.J. Strike subbasin is managed by BLM (Table 6 and Figure 11), with 64% of the total land area. Privately-owned land is 22% of the land area, with smaller percentages managed by the State of Idaho and Department of Defense (USGS 2002).

Table 6. Land Ownership in the King Hill-C.J. Strike Subbasin.

Land Owner	Area (square miles)	Area (percentage)
BLM	1,366.94	64
Private	462.88	22
State of Idaho	152.85	7
Department of Defense	132.42	6
Open Water	14.74	< 1
U.S. Forest Service	2.96	< 1
Total land area	2,132.79	--

The Department of Defense owns land used for the Mountain Home Air Force Base (MHAFB) and the Saylor Creek Range. The MHAFB provides the most significant employment in the area, with 4,666 people from Mountain Home working for national defense (Idaho Department of Commerce 2004). First built as the Mountain Home Army Air Field in 1943, the MHAFB is now home to the 366th Fighter Wing, and the Saylor Creek Range is the existing training range for the 366th Wing. Consisting of approximately 110,000 acres total, the exclusive use area of 12,200 acres, located in a fenced area near the center of the range, includes all of the training targets. A buffer zone of about 97,800 acres surrounds the exclusive use area and is used mainly for livestock grazing and hunting.

The two significant towns in the subbasin are Mountain Home and Glenns Ferry. Table 7 gives some demographic information, from the Idaho Department of Commerce, about these towns.

Where junction, where once Idaho Highway 20 met the old Oregon Trail and the old Boise stage road, was known as Rattlesnake Station, which is the original site of Mountain Home. Mountain Home moved to its current location when the Oregon Short Line Railroad arrived in the area in 1883 and became the Elmore County seat in 1891.

Table 7. Demographics of Mountain Home and Glenns Ferry

Community	2002 Population	Top Five Employers
Mountain Home	11,531	U.S. Air Force Base - 4,666 Mountain Home School District – 500 Wal-Mart – 300 Elmore Medical Center – 198 Simplot Livestock - 150
Glenns Ferry	1,571	Magic West Potato – 180 Glenns Ferry School District – 85 Health Electronics – 35 Idaho Circuit Technology – 35 Carmela Winery - 29

Glenns Ferry was incorporated in 1909 but has a history back to 1834 and the establishment of the Oregon Trail. On the trail between Fort Hall and Fort Boise, the Three Island Ford was a place for wagon trains to cross the Snake River. In 1863, Gus Glenn began operating a ferry across the Snake River about two miles above Three Island Ford. The ferry was used to move freight from Utah to Boise but was outmoded when the Oregon Short Line Railroad arrived and became the main means of transport.

