# DRAFT

# INITIAL WATERSHED ASSESSMENT
# WATER RESOURCES INVENTORY AREA 60
# KETTLE RIVER WATERSHED

## Open-File Technical Report 95-16

by
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and
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# INTRODUCTION

Washington Department of' Ecology's (Ecology) Shorelands and Water Resources Program is charged with managing the state's water resources to ensure that the waters of the state are protected and used for the greatest benefit. An important component of water management relies on permitting and enforcement of water rights. The State's authority on these issues, and that of the Department of Ecology, is outlined in Chapters 90.03 and 90.44 of the Revised Code of Washington (RCW). Water management decisions, particularly when considering whether to grant a permit for water use, Ecology must determine that the proposed water use passes the following four statutory tests (Chapter 90.03.290 RCW):

- The use will be beneficial;
- The use will be in the public interest;
- The water is available;
- The use will not impair senior water users.

In addition to these statutory tests, when Ecology makes a water use decision it must also consider other water management issues and concerns mandated by State and Federal Laws including non-degradation of water quality (Washington Administrative Code (WAC) 173-200 and 201A), preservation of instream flows to maintain aquatic habitat and other beneficial uses especially where specified by statute (WAC 173-500), and preservation of aquatic habitat for endangered fish stocks and other species.

The goal of this report is to document the status of surface and ground water resources in the Kettle River watershed in Washington State (Water Resources Inventory Area Number 60 (WRIA 60)), and to evaluate the information that is available for addressing regulatory concerns and for making appropriate water resource management decisions. To meet this goal, key water management issues in the WRIA which impact surface water and ground water appropriation decisions are identified and documented. For this initial survey, information on hydrologic conditions within the watershed as a whole was compiled to broadly indicate the "health" of the resource. These hydrologic conditions include water quantity, hydrogeology, water demand, water quality, and status of aquatic habitat and fish stocks.

Assessment of these conditions are based on readily available information about water rights and claims, streamflow, precipitation, hydrogeology and ground-water levels, fish stocks and water quality. Watershed data and information was obtained from the statewide geographic information system (GIS) which was supplied by the Department of Ecology, a limited review of literature for the geographic area, NOAA climatologic data bases, U.S. Geological Survey streamflow data (obtained from Hydrosphere Inc. CD-ROM compilation), the STORET water quality data base for the state (obtained from EarthInfo, Inc. CD-ROM compilation), and a limited survey of organizations including the Kettle River Advisory Board, and local, state and federal agencies serving the watershed.

# WATERSHED DESCRIPTION

## *GEOGRAPHY AND HYDROGRAPHY*

The Kettle River watershed within Washington State (WRIA 60) encompasses approximately 1,000 square miles in north-central Washington bordered by British Columbia to the north, the Okanogan watershed to the west and the Columbia River to the east (Map 1). The area includes the northeastern portion of Okanogan County, the northern part of Ferry County, and a small portion of northwestern Stevens County. The terrain in the WRIA is generally hilly to mountainous, cut by the narrow valley of the Kettle River and its major tributaries. Elevations range from approximately 1,600 feet above mean sea level where the Kettle River joins the Columbia River (in Franklin D. Roosevelt Lake) to greater than 7,000 feet above mean sea level.

All of the watershed drains directly into the Kettle River, which is the main watercourse in the WRIA. The major tributaries to the Kettle River located within the WRIA include Toroda Creek, Curlew Creek, Myers Creek, Boulder Creek and Deadman Creek. Curlew Creek drains the only major lake in the WRIA, Curlew Lake. Myers Creek flows into British Columbia before joining the Kettle River, and the lower portion of its watershed is located in Canada. The two largest tributaries to the Kettle River wholly contained within WRIA 60 are Toroda Creek and Curlew Creek, both draining watershed areas of approximately 160 square miles each.

The Kettle River originates in southern British Columbia within the Okanogan Highland and Monashee Mountains, draining a watershed area of approximately 4,200 square miles upstream of its confluence with the Columbia River. The mainstem of the Kettle River is free flowing (no dams) and enters the United States at Ferry, Washington. After entering the U.S., the river flows northward back into Canada crossing the border at Danville, Washington, and then returns to the U.S. near Laurier, Washington where it continues flowing south to the Columbia River. The streamflow in the Kettle River is gaged at both points of entry into the United States, near Ferry and Laurier, Washington.

The basin area of the Kettle River upstream of Ferry (in British Columbia) is approximately 2,200 square miles, and upstream of Laurier is 3,800 square miles. Comparatively, the Kettle watershed in Washington State represents approximately 23 percent of the total watershed area of the River basin.

## *LAND COVER AND LAND USE*

This section is a summary of existing land use information available from several sources, including Stevens County, Ferry County, and the Washington State Department of Natural Resources. Existing land uses within the Kettle River watershed have not been characterized in detail at this time.

The existing land use within WRIA 60 is primarily forest, both publicly and privately owned, with interspersed areas of forest-rangeland and agriculture. Approximately 75 percent of the watershed includes the federally managed Okanogan and Colville National Forests. Though principally forested and available for commercial timber operations, the Forest Service management scheme appears to keep the lands as public open space. Rangeland and agricultural areas are prominent within the corridors occupied by the Kettle River and its tributaries. These agriculturally based areas are composed of a variety of uses, including cultivated crops, grazing, and animal husbandry. Urban and developed areas are minimal and limited to small towns with populations less than 1,000 (such as Toroda, Curlew, Danville, Malo, Orient and Barstow) located along the Kettle River and several of its major tributaries.

The largest population centers in WRIA 60 as a whole are in British Columbia, including Grand Forks, Greenwood and Midway. Most of the developed areas in Canada are located just across the U.S - Canada border along the mainstem of the Kettle River and Boundary Creek which drains into the Kettle River in British Columbia.

The proposed land uses within the WRIA do not differ from the land uses currently found in the area. Based on a review of Stevens County and Ferry County planning documents, the privately owned upland forested areas will likely remain in forest-rangeland conditions with provisions for commercial timber harvesting. Agricultural uses are encouraged within the watershed to promote economic development of the region while urban/developed areas generally provide services to the rest of the WRIA.

## *CLIMATE AND PRECIPITATION TRENDS*

The climate of WRIA 60 combines characteristics of a typical mountain/continental climate, which predominates in the Rocky Mountains, and a maritime climate, which predominates west of the area. Most of the weather variation originates as easterly flow from the Pacific (PNRBC 1970). Average annual precipitation for the area ranges from 15 inches at Republic to 12 inches at Omak west of the watershed. Precipitation at Conconully, northwest of Republic is approximately 15 inches annually (Figure 1). Based on precipitation isohyet maps for the region (Map 2 and PNRBC 1970), average annual precipitation in the WRIA ranges from 15 to 35 inches annually, with the highest precipitation occurring at the higher elevations. The area of greatest annual precipitation is in the southwest corner of the WRIA (Map 2). Over the entire WRIA, precipitation averages approximately 21 inches annually.

Monthly precipitation patterns (Figure 1) show that precipitation is relatively evenly distributed, ranging from an average monthly high of 1.9 inches (at Republic) to a monthly low of 0.9 (at Republic) inches in September. The majority of precipitation falls in the winter and spring, with the highest totals occurring from November through January. Peak rainfall also occurs in May and June. The least precipitation occurs in July, September and October. Total annual snowfall averages 50 to 60 inches at Republic occurring typically from November to March. Total annual snowfall represents approximately 30 percent of the average annual precipitation (assuming a water equivalent of 10 inches of fresh snow to one inch of rain).

Long term regional trends in precipitation indicate that recently, total annual precipitation has been above normal compared to long term records beginning in the early 1900's for north-central Washington (as observed at Omak, Wenatchee and Colville - Appendix A.1). Inspection of precipitation trends for all of the above stations indicate that precipitation has been above normal since about 1980 when a rising precipitation trend began. Since 1986, although precipitation has been above normal, there has been a downward trend as seen from the long-term trend analysis. These trends are not as evident for the Republic and Conconully stations (Figure 1). At these stations, the last decade has shown greater variability of precipitation with an apparent decrease in precipitation.

Best fit linear regression analysis for Republic indicates a slight decrease in precipitation since 1948, and for Omak shows a slight increase (Appendix A.2). These data suggest local variability in precipitation patterns and trends, probably due to random probability and effects of geographic features including mountain ranges. Linear regression analysis of long term precipitation records over comparable time periods for stations across northeastern Washington show decreasing precipitation trends at Spokane, Republic and Newport, and increasing trends at Omak and Colville confirming the geographic variability (Appendix A.2).

Evaporation and transpiration (evapotranspiration) from plants (water lost through plant uptake and release to the atmosphere) is highest during the summer months where water is available. Potential evapotranspiration (the amount that would occur if water were always available) is estimated to range from 20 to 25 inches at lower elevations (PNRBC 1970), and 15 to 18 inches in the mountainous higher elevations. Actual evapotranspiration has been estimated to range between 12 and 16 inches annually (PNRBC 1970) over much of the area. Evapotranspiration occurs year round from plants and via sublimation even during periods when the air temperature is below freezing. However, the majority of the total annual evapotranspiration (80 percent or more) occurs during the months of May through September.

# HYDROGEOLOGY

## *HYDROLOGY OF THE WATERSHED*

Water availability and distribution in WRIA 60 is determined by the components of the hydrologic cycle as it occurs throughout the basin (Figure 2). The hydrologic cycle can be viewed as an overall water balance, which enables an assessment of the component inflows and outflows in the watershed. The water balance begins with the total quantity of water input to the watershed. As can be seen in Figure 2, water originates as precipitation which replenishes surface water and ground water reservoirs. Precipitation provides the only inflow to streams, lakes and ground waters whose catchment areas are completely contained in the watershed. In some watersheds, including WRIA 60, which do not encompass the entire drainage area of the main water courses, large rivers and regional aquifers (ground water reservoirs) receive inflow from upstream catchment areas outside of the watershed. Tributary streams and local ground water sources (fed by precipitation within the watershed) augment the large regional rivers and aquifers.

Outflows from the watershed include water lost to the atmosphere from evapotranspiration (direct evaporation from water bodies and transpiration via plant uptake of water from the soil), and flow out of the watershed from rivers and aquifers, and also from consumptive human use. A balance exists between the inflows and outflows within the watershed. Outflow cannot exceed inflow unless water stored within the watershed (in lakes, rivers and ground water reservoirs) is depleted. When inflow exceeds outflow, stored water increases in the watershed. Over the long term, gains and losses from storage tend to equalize, and outflow equals inflow. Thus, the total amount of water potentially available for maintaining streamflow, habitat and consumptive use is limited by the total inflow to the watershed.

The general hydrologic cycle or water balance for the Kettle River watershed in Washington State is described by the following equation:

$$P + IF = OF + Q + ET + \Delta S \qquad (1)$$

where

- P = total precipitation;
- IF = inflow from upstream sources (surface and ground);
- OF = outflow from the watershed via rivers, streams and natural ground water discharge;
- Q = consumptive water withdrawal and water diverted out of the watershed from ground water and surface water sources for human uses;
- ET = evapotranspiration;
- $\Delta S$ = change in water stored within surface and ground water reservoirs in the watershed.

Applying the above equation and using general climatic data for the WRIA, it is estimated that runoff to streams from within the watershed is on the order of 5 to 9 inches annually, which translates to between 250,000 and 500,000 acre-feet of streamflow and ground water recharge annually. PNRBC (1970) had previously estimated runoff from the basin ranging from 5 to 10 inches annually. Inflow from the Kettle River to the watershed as observed at the Ferry gaging station averages 1,500 cfs over the period of record, bringing more than 1 million acre feet into the watershed annually. The average flow of the Kettle River at Laurier is 2,900 cfs, which is more than 2 million acre-feet annually. These data show that most of the stream flow in the Kettle River originates outside of WRIA 60 in Canada. The watershed area in Washington State contributing to flow at the Laurier gaging station is approximately 600 square miles. Assuming 9 inches of runoff contributing over this area annually, runoff from WRIA 60 contributes approximately 15 percent of the flow gaged at Laurier.

The above analyses do not differentiate between surface water and ground water runoff. Outflow is derived from precipitation not lost to evapotranspiration. This water, called runoff, can either infiltrate into the ground recharging ground water, or it can flow to a stream over the ground surface. Runoff which recharges ground water causes ground water levels to rise (increasing storage). Ground water levels can also rise from water inputs originating outside of the watershed. For example, flood waters brought into a watershed from upstream can flow overland and seep into the ground (recharging ground water) or can seep into the ground from the river banks. Water recharging ground water in this way will also eventually flow back to surface water when the flood waters recede. When the ground water levels are higher than water levels in streams, ground water drainage occurs through openings in sediments and rock formations, slowly returning the infiltrated water to streams resulting in increased outflow. Hence there is hydraulic continuity between surface water and ground water which is a function of flow velocities through the ground. Ground water contained in rock fractures and pore spaces in sediments provides storage similar to a large lake or surface water reservoir.

The surface water and ground water runoff components of the water balance as they relate to watershed outflow are expressed as follows:

$$OF = IF + SR + GB - \Delta S \qquad (2)$$

where

OF = outflow from the watershed via rivers, streams, and natural ground water discharge;

IF = inflow from upstream sources;

SR = runoff to surface water via overland flow and direct precipitation;

GB = infiltrating runoff, ground water recharge and subsequent discharge as baseflow to streams.

$\Delta S$ = change in water stored within surface and ground water reservoirs in the watershed.

Consideration of the water balance equations show that increased consumptive uses and/or reduction in surface or ground water storage via consumptive use will reduce outflow from streams and rivers. This will reduce the amount of water available in the watershed for instream uses, either in the form of storage or streamflow.

As discussed above, the components of the annual water balance equation would be expected to be in balance with precipitation and inflow over the long term, with storage changes being minimized (Gray 1973). However, seasonal variability occurs in response to differences in precipitation and evapotranspiration patterns, as well as the effects of water storage in the snowpack.

Applying the above equation and using general climatic data for the WRIA, it is estimated that runoff to streams from within the watershed is on the order of 5 to 9 inches annually, which translates to between 250,000 and 500,000 acre-feet of streamflow and ground water recharge annually. PNRBC (1970) had previously estimated runoff from the basin ranging from 5 to 10 inches annually. Inflow from the Kettle River to the watershed as observed at the Ferry gaging station averages 1,500 cfs over the period of record, bringing more than 1 million acre feet into the watershed annually. The average flow of the Kettle River at Laurier is 2,900 cfs, which is more than 2 million acre-feet annually. These data show that most of the streamflow in the Kettle River originates outside of WRIA 60 in Canada. The watershed area in Washington State contributing to flow at the Laurier gaging station is approximately 600 square miles. Assuming 9 inches of runoff contributing over this area annually, runoff from WRIA 60 contributes approximately 15 percent of the flow gaged at Laurier.

However, seasonal variability occurs in response to differences in precipitation and evapotranspiration patterns, as well as the effects of water storage in the snowpack. In addition, the total runoff figures above will vary locally within the watershed due to varying balances between evapotranspiration and precipitation. In the lower elevations where precipitation is generally lower and potential evapotranspiration higher runoff may occur only during the wetter months, and a water deficit may occur during the drier months of July, September and October. During these drier months, runoff may decline to extreme low flows and may cease altogether.

The seasonal variability in the water balance results in seasonal variability in streamflow. Figures 3 and 4 show long term annual and average monthly hydrographs for gaged streams and rivers in WRIA 60. The average monthly hydrographs for both of the Kettle River stations exhibit similar characteristics including a strong seasonal peak in early to late spring, followed by the lowest flows during late summer through the fall and winter. This pattern reflects the dominance of snowmelt as the main hydrologic event in conjunction with low runoff. Low runoff occurs during the summer due to high evapotranspiration and lower precipitation and occurs during the winter due to precipitation accumulation as snow in the upland areas of the drainage basin.

Continuous streamflow data is not available for tributary streams within WRIA 60. Ecology collected discrete stream flow measurements at 48 sites within WRIA between 1986 and 1990 (Appendix A.3). In general these discrete measurements were collected monthly between May and September. Because of the lack of continuous stream flow information, seasonal flow characteristics for tributaries to the Kettle River associated with climatic and geologic conditions unique to the watershed have not been adequately documented. As previously discussed, based on water balance considerations alone, streams in areas of lower precipitation and higher evapotranspiration, which also do not include significant storage (in lakes, ponds and in ground water), may experience extreme seasonal low flows or may cease to flow altogether. Periodic streamflow measurements made on tributaries to the Kettle River (Appendix A.3) have shown zero or extreme low flows.

These measurements indicate there are surface water flow limitations in these streams in the summer months. The mechanisms that cause these zero or extreme low flows are not well understood, but may be due to climatic and geologic conditions in the watershed exacerbated by consumptive use of water in some areas. Hydrographs of streams located within WRIA 60 likely show different seasonal patterns compared to the flow patterns for the Kettle River, because the Kettle River basin as a whole (including areas in Canada) encompasses areas that exhibit different runoff characteristics. Based on limited seasonal streamflow data for Myers Creek (Golder and Associates 1994) and tributaries to Curlew Lake (Juul and Funk 1988), tributary streamflows within WRIA 60 show a large spring flow peak similar to the Kettle River, but also show peak flows occurring in fall in response to increased rainfall and reduced evapotranspiration.

Seasonal water balances for WRIA 60 indicate that on average, there is water available for appropriation in the Kettle River and its tributaries during the spring and early summer. During the summer months, especially July and September when flows in the Kettle River are low and the precipitation/evapotranspiration balance in the watershed produces little runoff, water availability would be expected to be low throughout the WRIA. During winter months, the Kettle River flow is low; however, precipitation and winter thaws may maintain flow in tributaries within the WRIA.

The climatic variables of the water balance equation (P and ET) have been previously estimated for the WRIA; however, they tend to have less accuracy than streamflow because they require extrapolation over the entire area from few data points. Consumptive use (Q) is also relatively inaccurate because actual water use is not documented by the water users (except for the commercial or municipal users), is not tracked by Ecology and undocumented or illegal water uses may also occur within the WRIA. Although changes in water storage within the WRIA could be tracked for both surface water and ground water reservoirs (e.g., ponds, lakes and aquifers), comprehensive monitoring of water levels in ground water and surface water is not being conducted and would be impractical.

## *GEOLOGY*

The Kettle River watershed lies within the Rocky Mountain Intermontane Physiographic Province (Fenneman 1931). The province is bordered by the Cascade Mountains to the west, the Rocky Mountains to the east, and the Columbia Plateau to the south. It is characterized by long, mountain ranges trending north to south, separated by wide similarly oriented valleys. As a result of alpine glaciation, the higher mountain ranges are sharp-edged or sawtoothed, while the lower ranges shaped by continental glaciation have a more rounded appearance. The Kettle River in British Columbia is oriented north to south flowing between mountain ranges within a well defined valley and floodplain. However, within WRIA 60 in Washington State, the Kettle River cuts across the ranges and forms a narrow moderately steep canyon with relatively narrow floodplain.

The geologic units in the area have been broadly categorized into three stratigraphic units based on geologic time relationships and type of deposit (Alt and Hyndman 1984). The units are described from the oldest to youngest as follows: Pre-Tertiary basement rocks (590 to 70 million years ago), Tertiary volcanics and intrusives (65 to 22 million years ago), and Quaternary unconsolidated deposits (2 million years ago to present). The location of these units is presented in Map 3, General Geologic Map. Figure 5 shows a generalized east-west geologic cross-section through the WRIA.

Most of the watershed is underlain by meta-sedimentary and meta-volcanic bedrock. The geologic basement rocks (bedrock) found within the Kettle River watershed consist primarily of metamorphosed sedimentary and volcanic rocks including gneiss, schist, and quartzite interbedded with dolomite, and limestone. The bedrock outcrops at the surface in the high mountain ranges and is encountered at depths ranging from 20 to greater than 100 feet deep in the valleys.

Volcanic eruptions occurred throughout most of the Tertiary Period resulting in several sequences of deposition, hence, in some locales the flows are interbedded with nonmarine sedimentary units. Volcanic deposits consist of andesites, breccias, tuffs, and basalts. Large masses of intrusive rocks consisting of granite, granodiorite, and quartz monzonite are found within the volcanic deposits. The Tertiary volcanic flows and igneous rocks outcrop in the central portion of the watershed.

The Quaternary glacial and alluvial deposits are among the most geologically recent deposits in the area. Sediments deposited during glacial advance were densely compacted by the glacial ice. Glacial till (a dense, unsorted mixture of clay, silt, sand, gravel, and cobbles), fine-grained glacial lake sediments (silt and clay with occasional gravels, cobbles and boulders), and glacial outwash (unconsolidated interbedded sand and gravel) were deposited in the valleys as the glacier receded. Recent alluvium is found overlying the glacial deposits bordering the river and its drainages, and is a result of the current erosional and depositional processes associated with the river and its drainages. The alluvial deposits consist of unconsolidated silt, sand, and gravel underlying flood plains and terraces.

The three stratigraphic units discussed above form aquifers where they are saturated with ground water. The development and usage of each aquifer unit will be discussed in the following hydrogeologic sections.

Dip-slip faults bounding the Tertiary volcanic flows have been mapped in several locations in the watershed area (Pardee 1918 and Stoffel et al. 1991). These faults generally are orientated from north to south and have formed elongate depressed units (grabens) that were filled with Tertiary volcanic flows. These areas are identified as the Republic Graben and Toroda Creek Graben on geologic maps. A low angle fault has also been identified along the Kettle River between Laurier, at the International Border, and F.D. Roosevelt Lake (Stoffel et al. 1991).

## ***GROUND WATER***

Regionally extensive aquifers (aquifers extending into two or more watersheds) have not been identified or evaluated in northeastern Washington; however, the meta-sedimentary and meta-volcanic basement rocks of the region may be interconnected through faults or fractures. Ground water in WRIA 60 occurs within the three previously identified stratigraphic units. This section details the ground water occurrences, typical aquifer yields, ground water flow directions and hydraulic characteristics. Table 1 presents a summary of the hydrogeological units and typical yields for wells in them. Well yields are based on well logs provided by the Washington Department of Ecology Shorelands and Water Resources Program. The generalized geologic map (Map 3) shows ground water rights as they relate to the hydrogeologic units.

Based on the readily available literature, the majority of ground water is withdrawn from unconsolidated glacial and alluvial deposits of Quaternary age contained within the major river and stream valleys within the watershed. These unconsolidated deposits include coarser-grained layers of sand and gravel within glacial outwash and glacial drift, and alluvial sand and gravel deposits. Small quantities of perched or semi-perched ground water may also be available in thinner silt, sand and gravel lenses within the glacial drift. Generally, the glacial outwash and alluvium are highly permeable. Yields of 20 to over 100 gallons per minute (gpm) can be withdrawn from these zones. Generally the higher yields are only available where the alluvial deposits are close to surface water sources.

Based on topographic relief of the watershed, the overall direction of movement of ground water within the glacial and alluvial deposits is probably toward the river and tributaries; however, localized flow direction may vary greatly based on geologic and hydrologic conditions. Seasonal fluctuation in ground water levels in the glacial and alluvial deposits range from less than a foot to over 10 feet in areas of heavy precipitation or large withdrawals (PNRBC 1970). The amount of water drained by gravity from the pore space of a saturated aquifer is called its specific yield. The specific yield for the glacial and alluvial aquifer ranges from 5 to 25 percent indicating the porosity and amount of water available for flow ranges from low to moderately high. In the upper 50 feet of the unit, the deposits are coarser-grained and the specific yield is estimated to be 20 percent (PNRBC 1970). .

Glacial (till and glacial lake deposits) and alluvial (lake) deposits of Quaternary age are generally fine-grained and dense and subsequently have a low porosity and permeability. However, thin beds of sand and gravel in the till commonly yield small quantities of perched or semi-perched ground water that may be suitable for domestic use. The location, extent and gradient of water within any perched zones are site-specific and locally controlled by the specific geologic and hydrologic conditions.

In the hard, lower permeability volcanic and igneous flow deposits of Tertiary, ground water occurrences are often only found in faults, fractures, and weathered zones in the rocks where more permeable and porous areas are developed or within the interbedded sedimentary units. Aquifers in the volcanics and intrusives provide a limited source of ground water in the watershed. Yields up to 20 gpm can be withdrawn from wells penetrating these zones.

Ground water also occurs in fractured and weathered zones in the pre-Tertiary metamorphic basement rocks of the region. In some areas, water table aquifers are present where a moderately deep zone of weathering is saturated (PNRBC 1970). These water table aquifers are generally shallow in depth and are perched on the underlying competent bedrock, hence, they provide a limited source of ground water. Extent of weathering and/or fracturing of the bedrock in this watershed has not been further assessed. Faults bounding the Tertiary volcanic rocks (the Republic Graben and Toroda Creek Graben) have been mapped in the central portion of the watershed area, but their significance to the ground water occurrence or yield has not been assessed at this time.

The metamorphic basement rocks generally have low porosity and specific yield in unfractured or unweathered areas (Golder Associates 1992). The average specific yield is estimated at approximately two percent (PNRBC 1970) which indicates the amount of water available for flow is low. Generally yields of 1 to 20 gallons per minute are common in the metamorphic basement rocks and ground water is primarily available only for domestic uses and limited stock (agricultural) use. Seasonal variations in the bedrock aquifers have not been well documented, but is assumed to be influenced by recharge from precipitation. Studies completed in the Myers and Toroda Creek drainages by Battle Mountain Gold as part of their baseline and permitting investigations for the Jewel Crown Mine (Golder Associates 1992), have shown that yields from bedrock aquifers, limited glacial deposits and in selected fracture zones within the bedrock generally do not exceed 30 gpm.

Ground water flow direction in the metamorphic and igneous basement rocks is generally controlled by the lineation of fractures and faults. Based on geologic maps of the basement rocks exposed at the surface, the lineation of faulting is from north to south; however, the nature of ground water flow within these fractures is not well documented. Localized confined and semi-confined aquifers occur within the watershed. Confined or semi-confined ground water occurrences in the alluvial and glacial aquifers are found where fine-grained layers of glacial clay and silt cap saturated deposits. Confined aquifers exist within the basement rocks where competent rock overlies saturated zones with weathering, fracturing, or faulting.

In general, ground water levels have not been monitored in the various water bearing units within the WRIA. Because of the lack of data, ground water flow directions, seasonal response of ground water reservoirs to recharge and discharge and long term effects of ground water withdrawals from wells on aquifer storage and interactions have not been documented. Ground water levels in confined aquifers typically show delayed response or no response to seasonal recharge due to the attenuation in the connection between the surface and ground water.

Recharge to the aquifer units occurs from direct precipitation where the aquifer outcrops, from stream seepage where the aquifer unit intersects the base of the stream, and from bank storage or flood water infiltration. The rate at which infiltration occurs is based on the type and extent of vegetative cover, physical properties of the surficial and underlying soils, amount of available storage, temperature, rainfall intensity, and water quality. The recharge and discharge relationships of an aquifer determine the resultant water levels and flow direction, whereas the thickness and hydraulic properties (permeability, porosity and confined or unconfined conditions) of the geologic formation which comprises the aquifer determine the availability of the resource to wells.

The alluvial and glacial aquifers outcrop in the stream and river valleys and hence, recharge primarily occurs across the areal extent of the outcrop from direct precipitation and snowmelt in the spring (April, May and June) and from direct precipitation in the early winter (October and November). In the spring, high surface water flows are sustained by snow melt in the upper elevation headwaters. During high flows, some of the available water goes into stream bank storage and some of the water seeps into the aquifer. The water level in the alluvial aquifer within the Kettle River valley is sustained by direct recharge from the Kettle River during flooding and subsequent recharge to the soils and aquifers underlying the flood plain. The alluvial aquifer is also recharged with surface water that is diverted for irrigation of lowland areas during the late spring and summer.

The volcanic and igneous Tertiary rocks and pre-Tertiary metamorphic basement rocks outcrop in the mountains where precipitation is greatest and are recharged directly from precipitation in the spring and fall and from snowmelt in the spring. Although total precipitation in the mountainous regions of the watershed is high, much of the precipitation occurs as snow. Hence, recharge to the aquifer from infiltration into the faults, fractured zones, and weathered zones within the basement rocks is probably low due to steep slopes, high runoff rates and thin or absent soils. Small amounts of recharge water may also enter the bedrock aquifers from overlying aquifers where the hydraulic gradient is downward. However, this source is regulated by the thickness and permeability of intervening strata.

## *GROUND WATER AND SURFACE WATER INTERACTION*

Recharge to an aquifer from stream seepage will occur when the water level in the stream is higher than underlying ground water levels. The rate of seepage is dependent on the magnitude of the water level difference and the permeability of the stream bed materials. Alluvial aquifers in hydraulic continuity with a river or stream typically experience a high degree of water exchange with the associated surface water. These aquifers discharge to streams during low flow periods and receive recharge from the stream during high flow periods. This is due to the relatively high permeability of the alluvial materials and the close proximity of the aquifer with a stream or river. Aquifers that are separated from surface water bodies by depth or distance, are confined and/or are composed of low permeability materials require greater periods of time for water exchange to occur resulting in attenuation or dampening of the seasonal variability associated with surface waters.

Although ground water level fluctuations have not been well documented, the water levels are expected to be highest in the spring following recharge and flood events. Because alluvial and outwash deposits are relatively porous and outcrop in the stream and river valleys, a hydraulic continuity is present between the surface water and ground water. The Kettle River, because of its large size and volume of flow (most of which originates upstream of Washington State), dominates ground water levels in the narrow alluvial aquifer located within the Kettle River valley. In the spring and early summer, some of the available water from high flows goes into stream bank storage (PNRBC 1970), contributing baseflow in the river during low flow periods. The water level in the alluvial aquifer within the valleys of the Kettle River and tributaries is sustained by direct recharge from the river and its tributaries during flooding and subsequent recharge to the soils and aquifers underlying the flood plain. The alluvial aquifer is also recharged with surface water that is diverted for irrigation of lowland areas during the late spring and summer.

Where the aquifer materials outcrop at the surface in the lower reaches of the streams and rivers, ground water generally discharges to streams. Streams that drain the mountains generally derive one-fifth to one-third of their average discharge from ground water (PNRBC 1970). The ratio of ground water to surface water generally ranges from a few percent during periods of high flow to 100 percent during periods of low flow (PNRBC 1970).

## *STATUS OF GROUND WATER RESOURCES*

The location and quantities of ground water rights that are registered with Ecology are presented in Map 3. Permitted ground water withdrawal mostly occurs from the alluvial and glacial deposits close to the central reach of the Kettle River, Curlew Lake and Curlew Creek. Significant ground water withdrawals also occur in limited areas associated with Myers Creek and Toroda Creeks.

In general, ground water rights were not identified in the alluvial and glacial outwash deposits in the eastern portion of the watershed. Ground water reservoirs with development potential may occur within the glacial deposits in this portion of the WRIA; however, these aquifers are likely to be directly connected to surface waters. Limited quantities, primarily for domestic use, are probably available within the fractured or weathered zones of the meta-sedimentary basement rocks in other portions of the WRIA.

Ground water level trends have not been documented in the WRIA, therefore, water level increases or decreases over time have not been identified. As previously mentioned, however, in the aquifers associated with the Kettle River, ground water levels are controlled by river levels.

To assess future ground water appropriations, the impact of the additional water withdrawal on availability of ground water for senior rights and for maintaining base flows to streams (including existing surface water rights) must be assessed to insure that the senior water rights or other beneficial water uses are not impaired. Additionally, the ground water source must be of sufficient quantity and quality for the intended use.

Ground water would be available for appropriation if a proposed ground water withdrawal (1) does not reduce surrounding water levels excessively such that surrounding wells can still obtain permitted quantities, (2) does not induce streamflow loss from streams, and (3) does not induce excessive streamflow loss from streams such that flows decrease below low flow criteria. Wells located too close to each other or too close to a stream (well interference), can cause excessive water level declines resulting from the cone of depression even though recharge to the aquifer is adequate to maintain year round supplies. In some cases, however, ground water withdrawals can exceed recharge rates and cause long-term water level declines as well. Ground water appropriations that result in long-term declines would gradually impact adjacent ground water rights and possibly surface water rights.

In WRIA 60, the densest concentration of wells and highest ground water use is located in the vicinity of Curlew Lake and the central reach of the Kettle River. In these areas risks of excessive ground water withdrawals impacting other water users and baseflows in tributary streams is the greatest, particularly in the Curlew Lake and Curlew Creek area. Periodic streamflow measurements made in streams in this area (Appendix A.3) have shown zero flow or extreme low flows in several tributaries to Curlew Creek and Curlew Lake. These measurements indicate that there are surface water flow limitations in these streams in the summer months. Increased ground water withdrawal in these stream basins, particularly from shallow wells directly connected to surface water would likely aggravate or extend the low or zero flow periods resulting in increased downstream impacts to senior water rights and aquatic habitat.

**Table 1.**
**Stratigraphy, Lithology and Water-Yield**
**Characteristics for Units in the Kettle River Watershed.**

| Period | Rock Unit | Thickness (feet) | Lithology | Water-yield (gpm) |
|---|---|---|---|---|
| Quaternary | Glacial Drift, Till, Drift and Glacio-lacusttine (Lake) Deposits | 0-50 (estimated) | Unsorted pebbles, cobbles, and boulders in a matrix of silt and clay or clay, silt, and fine sand deposited in glacial lakes. Contains occasional strata of poorly sorted to sorted sand and gravel outwash deposits. | 20 -150 gpm. |
| Tertiary | Volcanic Rocks | Unknown | andesite, breccias, tuff, and basalt flows. | Mostly impermeable but with small variable yield from fractured and weathered zones. Yield estimated from 1-20 gpm. |
| Pre-Tertiary | Basement Metamorphic, Sedimentary and Granitic Rock | Unknown | Metamophic, sediment and igneous rocks including quartzite, metes limestone, schist, gneiss, granodiorite, and marble. | Mostly impermeable but with small yield variable from and weathered zones. Yield estimated from 1-20 gpm. |

# WATER DEMAND

Records for water use in the Kettle River Watershed date back to the late 1800's and early 1900's. Water use is not metered at the present time and therefore, actual water use is not known. Numerous recorded or claimed rights may no longer be in use and it is also possible that illegal water users may be using water for irrigation and other purposes. Additionally, the number and quantity of exempt water uses, including single domestic use (less than 5,000 gallons per day) and some stock water uses are not documented.

Since water law requires Ecology to protect existing rights and claims, it is assumed that all recorded water rights and claims are fully in use today and represent consumptive water use. The location and quantity of ground water and surface water claims and rights that are registered with Ecology are presented on Maps 3 and 4 respectively. Water demand for ground water and surface water use in WRIA 60, the Kettle River Watershed, is summarized from available information from Ecology including:

- Watershed Assessment Water Rights and Claims Database for consumptive uses only (Ecology 1994); and
- Primary Water Rights Report from Water Right Information System (WRIS) (Ecology 1995a).

A summary of claims, water rights and applications is presented in the following paragraphs including:

- Number of claims, water rights and applications for ground water and surface water use;
- Quantity of use;
- Primary uses of ground water and surface water; and
- Locations of water rights.

## *CLAIMS*

To document those uses of surface water in existence prior to the adoption of the State Surface Water Code (Chapter 90.03 RCW), which was adopted in 1917, and those uses of ground water in existence prior to the adoption of the State Ground water Code (Chapter 90.44 RCW), which was adopted in 1945, the Claims Registration Act (Chapter 90.14 RCW) was enacted.

The Claims Registration Act established a period from 1969 to 1974 to register claims of ground water and surface water use. Documentation was submitted to Ecology on either a long form to claim detailed uses for domestic and irrigation uses or on a short form for a single domestic use with up to one-half acre non-commercial lawn and garden. Claims registries (i.e., long and short forms) were included in the Watershed Assessment Water Rights and Claims Database (Ecology 1994).

Short claim forms did not specify the quantity of water usage. For WRIA 60, Ecology assigned a quantity for ground water and surface water use for each claim. For ground water claims, quantities, $Q_i$ [gallons per minute (gpm)] and $Q_a$ (acre-feet per year), were assigned by Ecology as follows:

- If irrigated acreage is greater than 0 acres: $Q_i$ = [# of acres claimed] * 9 gpm and $Q_a$ = [# of acres claimed] * 4 acre-feet per year; and
- If irrigated acreage is 0 acres: $Q_i$ = 9 gpm and $Q_a$ = 2.0 acre-feet per year.

For surface water claims, quantities, $Q_i$ [cubic feet per second (cfs)] and $Q_a$ (acre-feet per year), were assigned by Ecology as follows:

- If irrigated acreage is greater than 0 acres: $Q_i$ = [# of acres claimed] * 0.02 cfs and $Q_a$ = [# of acres claimed] * 4 acre-feet per year; and
- If irrigated acreage is 0 acres: $Q_i$ = 0.02 cfs and $Q_a$ = 2.0 acre-feet per year.

A total of 1,011 claims were filed including 382 ground water claims for a total of 4,330 acre feet per year and 11,295 gpm; and 629 surface water claims for a total of 25,210 acre feet per year and 131.42 cfs.

## *WATER RIGHT PERMITS AND CERTIFICATES*

Since the adoption of the state surface water and ground water codes, the only means of acquiring a water right within the state is by making an application for and receiving a Permit and or subsequent Certificate from the Department of Ecology or its predecessors. An applicant must file a Water Right Application with Ecology when a water user or future water user (applicant) expects to:

- Use any amount of surface water for any purpose;
- Use more than 5,000 gallons per day of ground water (well) for any and all purposes including domestic, commercial, industrial, and/or irrigation; or
- Use ground water to irrigate more than one-half acre.

A Water Right Permit is issued to the applicant if Ecology determines that:

- The use will be beneficial;
- The use will be in the public interest;
- The water is available;
- The use will not impair senior water users.

The Water Right Permit allows the applicant to proceed with the development of the water use. Upon approved appropriation, a Certificate documenting the authorized water use is issued.

As shown in Figures 8 and 9, ground water and surface water use has increased steadily throughout the years, particularly after the mid-1960s. A total of 634 permits and certificates were filed for various purposes as detailed on Table 2. A total of 120 ground water permits/ certificates were filed for a total of 4,098.67 acre-feet per year and 10,622.5 gpm (23.7 cfs) and 514 surface water permits/certificates were filed for a total of 90.03 cfs. The total quantity of surface water allocated per year is not provided for all permits and certificates. However, the reported quantities allocated for surface water is 12,858 acre-feet/year. The location of these permits and certificates are shown on Maps 3 and 4.

The primary uses for the ground water and surface water permits and certificates are illustrated on Figures 10 and 11. The principal use in the watershed is irrigation. Specifically, 81 percent of the total allocated ground water and 94 percent of the total allocated surface water is used for irrigation. The total quantifies per use, including the total number of rights, are shown in Table 2.

Approximately 25 percent of the ground water rights account for 75 percent of the allocated ground water use volume. However, the ground water permits are comprised of many small quantity permits. The largest ground water user accounts for only 7 percent of the total allocated in the watershed. Approximately 6 percent of the surface water rights account for 50 percent of the allocated surface water use volume. However, the surface water permits are comprised of many small quantity permits. The largest surface water user accounts for only 6 percent of the total allocated in the watershed.

## *APPLICATIONS*

Issuance of a permit after an application has been filed may take one to three years or more (Ecology 1995b). The requested quantities shown on the applications and as presented in the WRIS report were used in the preparation of the report.

There are 50 water right applications divided into 19 ground water applications for 4,384 gpm; and 31 surface water applications for 7.53 cfs. The applications do not include total proposed annual water use (acre feet/year). The location of the proposed withdrawals are presented on Map 5. The requests for water by purpose of use can be seen in Figures 6 and 7. Ground water use was requested for domestic multiple, domestic single, mining, and irrigation. Irrigation was the largest ground water use request at 66 percent of the total volume requested.

Surface water use was requested for the following uses:

- Domestic multiple;
- Stock watering;
- Miscellaneous;
- Fire protection;
- Irrigation;
- Domestic single;

- Environmental quality;
- Commercial and industrial manufacturing; and
- Wildlife propagation.

Domestic multiple was the largest surface water use requested at 61 percent of the total volume requested.

### *SUMMARY*

The total quantity of ground water allocated by both rights and claims is 8,429 acre-feet/ year and 21,918 gpm (48.8 cfs). Including applications, the total quantity allocated for possible future use is 26,302 gpm (58.6 cfs). An estimate for total quantity of surface water allocated by both rights and claims is 221.3 cfs and including applications, total quantity is 229 cfs. An estimate for total quantity, $Q_a$, was provided only for surface water use claims and reported permits and certificates. This estimate of 38,068 acre-feet/year. The numbers represent reported quantities only. Actual usage may be less or more (i.e., due to unutilized claims/permits or illegal uses) than the quantities stated above.

**Table 2.**
**Quantities for Purpose of Use for WRIA 60**

| Purpose | Total $Q_i$ (cfs) | Total $Q_a$ (gpm) | Total $Q_a$ (acre-feedyear) (a) | Total Irrigation (acres) | Number of Rights |
|---|---|---|---|---|---|
| **Surface Water Rights** | | | | | |
| Domestic General | 0.02 | 9 | 2 | 0 | 1 |
| Domestic Multiple | 0.94 | 422 | 47.55 | 0 | 17 |
| Domestic Single | 5.616 | 2,520 | 141.3 | 0.3 | 121 |
| Fire Protection | 0.82 | 368 | 5 | 0 | 5 |
| Irrigation | 77.215 | 34,654 | 11,971.12 | 5,703.46 | 163 |
| Stock Watering | 3.897 | 1,749 | 277.7 | 0 | 204 |
| Commercial & Industrial Manufacturing | 1.34 | 601 | 413.6 | 0 | 2 |
| Railway | 0.0185 | 83 | 0 | 0 | 1 |
| Claims (specific use unknown) | 131.42 | 58,981 | 25,210 | NA | 629 |
| TOTAL SURFACE WATER RIGHTS | 221.29 | 99,387 | 38,068.27 | 5,703.76 | 1,143 |
| **Ground Water Rights** | | | | | |
| Domestic-Multiple | 2.53 | 1,137 | 357.2 | 0.10 | 21 |
| Domestic Single | 3.19 | 1,431.5 | 169.3 | 0 | 49 |
| Irrigation | 17.15 | 7,695 | 3,307.67 | 1,144.5 | 35 |
| Stock Watering | 0.21 | 94 | 2.5 | 0 | 3 |
| Mining | 2.35 | 155 | 165 | 0 | 4 |
| Domestic Municipal | 0.25 | 110 | 97 | 0 | ? |
| Claims (specific use unknown) | 25.17 | 11,295 | 4,330 | NA | 382 |
| TOTAL GROUND WATER RIGHTS | 48.85 | 21,917.5 | 8,428.67 | 1,144.6 | 502 |
| **Combined Surface and Ground Water Rights** | | | | | |
| TOTAL SURFACE WATER AND GROUND WATER RIGHTS | 270.13 | 121,305 | 46,497 | 6,848 | 1,645 |

(a) - only Total of $Q_a$ reported.

## *MINIMUM BASE FLOWS*

Minimum flows, stream closures, or restrictions to water appropriations are not specified by rule in the Washington Administrative Code (WAC 173-500) for any streams in WRIA 60. However, there are several creeks and streams, including the mainstem of the Kettle River which have administrative minimum flow requirements, closures, and/or seasonal closures (Table 3). The streams and rivers listed in Table 3 have been recommended for closure or minimum flow requirement based on low flows, fish and aquatic habitat considerations or water right adjudication. In addition, recommended instream flow for Myers Creek and maintenance of water levels in Lost Lake (which drains to Myers Creek) were set based on a U.S. treaty with Great Britain in 1909, and which was later supported by recommendations from Game and Fisheries in 1922. The nature and status of the U.S./Great Britain Treaty has not been ascertained.

According to RCW 75.20.050, these streams can be considered closed to future appropriations by the Department of Ecology based on recommendations from the Department of Fish and Wildlife or other agency in order to protect beneficial use of the resource. At a minimum, Ecology will consider the recommendations before issuing any additional water rights which would affect flow in these streams.

The tributary stream closures occur primarily in the central portion of the WRIA in the vicinity of Curlew Creek, Curlew Lake and other tributaries to the Kettle River due to extreme low flows which are exacerbated by low precipitation and high evaporation. Tributary stream closures also occur in the eastern portion of the watershed. Instream low flow limitations for the mainstem of the Kettle River have also been recommended to preserve aquatic habitat. The minimum flow recommendations apply to flows gaged at Ferry and at Laurier. A low flow limit of 600 cfs for the period April through July and 300 cfs of the period August through September apply to river flows at the Ferry gage, and a minimum flow of 570 cfs applies for the Laurier gage.

In order to meet the recommended flow limitations for the Ferry gage, special conditions may apply to future water allocations from the mainstem of the Kettle River as well as tributaries entering the Kettle (and associated ground water) upstream of Laurier such that instream flows within the mainstem reach between the two gages should not fall below the low flow values. The recommended minimum flows for the Laurier station would condition future allocations for the Kettle River, its tributaries and associated ground waters for the reach between Laurier and the confluence with the Columbia River. The flow limitations and closures are considered to be interim recommendations that may require further investigation in order to establish more definitive flows.

The administrative restrictions are established by the following procedure: (1) an application for water use is made, (2) during review of the application, the Washington Department of Fish and Wildlife or other appropriate agency may recommend stream closure to additional appropriation, or a low-flow/seasonal restriction on additional appropriation; (3) if Ecology accepts WDFW recommendation, the application for water use is denied (in the case of a stream closure recommendation) or a permit is issued with low flow provision or cut-off date;

(4) if the Ecology decision is not appealed, or if appealed and then affirmed by the Pollution Control Hearings Board (PCHB), then the closure or low flow is adopted administratively. This same provision is placed on every future application made or permit granted unless a future recommendation is made. If the recommendation is a closure, then all future permits are denied and the stream is closed. In the instance of a low flow limitation or cut-off date that may restrict an applicant, the application is returned to the applicant and the applicant is advised of the restrictions. The applicant may choose to accept the restrictions and the application will be processed or the application may be withdrawn.

**Table 3.**
**A Summary of Surface Water Limitations for the Kettle River Basin**

| Stream | Tributary To | Status | Documentary Basis | Remarks |
|---|---|---|---|---|
| Catherine Creek | Kettle River | Low Flow | | |
| Curlew Creek & All Tributaries | Kettle River | Closure | Letters, Game: 1/17/68, 1/3/69, Fisheries: 1/23/51 | |
| Twin Creek (Doyle Creek) | Kettle River | Adjudicated | Ferry County Superior Court, 5/29/36 | |
| Goosmus Creek | Kettle River | Closure | Letter, Game: 10/12/71 | |
| Lambert Creek | Curlew Creek | Closure | Ferry County Superior Court, 11/24/34 | Appropriated by Indian right. |
| Little Goosmus Creek & Tribs | Kettle River | Closure | | |
| Lone Ranch Creek | Kettle River | Low Flow | Letter, Wildlife: 10/18/90 | |
| Kettle River | Columbia River | Low Flow | Letter, Wildlife: 8/19/90 | Game fish habitat requirements |
| Lost Lake | Myers Creek | Lake Level | Letter, Fisheries & Game, 6/26/22 | Also Treaty U.S & Great Britain: 1/11/09 |
| Myers Creek | Kettle River | Treaty | Letter, Game & Fisheries: 6/26/22 | Also Treaty U.S & Great Britain: 1/11/09 |
| Sand Creek | Kettle River | Closure | Letter, Game, 10/19/71 | |
| Shasket | Kettle River | Base Flow | | |
| Tonasket Creek | Curlew Creek | Low Flow / Closure | Letter, Fisheries: 2/6/48 | |
| Toroda Creek | Kettle River | Closure | Letters, Fisheries: 5/31/50, 8/19/53, 3/2/55 | |
| Toulou Creek | Kettle River | Closure | Letter, Game: 9/19/74 | |
| Trout Creek & Tributaries | Curlew Creek | Low FLow | Letter, Game: 9/21/71, Wildlife: 3/9/90 | Game fish habitat requirements |
| Unnamed Creek | Kettle River | Stream Flow | | |

# WATER QUALITY

This section includes a compilation of historical water quality indicator data for surface water, and any available ground water quality indicator data for specific aquifers. These data are obtained from pertinent reports, the EPA STORET data base, Environment Canada, an on-going investigation sponsored by the Kettle River Advisory Board and the USGS.

There are no permitted point sources (discharges from a specific location or outfall) within the Kettle River basin in Washington State. In British Columbia, at least two point sources discharge to the Kettle River including effluent from the City of Grand Forks and Village of Midway sewage treatment facility. The effluent from both of these sources is considered to generally be in compliance with B.C. Ministry of Environment permit regulations. Non-point sources (those with no specific discharge point or outfall) of pollutants in the Kettle River basin that potentially affect the river are principally agriculture, livestock grazing and natural sources with other contributions from on-site sewage disposal (septic systems), stormwater and highway runoff, forest practices, land development, landfills, and mining. The Ferry County landfill, which used to operate in the floodplain of Curlew Lake, is currently closed.

The Federal Clean Water Act (Section 303 [d]) and federal regulations (40 CFR Part 130.7) require Washington State to develop a 303 (d) list every two years. The list is compiled and submitted by Washington State Department of Ecology to the United States Environmental Protection Agency for approval. The list describes the health of Washington's rivers, coastal waters, estuaries, and lakes. The listing of "troubled waters" is used by the state to set environmental priorities for action and to chart water quality trends. Water bodies must meet two criteria to be placed on the list including: 1) water quality does not meet state water quality standards, and 2) technology-based controls are not sufficient to achieve water quality standards. Waters on the list exceed standards for bacteria, temperature, siltation, oxygen levels, nutrients, and toxic compounds or heavy metals. The list helps Department of Ecology determine if there are human health concerns, dangers to fish and wildlife, and what kinds of uses the water body will support or impair.

In 1992, a statewide water quality assessment indicated that the Kettle River was not water quality limited and therefore had no section 303(d) categories, although temperature was exceeding state standards (Ecology 1992). The 303(d) list released for 1994 included the Kettle River (Map 6). The Kettle River was listed because temperature exceeded standards in the segment from the confluence with the Columbia River (Columbia River RM 706.4) to the Canadian boarder (Ecology 1994). Ecology indicates the likely causes of these excursions beyond criteria are due to temperature and thermal modifications as indicated in the 303(d) list. (Previous sentence requires clarification.) Uses that are impaired include salmonid (i.e., salmon and trout) spawning and, salmonid and non-salmonid migration (Ecology 1992).

The Kettle River is a freshwater class AA (extraordinary) waterbody (Ecology 1994). This classification is used to provide general guidelines for water use and water quality criteria as described in the Water Quality Standards for Surface Waters of the State of Washington (Chapter 173-201 WAC). In general AA waters should markedly and uniformly exceed the requirements for all or substantially all uses. Examples of these uses include all types of water supply (i.e., domestic and cattle watering), successful migration and propagation of fish and wildlife, and recreational activities.

Recent water quality data (1990 - 1992) for the Kettle River collected by B.C. Ministry of Environment at Midway (near Ferry, Washington) and Grand Forks (near Laurier, Washington) indicates that total dissolved solids increases in a downstream direction. Between the two stations the drainage area to the River doubles, and dissolved solids (as indicated by the specific conductance of the water) increases by about 20 percent. In addition, attendant with the increased total dissolved solids is an increase in concentrations of several metals including arsenic, copper and iron, and an increase in turbidity. However, none of the metals concentrations at either station exceed EPA drinking water standards and the general water quality meets EPA and Washington State Class AA criteria (WAC 173-201A) for both acute and chronic toxicity. The data indicates occasional exceedances of copper and mercury above chronic criteria; however, generally these metals meet the standards.

Water quality sampling conducted by the Kettle River Advisory Board at 13 locations in the Kettle River within Washington State (from the Canadian border to the confluence with the Columbia River) during 1993 and 1994 confirm the B.C. Environment data, showing in many cases lower levels of some metals. Additionally, this study sampled fecal coliform in the river (analyzed by the Spokane County Health Department) and found no exceedances of State standards for Class AA water. Fecal coliform levels have been below state standards since at least 1981 (EWU 1990).

Figure 12 provides a data summary of water temperatures in the Kettle River during the years 1960 through 1980. These data are the most recent long-term series of data found that can provide seasonal trends. This data is taken from a station near Barstow about 10 miles from the confluence of the Kettle River with the Columbia River. This data provides a general idea of the seasonal variation within the Kettle River. Temperature fluctuates considerably on an annually basis. The summer temperatures are highest in June through August with temperatures exceeding 24°C (75°F) at times in July and August.

These high summer temperatures are not compatible with cold water species such as trout and exceed the state standards. In general, the guidelines established by the Water Quality Standards for Surface Waters of the State of Washington provide that temperatures shall not exceed 16°C (60.8°F) and that temperature increase resulting from non-point source activities shall not exceed 2.8°C and the maximum water temperature shall not exceed 16.3°C. The withdrawal of water from surface or ground water can have a significant effect on water quantity and thus temperature of the remaining water; however, it is probable that water temperatures under natural conditions may also exceed 16°C. During the winter months, temperatures reach near freezing, especially during the months of December through February.

Dissolved oxygen values show an inverse (opposite) trend to that of temperature with higher values during the winter months and lower values for the summer months (Figure 13). This is expected since cold water is capable of having a higher concentration of oxygen than warmer water. For the years recorded in the time series, every year had dissolved oxygen concentrations below the state standard. The state standard provides that dissolved oxygen shall exceed 9.5 mg/L (Chapter 173-201 WAC). The low oxygen levels normally occur during the months of July and August.

The USFS has collected water quality data for several tributaries to the Kettle River. This data is still in draft form and has not been analyzed. Review of this raw data indicates that the tributaries maintain significantly lower temperatures and higher dissolved oxygen concentrations during the summer low flow period when compared to the mainstem Kettle River (USFS 1995).

Map 5 provides a summary of areas where water quality is known to impose a limit on a fish population's ability to annually perpetuate. In the Kettle watershed, there is only about 1 percent (9 miles) where limiting water quality factors are present throughout the entire year. Four percent (39 miles) of the watershed streams are known to be limiting during only part of the year or are only mildly limiting in nature and in 19 percent (204 miles) there are no known limiting factors. Over 76 percent of the watershed streams (810 miles) have no data to make a determination (WARIS 1994).

Studies in the Curlew Lake area and its tributaries (including Barrett and Trout Creeks which flow into Curlew Lake) have indicated that septic systems, livestock grazing near waterbodies and past timber harvesting are significant contributors of non-point source pollution to the drainage system (Juul and Funk 1988, and Sullivan 1990). The non-point pollution includes increased bacterial contamination, increased nutrient loading to the lake and stream system, and increased turbidity. The increased nutrient loadings have resulted in algal blooms in Curlew Lake (Juul and Funk 1988).

Although not listed on the 303(d) list, Curlew Lake was noted as having impaired uses for primary contact recreation, and aesthetic enjoyment. This 921 acre lake and Curlew Creek, which delivers the majority of the water to the lake, is apparently the focus of considerable controversy due to lake water levels. This is explained further below with regard to surface water source limitations.

Surface water source limitations are summarized in Table 3. This is a summary of documented concerns for waterbodies in the basin. When considering water rights decisions, Department of Ecology consults these files for potential conflicts and concerns. As seen in this table, the majority of limitations are based on fisheries concerns. There are many tributaries to the Kettle River listed and several tributaries to Curlew Creek. The Kettle River and Curlew Creek (including tributaries) are also included on the list.

Ground water quality is generally of good to excellent quality throughout the watershed. Dissolved solids commonly are less than 200 mg/1 in water from the alluvial deposits. The water ranges from soft to hard and hardness generally ranges from 50 to 150 mg/l. Boron and fluoride are low and iron is rarely a problem (PNRBC 1970). The state and county department of health have not documented areas where ground water quality is below drinking water standards, although iron and manganese are above secondary standards in some localized areas (Matsuahma and Justice, personal communication Stevens and Ferry County Departments of Health, 1995). In the Myers Creek and Toroda Creek drainages, ground water investigations completed by Battle Mountain Gold as part of the baseline data collection and permitting for the Crown Jewel Mine has indicated that ground waters contained within bedrock aquifers and localized water bearing strata of glacial origin generally contain water quality suitable for domestic and industrial purposes (Golder Associates 1992). In the Curlew Lake area, studies have shown some ground waters with relatively high levels of phosphorus and nitrogen (Juul and Funk 1988). The origin of these nutrients may be septic systems.

# FISHERIES AND AQUATIC RESOURCES

This section provides a compilation of fisheries habitat and fish presence information from available databases and communications with entities collecting such information. At present, existing fisheries information available for the basin is limited and much of the information is not complete and/or not analyzed. The USFS, Colville District, is presently collecting fisheries information in tributaries to the Kettle on USFS land. WDFW has a GIS data base (WARIS) that appears preliminary in nature and is still being developed. WDNR, the Colville Indian Tribe, and USFWS have not conducted fisheries work in the basin.

Table 4 provides a list of species known to inhabit the Kettle watershed. Also included in the table are the linear miles of stream and percentage of stream miles where they are documented as being present (WARIS 1994). This table is provided to give the reader a general idea of the fisheries resources that exist in the basin. For example, approximately 61 percent of the watershed streams either have a "no fisheries data" or "no fish species are present" designation. The WARIS data base does not distinguish between the two designations.

The fisheries resources of the Kettle River in the state of Washington have been changed extensively by downstream dams. There are no anadromous fish found in the basin due to conditions that prevent migration of these species. Anadromous species are those that ascend rivers from the ocean to spawn, with some species rearing 1 to 3 years, and then return to the ocean where they grow to adults. Historically, anadromous fish species of salmon utilized this portion of the basin for migration, spawning, and rearing until the building of the Grand Coulee Dam (NWPPC 1986). The two most common sport fish in the basin at present are resident rainbow trout and Eastern brook trout. There also appears to be significant populations of brown trout, sculpins, bridgelip suckers, and mountain whitefish.

Approximately 10 percent (105 miles) of the watershed streams provide known key reaches (areas) of spawning habitat which are critical to perpetuation of a fish population. About 18 percent (190 miles) are considered as not having critical spawning habitat or the absence of spawning habitat. Seventy-two percent (766 miles) have no data to make a determination on critical spawning habitat (WARIS data base).

Although not listed in Table 4, bull trout have been documented in one major tributary to the Kettle River (WARIS 1995). Bull trout are considered a sensitive species in the state of Washington and are a candidate for threatened and endangered status. If they are listed under the Endangered Species Act, this would have significant effects on water withdrawals from any area known to provide habitat. Approximately 3 percent (34 miles) of the watershed streams are inhabited by a species of concern which is most likely bull trout (WARIS 1994). Approximately 21 percent (223 miles) have no known species of concern and 76 percent (800 miles) has no data to make the determination (WARIS 1994).

**Table 4.
Fish species list and relative distribution data
within the Kettle River Watershed (WARTS 1994).**

| Common Name | Species Name | Miles | Total Percent of Miles |
|---|---|---|---|
| * | No species associated with these segments. | 806 | 76% |
| Resident Rainbow Trout | *Salmo gairdneri* | 241 | 23% |
| Eastern Brook Trout | *Salvelinus fontinalis* | 158 | 15% |
| Sculpin (General) | *Coftidae spp.* | 145 | 14% |
| Brown Trout | *Salmo trutta* | 71 | 7% |
| Mountain Whitefish | *Prosopium williamsoni* | 61 | 6% |
| Bridgelip Sucker | *Catostomus columbianus* | 53 | 5% |
| Kokanee Salmon | *Oncorhynchus nerka* | 34 | 3% |
| Small Mouth Bass | *Micropterus dolomieui* | 32 | 3% |
| Walleye | *Stizostedion vitreum vitreum* | 32 | 3% |
| Redside Shiner | *Richardsonius balteatus* | 29 | 3% |
| Northern Squawfish | *Ptychocheilus oregonensis* | 25 | 2% |
| Yellow Perch | *Perca tlavescens* | 17 | 2% |
| Slimy Sculpin | *Cottus cognatus* | 15 | 1% |
| Largemouth Bass | *Micropterus salmoides* | 9 | 1% |
| Lake Whitefish | *Coregonus clupeaformis* | 8 | 1% |
| Longnose Dace | *Rhinichthys cataractae* | 6 | 1% |
| Shorthead Sculpin | *Cottus confusus* | 6 | 1% |
| White Sturgeon | *Acipenser transmontanus* | 2 | < 1% |

# STATUS OF STREAMFLOW

All surface water withdrawals within WRIA 60 directly affect flow in the Kettle River because it receives all of the runoff from within the watershed. Similarly, ground water withdrawals also affect flow in the River; however, these effects are seasonally attenuated in many cases due to the longer residence time of water in the aquifer.

The total water withdrawals in the WRIA, as indicated by water right permits, certificates and claims are approximately 270 cfs peak withdrawal rate (114 cfs from permits and certificates and 156 cfs from claims) and 46,497 acre-feet per year total volume (16,957 from permits and certificates and 29,540 in claims). The total volume diverted or withdrawn under permits, certificates or claims is 64 cfs when annualized. In addition, 50 applications for surface water and ground water rights have been filed for a total peak withdrawal of 17.3 cfs (total acre-feet per year is not available).

Comparative trend analysis was performed for Kettle River streamflows at the Ferry and Laurier stations. Using linear regression techniques, annual average flows over a comparable period of record at both stations (1928 - 1992) were analyzed to determine the best fit trend line. The results of the analysis indicate that since 1928, streamflows at both stations have increased slightly (Appendix A.4). Inspection of the annual hydrographs for both stations (Figure 3). show a rise in flows between 1928 and then a decline after 1950 along with greater flow variability from year to year. These trends are similar to the precipitation pattern observed at Republic (Figure 1). The trend lines (slope of the predicted regression equations), although both increasing over the period of record, shows a greater increase at Ferry than at Laurier.

An estimate of the current flow difference between the two stations was developed from the normalized trend lines (divided by the mean flow) by using the equation to predict flows after 63 years for the same slope and the predicted slopes, and then differencing the two. The results of this analysis indicates that if the two stations were assumed to follow the same trend, 114 cfs of flow would be unaccounted for at the Laurier station. This quantity of flow would then have to be explained by natural differences in flow contribution between the watersheds contributing to the two stations, and/or by water withdrawals from the river. Annual peak surface water withdrawals for WRIA 60 are 270 cfs (64.2 cfs annualized), the majority of which occur within the drainage area contributing to the Laurier station (on the order of 70 percent, Map 3 and 4), and an unknown quantity of water is withdrawn in British Columbia. Assuming actual withdrawals from the river as gaged at Laurier are between 64 and 270 cfs, the percentage withdrawal for human consumption is on the order of 3 to 11 percent of the average annual flow.

Although the permitted annual withdrawals are small compared to the average annual flow in the Kettle River, withdrawals during low flow periods in the river can be critical. Low flow records (1-day, 7-day, 30-day, 60-day and 90-day) for 1930-1993 (period of record) and 1966 -1993 (recent record, incorporating increased water use) were compared for Kettle River streamflows at the Ferry and Laurier stations. Average low flows (2-year) for all time periods at both stations were lower in the recent record than in the full period of record suggesting increased recent (1966-1993) water usage is impacting the average low flow.

At Ferry, recent low flows for the less frequent events (5-year, 10-year, 50-year, and 100-year) are larger than low flows for the full period of record. This is likely due to extreme low flows which occurred in the early record (i.e., the 1930's) skewing the low flow statistics. During the more recent record, low flows have not been as extreme, and therefore the statistical analysis reflects larger low flow events. At Laurier, low flows for the less frequent events are generally lower in the recent record compared to low flows for the full period of record. This indicates that the lower reach of the Kettle River (which includes WRIA 60) has been experiencing greater reductions in flow relative to the upper portion of the river gaged at Ferry. The flow reductions may be due to and are certainly exacerbated by increased water withdrawals during recent years both in WRIA 60 and in Canada.

Low flows in the Kettle River can occur in the summer, fall and winter (Figure 3). Although the lowest flows typically occur in the winter, they can also occur in later summer (August, September and October). Table 5 and 6 list the low flow statistics for both the Ferry and Laurier stations, showing the event frequency (return period) and the time period or duration of the low flow (number of days over which the low flow occurs). Since these low flow statistics have been compiled from measured flows, they include the effects of consumptive water use in the basin.

The lowest flows, including the short duration 5, 10, 50 and 100 year events indicate that flows in the Kettle River between Ferry and Laurier can be below 100 cfs, and downstream from Laurier can be below 200 cfs. These flows are well below the recommended minimum flow values. Additionally, if current water right applications are approved and used during the low flow periods, instream flows would be reduced by as much as 17 percent at Ferry for 30 days on average every 5 years, and 10 percent for 7 days every 10 years on average at Laurier. Reductions of this magnitude may impact senior water users, and would increase the amount of time that recommended low flows are not met in the mainstem Kettle River. Since the Kettle River receives water from all of the tributary streams in the WRIA, flow restrictions in the Kettle would also impact upstream water sources.

The instream low flow limitations for the mainstem of the Kettle River include 600 cfs for the period April through July and 300 cfs for the period August through September as gaged at Ferry, and a minimum flow of 570 cfs as gaged at Laurier. These flows are frequently not met. For example, the flow limitations as gaged at Ferry are not met approximately 10 percent of the time in April, 1 percent of the time in May and June, 20 percent of the time in July and 50 percent of the time in August through September (USGS 1984). Annually the minimum flows for the Kettle River at Ferry are not met 48 days a year on average, with 95 percent of the years falling within the range 108 days and 0 days. Low flows at Laurier fall below the recommended minimum flows 1 percent of the time during April through July, 50 percent of the time in August, 80 percent of the time in September through February and 50 percent of the time during March (USGS 1984). Annually, the flows at Laurier do not meet instream flow requirements on average 140 days per year (Appendix A.2) with 95 percent of the years falling in the range 265 days per year to 1 day a year. The instream flow data indicates that future water allocations in the watershed will need to consider the flow limitations and will likely be conditioned for use only during periods when low flow limitations are exceeded, unless other beneficial use considerations take precedence.

**Table 5.**
**Statistical Low Flows, Kettle River at Ferry**

| Return Period | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1966 - 1993 (recent) | | | | | | | 1930 - 1993 (period of record) | | | | | | |
| Duration | 100-yr | 50-yr | 10-yr | 5-yr | 2-yr | 1-yr | Duration | 100-yr | 50-yr | 10-yr | 5-yr | 2-yr | 1-yr |
| 1-day | 51 | 53 | 62 | 69 | 89 | 276 | 1-day | 25 | 30 | 50 | 65 | 99 | 227 |
| 7-day | 53 | 57 | 71 | 82 | 112 | 323 | 7-day | 24 | 31 | 57 | 77 | 122 | 244 |
| 30-day | 61 | 66 | 84 | 99 | 140 | 503 | 30-day | 46 | 53 | 77 | 96 | 144 | 418 |
| 60-day | 77 | 83 | 103 | 119 | 163 | 501 | 60-day | 61 | 68 | 94 | 114 | 164 | 457 |
| 90-day | 84 | 90 | 113 | 131 | 179 | 539 | 90-day | 67 | 75 | 104 | 126 | 181 | 506 |

**Table 6.**
**Statistical Low Flows, Kettle River at Laurier**

| Return Period | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1966 - 1993 (recent) | | | | | | | 1930 - 1993 (period of record) | | | | | | |
| Duration | 100-yr | 50-yr | 10-yr | 5-yr | 2-yr | 1-yr | Duration | 100-yr | 50-yr | l0-yr | 5-yr | 2-yr | 1-yr |
| 1-day | 106 | 114 | 142 | 162 | 215 | 547 | 1-day | 111 | 121 | 155 | 180 | 242 | 614 |
| 7-day | 105 | 116 | 153 | 181 | 252 | 686 | 7-day | 117 | 129 | 170 | 199 | 272 | 663 |
| 30-day | 133 | 144 | 185 | 216 | 301 | 938 | 30-day | 136 | 149 | 195 | 229 | 320 | 913 |
| 60-day | 179 | 189 | 228 | 259 | 344 | 1048 | 60-day | 159 | 173 | 223 | 261 | 359 | 1015 |
| 90-day | 204 | 216 | 257 | 291 | 384 | 1163 | 90-day | 174 | 189 | 246 | 288 | 398 | 1139 |

Note: Low flow statistical data obtained from U.S. Geological Survey, Tacoma Washington.

Management issues facing tributary streams to the Kettle River within the WRIA can also be critical. Documented reduction in water quality and fish habitat in several streams have resulted in recommendations for instream flow requirements and stream closures to additional appropriations. Ecology has conducted a periodic flow measurement program in several creeks within the WRIA since 1985 (Appendix A.3). Ecology's measurements have shown zero or extreme low flows in several tributaries to the Kettle River. Additionally, estimates of low flow occurrences within the WRIA (LaFrance 1975) and monthly streamflows into and out of Curlew Lake estimated for the 1985 water year as part of a water quality study of the lake (Juul and Funk 1988) also indicate that extreme low flows or cessation of flow occurs regularly in many smaller tributaries (drainage areas less than 25 square miles). Additionally, flows in the tributary streams impact flows in the mainstem Kettle River, and therefore any management issues effecting the mainstem also effect the tributaries.

The location of streams measured by Ecology which exhibit summer extreme low flows or cease to flow are shown on the map in Appendix A.3. The majority of streams measured by Ecology which exhibit summer extreme low flows or cease to flow are located in the Curlew Lake and Curlew Creek drainage, or in the vicinity of the confluence of Curlew Creek and the Kettle River in the central portion of the WRIA. Other streams are located in the Kettle River valley in the southeast portion of the WRIA.

These extreme or zero low flows generally occur in late summer and reflect the natural water balance conditions in the central portion of the WRIA. This region experiences the lowest annual precipitation (Map 2) and is underlain by volcanic bedrock which contributes low baseflows. Because of these conditions, streams are naturally sensitive to water withdrawals and may be subject to natural flow limitations. Thus, water withdrawals exacerbate the natural sensitivity to low-flows. Additional water appropriations, therefore, have a high likelihood of interfering with senior water rights and other beneficial uses such as preservation of habitat and water quality. Documented water quality problems in several of the tributaries, particularly in the Curlew Creek drainage, also contributes to limited beneficial use of the water resource.

Currently, extreme low flows and zero flows in many tributaries to the Kettle River limit the amount of water available during low flow periods, and therefore impact the Kettle River downstream. If ground water rights were issued to replace surface water that is naturally limited by climatic factors and from over appropriation, low flow impacts would likely persist over longer periods of time, as surface water runoff becomes ground water recharge rather than becoming streamflow. Increased ground water use in the Kettle River valley, within the narrow alluvial aquifer associated with the river, would also contribute directly to increasing declines in streamflow.

Streamflow availability in streams tributary to the Kettle River where extreme low flows or zero flows indicates little or no availability during the low flow periods. However, long term streamflow and recent continuous flow data is generally unavailable for tributary streams in the WRIA. Because of the lack of streamflow data, the seasonal availability of water from the tributaries is difficult to assess and specific instream flows are difficult to define. Without adequate streamflow data, informed and supportable water availability and instream flow management assessments cannot be made for the tributary and for the mainstem downstream. This results in an inability to develop adequate decisions regarding future water allocations because potential impacts of the withdrawal on senior water users and other beneficial uses are ill defined.

# DISCUSSION AND CONCLUSIONS

During average and high flow conditions, there appears to be ample water within the Kettle River to preserve senior water rights, beneficial uses (water quality is currently good), and still allow for additional appropriation. However, during low flow periods, especially during summer low flows which coincide with increased water use and instream flow needs for fish, the Kettle River and tributaries to the Kettle probably cannot sustain significant amounts of additional appropriations, either surface water or ground water.

Because instream flow requirements have not been specified for tributary streams in the WRIA and because continuous long term streamflow data for the tributaries is generally unavailable, informed and supportable water management decisions for the tributaries and the mainstem Kettle River cannot be made. Assessing the amount of surface water available for additional appropriation must consider the beneficial uses of the Kettle River other than water supply. Also, it is impossible to assess ground waters available for additional appropriation from aquifers in association with streams and other surface water bodies without an instream flow designation. Lack of continuous streamflow data for tributaries within the WRIA also reduces the understanding and effectiveness of water allocation decisions in the watershed. Without a thorough understanding of flow conditions in the tributaries as they relate to flow in the Kettle River, it is not possible to evaluate how allocated waters in the tributaries affect instream flows within the mainstem of the Kettle.

Variability in flows within the tributary streams may provide a means to seasonally appropriate water during periods of higher flows or during less critical flow periods. Since most of the flow in the Kettle River originates in British Columbia, the provincial government should be part of any overall strategy to preserve instream flows in the river. Currently there are no international agreements between the US and Canada regarding flow or water quality in the Kettle River.

The major conclusions regarding the state or "health" of water resources in the Kettle River watershed include:

- During low flow periods, especially during summer low flows which coincide with increased water use and instream flow needs for fish, the Kettle River and its tributaries may not be able to sustain additional appropriations especially during summer low flow periods, either surface water or ground water. This is especially evident in the Curlew Creek basin located in the central portion of the watershed, where extreme low or zero flows have been documented, stream closures for some streams have been recommended, and water quality concerns are evident. Hence, ground water and surface water appropriation within these basins will require detailed evaluation with regards to potential impacts to senior water rights and downstream aquatic habitat.
- Flows in the Kettle River depend to a large extent on hydrologic conditions outside of the WRIA in Canada because most of its total contributing watershed is upstream.

Thus, comprehensive water management for the river will necessitate cooperative efforts with the Ministry of Environment in British Columbia.

- Current consumptive water use in the WRIA is only a small percentage of average annual streamflows; in the Kettle River and its tributaries; however, water use is a significant portion of summer low flows and appears to have exacerbated low flow conditions in the Kettle River over the last 30 years.
- All surface water withdrawals within WRIA 60 directly affect flow in the Kettle River because the river receives all of the runoff from within the watershed. Similarly, ground water withdrawals also affect flow in the river; however, these effects are seasonally attenuated in many cases due to the longer residence time of water in the aquifer.
- Currently, water use in tributary drainages is limited; however, in many cases water availability is limited as well, evidenced by extreme low flows and recommendations for minimum streamflow requirements and/or stream closures in several streams. In the flow limited tributaries, future surface and ground water appropriations must consider the potential impact on downstream senior water rights and other beneficial uses, particularly maintenance of fisheries and aquatic habitat.
- Some tributaries in the WRIA provide habitat for bull trout, a fish species which may soon be listed as endangered. If this species is listed, instream flow requirements, water quality and habitat conditions will become much more critical for the tributary streams which flow into the Kettle River.

# RECOMMENDATIONS

Managing water resources in WRIA 60, and specifically evaluation of ground and surface water rights applications in the watershed, require consideration and assessment of water quantity, quality and use. The key water management issues include:

- Evaluation of instream flows for habitat, water quality and senior water right preservation in the Kettle River and its tributaries.
- Cooperation between Agencies in Washington and British Columbia to set and maintain instream flows and water quality in the Kettle River.
- Determination of causes and implications of extreme low flows and zero flows during summer/fall months in selected tributary streams in the central portion of the watershed (particularly Curlew Creek drainage).

Resolution and understanding of these issues will enable better management decisions designed to preserve senior water rights, aquatic habitat, water quality, and allow for additional water development in the WRIA. However, lack of information concerning streamflows and ground water conditions in the watershed limit the ability to address these issues. In addition, cooperation and sharing of information is essential to effective management of the Kettle River. Specific recommendations to provide adequate information and strategies to address water management issues include:

- Re-establish select streamflow monitoring stations on tributary streams in the WRIA to provide continuous long term streamflow data.
- Develop ground water level and water quality monitoring network for tributary streams in the WRIA.
- Develop instream flow models (IFIM) to evaluate low flow requirements in the mainstem of the Kettle River to preserve all beneficial uses. Include appropriate state and federal agencies, the British Columbian Ministry of Environment, tribes and local organizations to review and assist in the instream flow and water quality management guidelines.
- Develop instream flow requirements for tributary streams in the basin.