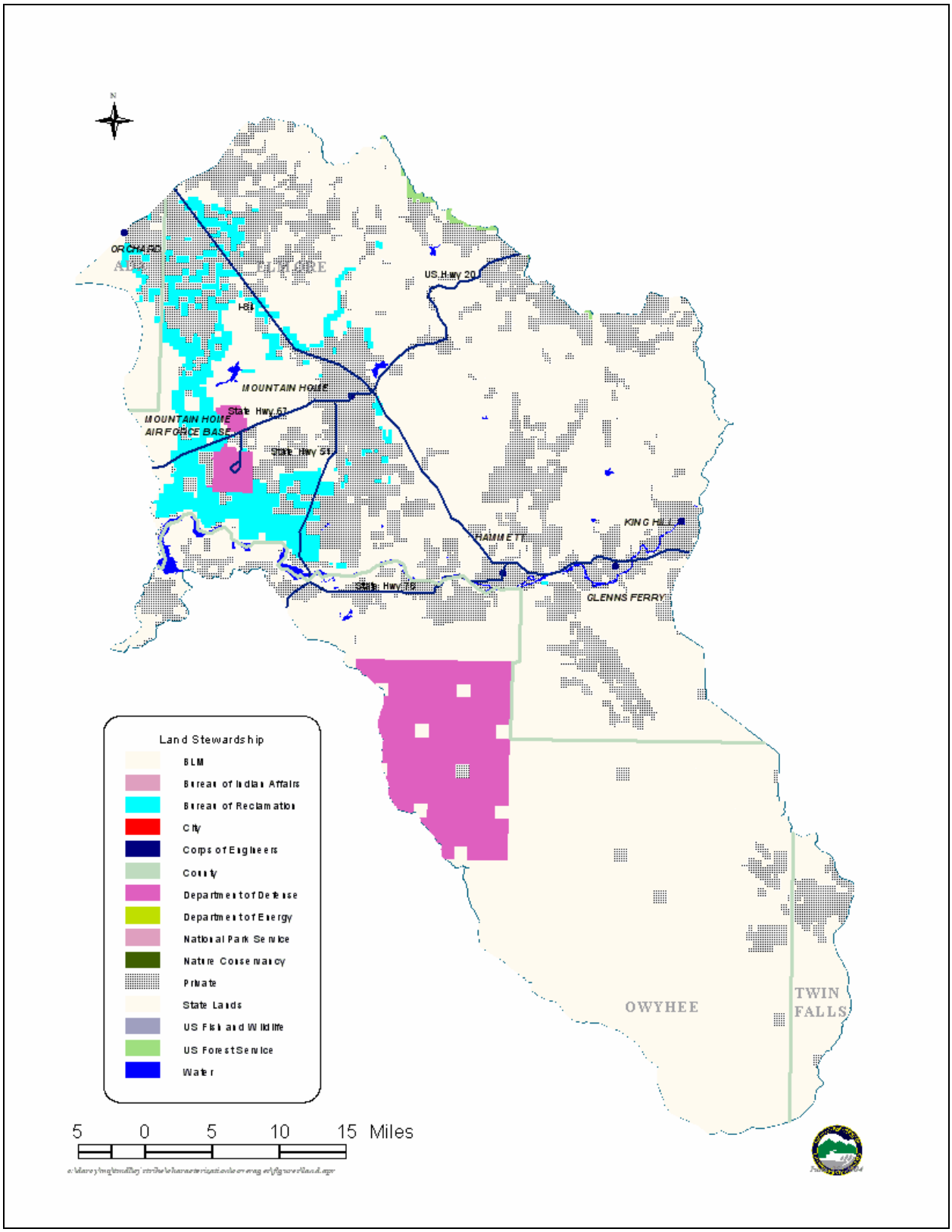


Figure 11. Land Ownership in the King Hill –C.J. Strike Subbasin.

Land Use

As indicated in Table 8 and Figure 12, most of the land (86%) in the King Hill-C.J. Strike subbasin is used for rangeland. Of that 86%, the Bureau of Land Management manages the vast majority. Grazing management practices and facilities are typically implemented locally on an allotment or watershed basis. Grazing management programs are based on a combination of appropriate grazing management practices and facilities developed through consultation, coordination, and cooperation with the Bureau of Land Management, permittees, other agencies, Indian tribes, and interested publics.

Table 8. Land Use in the King Hill-C.J. Strike Subbasin

Land Use		Area (square miles)		Area (percentage)
Rangeland		1,835.72		86%
Irrigated – Sprinkler Irrigated - Gravity	Total Irrigated	163.47 34.19	197.66	9%
Riparian		38.78		2%
Dryland Agriculture		35.35		2%
Open Water		8.52		<1%
Township		7.36		<1%
Bare Rock		5.35		<1%
U.S. Forest Service		4.04		<1%
Total land area		2,132.79		--