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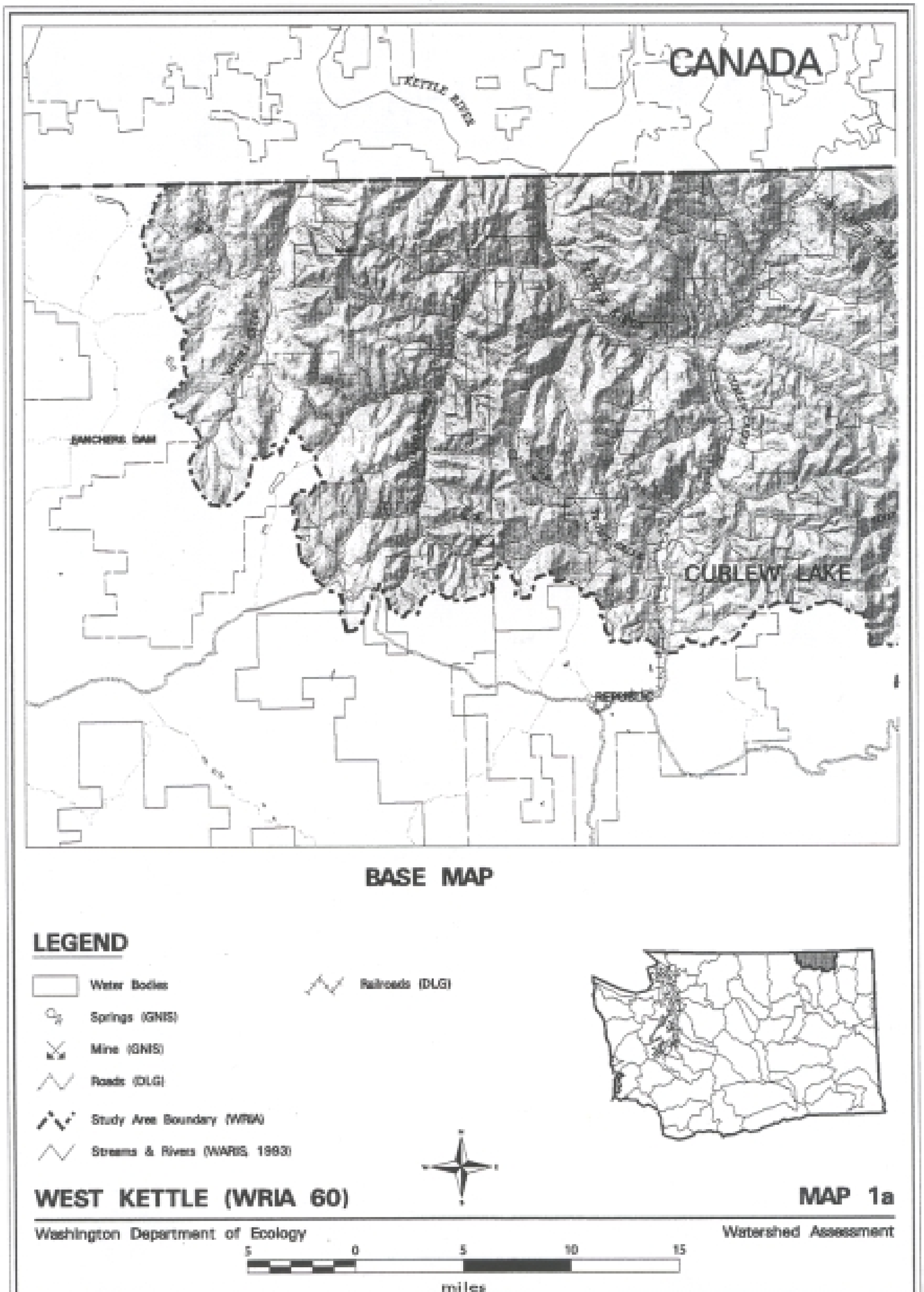
# MAPS



CANADA
KETTLE RIVER
CURLEW LAKE
BASE MAP
LEGEND
Water Bodies
Railroads (DLG)
Springs (GNIS)
Mine (GNIS)
Roads (DLG)
Study Area Boundary (WRIA)
Streams & Rivers (WARIS, 1993)
WEST KETTLE (WRIA 60)
MAP 1a
Washington Department of Ecology
Watershed Assessment
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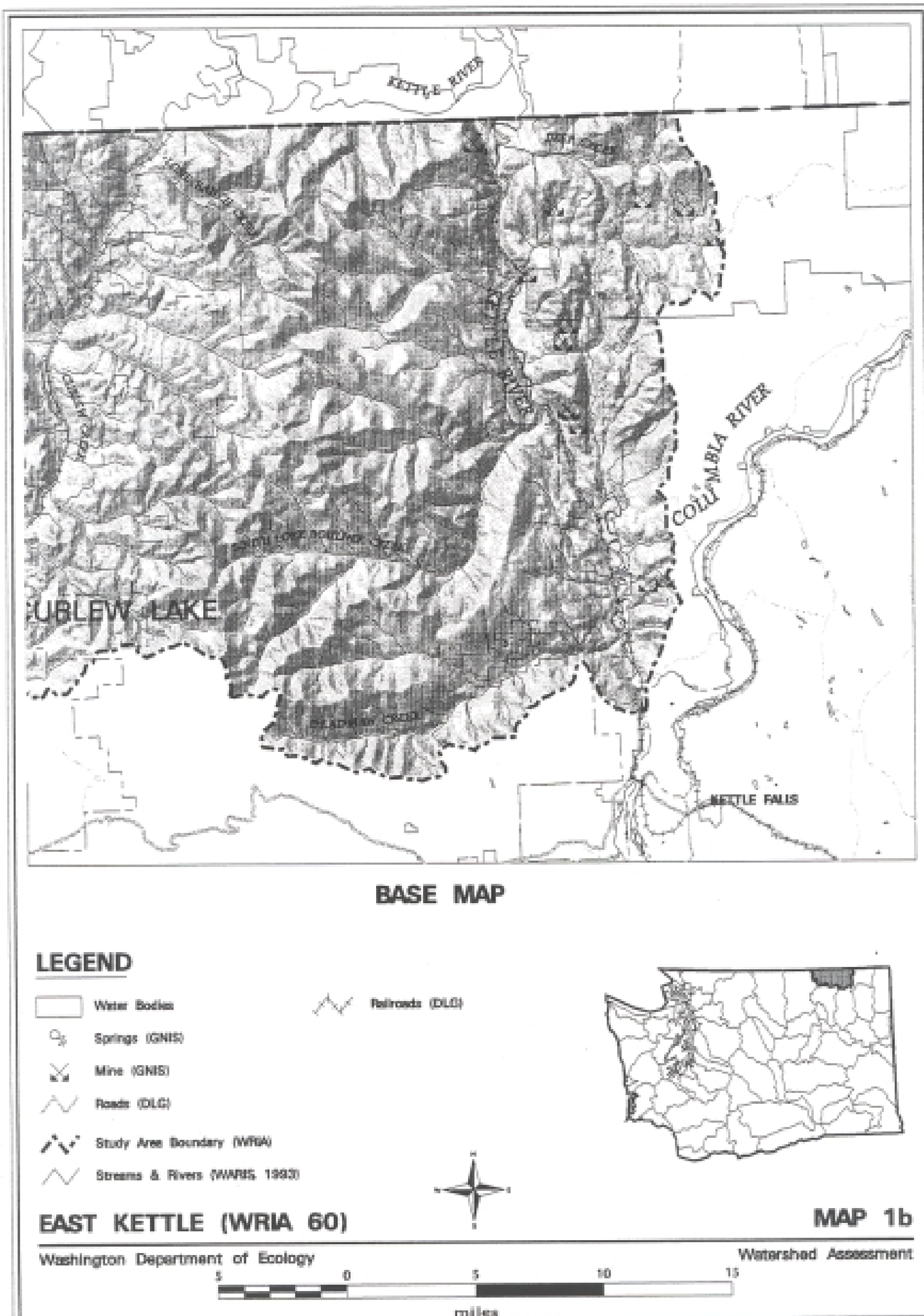
May 05, [illegible]


KETTLE RIVER
COLUMBIA RIVER
KETTLE FALLS
BASE MAP
LEGEND
Water Bodies
Springs (GNIS)
Mine (GNIS)
Roads (DLG)
Study Area Boundary (WRIA)
Streams & Rivers (WARIS, 1993)
Railroads (DLG)
EAST KETTLE (WRIA 60)
MAP 1b
Washington Department of Ecology
Watershed Assessment
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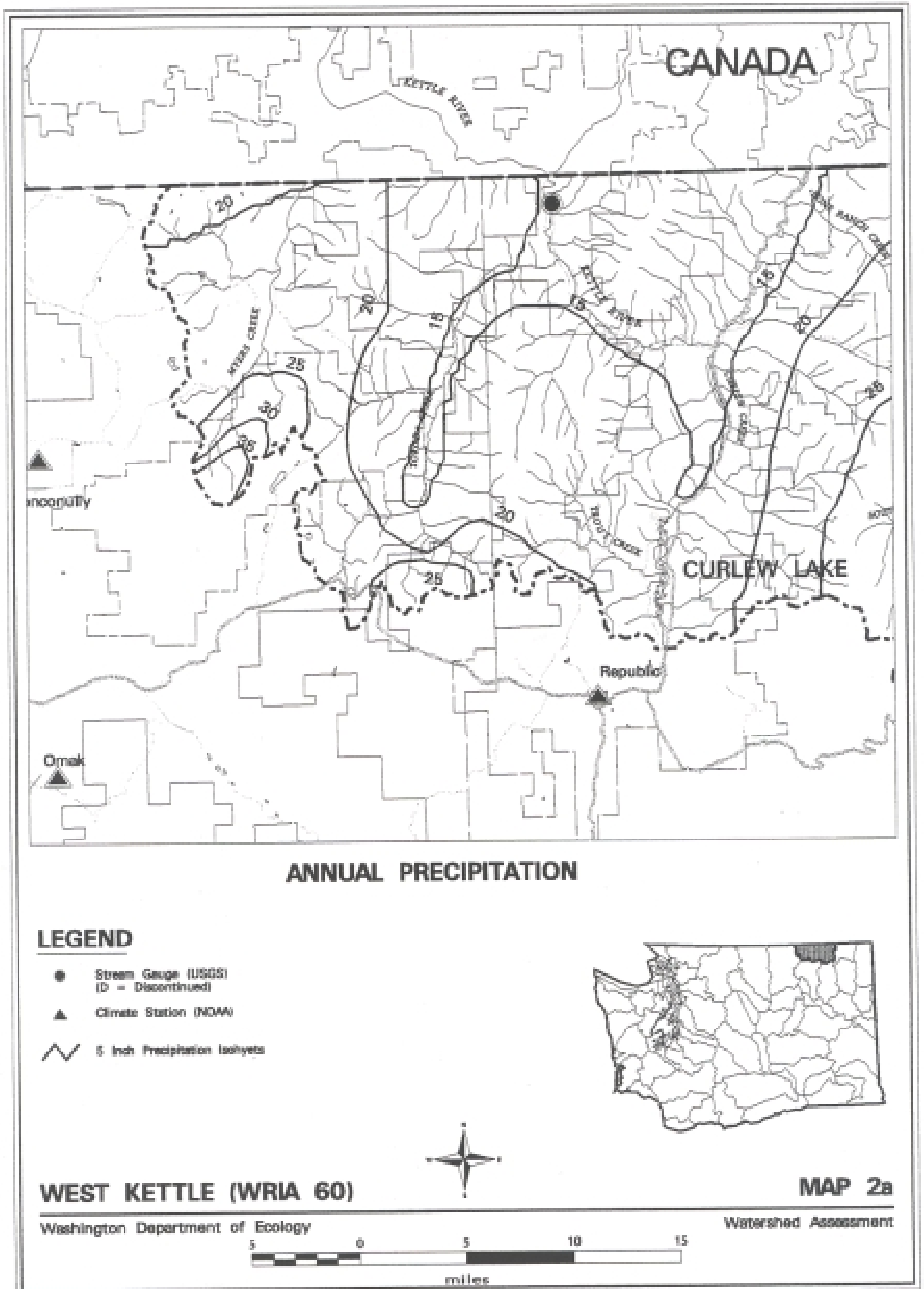
May 05, 1995


CANADA
KETTLE RIVER
KETTLE RIVER
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CURLEW LAKE
Republic
Omak
ANNUAL PRECIPITATION
LEGEND
Stream Gauge (USGS)
(D = Discontinued)
Climate Station (NOAA)
5 Inch Precipitation Isohyets
WEST KETTLE (WRIA 60)
MAP 2a
Washington Department of Ecology
Watershed Assessment
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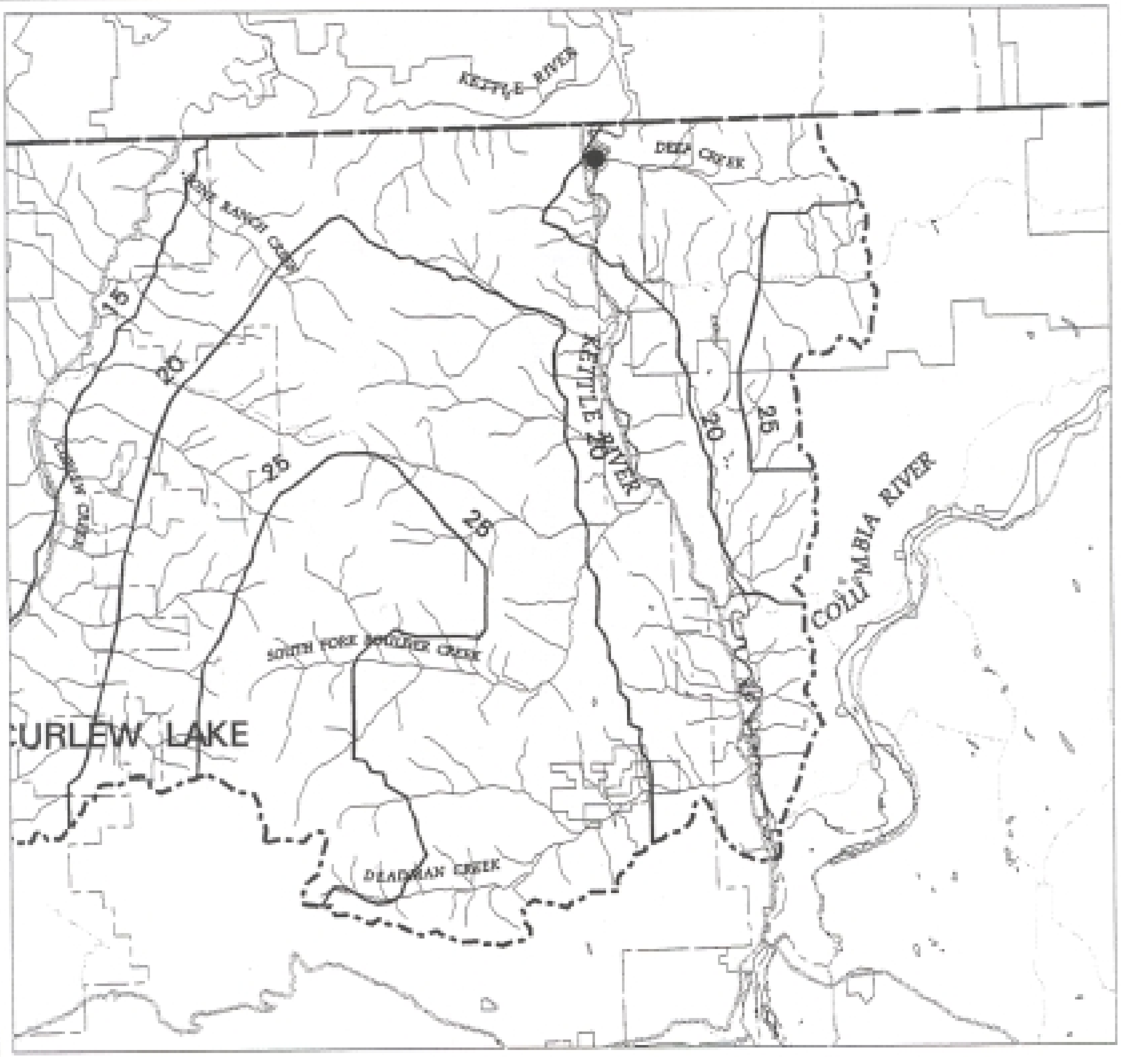



## ANNUAL PRECIPITATION

### LEGEND

- Stream Gauge (USGS) (D = Discontinued)
- Climate Station (NOAA)
- 5 Inch Precipitation Isohyets

**EAST KETTLE (WRIA 60)** **MAP 2b**

Washington Department of Ecology — Watershed Assessment

5 0 5 10 15

miles


# GROUND WATER USE AND GENERALIZED GEOLOGY

## LEGEND

- ● 100-1,000 Acre-Feet/Year
- ● 5-100 Acre-Feet/Year
- • < 5 Acre-Feet/Year

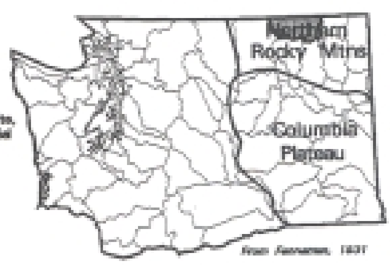
**Generalized Geologic Features**

From Hunting et al (1961) and Stoffel et al (1991)

- Qg — Quaternary glacial deposits. Till, outwash, and glacial lacustrine deposits filling valleys. Locally includes alluvium, peat, loess, or mass-wasting deposits.
- Tv — Tertiary volcanic and intrusive rocks. Includes andesite, breccias, tuffs, and basalts. Locally mantled by alluvial deposits in two valleys.
- Pt — Pre-tertiary metamorphic, igneous, and sedimentary basement rocks. Includes quartzite, meta-limestone, schist, gneiss, and granodiorite marble. Locally mantled by alluvial deposits in valleys.

A ——— A' Geologic cross-section location

Physiographic Provinces




From Fenneman, 1931

## WEST KETTLE (WRIA 60)

**MAP 3a**

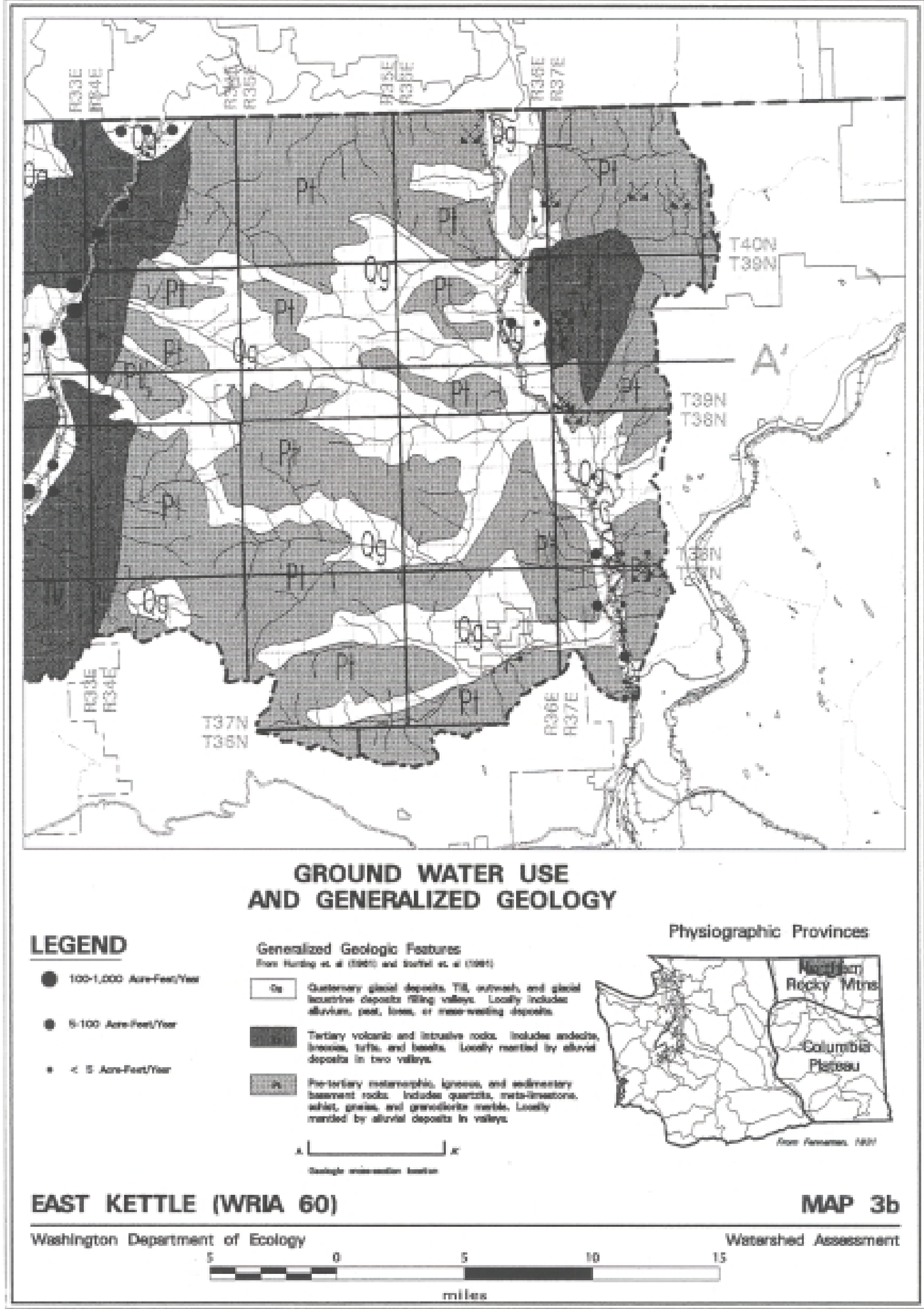
Washington Department of Ecology

Watershed Assessment

5 0 5 10 15

miles

May 05, 1995


R33E
R34E
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R36E
R36E
R37E
T40N
T39N
T39N
T38N
T38N
T37N
T37N
T36N
A'
Qg
Pt
GROUND WATER USE
AND GENERALIZED GEOLOGY
LEGEND
100-1,000 Acre-Feet/Year
5-100 Acre-Feet/Year
< 5 Acre-Feet/Year
Generalized Geologic Features
Quaternary glacial deposits. Till, outwash, and glacial lacustrine deposits filling valleys. Locally includes alluvium, peat, loess, or mass-wasting deposits.
Tertiary volcanic and intrusive rocks. Includes andesite, breccias, tuffs, and basalts. Locally mantled by alluvial deposits in two valleys.
Pre-tertiary metamorphic, igneous, and sedimentary basement rocks. Includes quartzite, meta-limestone, schist, gneiss, and granodiorite marble. Locally mantled by alluvial deposits in valleys.
A
A'
Physiographic Provinces
Rocky Mtns
Columbia
Plateau
EAST KETTLE (WRIA 60)
MAP 3b
Washington Department of Ecology
Watershed Assessment
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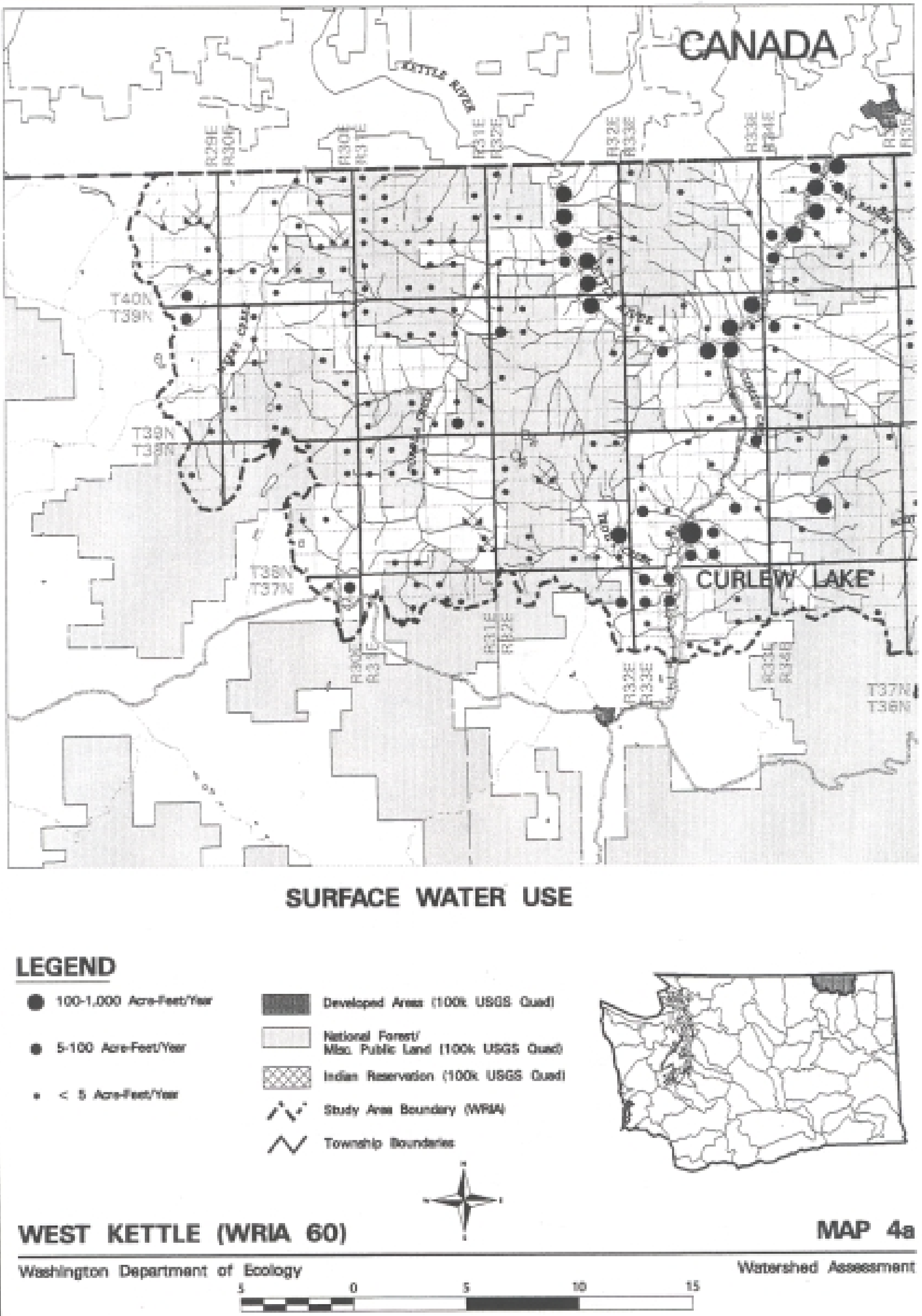
May 05, 1995




SURFACE WATER USE

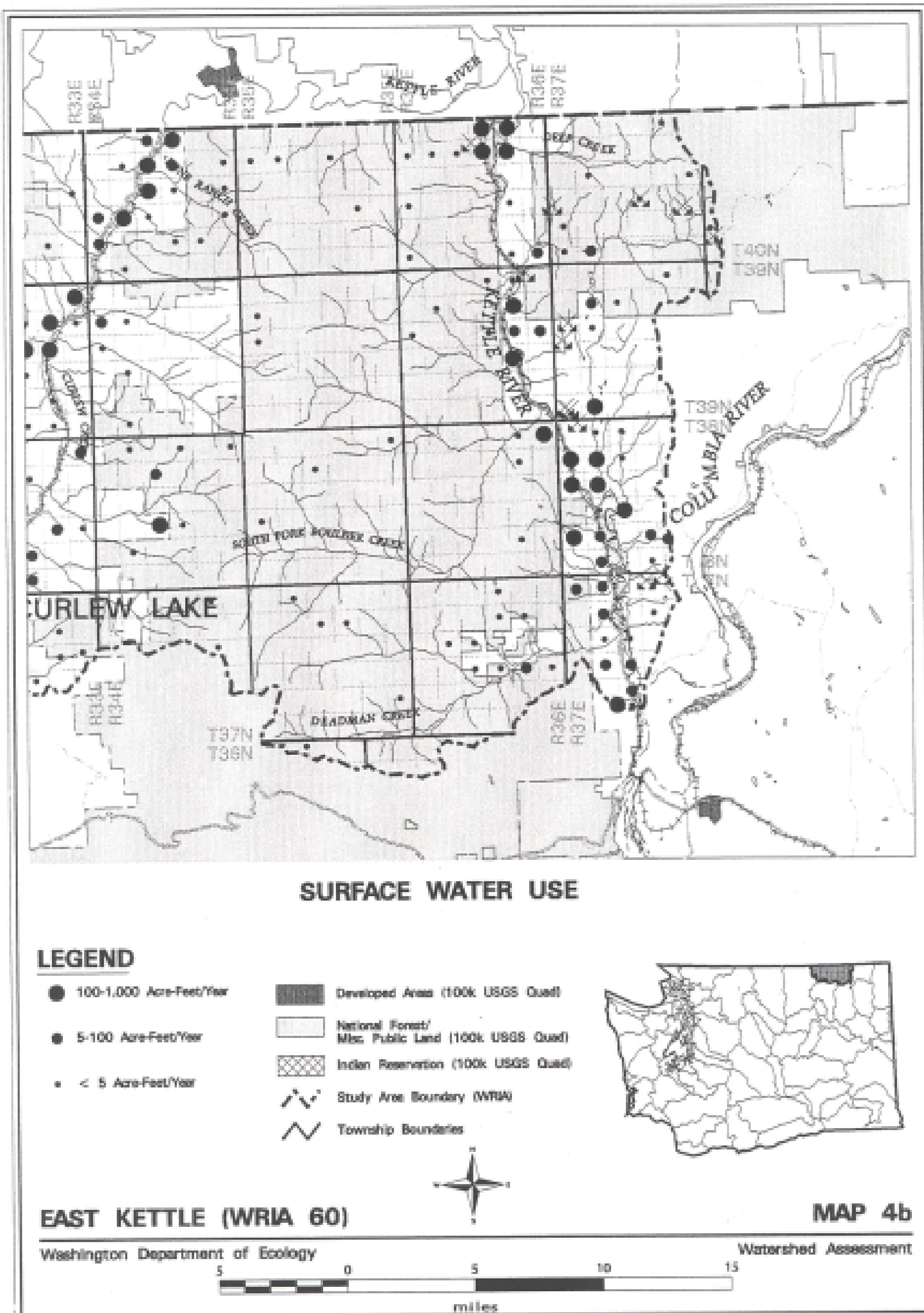
**WEST KETTLE (WRIA 60)**

**MAP 4a**

Washington Department of Ecology

Watershed Assessment

May 05, 1995



KETTLE RIVER
R33E
R34E
R35E
R36E
R37E
T40N
T39N
T38N
T37N
T36N
KETTLE RIVER
COLUMBIA RIVER
SOUTH FORK BOULDER CREEK
DEADMAN CREEK
CURLEW LAKE
SURFACE WATER USE
LEGEND
100-1,000 Acre-Feet/Year
5-100 Acre-Feet/Year
< 5 Acre-Feet/Year
Developed Areas (100k USGS Quad)
National Forest/ Misc. Public Land (100k USGS Quad)
Indian Reservation (100k USGS Quad)
Study Area Boundary (WRIA)
Township Boundaries
EAST KETTLE (WRIA 60)
MAP 4b
Washington Department of Ecology
Watershed Assessment
5
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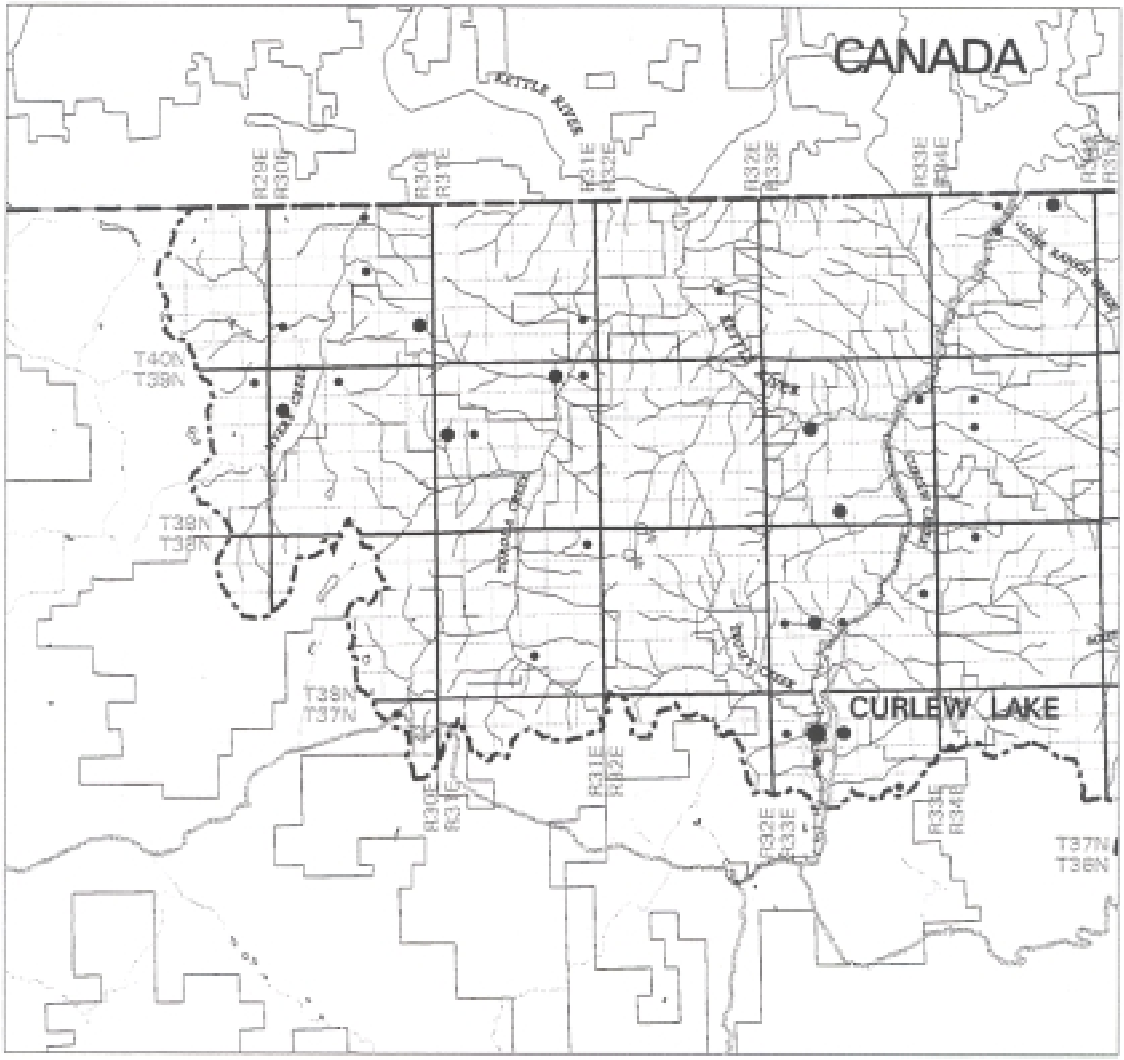



## LOCATION OF WATER USE APPLICATIONS

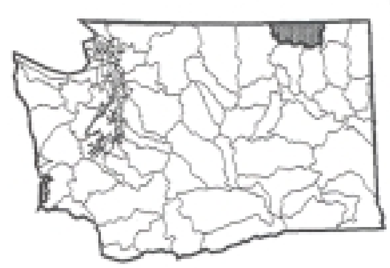
### LEGEND

Number of Applications per Section (Groundwater and Surfacewater)

- 1
- 2
- 3 or more

Study Area Boundary (WRIA)

Township Boundaries



## WEST KETTLE (WRIA 60)

## MAP 5a

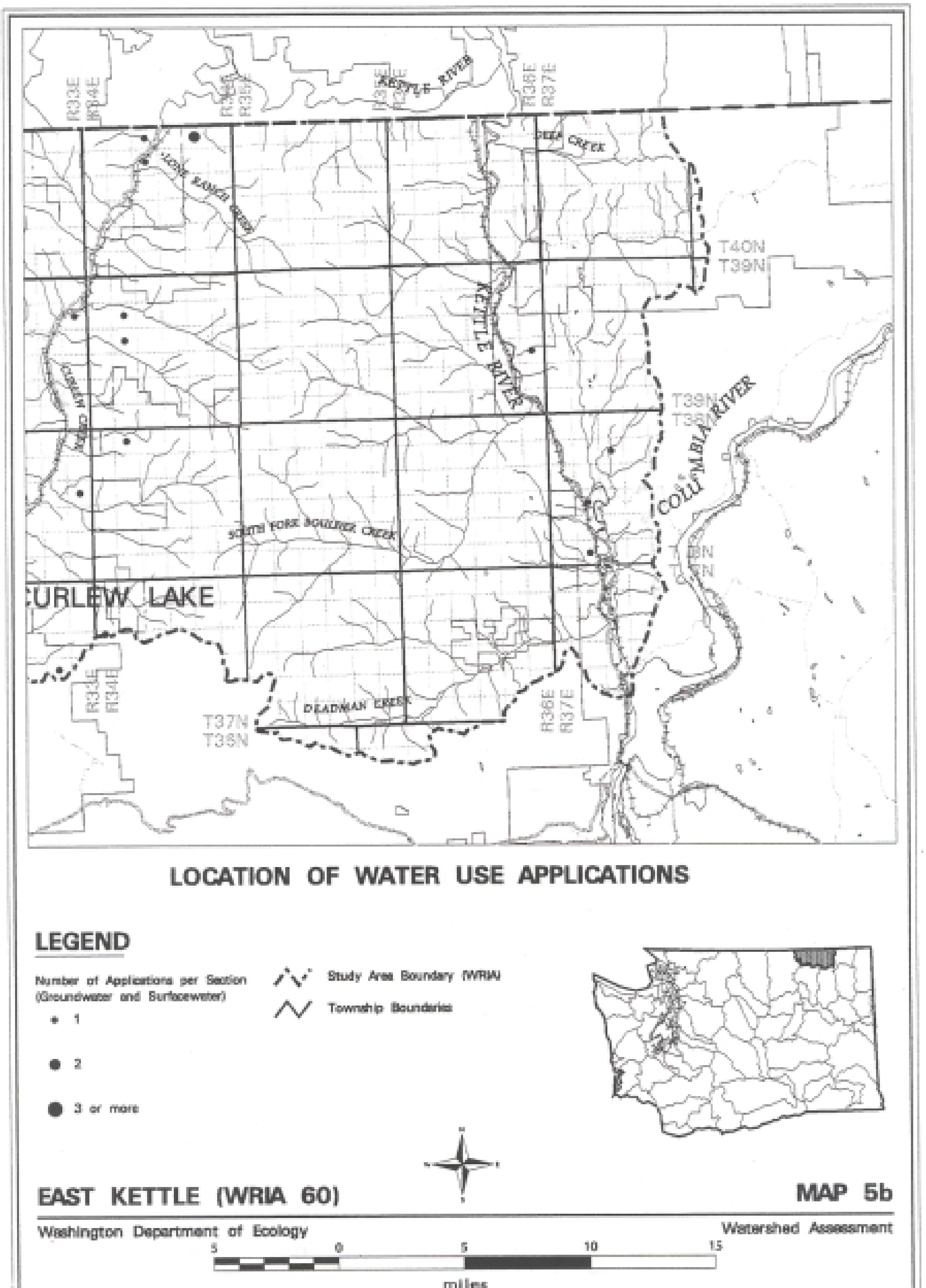
Washington Department of Ecology

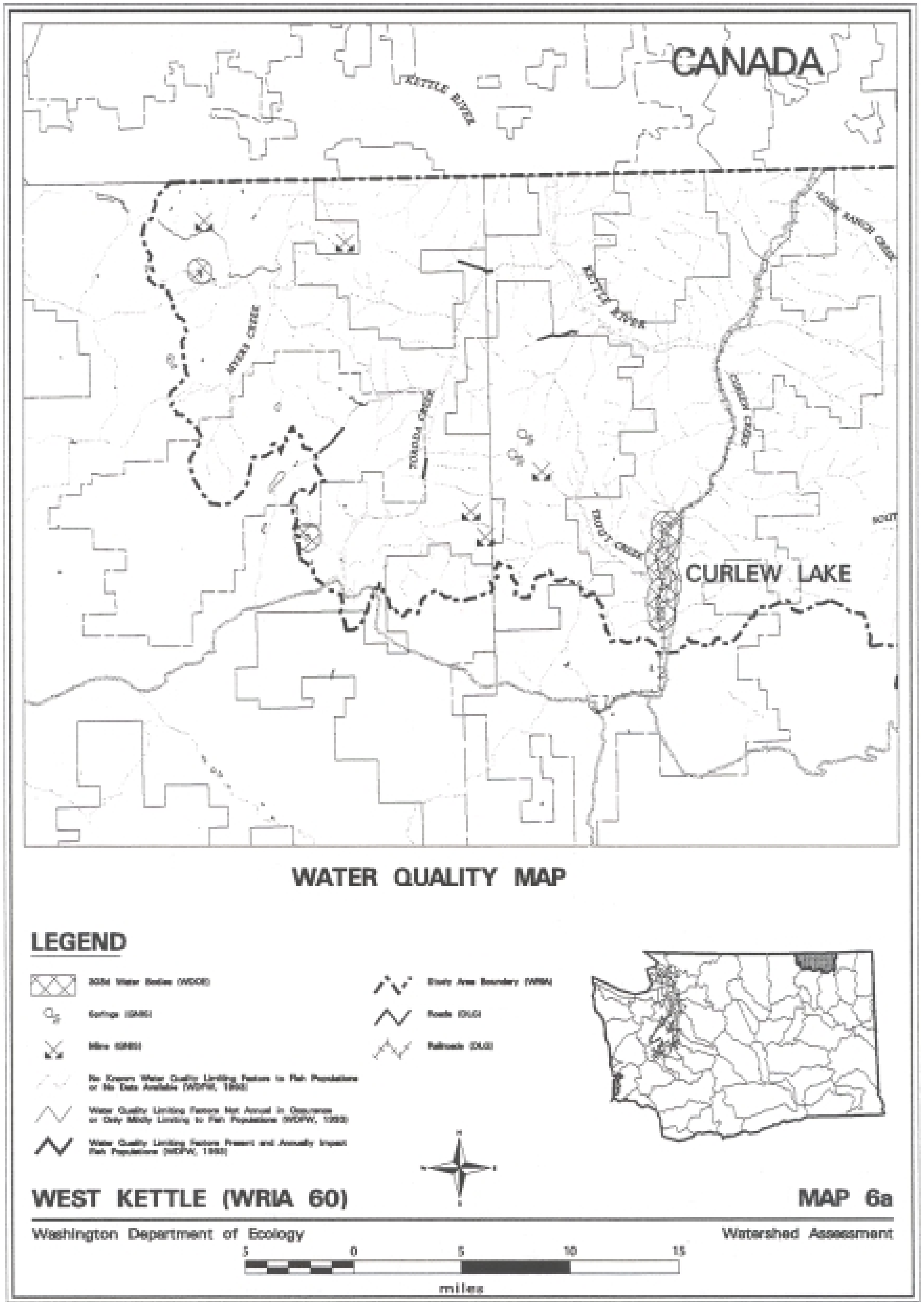
Watershed Assessment

5 0 5 10 15

miles

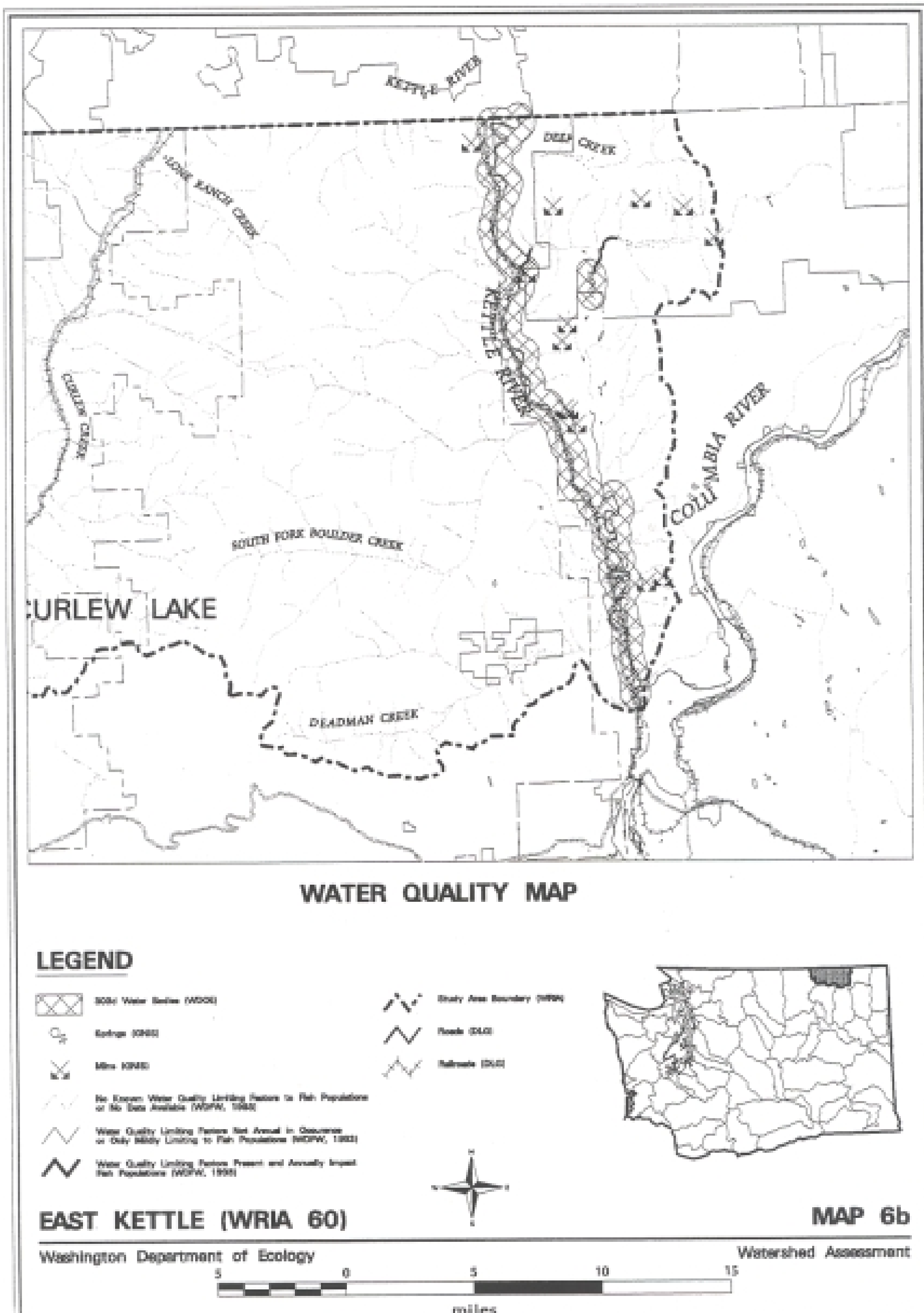
May 05, 1995


KETTLE RIVER
R33E
R34E
R35E
R36E
R37E
LONE RANGER CREEK
DEER CREEK
T40N
T39N
KETTLE RIVER
CURLEW CREEK
T38N
COLUMBIA RIVER
SOUTH FORK BOULDER CREEK
CURLEW LAKE
DEADMAN CREEK
T37N
T36N
LOCATION OF WATER USE APPLICATIONS
LEGEND
Number of Applications per Section
(Groundwater and Surfacewater)
1
2
3 or more
Study Area Boundary (WRIA)
Township Boundaries
EAST KETTLE (WRIA 60)
MAP 5b
Washington Department of Ecology
Watershed Assessment
5
0
5
10
15
miles
May 05, 1995



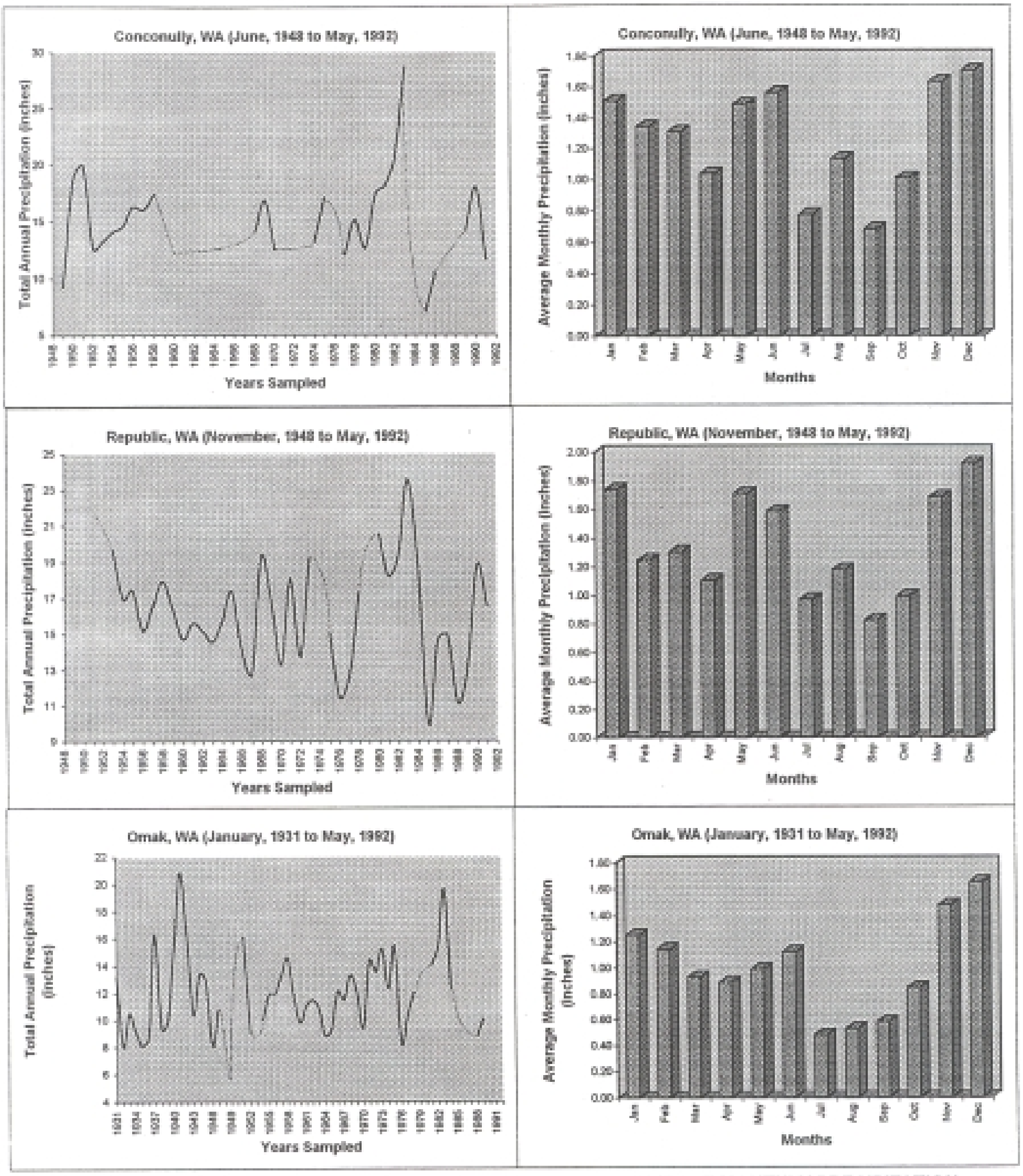
CANADA
KETTLE RIVER
KETTLE RIVER
MYERS CREEK
TORODA CREEK
CURLEW CREEK
TROUT CREEK
CURLEW LAKE
WATER QUALITY MAP
LEGEND
WEST KETTLE (WRIA 60)
MAP 6a
Washington Department of Ecology
Watershed Assessment
5 0 5 10 15
miles


May 05, 1995


KETTLE RIVER
DEEP CREEK
LONE RANCH CREEK
CURLEW CREEK
KETTLE RIVER
COLUMBIA RIVER
SOUTH FORK BOULDER CREEK
CURLEW LAKE
DEADMAN CREEK
WATER QUALITY MAP
LEGEND
EAST KETTLE (WRIA 60)
MAP 6b
Washington Department of Ecology
Watershed Assessment
5
0
5
10
15
miles

May 05, 1995

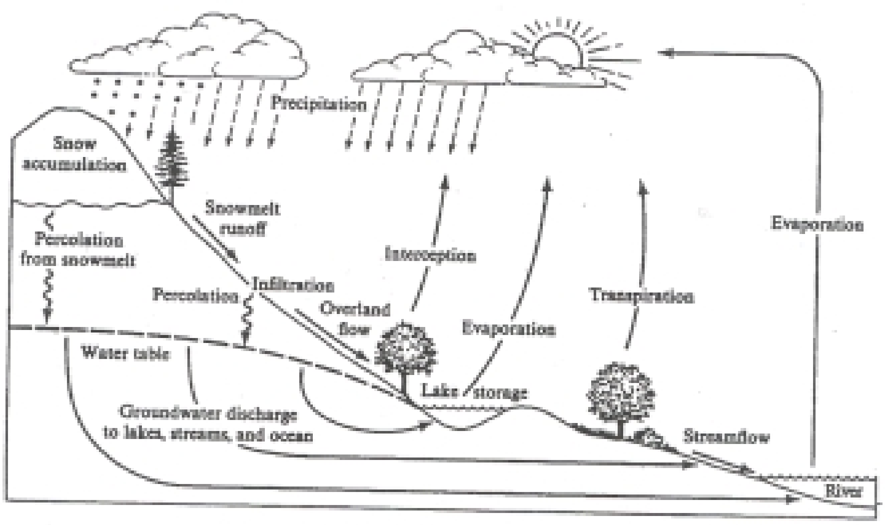
# FIGURES




TOTAL ANNUAL PRECIPITATION ( — data not collected for that year)

AVERAGE MONTHLY PRECIPITATION

Figure 1. Total Annual and Average Monthly Precipitation at Three Stations Located in the Kettle River Watershed.

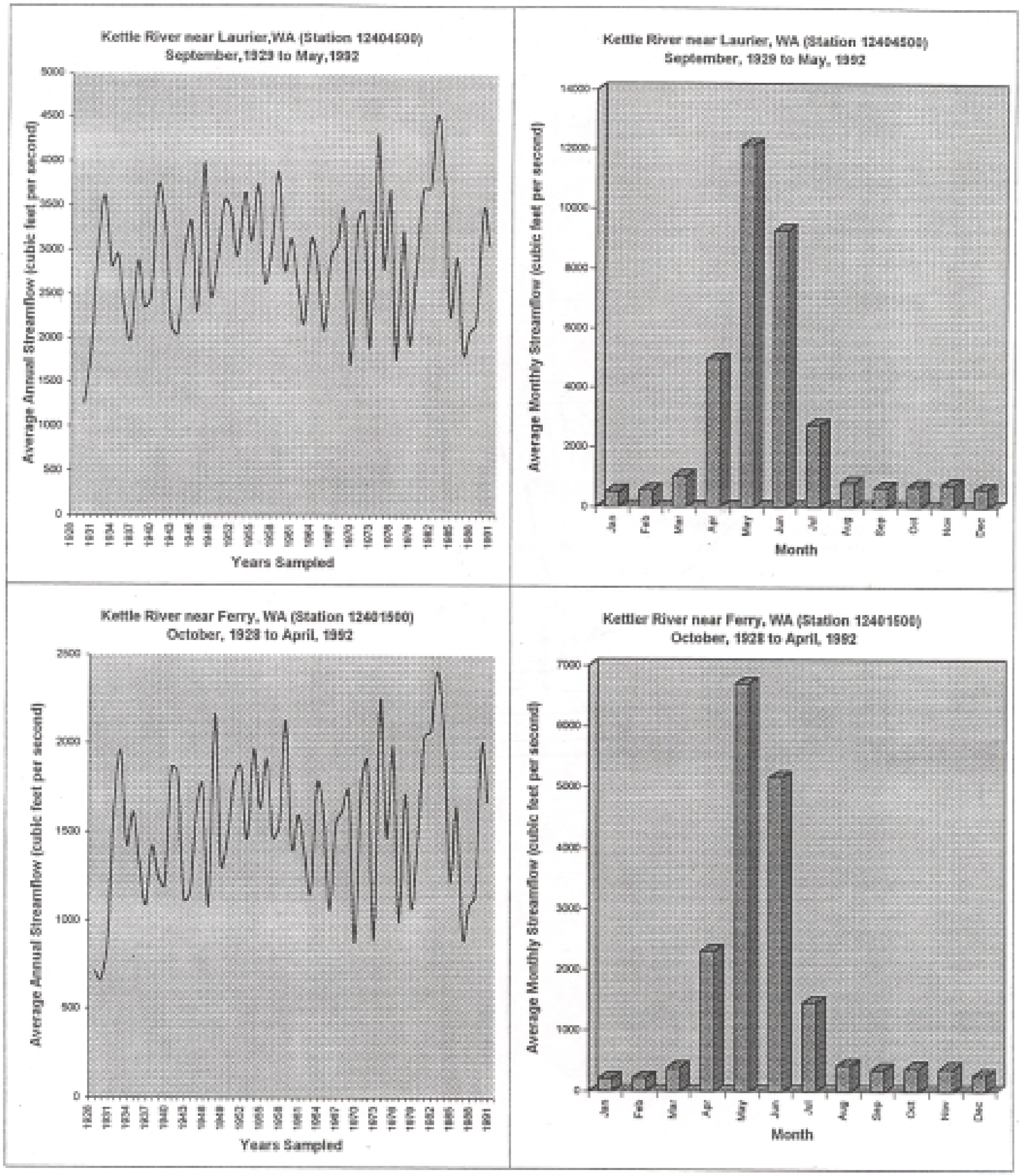



**SCHEMATIC DIAGRAM OF HYDROLOGIC CYCLE**

Job No. 07927-007-005

DAMES & MOORE

FIGURE 2




Average Annual Streamflow ( — data not collected for that year)

Average Monthly Streamflow

Figure 3. Average Annual and Monthly Streamflow at Two Stations Located in the Kettle River Watershed.

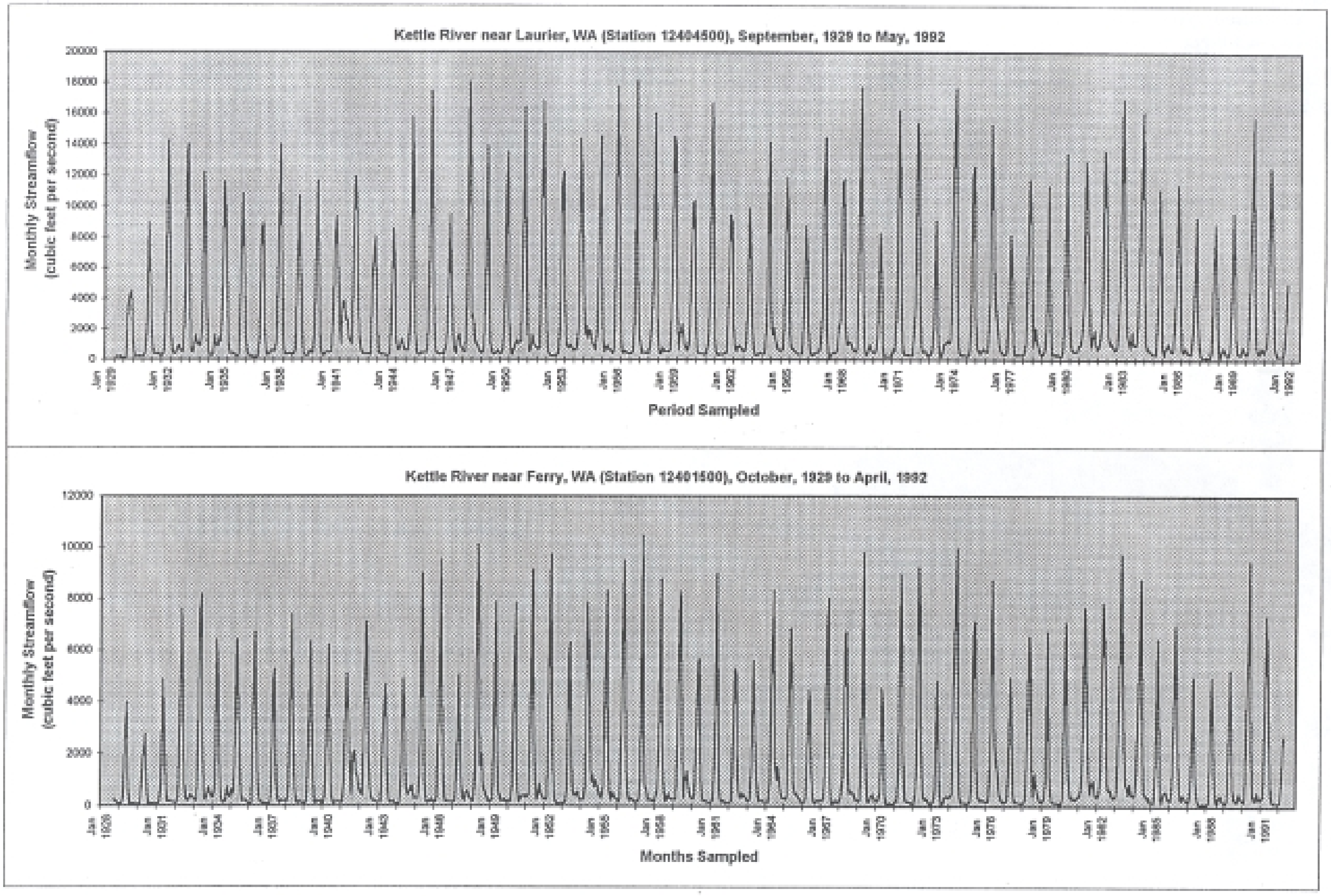
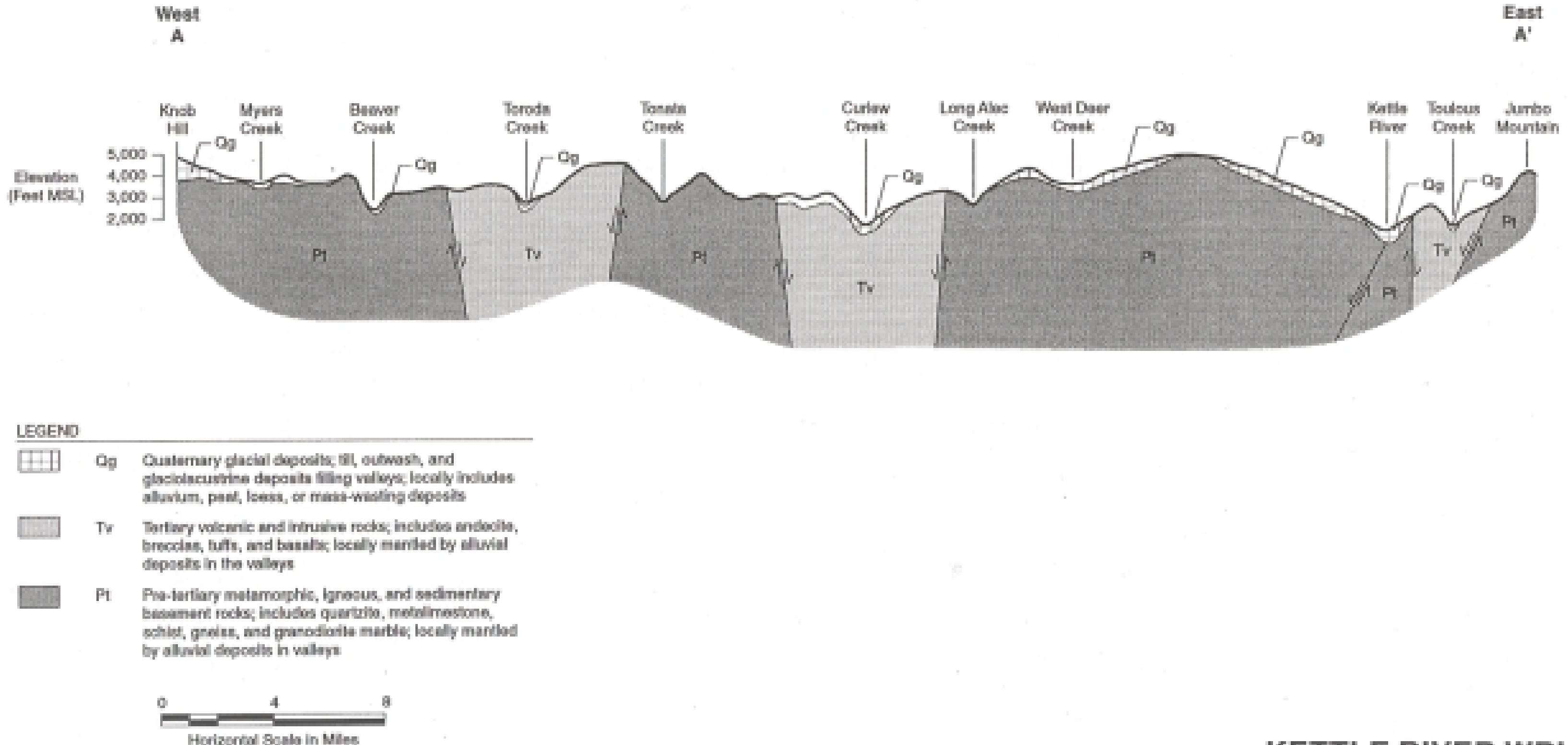



Figure 4. Streamflow, by Month, at Two Stations Located in the Kettle River Watershed.




# KETTLE RIVER WRIA
# GENERALIZED GEOLOGIC CROSS-SECTION

Job No. 07927-010-005

DAMES & MOORE

Watershed Assessment
Washington Department of Ecology
FIGURE 5

Figure 6. WRIA 60 - Kettle River Watershed

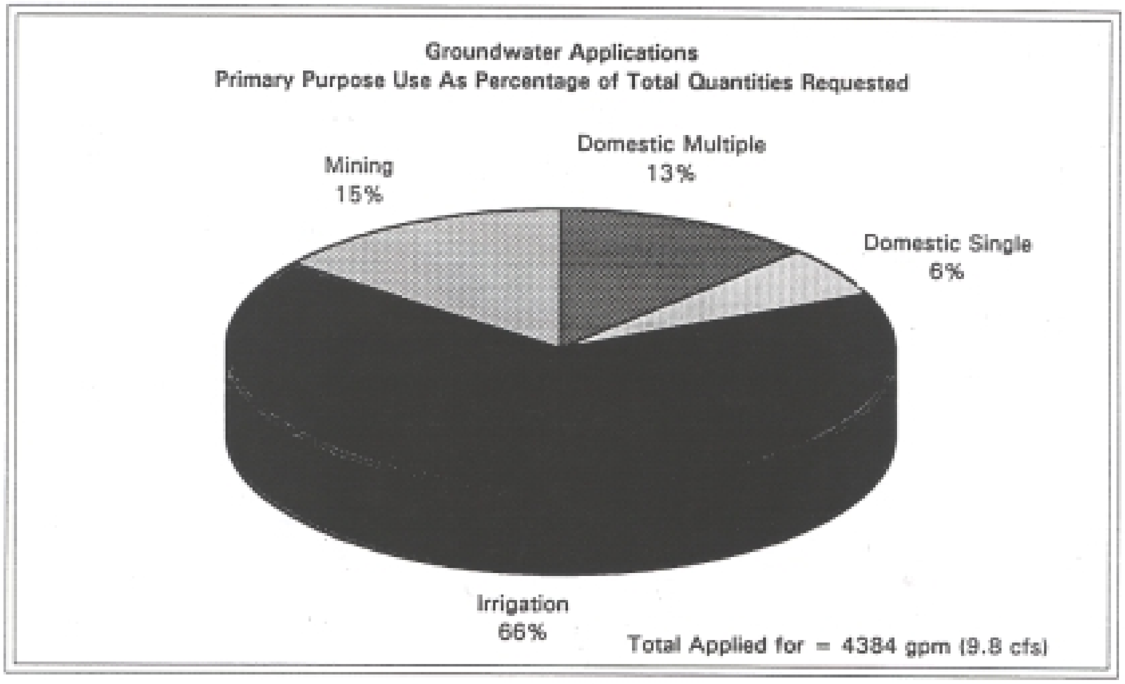



Figure 7. WRIA 60 - Kettle River Watershed

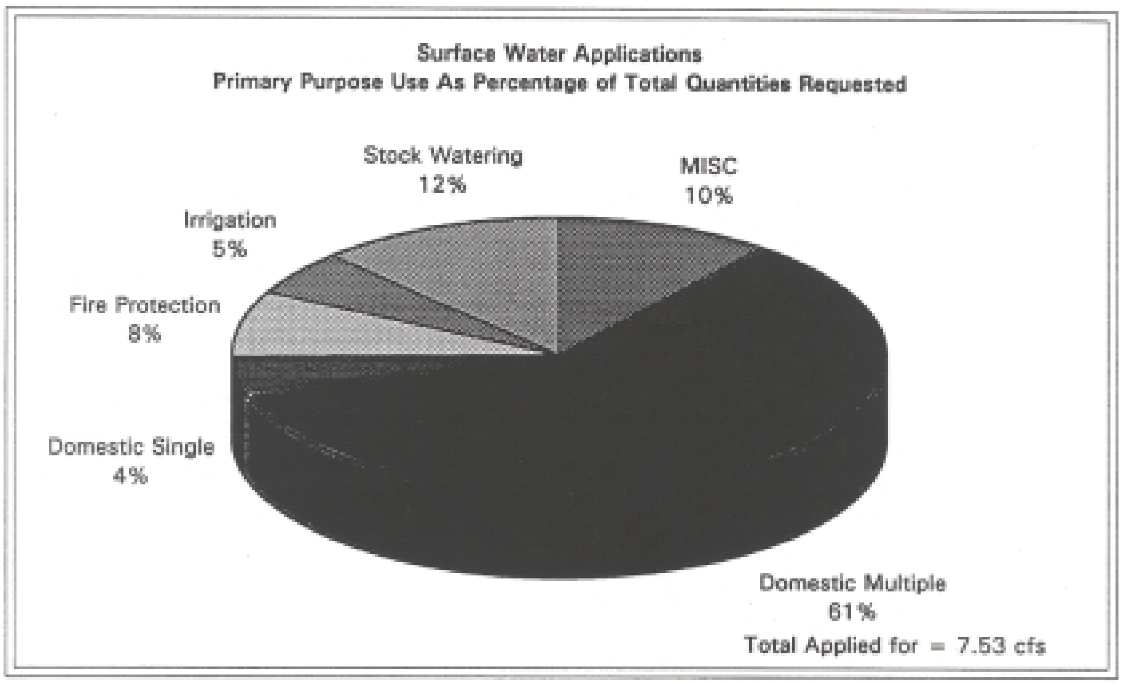


Figure 8. WRIA 60 - Kettle River Watershed.

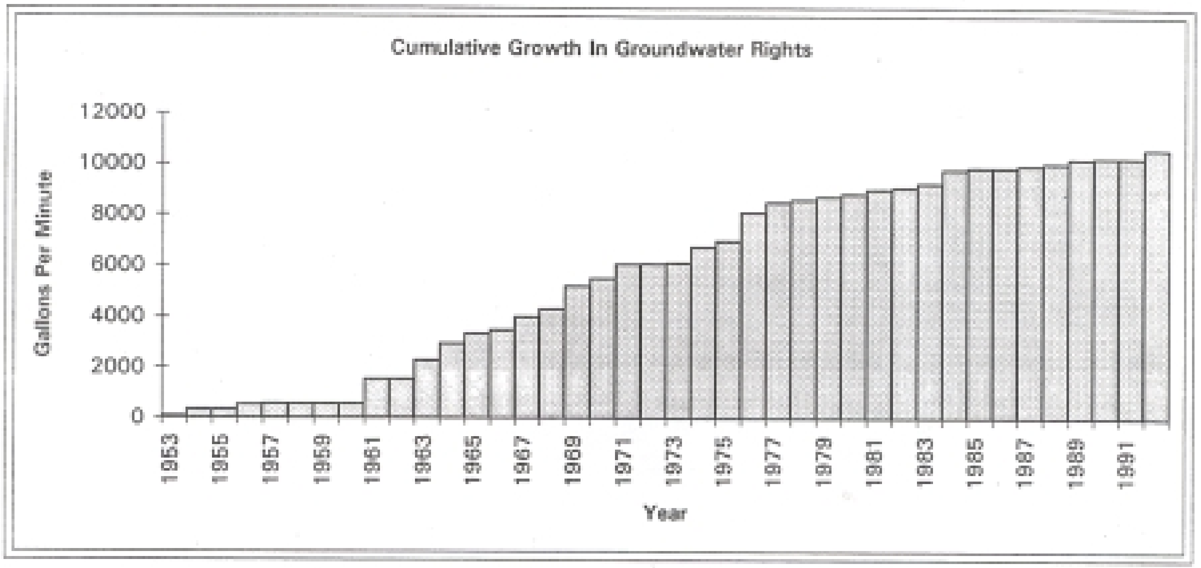



Figure 9. WRIA 60 - Kettle River Watershed.

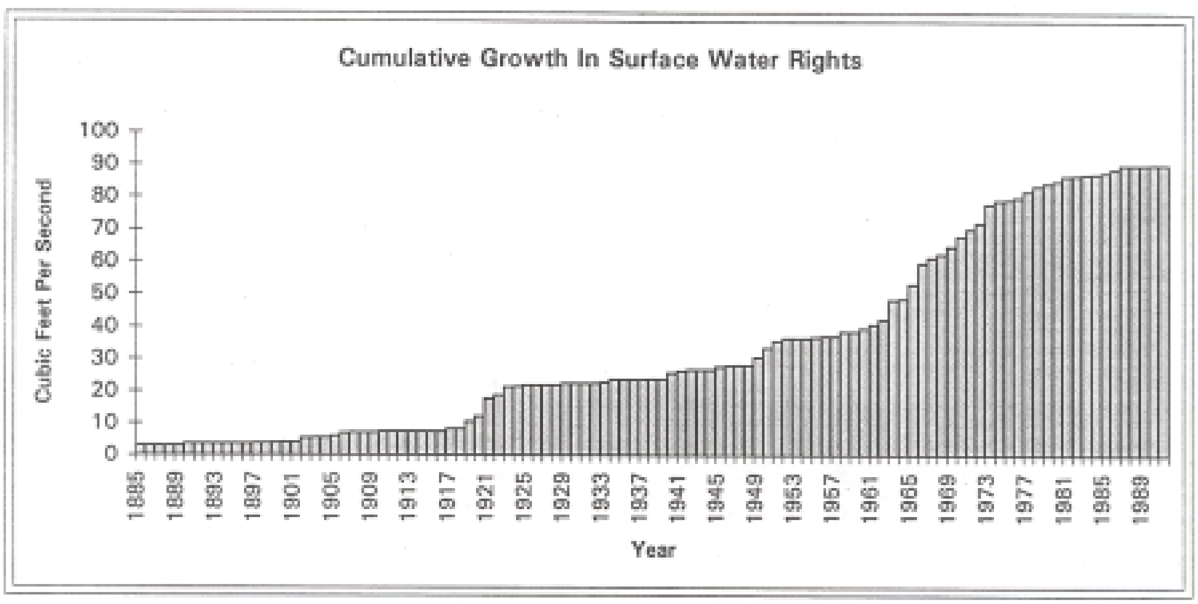


Figure 10. WRIA 60 - Kettle River Watershed.

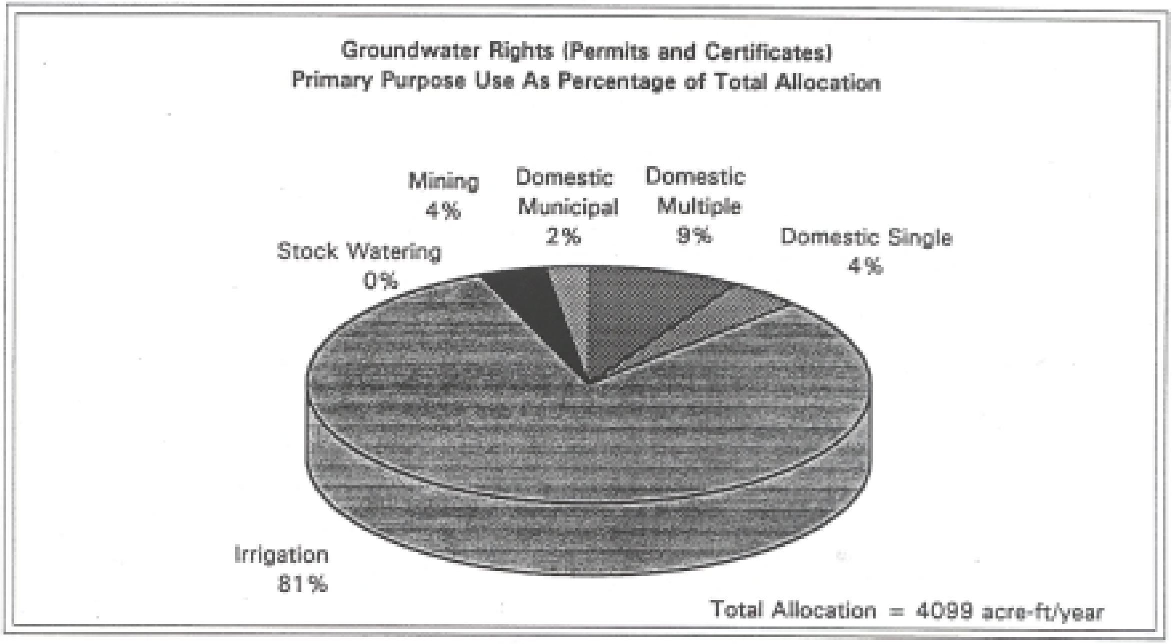



Figure 11. WRIA 60 - Kettle River Watershed.