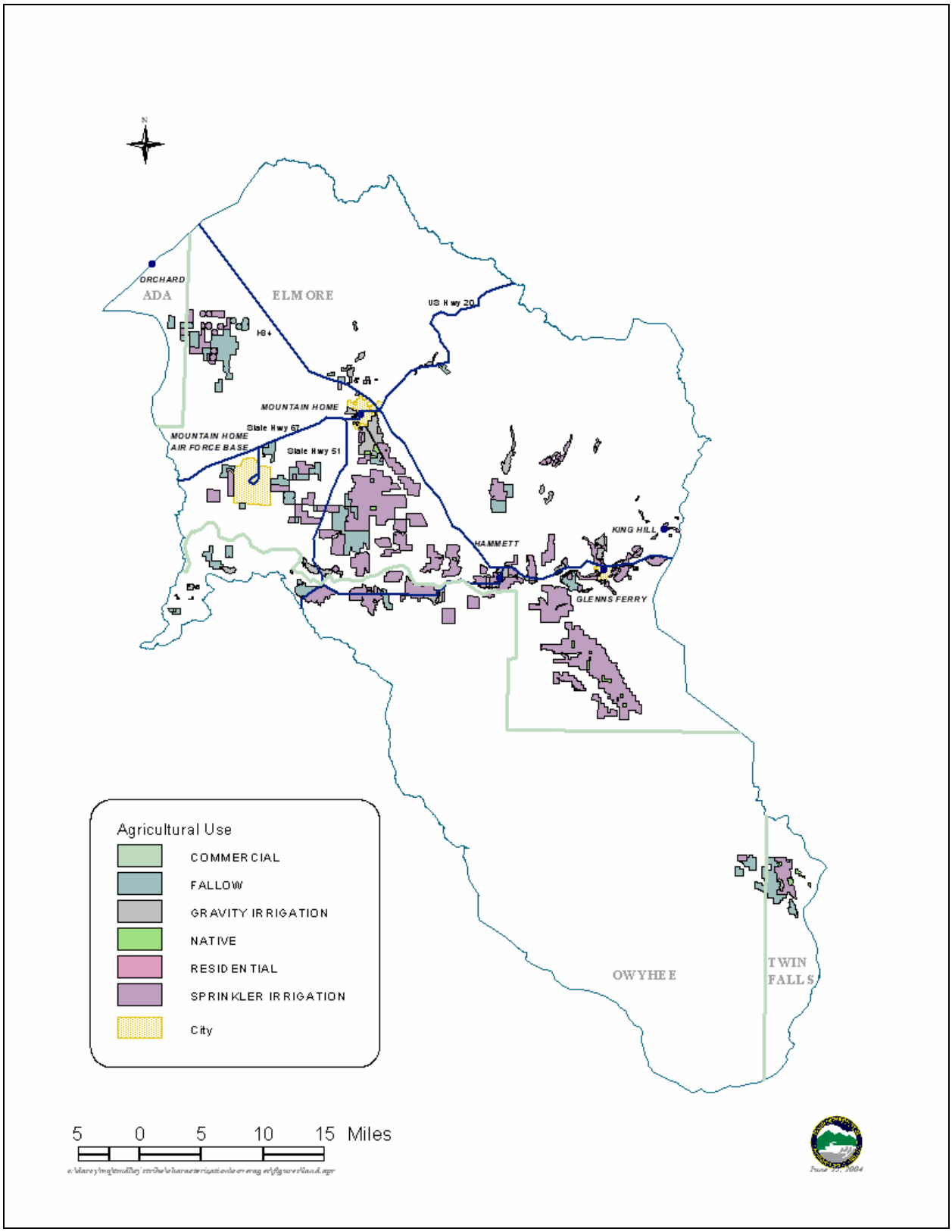


Figure 12. Land Use in the King Hill-C.J. Strike Subbasin.

Water Resource Activities

One of Idaho Power's 17 hydropower projects on the Snake River and its tributaries is the C.J. Strike Project. Located on the Snake River at river mile 494, just below the confluence of Bruneau River with the Snake, it is about 20 miles southwest of Mountain Home, and 7 miles east of Grand View. Idaho Power began constructing the C.J. Strike Project in 1950, the project was named after Clifford J. Strike, general manager of Idaho Power from 1938 to 1948. Energy was first produced there in March 1952.

C.J. Strike Dam is an earthfill structure, 3,220 feet long and 115 feet high with a crest elevation of 2,465 feet above sea level. On the north abutment, a spillway with eight bays is capable of passing 99,200 cubic feet per second (cfs) of water at normal reservoir elevation. The current discharge capacity of the three existing units at the C.J. Strike powerhouse is 15,500 cfs. Therefore, spill flows occur when total Snake River flows exceed hydraulic capacity of the powerhouse. On the south abutment, an intake structure is fitted with trash racks and connections to three penstocks, which direct water to the three generating units in the powerhouse.

C.J. Strike Reservoir is not used to store water on a seasonal basis but is fluctuated daily to meet power needs. The project is operated to increase power generation at times of peak demand, approximately 7:00 to 10:00 A.M. and 5:00 to 7:00 P.M. Mean headwater fluctuations for a typical day are 0.3 feet, and 90% of the maximum daily change in headwater elevation is less than 0.4 feet per day. Because peak demands last approximately three hours, elevation changes of up to 3 feet can be expected below C.J. Strike Dam during a typical day (Idaho Power Company 1998).

In addition to hydroelectric development, the flow patterns of the Snake River have been significantly altered by agricultural demands and several large pumping diversions have reduced water supply during irrigation season. Average annual withdrawal volumes are given, in Table 9, for pump sites moving irrigation water from the Snake River. These are pump sites with a period of record from USGS gauging. See Figure 13 for approximate locations of the pump sites monitored (Maupin 1999).

Table 9. Irrigation withdrawal averages, 1990-1995.