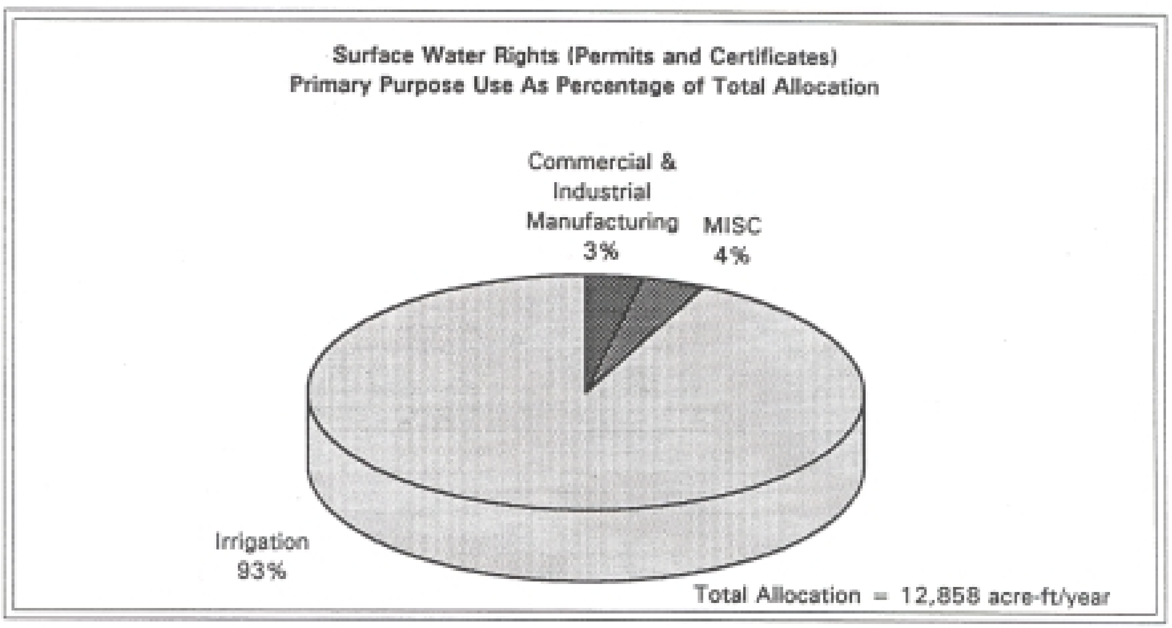


**Figure 12. Kettle River Temperature Values (°C) at a Station near Barstow, WA for the Years 1960 through 1980.**

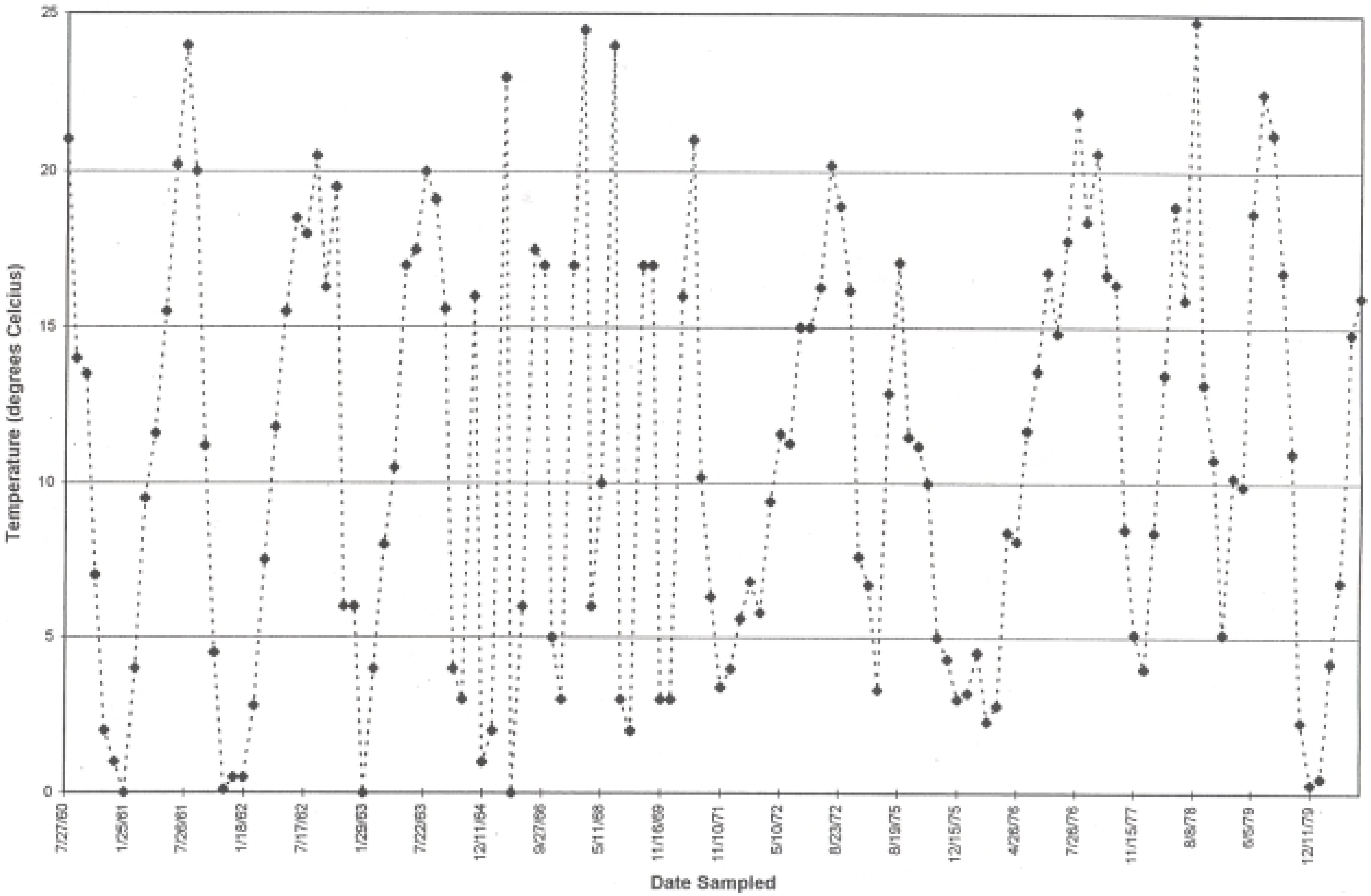
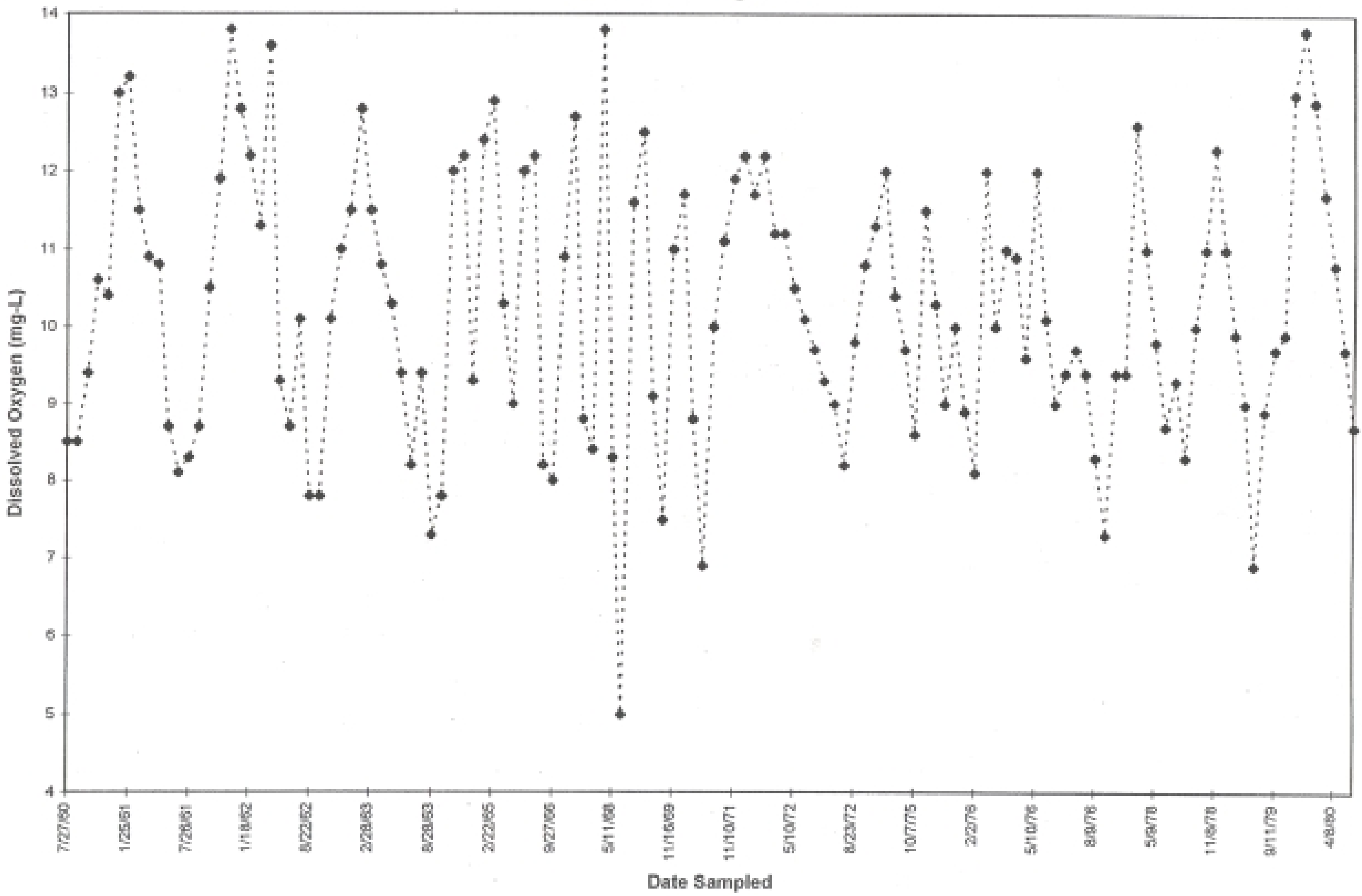


Figure 13. Kettle River Dissolved Oxygen Values (Milligrams per Liter) at a Station near Barstow for the Years 1960 through 1980.



# Appendix A.1 Department of Ecology Regional Precipitation Analysis (Barker 1995)

## LONG TERM PRECIPITATION TRENDS

### Introduction

Precipitation data from gages located throughout the state were used to examine long term trends and identify extended periods of above or below average precipitation. This analysis will put the more recent weather patterns that we have experienced into a long-term perspective. Such a perspective is necessary when considering the issuance of additional water rights because periods of extended drought identified in the historical record can be expected to occur again in the future.

### Precipitation Stations

Precipitation stations located at 16 sites throughout the state were used for the analysis (Figure 1). The criteria used to select a particular station was that the record should be relatively long (80 or more years), have few periods of missing data, and be geographically disperse from the other stations. Periods of missing data were filled in using nearby stations if available, or at-station monthly mean values if a secondary station was not available. Table 1 shows the stations used in the analysis. Stations 1 through 8 are in western Washington, stations 9 through 16 are in eastern Washington.

**Table 1**
**Long Term Precipitation Stations Used in Analysis**

| Name | County | Period of Record | Mean Annual Precipitation (inches) |
|---|---|---|---|
| 1. Port Angeles | Clallam | 1878-1992 | 25.5 |
| 2. Olympia | Thurston | 1878-1992 | 51.6 |
| 3. Vancouver | Clark | 1899-1992 | 38.7 |
| 4. Sedro Woolley | Skagit | 1897-1992 | 45.9 |
| 5. Cedar Lake | King | 1903-1992 | 102.7 |
| 6. Seattle | King | 1878-1992 | 35.5 |
| 7. Aberdeen | Grays Harbor | 1891-1992 | 82.5 |
| 8. Centralia | Lewis | 1892-1992 | 45.6 |
| 9. Lake Kachess | Kittitas | 1909-1974 | 51.4 |
| 10. Wenatchee | Chelan | 1913-1992 | 9.8 |
| 11. Yakima | Yakima | 1910-1992 | 7.6 |
| 12. Omak | Okanogan | 1909-1989 | 11.6 |
| 13. Odessa | Lincoln | 1903-1992 | 10.0 |
| 14. Colville | Stevens | 1898-1986 | 17.5 |
| 15. Spokane | Spokane | 1881-1992 | 16.3 |
| 16. Walla Walla | Walla Walla | 1973-1992 | 16.7 |

**Results**

The deviation of the annual precipitation total from the mean for each station is shown in Figures 2A-2H and 3A-3H. The trend line on each graph is a moving average of the previous 10 years.

For presentation purposes, the gages were grouped into two broad categories; those located west of the cascade divide and those located east of the divide. The data for each station was normalized by dividing the annual deviation from the mean by the at-site mean annual precipitation. The normalized data for each group was then averaged to obtain a trend line for each region (Figures 4 and 5).

In western Washington, high variability can be seen throughout the period of record. Since the mid-1950's, the precipitation has been typically above the long-term mean. Extended periods of below average precipitation occurred in the 1920's and 1930's and again in the late 1940's.

In eastern Washington, precipitation was generally above the long-term average since the 1940's except for a period in the mid-1970's. An extended period of below average precipitation occurred in the 1920's through about 1940.


**Figure 1. Station Locations**

Figure 2A

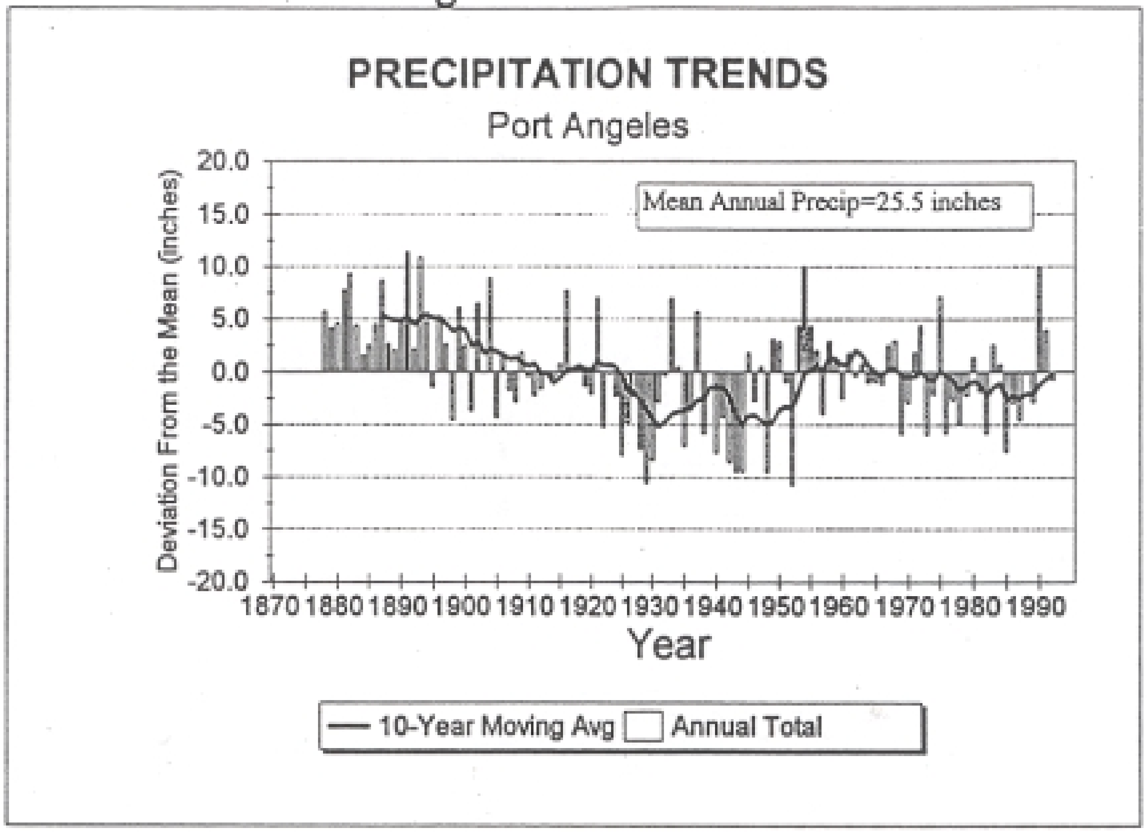



Figure 2B

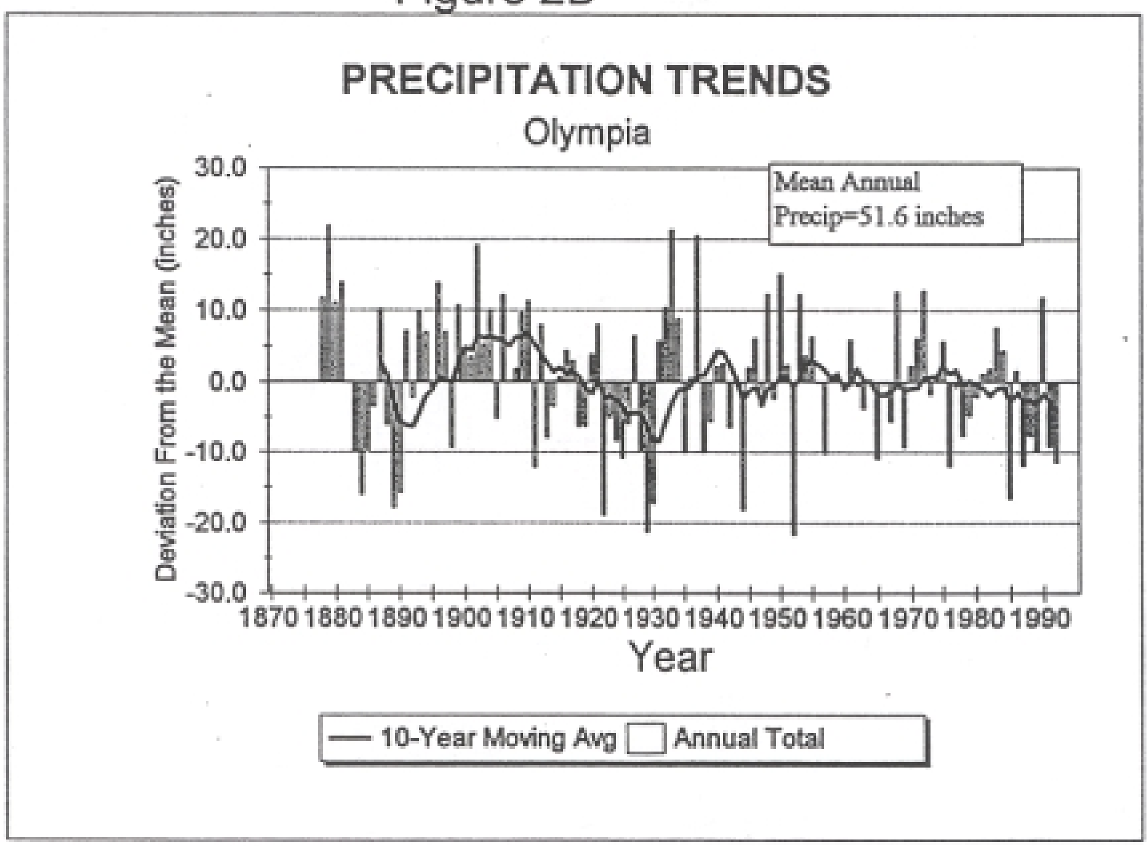


Figure 2C

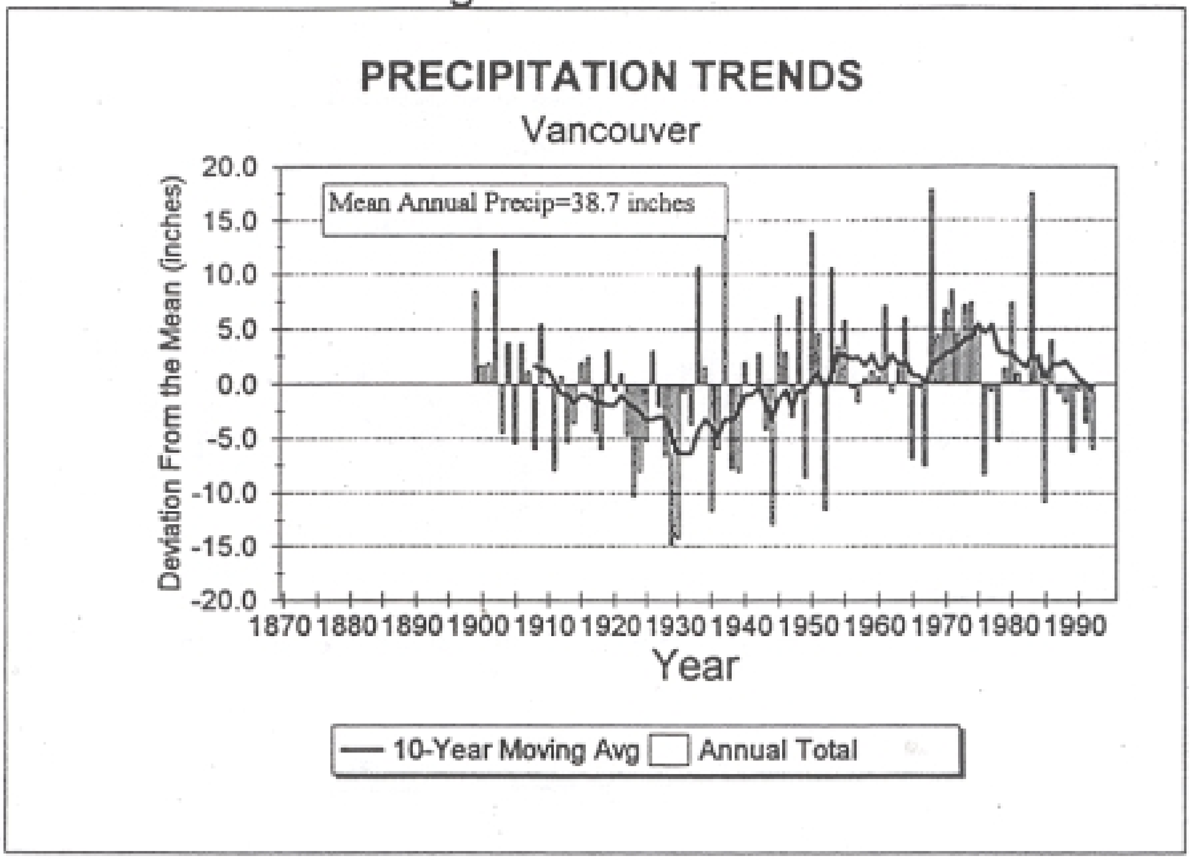



Figure 2D

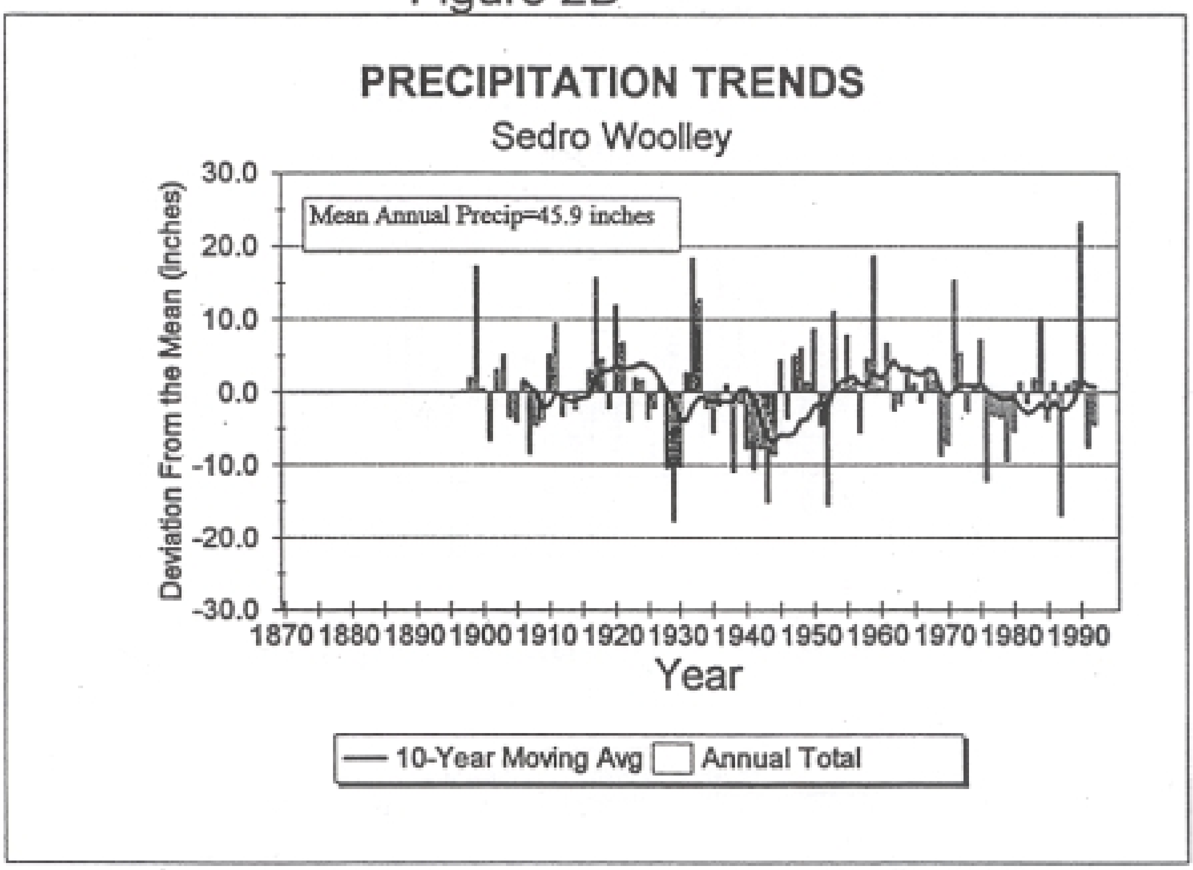


Figure 2E

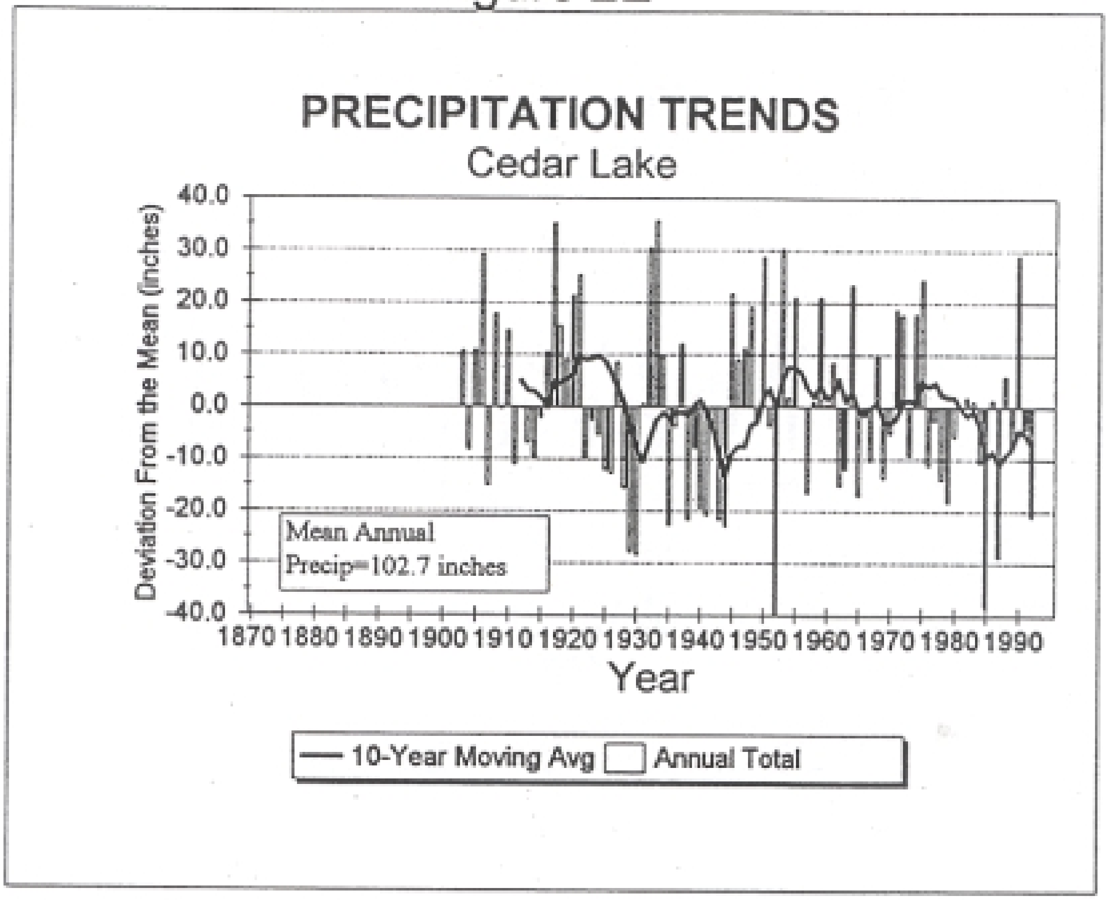



Figure 2F

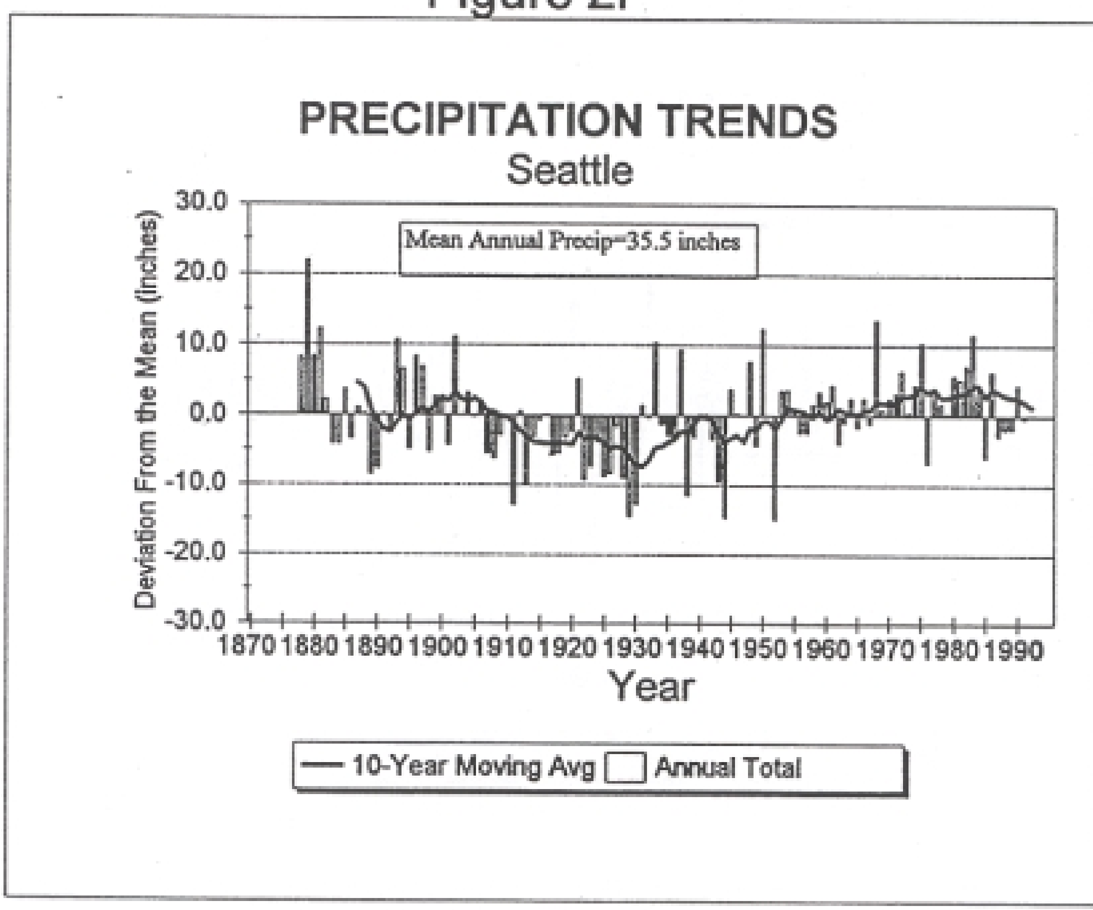


Figure 2G

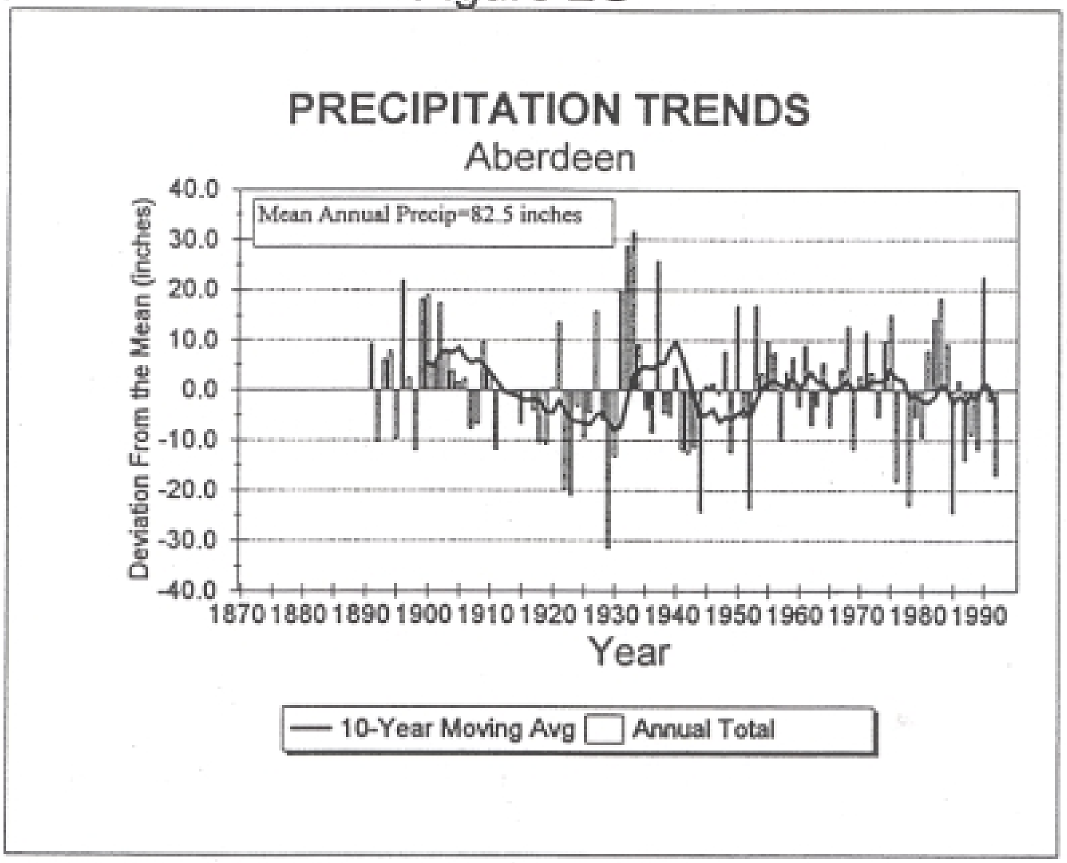
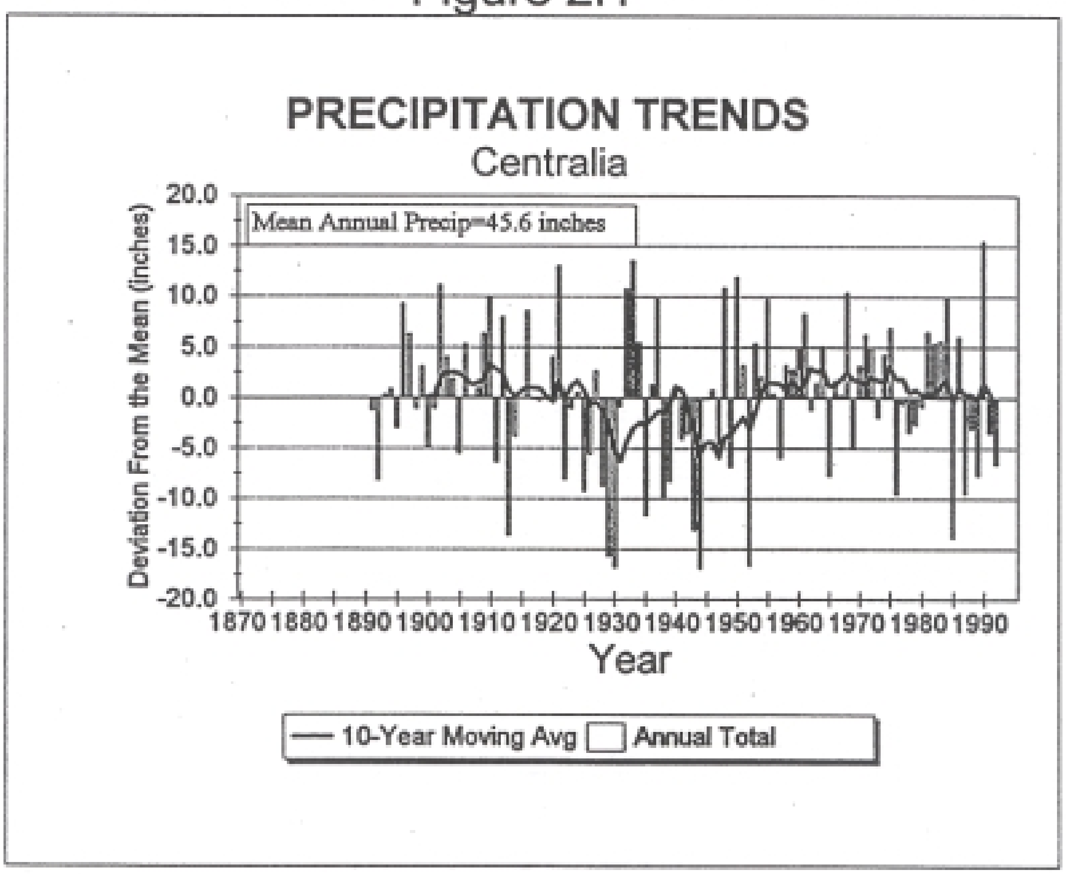
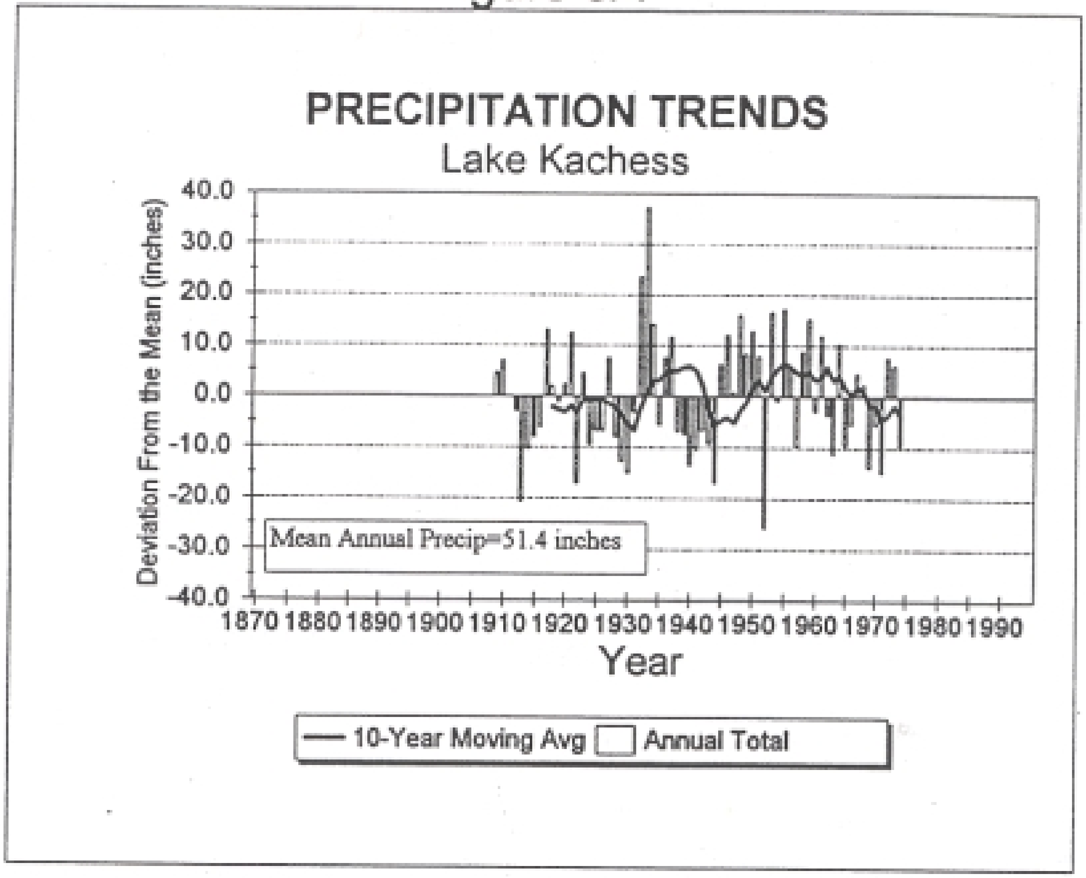



Figure 2H



## Figure 3A




## Figure 3B

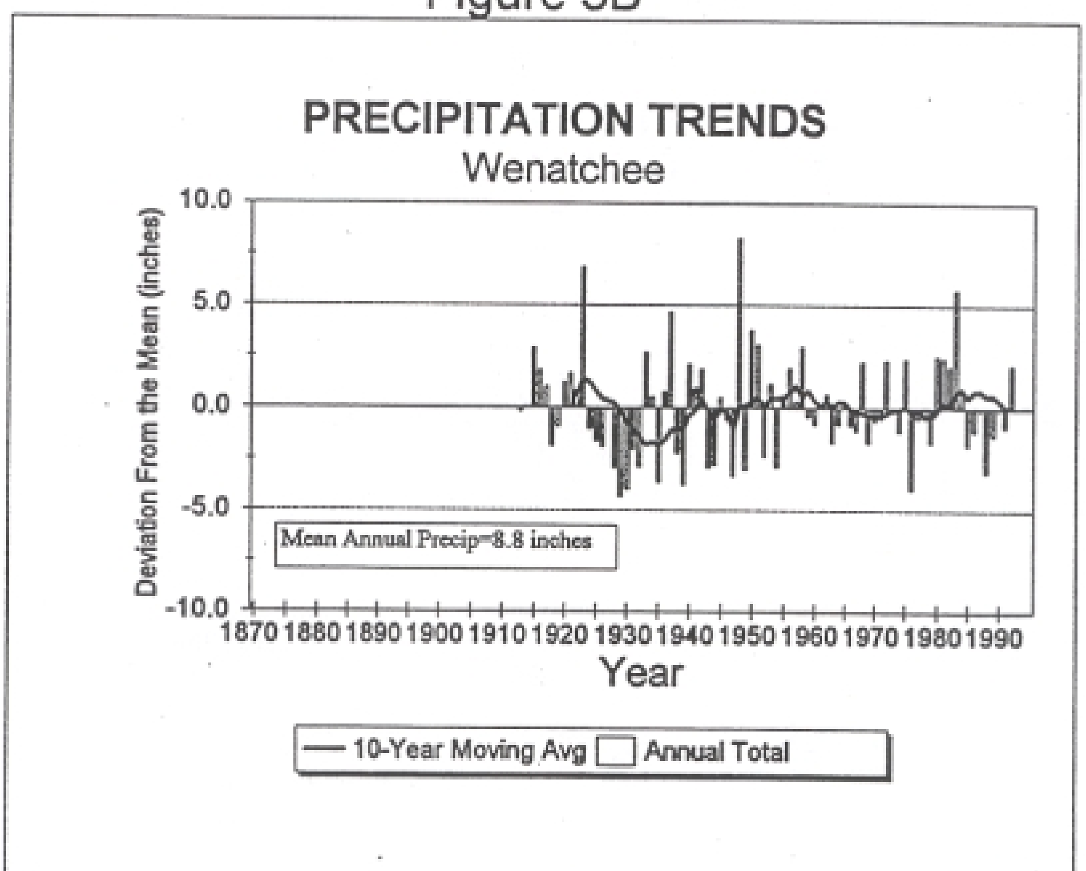


Figure 3C

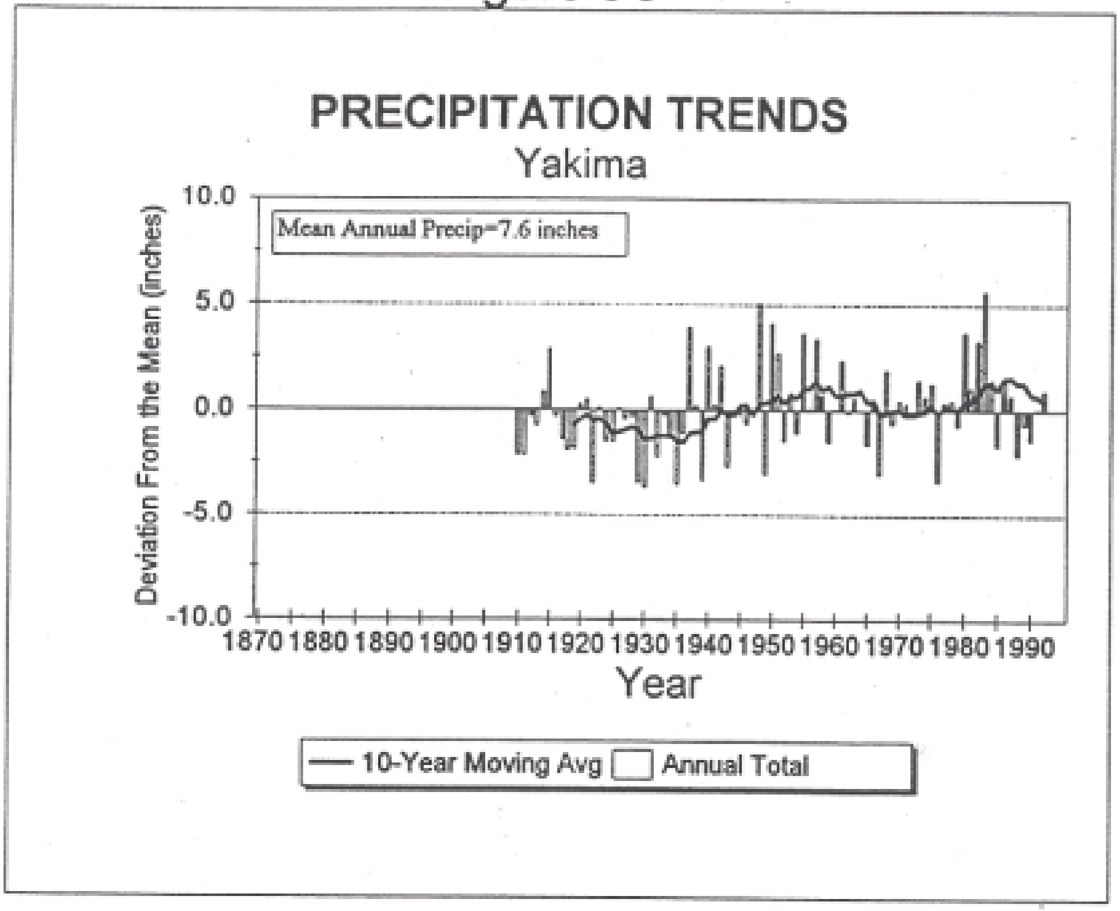



Figure 3D

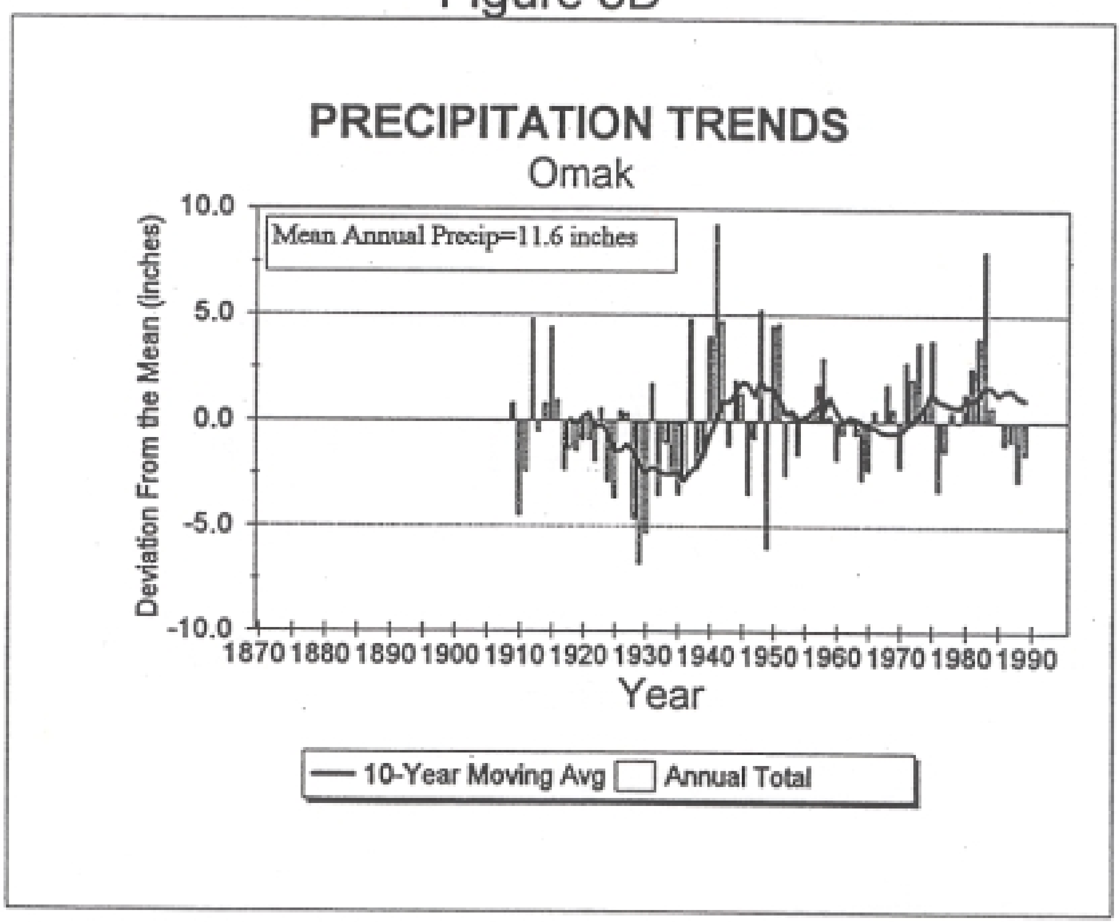


Figure 3E

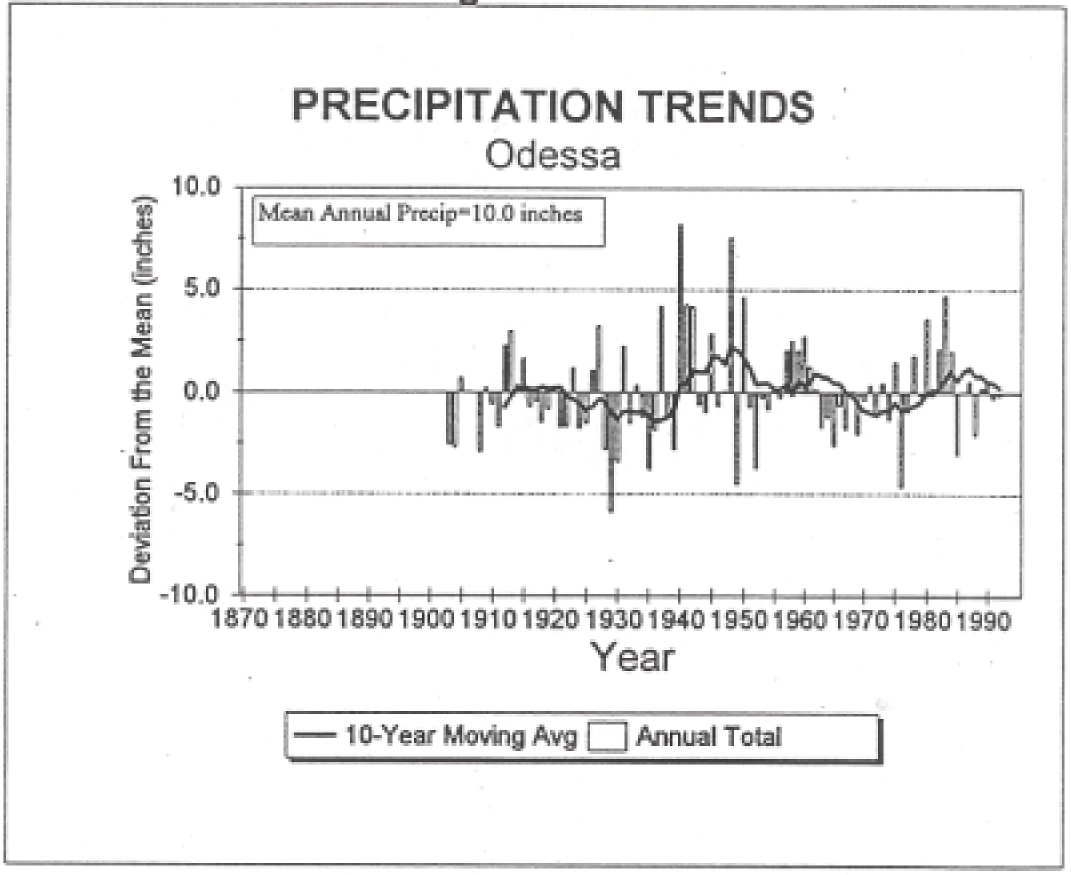



Figure 3F

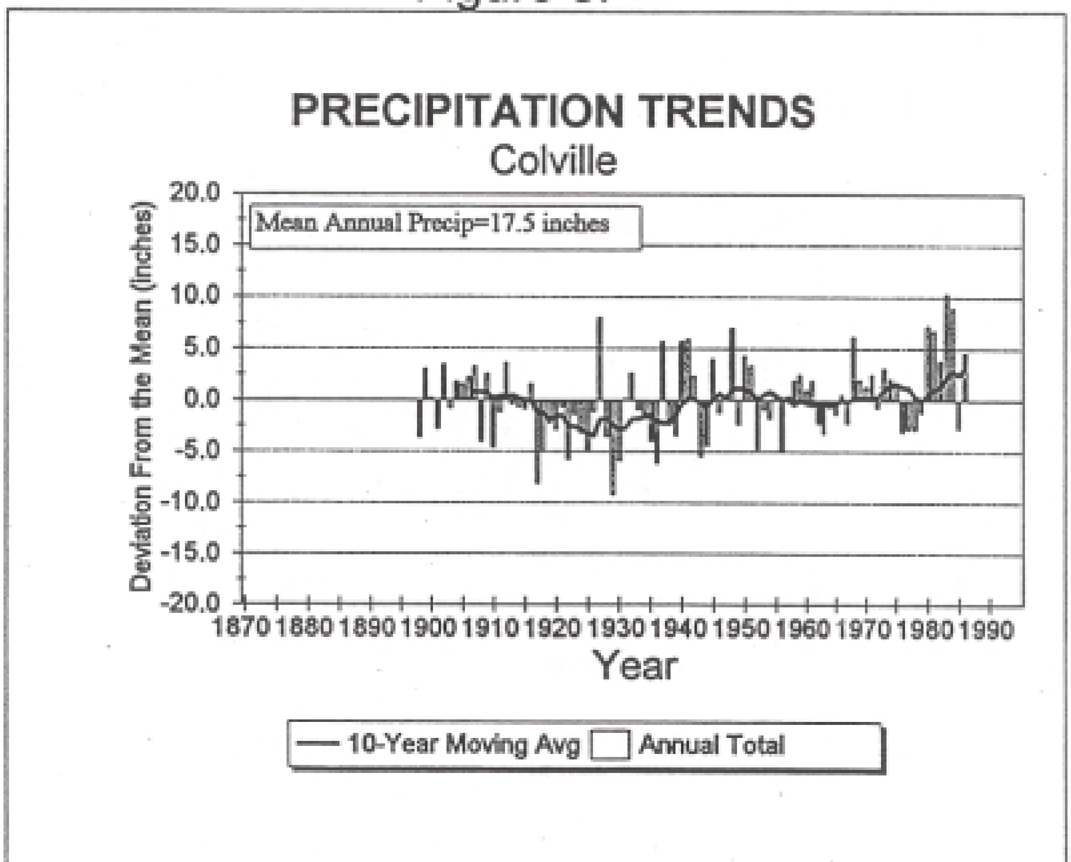


Figure 3G

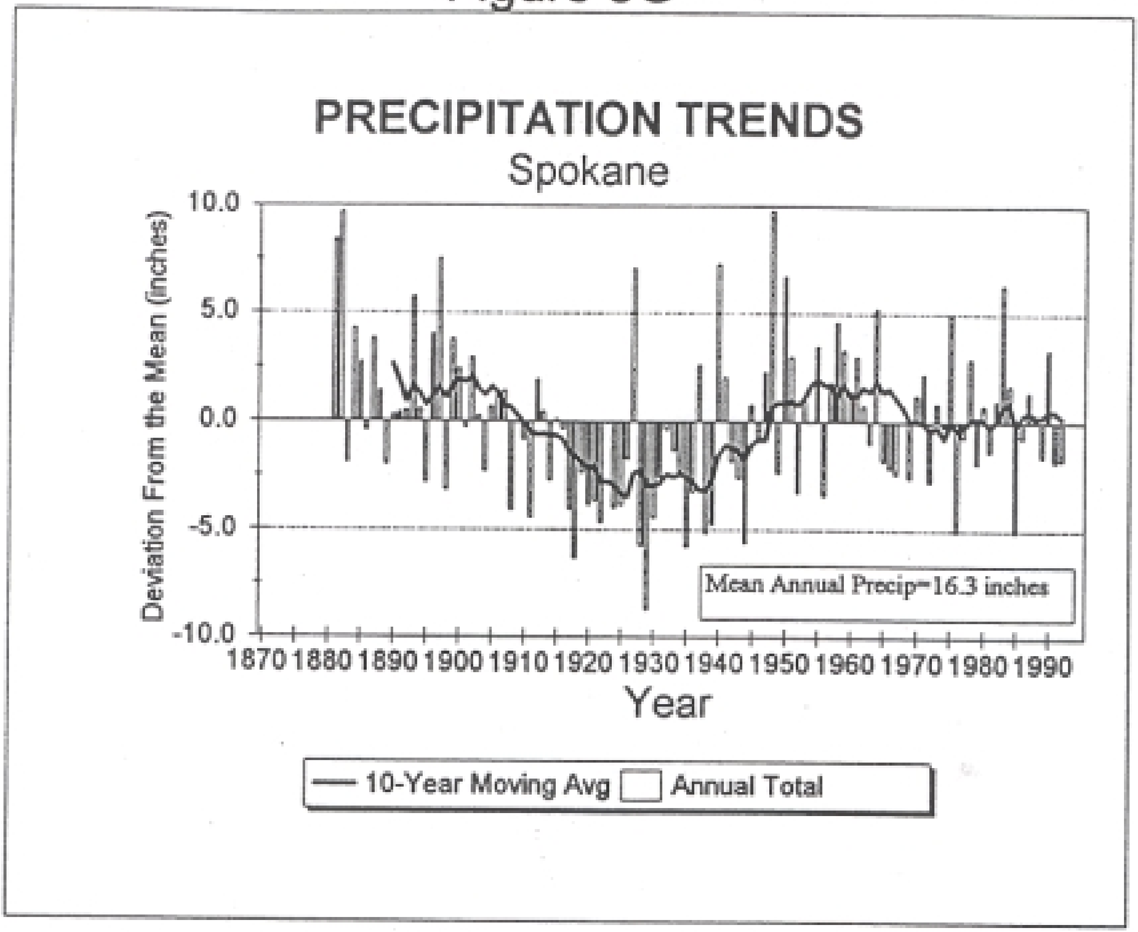



Figure 3H

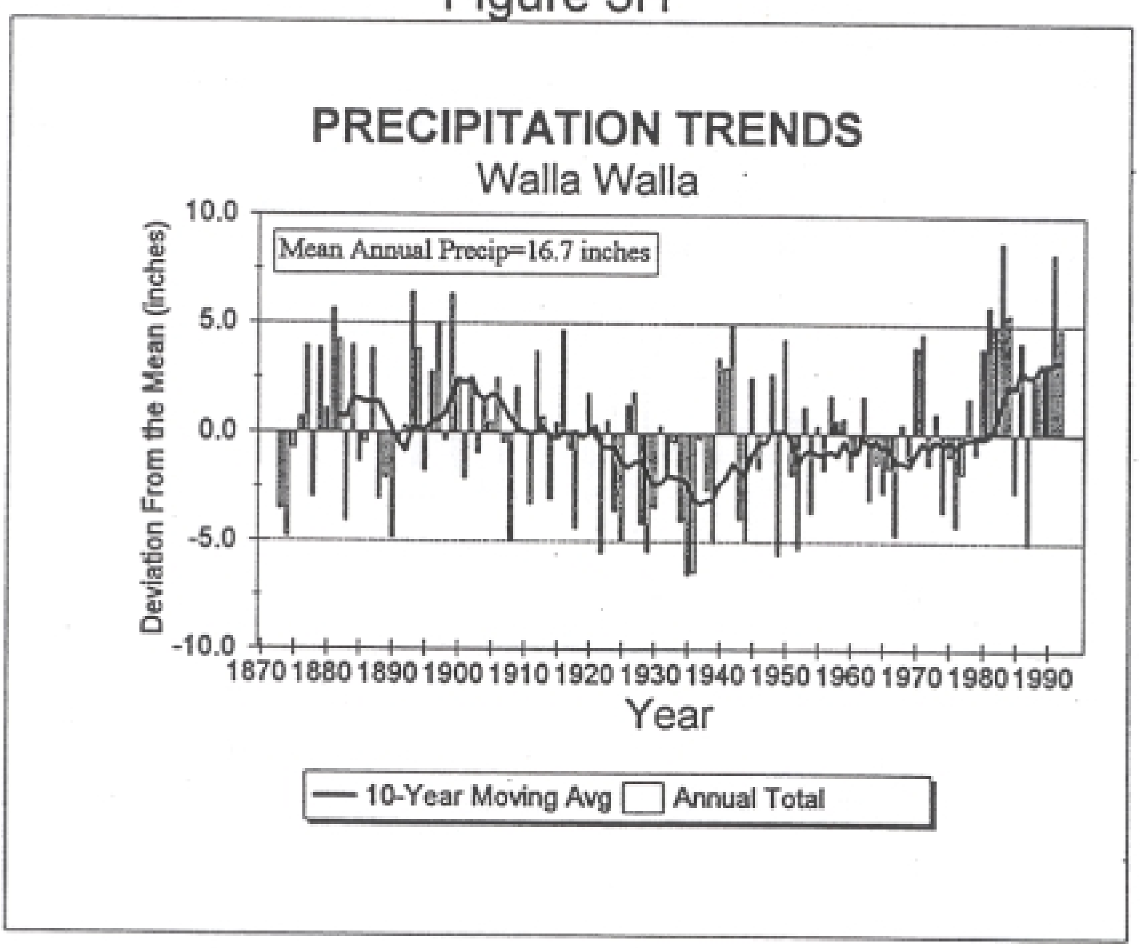


Figure 4

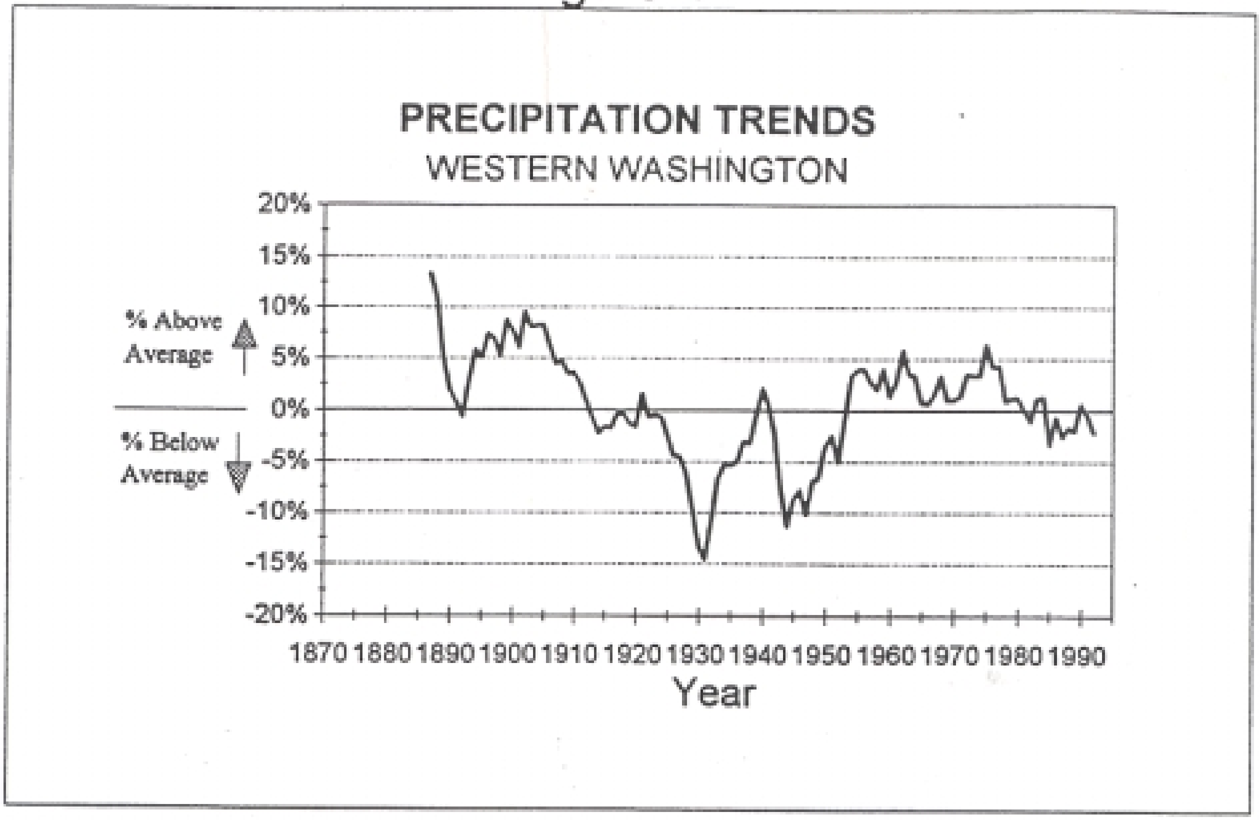
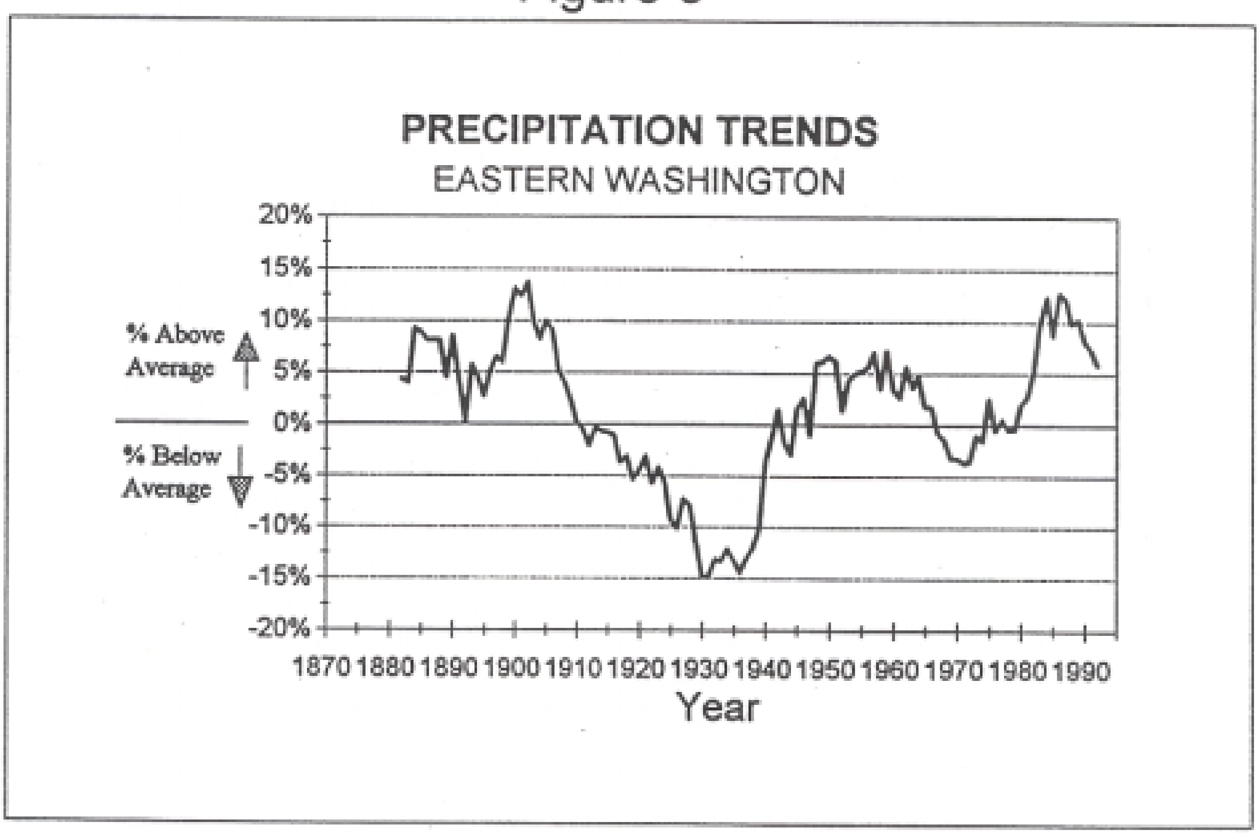



Figure 5



# Appendix A.2 Precipitation and Streamflow Trend Analysis Results and Summary of Compliance with Instream Flow Requirements

**Appendix A.2**

This appendix presents data sheets for the statistical analyses performed on the annual precipitation data and annual streamflow data for the period of record at each station. The data sheets show the data used and the resultant best fit equation in the form:

$$y = mx + b$$

where y = predicted annual precipitation

m = slope of trend line (positive is increasing over time and negative is decreasing overtime)

x = sequential time (as the predictor variable)

b = the predicted y value at zero time (start of the record)

The years of no record were deleted from the data sets before analysis. Also, analysis was conducted after normalizing on the mean value for each record. The normalized record allows comparison of the trend slope between stations without adjusting for absolute values of the data for each station. Trend comparisons between stations were conducted using the normalized data sets over identical years of record.

Also included is the tabulated values for the number of days specified instream flows are not met for the period of record at the Ferry and Laurier gaging stations. The recommended instream minimum flow at Ferry is 600 cfs for the period April through July, and 300 cfs for the period August through September. The recommended minimum instream flow at Laurier is 570 cfs year round.

**Appendix A.2**
**Precipitation and Streamflow Trend Analysis Results**
**Kettle River Watershed - WRIA 60**

| Analysis | Regression Equation | Normalized Regression Equation |
|---|---|---|
| **Precipitation Analysis** | | |
| Linear Regression of Annual Precipitation Totals at Republic | precip = 17.1 - 0.0413 int | norm precip = 1.05 - 0.00254 int |
| Linear Regression of Annual Precipitation Totals at Omak | precip = 11.2 + 0.0237 int | norm precip = 0.947 + 0.00199 int |
| Comparative Trend Analysis of Annual Precipitation Totals at Newport | precip = 29.6 - 0.810 int | norm precip = 1.04 - 0.00284 int |
| Comparative Trend Analysis of Annual Precipitation Totals at Colville | precip = 15.8 + 0.203 int | norm precip = 0.843 + 0.0108 int |
| Comparative Trend Analysis of Annual Precipitation Totals at Omak | precip = 11.7 + 0.0349 int | norm precip = 0.958 + 0.00286 int |
| Comparative Trend Analysis of Annual Precipitation Totals at Republic | precip = 16.6 - 0.0142 int | norm precip = 1.96 - 0.00049 int |
| Comparative Trend Analysis of Annual Precipitation Totals at Spokane | precip = 17.7 - 0.0689 int | norm precip = 1.06 - 0.00413 int |
| **Streamflow Analysis** | | |
| Linear Regression of Annual Flows for the Kettle River at Ferry | flow = 1373 + 4.58 int | norm flow = 0.903 + 0.00302 int |
| Linear Regression of Annual Flows for the Kettle River at Laurier | flow = 2733 + 4.94 int | norm flow = 0.946 + 0.00171 int |
| Regression of Normalized Equivalent Flow Data Set from Kettle River at Ferry | flow = 1444 + 4.51 int | norm flow = 0.940 + 0.00293 int |
| Regression of Normalized Equivalent Flow Data Set from Kettle River at Lauder | flow = 2782 + 5.3 int | norm flow = 0.963 + 0.00182 int |

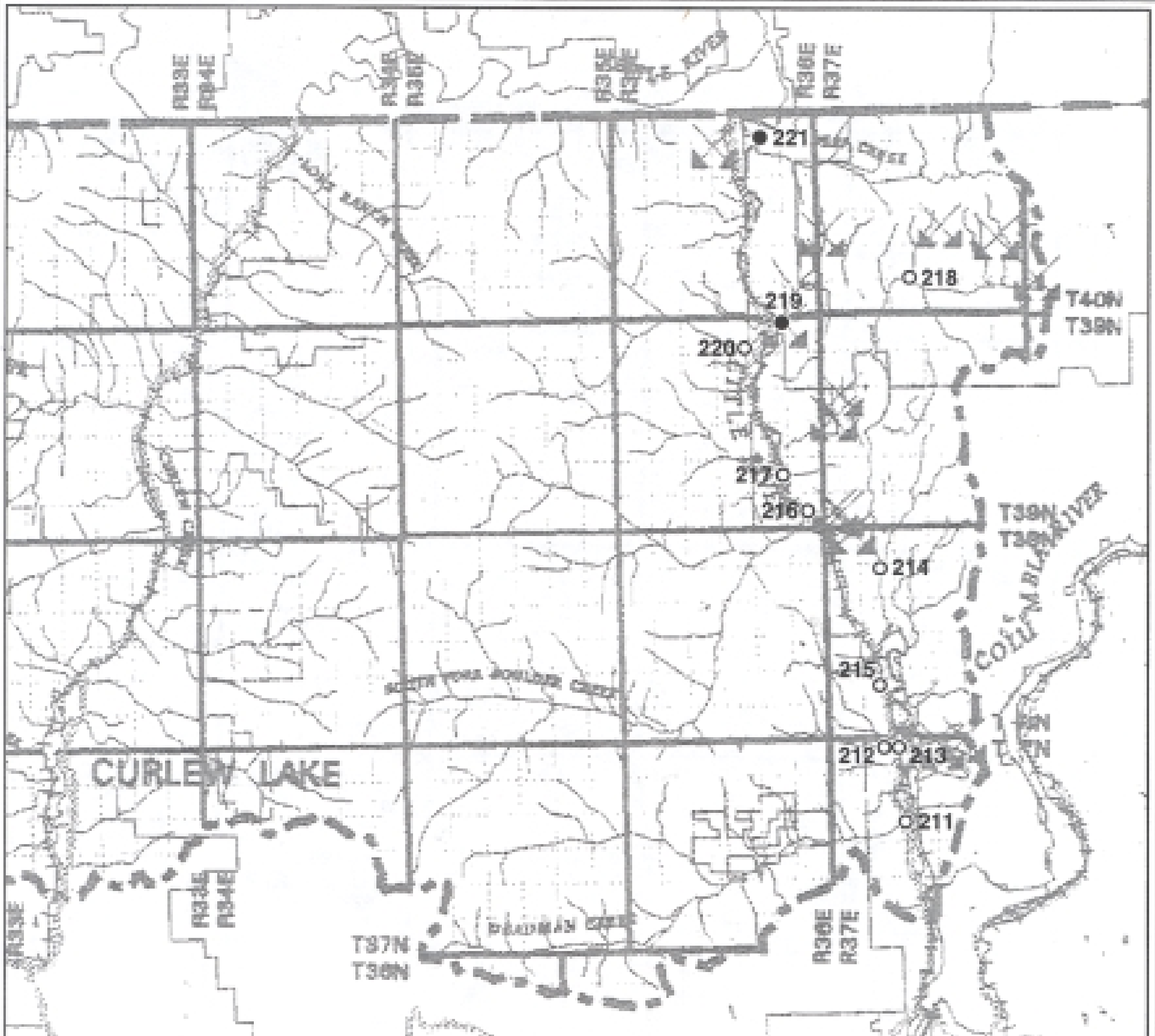
**Key to Variables**

| | | |
|---|---|---|
| precip | = | Annual total precipitation for the period of record |
| flow | = | Annual average flow for the period of record |
| int | = | Integer representing year number in numerical order from the start of the record (i.e. for period of record 1929 to 1993, the integers are 1-65) |
| norm precip | = | Precipitation values are divided by the mean value for the entire record allowing direct comparison between dimensionless data sets. |
| norm flow | = | Flow values are divided by the mean value for the entire record allowing direct comparison between dimensionless data sets. |

# Appendix A.3 Department of Ecology Discrete Stream Flow Measurements and Location of Monitoring Points

## Appendix A.3

This appendix presents Ecology's discrete stream flow measurements at 48 sites within WRIA 60. These discrete measurements were generally collected monthly between May and September in between 1986 through 1990. A map indication station locations is also provided in this appendix.