	Pump site name	Average annual withdrawal (1990-95), in acre-feet
Pump sites from the Snake River in the reach from King Hill to C.J. Strike	King Hill Irrigation District at King Hill	5,125
	King Hill Irrigation District at Glenns Ferry	25,100
	Sailor Creek	11,720
	Grindstone Butte	28,840
	Danskin Cattle Company	2,695
	Chalk Flats Farm	2,495
	Bledsoe Farm	1,185
	Upper Indian Cove	Only measured in 1990
	Lower Indian Cove	Only measured in 1990
	Wes Farris	1,580
	Flying H Ranch	3,785
	West Indian Cove	Only measured in 1990
	Mecham & Sons	1,690
	Rocking R Ranch	10,710
	South Elmore	15,775
	Sand Dunes Farm	1,460
	Eagle Cove	3,100
	Triple C Farm	3,535
	Ken Johns & Sons	1,515
	River Ranch	2,640
	Roger Young	6,065
	Simplot No. 4 Farm	7,350
Pump sites from the Bruneau River arm of the C.J. Strike Reservoir	Basin Mutual	1,120
	Grand View No. 3 Farm	2,980
	Little Valley Mutual	12,835
	Grand View Realty	7,170
	Bybee Lateral	18,475
	Total average withdrawal From 1990-1995	**178,945**

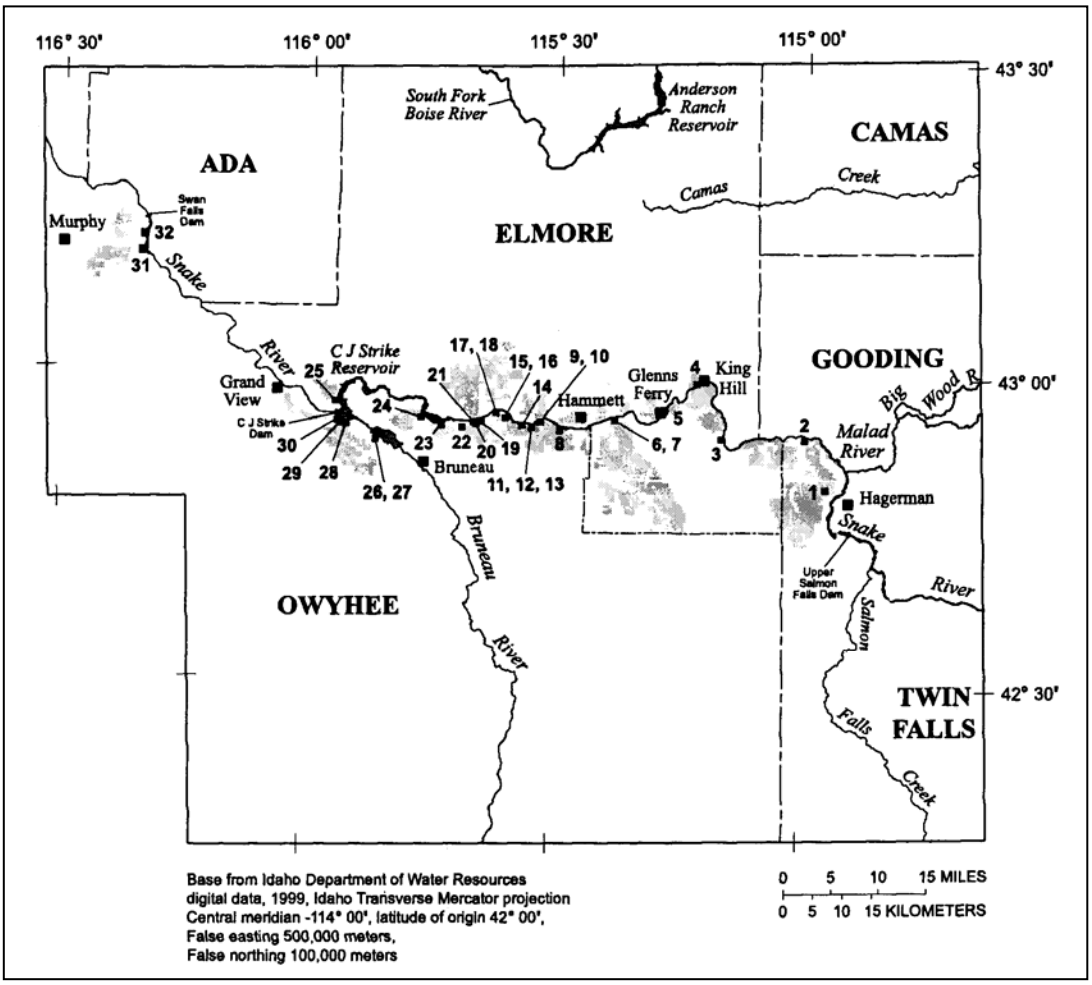


Figure 13. Pump site locations.