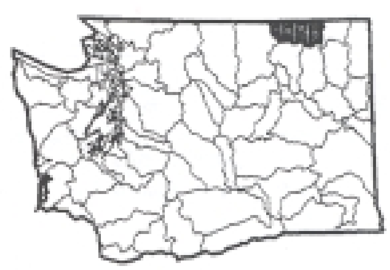



**DISCRETE STREAM GAGING LOCATIONS**
**DEPARTMENT OF ECOLOGY**

LEGEND

- ○ Approximate location and station number
- ● Extreme low or zero flow measured where solid

See database for stream flow measurements



## EAST HALF OF KETTLE (WRIA 60)

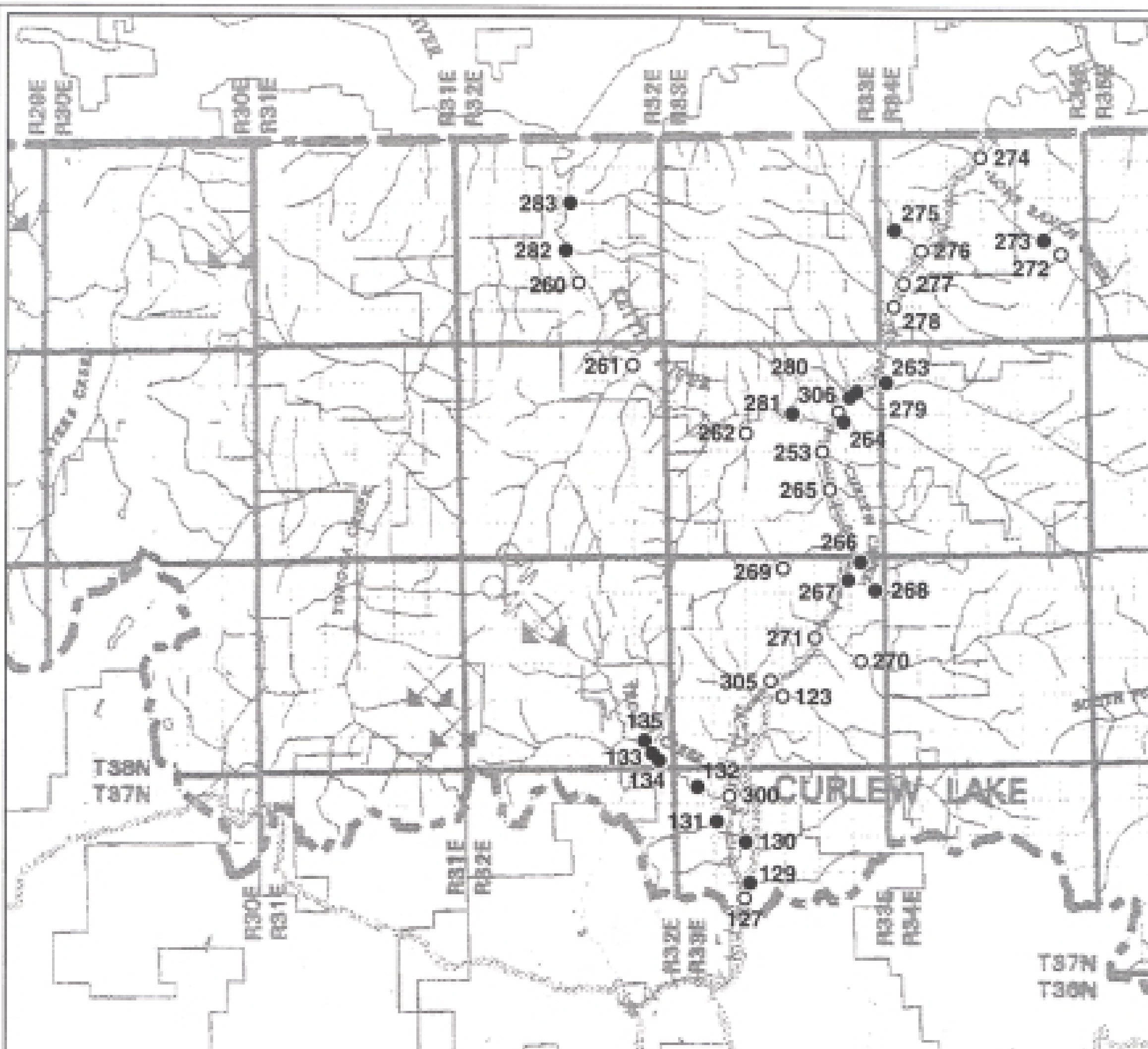
Washington Department of Ecology

0 5 10

Scale in Miles

## APPENDIX A.3

Watershed Assessment




## DISCRETE STREAM GAGING LOCATIONS
## DEPARTMENT OF ECOLOGY

LEGEND

- ○ Approximate location and station number
- ● Extreme low or zero flow measured where solid

See database for stream flow measurements

**WEST HALF OF KETTLE (WRIA 60)**

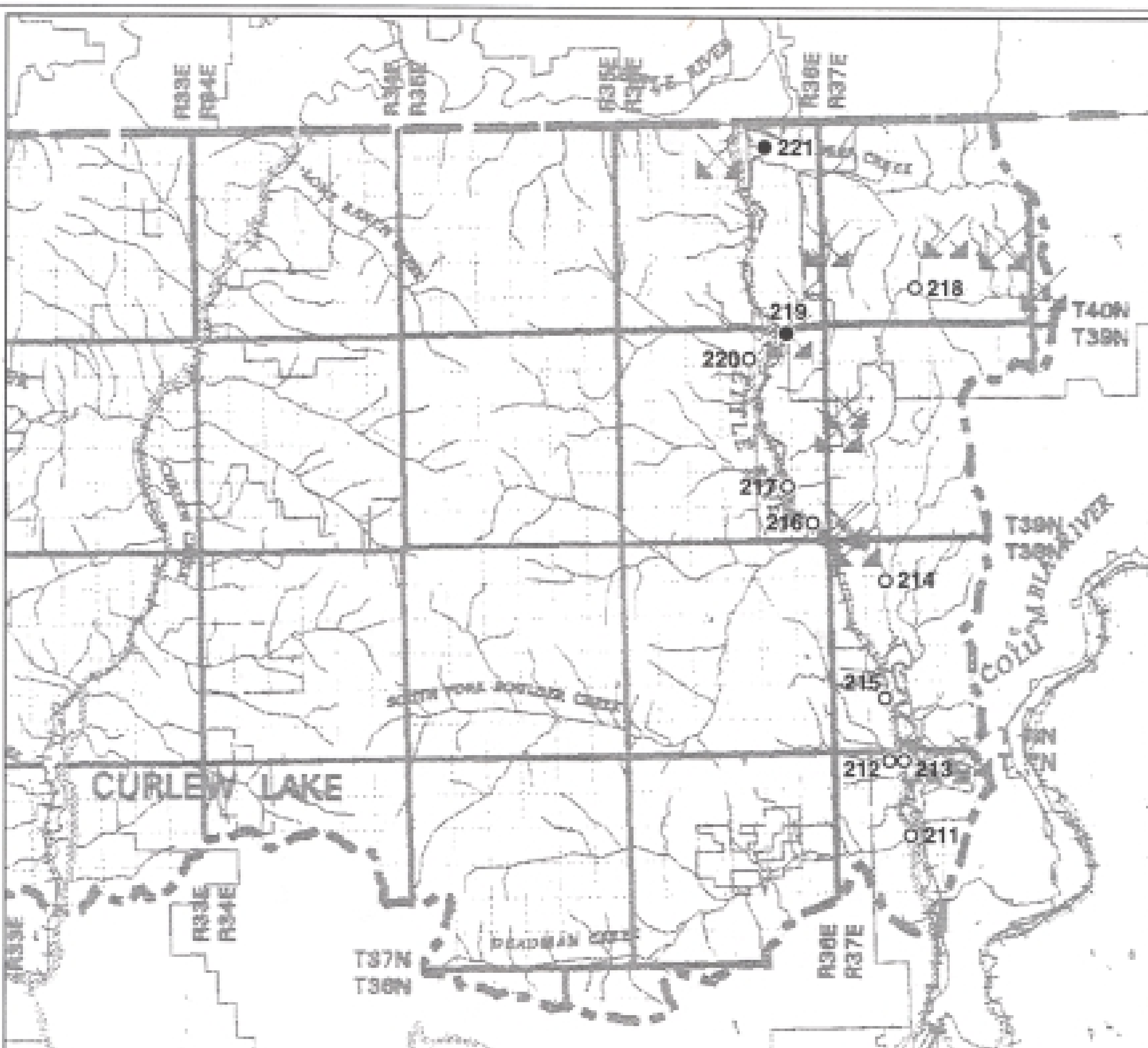
Washington Department of Ecology

0 5 10

Scale in Miles

**APPENDIX A.3**

Watershed Assessment

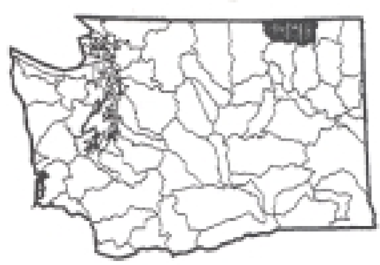



**DISCRETE STREAM GAGING LOCATIONS**
**DEPARTMENT OF ECOLOGY**

LEGEND

- ○ Approximate location and station number
- ● Extreme low or zero flow measured where solid

See database for stream flow measurements



## EAST HALF OF KETTLE (WRIA 60)

Washington Department of Ecology

0 5 10

Scale in Miles

## APPENDIX A.3

Watershed Assessment

# Database of Ecology Stream Measurements
# Kettle River Watershed (WRIA 60)

| Point Number | WRIA | County | Source | Tributary | Location TO RA SE Quarters | Point of Measurement | USGS Map | Date | Flow (cfs) | Flow Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 00123 | 60 | FE | Lambert Creek | Curlew Creek | 38 33 21 SE SE | @ dirt road | Karamin | 6/23/88 | 0.5100 | |
| 00123 | 60 | FE | Lambert Creek | Curlew Creek | 38 33 21 SE SE | @ dirt road | Karamin | 7/20/88 | 0.1400 | |
| 00123 | 60 | FE | Lambert Creek | Curlew Creek | 38 33 21 SE SE | @ dirt road | Karamin | 8/10/88 | 0.1200 | |
| 00123 | 60 | FE | Lambert Creek | Curlew Creek | 38 33 21 SE SE | @ dirt road | Karamin | 6/21/89 | 0.6500 | |
| 00123 | 60 | FE | Lambert Creek | Curlew Creek | 38 33 21 SE SE | @ dirt road | Karamin | 7/19/89 | 0.2400 | |
| 00123 | 60 | FE | Lambert Creek | Curlew Creek | 38 33 21 SE SE | @ dirt road | Karamin | 8/22/89 | 0.2070 | |
| 00123 | 60 | FE | Lambert Creek | Curlew Creek | 38 33 21 SE SE | @ did road | Karamin | 6/29/90 | 9.6400 | |
| 00123 | 60 | FE | Lambert Creek | Curlew Creek | 38 33 21 SE SE | @ did road | Karamin | 7/17/90 | 3.3900 | |
| 00123 | 60 | FE | Lambert Creek | Curlew Creek | 38 33 21 SE SE | @ did road | Karamin | 8/28/90 | 1.9800 | |
| 00127 | 60 | FE | Sanpoil River (S.Fork) | Curlew Lake | 37 33 29 NE NE | @ highway | Republic 15' | 7/6/87 | 0.7900 | Vegetation @ LEW |
| 00127 | 60 | FE | Sanpoil River (S.Fork) | Curlew Lake | 37 33 29 NE NE | @ highway | Republic 15' | 7/21/87 | 0.0600 | |
| 00127 | 60 | FE | Sanpoil River (S.Fork) | Curlew Lake | 37 33 29 NE NE | @ highway | Republic 15' | 9/15/87 | 0.6200 | |
| 00127 | 60 | FE | Sanpoil River (S.Fork) | Curlew Lake | 37 33 29 NE NE | @ highway | Republic 15' | 6/21/88 | 116.0000 | |
| 00127 | 60 | FE | Sanpoil River (S.Fork) | Curlew Lake | 37 33 29 NE NE | @ highway | Republic 15' | 6/22/88 | 2.3500 | |
| 00127 | 60 | FE | Sanpoil River (S.Fork) | Curlew Lake | 37 33 29 NE NE | @ highway | Republic 15' | 7/20/88 | 0.3020 | |
| 00127 | 60 | FE | Sanpoil River (S.Fork) | Curlew Lake | 37 33 29 NE NE | @ highway | Republic 15' | 7/25/88 | 38.7000 | |
| 00127 | 60 | FE | Sanpoil River (S.Fork) | Curlew Lake | 37 33 29 NE NE | @ highway | Republic 15' | 8/9/88 | 27.1000 | |
| 00127 | 60 | FE | Sanpoil River (S.Fork) | Curlew Lake | 37 33 29 NE NE | @ highway | Republic 15' | 8/10/88 | 0.1070 | |
| 00127 | 60 | FE | Sanpoil River (S.Fork) | Curlew Lake | 37 33 29 NE NE | @ highway | Republic 15' | 6/21/89 | 1.5500 | |
| 00127 | 60 | FE | Sanpoil River (S.Fork) | Curlew Lake | 37 33 29 NE NE | @ highway | Republic 15' | 7/19/89 | 0.2200 | |
| 00127 | 60 | FE | Sanpoil River (S.Fork) | Curlew Lake | 37 33 29 NE NE | @ highway | Republic 15' | 8/22/89 | 0.2640 | |
| 00127 | 60 | FE | Sanpoil River (S.Fork) | Curlew Lake | 37 33 29 NE NE | @ highway | Republic 15' | 6/28/90 | 10.9000 | |
| 00127 | 60 | FE | Sanpoil River (S.Fork) | Curlew Lake | 37 33 29 NE NE | @ highway | Republic 15' | 7/17/90 | 4.7000 | |
| 00127 | 60 | FE | Sanpoil River (S.Fork) | Curlew Lake | 37 33 29 NE NE | @ highway | Republic 15' | 8/28/90 | 3.3500 | |
| 00129 | 60 | FE | Herron Creek | Curlew Creek | 37 33 20 SE NE | @ highway | Republic 15' | 6/22/88 | 0.0000 | |
| 00129 | 60 | FE | Herron Creek | Curlew Creek | 37 33 20 SE NE | @ highway | Republic 15' | 7/20/88 | 0.0000 | |
| 00129 | 60 | FE | Herron Creek | Curlew Creek | 37 33 20 SE NE | @ highway | Republic 15' | 8/10/88 | 0.0000 | |
| 00129 | 60 | FE | Herron Creek | Curlew Creek | 37 33 20 SE NE | @ highway | Republic 15' | 6/21/89 | 0.0000 | |
| 00129 | 60 | FE | Herron Creek | Curlew Creek | 37 33 20 SE NE | @ highway | Republic 15' | 7/19/89 | 0.0000 | |
| 00129 | 60 | FE | Herron Creek | Curlew Creek | 37 33 20 SE NE | @ highway | Republic 15' | 8/22/89 | 0.0000 | |

# Database of Ecology Stream Measurements
# Kettle River Watershed (WRIA 60)

| Point Number | WRIA | County | Source | Tributary | Location TO RA SE Quarters | Point of Measurement | USGS Map | Date | Flow (cfs) | Flow Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 00129 | 60 | FE | Herron Creek | Curlew Creek | 37 33 20 SE NE | @ highway | Republic 15' | 6/29/90 | 0.0000 | DRY |
| 00129 | 60 | FE | Herron Creek | Curlew Creek | 37 33 20 SE NE | @ highway | Republic 15' | 7/17/90 | 0.0000 | DRY |
| 00130 | 60 | FE | Mires Creek | Curlew Lake | 37 33 16 SW NW | @ highway | Republic 15' | 7/29/86 | 0.0700 | |
| 00130 | 60 | FE | Mires Creek | Curlew Lake | 37 33 16 SW NW | @ highway | Republic 15' | 7/6/87 | 0.0600 | |
| 00130 | 60 | FE | Mires Creek | Curlew Lake | 37 33 16 SW NW | @ highway | Republic 15' | 6/22/88 | 0.0170 | |
| 00130 | 60 | FE | Mires Creek | Curlew Lake | 37 33 16 SW NW | @ highway | Republic 15' | 7/20/88 | 0.0000 | |
| 00130 | 60 | FE | Mires Creek | Curlew Lake | 37 33 16 SW NW | @ highway | Republic 15' | 8/10/88 | 0.0000 | |
| 00130 | 60 | FE | Mires Creek | Curlew Lake | 37 33 16 SW NW | @ highway | Republic 15' | 6/21/89 | 0.0000 | |
| 00130 | 60 | FE | Mires Creek | Curlew Lake | 37 33 16 SW NW | @ highway | Republic 15' | 7/19/89 | 0.0000 | |
| 00130 | 60 | FE | Mires Creek | Curlew Lake | 37 33 16 SW NW | @ highway | Republic 15' | 8/22/89 | 0.0000 | |
| 00130 | 60 | FE | Mires Creek | Curlew Lake | 37 33 16 SW NW | @ highway | Republic 15' | 6/28/90 | 0.7900 | |
| 00130 | 60 | FE | Mires Creek | Curlew Lake | 37 33 16 SW NW | @ highway | Republic 15' | 7/17/90 | 0.0440 | |
| 00130 | 60 | FE | Mires Creek | Curlew Lake | 37 33 16 SW NW | @ highway | Republic 15' | 8/28/90 | 0.0300 | |
| 00131 | 60 | FE | Barrett Creek | Curlew Lake | 37 33 08 W2 SW | @ highway | Republic 15' | 6/25/85 | 0.2200 | Bucket |
| 00131 | 60 | FE | Barrett Creek | Curlew Lake | 37 33 08 W2 SW | @ highway | Republic 15' | 8/2/85 | 0.0000 | Dry |
| 00131 | 60 | FE | Barrett Creek | Curlew Lake | 37 33 08 W2 SW | @ highway | Republic 15' | 9/13/85 | 0.0020 | Bucket |
| 00131 | 60 | FE | Barrett Creek | Curlew Lake | 37 33 08 W2 SW | @ highway | Republic 15' | 6/29/86 | 0.1500 | |
| 00131 | 60 | FE | Barrett Creek | Curlew Lake | 37 33 08 W2 SW | @ highway | Republic 15' | 7/29/86 | 0.0100 | |
| 00131 | 60 | FE | Barrett Creek | Curlew Lake | 37 33 08 W2 SW | @ highway | Republic 15' | 7/6/87 | 0.0500 | |
| 00131 | 60 | FE | Barrett Creek | Curlew Lake | 37 33 08 W2 SW | @ highway | Republic 15' | 8/11/87 | 0.0000 | |
| 00131 | 60 | FE | Barrett Creek | Curlew Lake | 37 33 08 W2 SW | @ highway | Republic 15' | 6/22/88 | 0.0500 | |
| 00131 | 60 | FE | Barrett Creek | Curlew Lake | 37 33 08 W2 SW | @ highway | Republic 15' | 7/20/88 | 0.0000 | |
| 00131 | 60 | FE | Barrett Creek | Curlew Lake | 37 33 08 W2 SW | @ highway | Republic 15' | 8/10/88 | 0.0000 | |
| 00131 | 60 | FE | Barrett Creek | Curlew Lake | 37 33 08 W2 SW | @ highway | Republic 15' | 6/22/89 | 0.3100 | |
| 00131 | 60 | FE | Barrett Creek | Curlew Lake | 37 33 08 W2 SW | @ highway | Republic 15' | 7/19/89 | 0.0300 | |
| 00131 | 60 | FE | Barrett Creek | Curlew Lake | 37 33 08 W2 SW | @ highway | Republic 15' | 8/23/89 | 0.0020 | |
| 00131 | 60 | FE | Barrett Creek | Curlew Lake | 37 33 08 W2 SW | @ highway | Republic 15' | 6/29/90 | 1.4100 | |
| 00131 | 60 | FE | Barrett Creek | Curlew Lake | 37 33 08 W2 SW | @ highway | Republic 15' | 7/18/90 | 0.4100 | |
| 00131 | 60 | FE | Barrett Creek | Curlew Lake | 37 33 08 W2 SW | @ highway | Republic 15' | 8/28/90 | 0.1400 | |
| 00132 | 60 | FE | Trout Creek | Curlew Lake | 37 33 06 SE | @ dirt road | Republic 15' | 4/27/87 | 16.8000 | |

# Database of Ecology Stream Measurements
# Kettle River Watershed (WRIA 60)

| Point Number | WRIA | County | Source | Tributary | Location TO RA SE Quarters | Point of Measurement | USGS Map | Date | Flow (cfs) | Flow Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 00132 | 60 | FE | Trout Creek | Curlew Lake | 37 33 06 SE | @ dirt road | Republic 15' | 7/6/87 | 2.1700 | |
| 00132 | 60 | FE | Trout Creek | Curlew Lake | 37 33 06 SE | @ dirt road | Republic 15' | 9/15/87 | 0.2640 | |
| 00132 | 60 | FE | Trout Creek | Curlew Lake | 37 33 06 SE | @ dirt road | Republic 15' | 5/15/88 | 5.8500 | |
| 00132 | 60 | FE | Trout Creek | Curlew Lake | 37 33 06 SE | @ dirt road | Republic 15' | 6/23/88 | 3.2600 | |
| 00132 | 60 | FE | Trout Creek | Curlew Lake | 37 33 06 SE | @ dirt road | Republic 15' | 7/20/88 | 0.0000 | |
| 00132 | 60 | FE | Trout Creek | Curlew Lake | 37 33 06 SE | @ dirt road | Republic 15' | 6/22/89 | 3.6000 | |
| 00132 | 60 | FE | Trout Creek | Curlew Lake | 37 33 06 SE | @ dirt road | Republic 15' | 7/19/89 | 1.3100 | |
| 00132 | 60 | FE | Trout Creek | Curlew Lake | 37 33 06 SE | @ dirt road | Republic 15' | 8/23/89 | 0.8900 | |
| 00132 | 60 | FE | Trout Creek | Curlew Lake | 37 33 06 SE | @ dirt road | Republic 15' | 6/29/90 | 17.9000 | |
| 00132 | 60 | FE | Trout Creek | Curlew Lake | 37 33 06 SE | @ dirt road | Republic 15' | 7/18/90 | 5.5300 | |
| 00132 | 60 | FE | Trout Creek | Curlew Lake | 37 33 06 SE | @ dirt road | Republic 15' | 8/29/90 | 3.0800 | |
| 00133 | 60 | FE | Trout Creek (S.Fork) | Trout Creek | 38 32 36 S2 SW | @ road | Republic 15' | 6/27/86 | 0.0200 | |
| 00133 | 60 | FE | Trout Creek (S.Fork) | Trout Creek | 38 32 36 S2 SW | @ road | Republic 15' | 7/28/86 | 0.0000 | |
| 00133 | 60 | FE | Trout Creek (S.Fork) | Trout Creek | 38 32 36 S2 SW | @ road | Republic 15' | 7/6/87 | 0.0000 | |
| 00133 | 60 | FE | Trout Creek (S.Fork) | Trout Creek | 38 32 36 S2 SW | @ road | Republic 15' | 8/11/87 | 0.0000 | |
| 00133 | 60 | FE | Trout Creek (S.Fork) | Trout Creek | 38 32 36 S2 SW | @ road | Republic 15' | 9/15/87 | 0.0000 | |
| 00133 | 60 | FE | Trout Creek (S.Fork) | Trout Creek | 38 32 36 S2 SW | @ road | Republic 15' | 6/21/88 | 0.0000 | |
| 00133 | 60 | FE | Trout Creek (S.Fork) | Trout Creek | 38 32 36 S2 SW | @ road | Republic 15' | 7/20/88 | 0.0000 | |
| 00133 | 60 | FE | Trout Creek (S.Fork) | Trout Creek | 38 32 36 S2 SW | @ road | Republic 15' | 8/10/88 | 0.0000 | |
| 00133 | 60 | FE | Trout Creek (S.Fork) | Trout Creek | 38 32 36 S2 SW | @ road | Republic 15' | 6/22/89 | 0.0250 | |
| 00133 | 60 | FE | Trout Creek (S.Fork) | Trout Creek | 38 32 36 S2 SW | @ road | Republic 15' | 7/19/89 | 0.0000 | |
| 00133 | 60 | FE | Trout Creek (S.Fork) | Trout Creek | 38 32 36 S2 SW | @ road | Republic 15' | 8/23/89 | 0.0000 | |
| 00133 | 60 | FE | Trout Creek (S.Fork) | Trout Creek | 38 32 36 S2 SW | @ road | Republic 15' | 6/29/90 | 1.0300 | |
| 00133 | 60 | FE | Trout Creek (S.Fork) | Trout Creek | 38 32 36 S2 SW | @ road | Republic 15' | 7/18/90 | 0.8200 | |
| 00133 | 60 | FE | Trout Creek (S.Fork) | Trout Creek | 38 32 36 S2 SW | @ road | Republic 15' | 8/29/90 | 0.6000 | |
| 00134 | 60 | FE | Trout Creek (N.Fork) | Trout Creek | 38 32 36 SW SE | @ road | Republic 15' | 7/28/86 | 1.9800 | |
| 00134 | 60 | FE | Trout Creek (N.Fork) | Trout Creek | 38 32 36 SW SE | @ road | Republic 15' | 7/6/87 | 1.5100 | |
| 00134 | 60 | FE | Trout Creek (N.Fork) | Trout Creek | 38 32 36 SW SE | @ road | Republic 15' | 9/15/87 | 0.1930 | |
| 00134 | 60 | FE | Trout Creek (N.Fork) | Trout Creek | 38 32 36 SW SE | @ road | Republic 15' | 6/23/88 | 2.4300 | |
| 00134 | 60 | FE | Trout Creek (N.Fork) | Trout Creek | 38 32 36 SW SE | @ road | Republic 15' | 7/20/88 | 0.0000 | |

# Database of Ecology Stream Measurements
# Kettle River Watershed (WRIA 60)

| Point Number | WRIA | County | Source | Tributary | Location TO RA SE Quarters | Point of Measurement | USGS Map | Date | Flow (cfs) | Flow Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 00134 | 60 | FE | Trout Creek (N.Fork) | Trout Creek | 38 32 36 SW SE | @ road | Republic 15' | 8/10/88 | 0.0000 | |
| 00134 | 60 | FE | Trout Creek (N.Fork) | Trout Creek | 38 32 36 SW SE | @ road | Republic 15' | 6/22/89 | 3.1800 | |
| 00134 | 60 | FE | Trout Creek (N.Fork) | Trout Creek | 38 32 36 SW SE | @ road | Republic 15' | 7/19/89 | 1.4400 | |
| 00134 | 60 | FE | Trout Creek (N.Fork) | Trout Creek | 38 32 36 SW SE | @ road | Republic 15' | 8/23/89 | 0.4400 | |
| 00134 | 60 | FE | Trout Creek (N.Fork) | Trout Creek | 38 32 36 SW SE | @ road | Republic 15' | 6/28/90 | 14.0000 | |
| 00134 | 60 | FE | Trout Creek (N.Fork) | Trout Creek | 38 32 36 SW SE | @ road | Republic 15' | 7/18/90 | 5.1900 | |
| 00134 | 60 | FE | Trout Creek (N.Fork) | Trout Creek | 38 32 36 SW SE | @ road | Republic 15' | 8/29/90 | 1.8400 | |
| 00135 | 60 | FE | Bacon Creek | Trout Creek | 38 32 36 NW | @ road | Republic 15' | 6/27/86 | 0.0200 | |
| 00135 | 60 | FE | Bacon Creek | Trout Creek | 38 32 36 NW | @ road | Republic 15' | 7/29/86 | 0.0200 | |
| 00135 | 60 | FE | Bacon Creek | Trout Creek | 38 32 36 NW | @ road | Republic 15' | 7/13/87 | 0.0000 | |
| 00135 | 60 | FE | Bacon Creek | Trout Creek | 38 32 36 NW | @ road | Republic 15' | 6/23/88 | 0.0320 | |
| 00135 | 60 | FE | Bacon Creek | Trout Creek | 38 32 36 NW | @ road | Republic 15' | 7/20/88 | 0.0000 | |
| 00135 | 60 | FE | Bacon Creek | Trout Creek | 38 32 36 NW | @ road | Republic 15' | 8/10/88 | 0.0000 | |
| 00135 | 60 | FE | Bacon Creek | Trout Creek | 38 32 36 NW | @ road | Republic 15' | 6/22/89 | 0.1630 | |
| 00135 | 60 | FE | Bacon Creek | Trout Creek | 38 32 36 NW | @ road | Republic 15' | 7/19/89 | 0.0060 | |
| 00135 | 60 | FE | Bacon Creek | Trout Creek | 38 32 36 NW | @ road | Republic 15' | 8/23/89 | 0.0000 | |
| 00135 | 60 | FE | Bacon Creek | Trout Creek | 38 32 36 NW | @ road | Republic 15' | 6/28/90 | 0.5700 | |
| 00135 | 60 | FE | Bacon Creek | Trout Creek | 38 32 36 NW | @ road | Republic 15' | 7/18/90 | 0.4100 | |
| 00135 | 60 | FE | Bacon Creek | Trout Creek | 38 32 36 NW | @ road | Republic 15' | 8/29/90 | 0.2200 | |
| 00211 | 60 | FE | Deadman Creek | Kettle River | 37 37 16 NW | @ highway | Boyds | 6/24/86 | 22.8000 | |
| 00211 | 60 | FE | Deadman Creek | Kettle River | 37 37 16 NW | @ highway | Boyds | 9/10/86 | 6.7300 | |
| 00211 | 60 | FE | Deadman Creek | Kettle River | 37 37 16 NW | @ highway | Boyds | 6/11/87 | 14.0000 | |
| 00211 | 60 | FE | Deadman Creek | Kettle River | 37 37 16 NW | @ highway | Boyds | 7/22/87 | 6.8500 | |
| 00211 | 60 | FE | Deadman Creek | Kettle River | 37 37 16 NW | @ highway | Boyds | 6/29/88 | 15.5000 | |
| 00211 | 60 | FE | Deadman Creek | Kettle River | 37 37 16 NW | @ highway | Boyds | 7/18/88 | 9.1900 | |
| 00211 | 60 | FE | Deadman Creek | Kettle River | 37 37 16 NW | @ highway | Boyds | 8/16/88 | 4.7200 | |
| 00211 | 60 | FE | Deadman Creek | Kettle River | 37 37 16 NW | @ highway | Boyds | 6/14/89 | 33.9300 | |
| 00211 | 60 | FE | Deadman Creek | Kettle River | 37 37 16 NW | @ highway | Boyds | 7/24/89 | 8.3800 | |
| 00211 | 60 | FE | Deadman Creek | Kettle River | 37 37 16 NW | @ highway | Boyds | 8/14/89 | 6.7800 | |
| 00211 | 60 | FE | Deadman Creek | Kettle River | 37 37 16 NW | @ highway | Boyds | 6/20/90 | 55.2000 | |

| Point Number | WRIA | County | Source | Tributary | Location TO RA SE Quarters | Point of Measurement | USGS Map | Date | Flow (cfs) | Flow Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 00211 | 60 | FE | Deadman Creek | Kettle River | 37 37 16 NW | @ highway | Boyds | 6/27/90 | 47.8000 | |
| 00211 | 60 | FE | Deadman Creek | Kettle River | 37 37 16 NW | @ highway | Boyds | 7/18/90 | 14.3000 | |
| 00211 | 60 | FE | Deadman Creek | Kettle River | 37 37 16 NW | @ highway | Boyds | 8/27/90 | 10.1000 | |
| 00212 | 60 | FE | Matsen Creek | Kettle River | 37 37 05 NE | @ farmhouse | Boyds | 10/21/84 | 0.81000 | no meas 0.7-2.0, 4.4-4.5 |
| 00212 | 60 | FE | Matsen Creek | Kettle River | 37 37 05 NE | @ farmhouse | Boyds | 7/15/85 | 0.1100 | none Irrig Approx 20 Spr |
| 00212 | 60 | FE | Matsen Creek | Kettle River | 37 37 05 NE | @ farmhouse | Boyds | 7/25/85 | 0.1000 | Above POM No meas 1.8-24/ 4.2-5.0 |
| 00212 | 60 | FE | Matsen Creek | Kettle River | 37 37 05 NE | @ farmhouse | Boyds | 8/5/85 | 0.1600 | |
| 00212 | 60 | FE | Matsen Creek | Kettle River | 37 37 05 NE | @ farmhouse | Boyds | 7/22/87 | 0.2900 | |
| 00212 | 60 | FE | Matsen Creek | Kettle River | 37 37 05 NE | @ farmhouse | Boyds | 6/29/88 | 0.3100 | |
| 00212 | 60 | FE | Matsen Creek | Kettle River | 37 37 05 NE | @ farmhouse | Boyds | 7/18/88 | 0.2200 | |
| 00212 | 60 | FE | Matsen Creek | Kettle River | 37 37 05 NE | @ farmhouse | Boyds | 8/16/88 | 0.1300 | |
| 00212 | 60 | FE | Matsen Creek | Kettle River | 37 37 05 NE | @ farmhouse | Boyds | 6/19/89 | 1.2900 | |
| 00212 | 60 | FE | Matsen Creek | Kettle River | 37 37 05 NE | @ farmhouse | Boyds | 7/24/89 | 0.3900 | |
| 00212 | 60 | FE | Matsen Creek | Kettle River | 37 37 05 NE | @ farmhouse | Boyds | 8/14/89 | 0.4700 | |
| 00212 | 60 | FE | Matsen Creek | Kettle River | 37 37 05 NE | @ farmhouse | Boyds | 5/20/90 | 2.7000 | |
| 00212 | 60 | FE | Matsen Creek | Kettle River | 37 37 05 NE | @ farmhouse | Boyds | 7/18/90 | 0.9900 | |
| 00212 | 60 | FE | Matsen Creek | Kettle River | 37 37 05 NE | @ farmhouse | Boyds | 8/27/90 | 0.9270 | |
| 00213 | 60 | FE | Doyle Creek | Kettle River | 37 37 05 N2 NE | @ highway | Boyds | 5/4/86 | 1.3800 | |
| 00213 | 60 | FE | Doyle Creek | Kettle River | 37 37 05 N2 NE | @ highway | Boyds | 6/24/86 | 0.9800 | |
| 00213 | 60 | FE | Doyle Creek | Kettle River | 37 37 05 N2 NE | @ highway | Boyds | 9/10/86 | 0.0900 | |
| 00213 | 60 | FE | Doyle Creek | Kettle River | 37 37 05 N2 NE | @ highway | Boyds | 7/22/87 | 0.4200 | |
| 00213 | 60 | FE | Doyle Creek | Kettle River | 37 37 05 N2 NE | @ highway | Boyds | 8/20/87 | 0.7400 | |
| 00213 | 60 | FE | Doyle Creek | Kettle River | 37 37 05 N2 NE | @ highway | Boyds | 6/29/88 | 1.3100 | |
| 00213 | 60 | FE | Doyle Creek | Kettle River | 37 37 05 N2 NE | @ highway | Boyds | 7/18/88 | 0.3800 | |
| 00213 | 60 | FE | Doyle Creek | Kettle River | 37 37 05 N2 NE | @ highway | Boyds | 8/16/88 | 0.2100 | |
| 00213 | 60 | FE | Doyle Creek | Kettle River | 37 37 05 N2 NE | @ highway | Boyds | 6/19/89 | 1.8300 | |
| 00213 | 60 | FE | Doyle Creek | Kettle River | 37 37 05 N2 NE | @ highway | Boyds | 7/24/89 | 1.0000 | |

| Point Number | WRIA | County | Source | Tributary | Location TO RA SE Quarters | Point of Measurement | USGS Map | Date | Flow (cfs) | Flow Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 00213 | 60 | FE | Doyle Creek | Kettle River | 37 37 05 N2 NE | @ highway | Boyds | 8/14/89 | 0.2900 | |
| 00213 | 60 | FE | Doyle Creek | Kettle River | 37 37 05 N2 NE | @ highway | Boyds | 5/20/90 | 0.8000 | |
| 00213 | 60 | FE | Doyle Creek | Kettle River | 37 37 05 N2 NE | @ highway | Boyds | 7/18/90 | 1.1300 | |
| 00213 | 60 | FE | Doyle Creek | Kettle River | 37 37 05 N2 NE | @ highway | Boyds | 8/27/90 | 0.5720 | |
| 00214 | 60 | FE | Toulou Creek | Kettle River | 38 37 05 E2 SW | @ access road | Orient | 8/26/87 | 5.4400 | 15-20 spr.hds. 3/4 mile upstream |
| 00214 | 60 | FE | Toulou Creek | Kettle River | 38 37 05 E2 SW | @ access road | Orient | 6/29/88 | 0.1800 | |
| 00214 | 60 | FE | Toulou Creek | Kettle River | 38 37 05 E2 SW | @ access road | Orient | 7/18/88 | 0.5200 | |
| 00214 | 60 | FE | Toulou Creek | Kettle River | 38 37 05 E2 SW | @ access road | Orient | 8/16/88 | 1.9800 | |
| 00214 | 60 | FE | Toulou Creek | Kettle River | 38 37 05 E2 SW | @ access road | Orient | 5/20/90 | 3.5700 | |
| 00214 | 60 | FE | Toulou Creek | Kettle River | 38 37 05 E2 SW | @ access road | Orient | 7/23/90 | 17.0000 | |
| 00214 | 60 | FE | Toulou Creek | Kettle River | 38 37 05 E2 SW | @ access road | Orient | 9/4/90 | 12.0000 | |
| 00215 | 60 | FE | Hodgson Creek | Kettle River | 38 37 29 Center | @ highway | Orient | 5/4/86 | 1.1100 | |
| 00215 | 60 | FE | Hodgson Creek | Kettle River | 38 37 29 Center | @ highway | Orient | 6/24/86 | 0.1000 | |
| 00215 | .60 | FE | Hodgson Creek | Kettle River | 38 37 29 Center | @ highway | Orient | 9/10/86 | 0.0460 | |
| 00215 | 60 | FE | Hodgson Creek | Kettle River | 38 37 29 Center | @ highway | Orient | 6/15/87 | 0.1300 | |
| 00215 | 60 | FE | Hodgson Creek | Kettle River | 38 37 29 Center | @ highway | Orient | 8/20/87 | 0.0600 | |
| 00215 | 60 | FE | Hodgson Creek | Kettle River | 38 37 29 Center | @ highway | Orient | 6/29/88 | 0.6500 | |
| 00215 | 60 | FE | Hodgson Creek | Kettle River | 38 37 29 Center | @ highway | Orient | 7/18/88 | 0.3500 | |
| 00215 | 60 | FE | Hodgson Creek | Kettle River | 38 37 29 Center | @ highway | Orient | 9/16/88 | 0.1000 | |
| 00215 | 60 | FE | Hodgson Creek | Kettle River | 38 37 29 Center | @ highway | Orient | 6/19/89 | 0.4600 | |
| 00215 | 60 | FE | Hodgson Creek | Kettle River | 38 37 29 Center | @ highway | Orient | 7/24/89 | 0.0700 | |
| 00215 | 60 | FE | Hodgson Creek | Kettle River | 38 37 29 Center | @ highway | Orient | 5/20/90 | 0.7900 | |
| 00215 | 60 | FE | Hodgson Creek | Kettle River | 38 37 29 Center | @ highway | Orient | 7/18/90 | 0.4700 | |
| 00216 | 60 | FE | Boulder Creek | Kettle River | 39 36 36 Center | @ highway | Orient | 6/15/87 | 24.5000 | |
| 00216 | 60 | FE | Boulder Creek | Kettle River | 39 36 36 Center | @ highway | Orient | 7/22/87 | 10.7000 | |
| 00216 | 60 | FE | Boulder Creek | Kettle River | 39 36 36 Center | @ highway | Orient | 8/26/87 | 6.1800 | |
| 00216 | 60 | FE | Boulder Creek | Kettle River | 39 36 36 Center | @ highway | Orient | 6/29/88 | 19.4200 | |
| 00216 | 60 | FE | Boulder Creek | Kettle River | 39 36 36 Center | @ highway | Orient | 7/18/88 | 9.7200 | |
| 00216 | 60 | FE | Boulder Creek | Kettle River | 39 36 36 Center | @ highway | Orient | 8/16/88 | 4.2000 | |

# Database of Ecology Stream Measurements
## Kettle River Watershed (WRIA 60)

| Point Number | WRIA | County | Source | Tributary | Location TO RA SE Quarters | Point of Measurement | USGS Map | Date | Flow (cfs) | Flow Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 00216 | 60 | FE | Boulder Creek | Kettle River | 39 36 36 Center | @ highway | Orient | 6/19/89 | 32.3000 | |
| 00216 | 60 | FE | Boulder Creek | Kettle River | 39 36 36 Center | @ highway | Orient | 7/24/89 | 9.1200 | |
| 00216 | 60 | FE | Boulder Creek | Kettle River | 39 36 36 Center | @ highway | Orient | 5/20/90 | | Too swift to measure Very muddy |
| 00216 | 60 | FE | Boulder Creek | Kettle River | 39 36 36 Center | @ highway | Orient | 7/18/90 | 27.8000 | |
| 00216 | 60 | FE | Boulder Creek | Kettle River | 39 36 36 Center | @ highway | Orient | 9/4/90 | 9.4100 | |
| 00217 | 60 | FE | East Deer Creek | Kettle River | 39 36 26 W2 SE | @ highway | Orient | 5/4/86 | 29.1000 | |
| 00217 | 60 | FE | East Deer Creek | Kettle River | 39 36 26 W2 SE | @ highway | Orient | 6/23/86 | 5.0000 | |
| 00217 | 60 | FE | East Deer Creek | Kettle River | 39 36 26 W2 SE | @ highway | Orient | 6/15/87 | 3.7700 | |
| 00217 | 60 | FE | East Deer Creek | Kettle River | 39 36 26 W2 SE | @ highway | Orient | 7/22/87 | 2.3300 | |
| 00217 | 60 | FE | East Deer Creek | Kettle River | 39 36 26 W2 SE | @ highway | Orient | 6/29/88 | 2.0800 | |
| 00217 | 60 | FE | East Deer Creek | Kettle River | 39 36 26 W2 SE | @ highway | Orient | 7/18/88 | 0.8800 | |
| 00217 | 60 | FE | East Deer Creek | Kettle River | 39 36 26 W2 SE | @ highway | Orient | 8/16/88 | 0.1900 | |
| 00217 | 60 | FE | East Deer Creek | Kettle River | 39 36 26 W2 SE | @ highway | Orient | 6/19/89 | 5.6600 | |
| 00217 | 60 | FE | East Deer Creek | Kettle River | 39 36 26 W2 SE | @ highway | Orient | 7/24/89 | 1.3800 | |
| 00217 | 60 | FE | East Deer Creek | Kettle River | 39 36 26 W2 SE | @ highway | Orient | 5/20/90 | 18.5000 | |
| 00217 | 60 | FE | East Deer Creek | Kettle River | 39 36 26 W2 SE | @ highway | Orient | 6/29/90 | 12.9000 | |
| 00217 | 60 | FE | East Deer Creek | Kettle River | 39 36 26 W2 SE | @ highway | Orient | 7/18/90 | 4.6400 | |
| 00217 | 60 | FE | East Deer Creek | Kettle River | 39 36 26 W2 SE | @ highway | Orient | 9/4/90 | 1.7800 | |
| 00218 | 60 | FE | Pierre Creek | Pierre Lake | 40 37 33 N2 NW | @ access road | Churchill Mt | 6/15/87 | 1.3300 | Est. discharge |
| 00218 | 60 | FE | Pierre Creek | Pierre Lake | 40 37 33 N2 IM | @ access road | Churchill Mt | 8/26/87 | 1.4700 | |
| 00218 | 60 | FE | Pierre Creek | Pierre Lake | 40 37 33 N2 NW | @ access road | Churchill Mt | 6/29/88 | 4.9900 | |
| 00218 | 60 | FE | Pierre Creek | Pierre Lake | 40 37 33 N2 NW | @ access road | Churchill Mt | 7/18/88 | 2.8100 | |
| 00218 | 60 | FE | Pierre Creek | Pierre Lake | 40 37 33 N2 NW | @ access road | Churchill Mt | 8/16/88 | 1.4700 | |
| 00218 | 60 | FE | Pierre Creek | Pierre Lake | 40 37 33 N2 NW | @ access road | Churchill Mt | 6/19/89 | 6.5500 | |
| 00218 | 60 | FE | Pierre Creek | Pierre Lake | 40 37 33 N2 NW | @ access road | Churchill Mt | 7/24/89 | 0.4700 | |
| 00218 | 60 | FE | Pierre Creek | Pierre Lake | 40 37 33 N2 NW | @ access road | Churchill Mt | 8/14/89 | 2.0900 | |
| 00218 | 60 | FE | Pierre Creek | Pierre Lake | 40 37 33 N2 NW | @ access road | Churchill Mt | 7/18/90 | 8.4200 | |
| 00218 | 60 | FE | Pierre Creek | Pierre Lake | 40 37 33 N2 NW | @ access road | Churchill Mt | 9/4/90 | 3.1800 | |
| 00219 | 60 | FE | Sand Creek | Kettle River | 39 36 02 NE NE | @ road | Laurier | 8/21/84 | 0.7700 | No Meas 8.3-9.3, Backwater |

**Database of Ecology Stream Measurements**
**Kettle River Watershed (WRIA 60)**

| Point Number | WRIA | County | Source | Tributary | Location TO RA SE Quarters | Point of Measurement | USGS Map | Date | Flow (cfs) | Flow Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 00219 | 60 | FE | Sand Creek | Kettle River | 39 36 02 NE NE | @ road | Laurier | 7/16/85 | 0.3300 | Bucket |
| 00219 | 60 | FE | Sand Creek | Kettle River | 39 36 02 NE NE | @ road | Laurier | 9/4/85 | 0.2000 | Bucket |
| 00219 | 60 | FE | Sand Creek | Kettle River | 39 36 02 NE NE | @ road | Laurier | 5/4/86 | 2.1200 | |
| 00219 | 60 | FE | Sand Creek | Kettle River | 39 36 02 NE NE | @ road | Laurier | 6/23/86 | 0.4000 | |
| 00219 | 60 | FE | Sand Creek | Kettle River | 39 36 02 NE NE | road | Laurier | 9/10/86 | 0.0900 | |
| 00219 | 60 | FE | Sand Creek | Kettle River | 39 36 02 NE NE | @ road | Laurier | 6/15/87 | 0.2000 | |
| 00219 | 60 | FE | Sand Creek | Kettle River | 39 36 02 NE NE | @ road | Laurier | 7/22/87 | 0.1900 | |
| 00219 | 60 | FE | Sand Creek | Kettle River | 39 36 02 NE NE | @ road | Laurier | 8/26/87 | 0.0400 | |
| 00219 | 60 | FE | Sand Creek | Kettle River | 39 36 02 NE NE | @ road | Laurier | 5/8/88 | 0.3000 | |
| 00219 | 60 | FE | Sand Creek | Kettle River | 39 36 02 NE NE | @ road | Laurier | 6/29/88 | 0.1100 | |
| 00219 | 60 | FE | Sand Creek | Kettle River | 39 36 02 NE NE | @ road | Laurier | 7/18/88 | 0.0090 | |
| 00219 | 60 | FE | Sand Creek | Kettle River | 39 36 02 NE NE | @ road | Laurier | 8/16/88 | 0.0000 | |
| 00219 | 60 | FE | Sand Creek | Kettle River | 39 36 02 NE NE | @ road | Laurier | 6/19/89 | 0.9500 | |
| 00219 | 60 | FE | Sand Creek | Kettle River | 39 36 02 NE NE | @ road | Laurier | 7/24/89 | 0.5300 | |
| 00219 | 60 | FE | Sand Creek | Kettle River | 39 36 02 NE NE | @ road | Laurier | 8/14/89 | 0.0600 | |
| 00219 | 60 | FE | Sand Creek | Kettle River | 39 36 02 NE NE | @ road | Laurier | 5/20/90 | 1.1900 | |
| 00219 | 60 | FE | Sand Creek | Kettle River | 39 36 02 NE NE | @ road | Laurier | 7/18/90 | 1.2100 | |
| 00219 | 60 | FE | Sand Creek | Kettle River | 39 36 02 NE NE | @ road | Laurier | 9/4/90 | 1.3300 | |
| 00220 | 60 | FE | Little Boulder Creek | Kettle River | 39 36 03 S2 SE | @ intersection | Laurier | 6/15/87 | 6.3200 | |
| 00220 | 60 | FE | Little Boulder Creek | Kettle River | 39. 36 03 S2 SE | @ intersection | Laurier | 81/6/87 | 2.4900 | |
| 00220 | 60 | FE | Little Boulder Creek | Kettle River | 39 36 03 S2 SE | @ intersection | Laurier | 6/29/88 | 4.5300 | |
| 00220 | 60 | FE | Little Boulder Creek | Kettle River | 39 36 03 S2 SE | @ intersection | Laurier | 7/18/88 | 2.3900 | |
| 00220 | 60 | FE | Little Boulder Creek | Kettle River | 39 36 03 S2 SE | @ intersection | Laurier | 8/16/88 | 0.9600 | |
| 00220 | 60 | FE | Little Boulder Creek | Kettle River | 39 36 03 S2 SE | @ intersection | Laurier | 6/19/89 | 6.4300 | |
| 00220 | 60 | FE | Little Boulder Creek | Kettle River | 39 36 03 S2 SE | @ intersection | Laurier | 7/24/89 | 0.4800 | |
| 00220 | 60 | FE | Little Boulder Creek | Kettle River | 39 36 03 S2 SE | @ intersection | Laurier | 8/14/89 | 2.3200 | |
| 00220 | 60 | FE | Little Boulder Creek | Kettle River | 39 36 03 S2 SE | @ intersection | Laurier | 5/20/90 | 23.4000 | |
| 00220 | 60 | FE | Little Boulder Creek | Kettle River | 39 36 03 S2 SE | @ intersection | Laurier | 6/29190 | 14.5000 | |
| 00220 | 60 | FE | Little Boulder Creek | Kettle River | 39 36 03 S2 SE | @ intersection | Laurier | 7/18/90 | 8.1600 | |
| 00220 | 60 | FE | Little Boulder Creek | Kettle River | 39 36 03 S2 SE | @ intersection | Laurier | 9/4/90 | 3.3400 | |

# Database of Ecology Stream Measurements
# Kettle River Watershed (WRIA 60)

| Point Number | WRIA | County | Source | Tributary | Location TO RA SE Quarters | Point of Measurement | USGS Map | Date | Flow (cfs) | Flow Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 00221 | 60 | FE | Deep Creek | Kettle River | 40 36 11 NW | @ access road | Laurier | 9/4/85 | 0.0000 | Dry |
| 00221 | 60 | FE | Deep Creek | Kettle River | 40 36 11 NW | @ access road | Laurier | 5/4/86 | 42.0000 | |
| 00221 | 60 | FE | Deep Creek | Kettle River | 40 36 11 NW | @ access road | Laurier | 6/23/86 | 5.2000 | |
| 00221 | 60 | FE | Deep Creek | Kettle River | 40 36 11 NW | @ access road | Laurier | 9/10/86 | 0.0000 | |
| 00221 | 60 | FE | Deep Creek | Kettle River | 40 36 11 NW | @ access road | Laurier | 6/15/87 | 5.6700 | |
| 00221 | 60 | FE | Deep Creek | Kettle River | 40 36 11 NW | @ access road | Laurier | 8/26/87 | 0.2600 | |
| 00221 | 60 | FE | Deep Creek | Kettle River | 40 36 11 NW | @ access road | Laurier | 6/29/88 | 11.2000 | |
| 00221 | 60 | FE | Deep Creek | Kettle River | 40 36 11 NW | @ access road | Laurier | 7/18/88 | 3.9700 | |
| 00221 | 60 | FE | Deep Creek | Kettle River | 40 36 11 NW | @ access road | Laurier | 8/16/88 | 0.0600 | |
| 00221 | 60 | FE | Deep Creek | Kettle River | 40 36 11 NW | @ access road | Laurier | 6/19/89 | 14.0900 | |
| 00221 | 60 | FE | Deep Creek | Kettle River | 40 36 11 NW | @ access road | Laurier | 7/4/89 | 0.1300 | |
| 00221 | 60 | FE | Deep Creek | Kettle River | 40 36 11 NW | @ access road | Laurier | 8/14/89 | 0.0000 | |
| 00221 | 60 | FE | Deep Creek | Kettle River | 40 36 11 NW | @ access road | Laurier | 7/23/90 | 11.4000 | |
| 00221 | 60 | FE | Deep Creek | Kettle River | 40 36 11 NW | @ access road | Laurier | 9/4/90 | 4.7400 | |
| 00260 | 60 | FE | Toroda Creek | Kettle River | 40 32 27 NE NW | @ highway | Bodie Mtn. | 6/26/85 | 12.1000 | No Meas 0.4-1.5, Backwater |
| 00260 | 60 | FE | Toroda Creek | Kettle River | 40 32 27 NE NW | @ highway | Bodie Mtn. | 8/8/85 | 5.7300 | |
| 00260 | 60 | FE | Toroda Creek | Kettle River | 40 32 27 NE NW | @ highway | Bodie Mtn. | 9/6/85 | 5.9500 | No Meas 0.9-1.9/ 8.4-9.6 |
| 00260 | 60 | FE | Toroda Creek | Kettle River | 40 32 27 NE NW | @ highway | Bodie Mtn. | 6/27/86 | 8.7500 | None |
| 00260 | 60 | FE | Toroda Creek | Kettle River | 40 32 27 NE NW | @ highway | Bodie Mtn. | 7/30/86 | 10.0000 | |
| 00260 | 60 | FE | Toroda Creek | Kettle River | 40 32 27 NE NW | @ highway | Bodie Mtn. | 7/7/87 | 7.2000 | |
| 00260 | 60 | FE | Toroda Creek | Kettle River | 40 32 27 NE NW | @ highway | Bodie Mtn. | 8/11/87 | 2.3800 | 30 spr.hds.in field SE of POM |
| 00260 | 60 | FE | Toroda Creek | Kettle River | 40 32 27 NE NW | @ highway | Bodie Mtn. | 6/21/88 | 8.0800 | |
| 00260 | 60 | FE | Toroda Creek | Kettle River | 40 32 27 NE NW | @ highway | Bodie Mtn. | 7/19/88 | 3.3500 | |
| 00260 | 60 | FE | Toroda Creek | Kettle River | 40 32 27 NE NW | @ highway | Bodie Mtn. | 8/9/88 | 1.8200 | |
| 00260 | 60 | FE | Toroda Creek | Kettle River | 40 32 27 NE NW | @ highway | Bodie Mtn. | 6/20/89 | 10.8400 | |
| 00260 | 60 | FE | Toroda Creek | Kettle River | 40,32 27 NE NW | @ highway | Bodie Mtn. | 7/19/89 | 6.1100 | |
| 00260 | 60 | FE | Toroda Creek | Kettle River | 40 32 27 NE NW | @ highway | Bodie Mtn. | 8/22/89 | 3.7500 | |
| 00260 | 60 | FE | Toroda Creek | Kettle River | 40 32 27 NE NW | @ highway | Bodie Mtn. | 6/29/90 | 47.2000 | |

# Database of Ecology Stream Measurements
# Kettle River Watershed (WRIA 60)

| Point Number | WRIA | County | Source | Tributary | Location TO RA SE Quarters | Point of Measurement | USGS Map | Date | Flow (cfs) | Flow Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 00260 | 60 | FE | Toroda Creek | Kettle River | 40 32 27 NE NW | @ highway | Bodie Mtn. | 7/17/90 | 26.7000 | |
| 00260 | 60 | FE | Toroda Creek | Kettle River | 40 32 27 NE NW | @ highway | Bodie Mtn. | 8/28/90 | 14.0000 | |
| 00261 | 60 | FE | Tonata Creek | Kettle River | 39 32 02 NE SE | @ highway | Curlew 15' | 6/26/85 | 0.5300 | Bucket |
| 00261 | 60 | FE | Tonata Creek | Kettle River | 39 32 02 NE SE | @ highway | Curlew 15' | 8/8/85 | 0.3500 | No meas. 1.5-2.9, 5.3-6.1 |
| 00261 | 60 | FE | Tonata Creek | Kettle River | 39 32 02 NE SE | @ highway | Curlew 15' | 9/6/85 | 0.5200 | No meas. 0.9-24, 5.1-5.7 |
| 00261 | 60 | FE | Tonata Creek | Kettle River | 39 32 02 NE SE | @ highway | Curlew 15' | 6/27/86 | 1.1800 | |
| 00261 | 60 | FE | Tonata Creek | Kettle River | 39 32 02 NE SE | @ highway | Curlew 15' | 7/30/86 | 0.5200 | |
| 00261 | 60 | FE | Tonata Creek | Kettle River | 39 32 02 NE SE | @ highway | Curlew 15' | 7/7/87 | 0.8300 | |
| 00261 | 60 | FE | Tonata Creek | Kettle River | 39 32 02 NE SE | @ highway | Curlew 15' | 8/10/87 | 0.0580 | |
| 00261 | 60 | FE | Tonata Creek | Kettle River | 39 32 02 NE SE | @ highway | Curlew 15' | 6/21/88 | 0.8300 | |
| 00261 | 60 | FE | Tonata Creek | Kettle River | 39 32 02 NE SE | @ highway | Curlew 15' | 7/19/88 | 0.2700 | |
| 00261 | 60 | FE | Tonata Creek | Kettle River | 39 32 02 NE SE | @ highway | Curlew 15' | 8/9/88 | 0.0500 | |
| 00261 | 60 | FE | Tonata Creek | Kettle River | 39 32 02 NE SE | @ highway | Curlew 15' | 6/20/89 | 1.6500 | |
| 00261 | 60 | FE | Tonata Creek | Kettle River | 39 32 02 NE SE | @ highway | Curlew 15' | 7/19/89 | 0.7800 | |
| 00261 | 60 | FE | Tonata Creek | Kettle River | 39 32 02 NE SE | @ highway | Curlew 15' | 8/22/89 | 0.3300 | |
| 00261 | 60 | FE | Tonata Creek | Kettle River | 39 32 02 NE SE | @ highway | Curlew 15' | 6/29/90 | 8.7300 | |
| 00261 | 60 | FE | Tonata Creek | Kettle River | 39 32 02 NE SE | @ highway | Curlew 15' | 7/17/90 | 2.8200 | |
| 00261 | 60 | FE | Tonata Creek | Kettle River | 39 32 02 NE SE | @ highway | Curlew 15' | 8/28/90 | 1.2700 | |
| 00262 | 60 | FE | Emanuel Creek | Kettle River | 39 33 16 W2 NW | @ highway | Curlew 15' | 6/27/86 | 0.8100 | |
| 00262 | 60 | FE | Emanuel Creek | Kettle River | 39 33 16 W2 NW | @ highway | Curlew 15' | 7/30/86 | 0.4200 | |
| 00262 | 60 | FE | Emanuel Creek | Kettle River | 39 33 16 W2 NW | @ highway | Curlew 15' | 7/7/87 | 0.3800 | |
| 00262 | 60 | FE | Emanuel Creek | Kettle River | 39 33 16 W2 NW | @ highway | Curlew 15' | 8/11/87 | 0.3600 | |
| 00262 | 60 | FE | Emanuel Creek | Kettle River | 39 33 16 W2 NW | @ highway | Curlew 15' | 6/21/88 | 0.3900 | |
| 00262 | 60 | FE | Emanuel Creek | Kettle River | 39 33 16 W2 NW | @ highway | Curlew 15' | 7/19/88 | 0.2700 | |
| 00262 | 60 | FE | Emanuel Creek | Kettle River | 39 33 16 W2 NW | @ highway | Curlew 15' | 8/9/88 | 0.2800 | |
| 00262 | 60 | FE | Emanuel Creek | Kettle River | 39 33 16 W2 NW | @ highway | Curlew 15' | 6/20/89 | 0.3200 | |
| 00262 | 60 | FE | Emanuel Creek | Kettle River | 39 33 16 W2 NW | @ highway | Curlew 15' | 7/19/89 | 0.3200 | |
| 00262 | 60 | FE | Emanuel Creek | Kettle River | 39 33 16 W2 NW | @ highway | Curlew 15' | 8/22/89 | 0.2800 | |
| 00262 | 60 | FE | Emanuel Creek | Kettle River | 39 33 16 W2 NW | @ highway | Curlew 15' | 6/29/90 | 1.0800 | |

# Database of Ecology Stream Measurements
# Kettle River Watershed (WRIA 60)

| Point Number | WRIA | County | Source | Tributary | Location TO RA SE Quarters | Point of Measurement | USGS Map | Date | Flow (cfs) | Flow Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 00262 | 60 | FE | Emanuel Creek | Kettle River | 39 33 16 W2 NW | @ highway | Curlew 15' | 7/17/90 | 0.3900 | |
| 00262 | 60 | FE | Emanuel Creek | Kettle River | 39 33 16 W2 NW | @ highway | Curlew 15' | 8/28/90 | 0.4900 | |
| 00263 | 60 | FE | West Deer Creek | Kettle River | 39 34 07 NW NW | @ highway | Curlew 15' | 6/26/85 | 2.0200 | No meas. 0.8-1.8, 7.2-8.0 |
| 00263 | 60 | FE | West Deer Creek | Kettle River | 39 34 07 NW NW | @ highway | Curlew 15' | 8/8/85 | 0.0700 | No meas. 1.9-2.4, 6.6-8.0 |
| 00263 | 60 | FE | West Deer Creek | Kettle River | 39 34 07 NW NW | @ highway | Curlew 15' | 9/6/85 | 1.4000 | No meas. 1.9-3.0, 6.0-6.4 |
| 00263 | 60 | FE | West Deer Creek | Kettle River | 39 34 07 NW NW | @ highway | Curlew 15' | 6/27/86 | 1.1900 | |
| 00263 | 60 | FE | West Deer Creek | Kettle River | 39 34 07 NW NW | @ highway | Curlew 15' | 7/28/86 | 1.1100 | |
| 00263 | 60 | FE | West Deer Creek | Kettle River | 39 34 07 NW NW | @ highway | Curlew 15' | 7//87 | 0.5300 | |
| 00263 | 60 | FE | West Deer Creek | Kettle River | 39 34 07 NW NW | @ highway | Curlew 15' | 8/11/87 | 0.3500 | |
| 00263 | 60 | FE | West Deer Creek | Kettle River | 39 34 07 NW NW | @ highway | Curlew 15' | 6/21/88 | 0.4700 | |
| 00263 | 60 | FE | West Deer Creek | Kettle River | 39 34 07 NW NW | @ highway | Curlew 15' | 7/19/88 | 0.0600 | |
| 00263 | 60 | FE | West Deer Creek | Kettle River | 39 34 07 NW NW | @ highway | Curlew 15' | 8/9/88 | 0.0300 | |
| 00263 | 60 | FE | West Deer Creek | Kettle River | 39 34 07 NW NW | @ highway | Curlew 15' | 6/20/89 | 1.5300 | |
| 00263 | 60 | FE | West Deer Creek | Kettle River | 39 34 07 NW NW | @ highway | Curlew 15' | 7/20/89 | 0.5200 | |
| 00263 | 60 | FE | West Deer Creek | Kettle River | 39 34 07 NW NW | @ highway | Curlew 15' | 8/23/89 | 0.0000 | |
| 00263 | 60 | FE | West Deer Creek | Kettle River | 39 34 07 NW NW | @ highway | Curlew 15' | 6/29/90 | 6.0900 | |
| 00263 | 60 | FE | West Deer Creek | Kettle River | 39 34 07 NW NW | @ highway | Curlew 15' | 7/16/90 | 1.4800 | |
| 00263 | 60 | FE | West Deer Creek | Kettle River | 39 34 07 NW NW | @ highway | Curlew 15' | 8/29190 | 0.6800 | |
| 00264 | 60 | FE | Long Alec Creek | Kettle River | 39 33 14 NE NE | @ road | Curlew 15' | 6/26/85 | 1.3300 | No meas. 6.7-7.5 Backwater |
| 00264 | 60 | FE | Long Alec Creek | Kettle River | 39 33 14 NE NE | @ road | Curlew 15' | 8/8/85 | 0.3600 | Bucket |
| 00264 | 60 | FE | Long Alec Creek | Kettle River | 39 33 14 NE NE | @ road | Curlew 15' | 9/6/85 | 0.8700 | Bucket |
| 00264 | 60 | FE | Long Alec Creek | Kettle River | 39 33 14 NE NE | @ road | Curlew 15' | 6/27/86 | 1.0400 | |
| 00264 | 60 | FE | Long Alec Creek | Kettle River | 39 33 14 NE NE | @ road | Curlew 15' | 7/28/86 | 0.4100 | |
| 00264 | 60 | FE | Long Alec Creek | Kettle River | 39 33 14 NE NE | @ road | Curlew 15' | 7/7/87 | 0.5500 | |
| 00264 | 60 | FE | Long Alec Creek | Kettle River | 39 33 14 NE NE | @ road | Curlew 15' | 6/21/88 | 0.5100 | |
| 05264 | 95 | FE | Long Alec Creek | Kettle River | 39 33 14 NE NE | @ road | Curlew 15' | 7/19/88 | 0.0000 | |
| 00264 | 60 | FE | Long Alec Creek | Kettle River | 39 33 14 NE NE | @ road | Curlew 15' | 8/9/88 | 0.0000 | |

# Database of Ecology Stream Measurements
# Kettle River Watershed (WRIA 60)

| Point Number | WRIA | County | Source | Tributary | Location TO RA SE Quarters | Point of Measurement | USGS Map | Date | Flow (cfs) | Flow Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 00264 | 60 | FE | Long Alec Creek | Kettle River | 39 33 14 NE NE | @ road | Curlew 15' | 6/20/89 | 0.9400 | |
| 00264 | 60 | FE | Long Alec Creek | Kettle River | 39 33 14 NE NE | @ road | Curlew 15' | 7/19/89 | 0.0000 | |
| 00264 | 60 | FE | Long Alec Creek | Kettle River | 39 33 14 NE NE | @ road | Curlew 15' | 8/22/89 | 0.0000 | |
| 00264 | 60 | FE | Long Alec Creek | Kettle River | 39 33 14 NE NE | @ road | Curlew 15' | 6/27/90 | 5.8700 | |
| 00264 | 60 | FE | Long Alec Creek | Kettle River | 39 33 14 NE NE | @ road | Curlew 15' | 7/16/90 | 0.9500 | |
| 00264 | 60 | FE | Long Alec Creek | Kettle River | 39 33 14 NE NE | @ road | Curlew 15' | 8/29/90 | 0.5100 | |
| 00265 | 60 | FE | Tonasket Creek | Curlew Creek | 39 33 26 NW NE | @ highway | Curlew 15' | 7/28/86 | 0.1300 | |
| 00265 | 60 | FE | Tonasket Creek | Curlew Creek | 39 33 26 NW NE | @ highway | Curlew 15' | 8/12/87 | 0.0300 | |
| 00265 | 60 | FE | Tonasket Creek | Curlew Creek | 39 33 26 NW NE | @ highway | Curlew 15' | 6/22/88 | 0.1000 | |
| 00265 | 60 | FE | Tonasket Creek | Curlew Creek | 39 33 26 NW NE | @ highway | Curlew 15' | 7/20/88 | 0.0300 | |
| 00265 | 60 | FE | Tonasket Creek | Curlew Creek | 39 33 26 NW NE | @ highway | Curlew 15' | 8/9/88 | 0.0500 | |
| 00265 | 60 | FE | Tonasket Creek | Curlew Creek | 39 33 26 NW NE | @ highway | Curlew 15' | 6/20/89 | 0.0700 | |
| 00265 | 60 | FE | Tonasket Creek | Curlew Creek | 39 33 26 NW NE | @ highway | Curlew 15' | 7/19/89 | 0.0100 | |
| 00265 | 60 | FE | Tonasket Creek | Curlew Creek | 39 33 26 NW NE | @ highway | Curlew 15' | 8/29/89 | 0.0600 | |
| 00265 | 60 | FE | Tonasket Creek | Curlew Creek | 39 33 26 NW NE | @ highway | Curlew 15' | 6/29/90 | 0.0400 | |
| 00265 | 60 | FE | Tonasket Creek | Curlew Creek | 39 33 26 NW NE | @ highway | Curlew 15' | 7/16/90 | 0.0300 | |
| 00265 | 60 | FE | Tonasket Creek | Curlew Creek | 39 33 26 NW NE | @ highway | Curlew 15' | 8/29/90 | 0.0440 | |
| 00266 | 60 | FE | Aeneas Creek | Curlew Creek | 38 33 01 NW NW | @ highway | Curlew 15' | 6/2/88 | 0.0030 | |
| 00266 | 60 | FE | Aeneas Creek | Curlew Creek | 38 33 01 NW NW | @ highway | Curlew 15' | 7/20/88 | 0.0000 | |
| 00266 | 60 | FE | Aeneas Creek | Curlew Creek | 38 33 01 NW NW | @ highway | Curlew 15' | 8/9/88 | 0.0000 | |
| 00266 | 60 | FE | Aeneas Creek | Curlew Creek | 38 33 01 NW NW | @ highway | Curlew 15' | 6/21/89 | 0.0200 | |
| 00266 | 60 | FE | Aeneas Creek | Curlew Creek | 38 33 01 NW NW | @ highway | Curlew 15' | 7/19/89 | 0.0500 | |
| 00266 | 60 | FE | Aeneas Creek | Curlew Creek | 38 33 01 NW NW | @ highway | Curlew 15' | 8/29/89 | 0.1200 | |
| 00266 | 60 | FE | Aeneas Creek | Curlew Creek | 38 33 01 NW NW | @ highway | Curlew 15' | 6/29/90 | 1.6500 | |
| 00266 | 60 | FE | Aeneas Creek | Curlew Creek | 38 33 01 NW NW | @ highway | Curlew 15' | 7/16/90 | 0.5000 | |
| 00266 | 60 | FE | Aeneas Creek | Curlew Creek | 38 33 01 NW NW | @ highway | Curlew 15' | 8/29/90 | 0.3000 | |
| 00267 | 60 | FE | Art Creek | Curlew Creek | 38 33 02 NE SE | @ highway | Curlew 15' | 7/13/87 | 0.0000 | |
| 00267 | 60 | FE | Art Creek | Curlew Creek | 38 33 02 NE SE | @ highway | Curlew 15' | 8/12/87 | 0.0000 | |
| 00267 | 60 | FE | Art Creek | Curlew Creek | 38 33 02 NE SE | @ highway | Curlew 15' | 6/22/88 | 0.0000 | |
| 00267 | 60 | FE | Art Creek | Curlew Creek | 38 33 02 NE SE | @ highway | Curlew 15' | 7/20/88 | 0.0000 | |

# Database of Ecology Stream Measurements
# Kettle River Watershed (WRIA 60)

| Point Number | WRIA | County | Source | Tributary | Location TO RA SE Quarters | Point of Measurement | USGS Map | Date | Flow (cfs) | Flow Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 00267 | 60 | FE | Art Creek | Curlew Creek | 38 33 02 NE SE | @ highway | Curlew 15' | 8/10/88 | 0.0000 | |
| 00267 | 60 | FE | Art Creek | Curlew Creek | 38 33 02 NE SE | @ highway | Curlew 15' | 6/21/89 | 0.0000 | |
| 00267 | 60 | FE | Art Creek | Curlew Creek | 38 33 02 NE SE | @ highway | Curlew 15' | 7/19/89 | 0.0000 | |
| 00267 | 60 | FE | Art Creek | Curlew Creek | 38 33 02 NE SE | @ highway | Curlew 15' | 8/29/89 | 0.0000 | |
| 00267 | 60 | FE | Art Creek | Curlew Creek | 38 33 02 NE SE | @ highway | Curlew 15' | 6/27/90 | 0.0000 | Dry |
| 00267 | 60 | FE | Art Creek | Curlew Creek | 38 33 02 NE SE | @ highway | Curlew 15' | 7/16/90 | 0.0000 | Dry |
| 00267 | 60 | FE | Art Creek | Curlew Creek | 38 33 02 NE SE | @ highway | Curlew 15' | 8/29/90 | 0.0000 | Dry |
| 00268 | 60 | FE | Art Creek | Curlew Creek | 38 33 01 S2 SE | @ dirt road | Curlew 15' | 7/13/87 | 0.0180 | |
| 00268 | 60 | FE | Art Creek | Curlew Creek | 38 33 01 S2 SE | @ dirt road | Curlew 15' | 8/12/87 | 0.0200 | |
| 00268 | 60 | FE | Art Creek | Curlew Creek | 38 33 01 S2 SE | @ dirt road | Curlew 15' | 6/22/88 | 0.0300 | |
| 00268 | 60 | FE | Art Creek | Curlew Creek | 38 33 01 S2 SE | @ dirt road | Curlew 15' | 7/20/88 | 0.0200 | |
| 00268 | 60 | FE | Art Creek | Curlew Creek | 38 33 01 S2 SE | @ dirt road | Curlew 15' | 8/9/88 | 0.0200 | |
| 00268 | 60 | FE | Art Creek | Curlew Creek | 38 33 01 S2 SE | @ dirt road | Curlew 15' | 6/21/89 | 0.0200 | |
| 00268 | 60 | FE | Art Creek | Curlew Creek | 38 33 01 S2 SE | @ dirt road | Curlew 15' | 7/19/89 | 0.0200 | |
| 00268 | 60 | FE | Art Creek | Curlew Creek | 38 33 01 S2 SE | @ dirt road | Curlew 15' | 8/29/89 | 0.0100 | |
| 00268 | 60 | FE | Art Creek | Curlew Creek | 38 33 01 S2 SE | @ dirt road | Curlew 15' | 6/27/90 | 0.0490 | |
| 00268 | 60 | FE | Art Creek | Curlew Creek | 38 33 01 S2 SE | @ dirt road | Curlew 15' | 7/16/90 | 0.0470 | |
| 00268 | 60 | FE | Art Creek | Curlew Creek | 38 33 01 S2 SE | @ dirt road | Curlew 15' | 8/29/90 | 0.0160 | |
| 00269 | 60 | FE | Empire Creek | Curlew Creek | 38 33 03 NE NW | @ access road | Curlew 15' | 6/25/85 | 0.3300 | Bucket |
| 00269 | 60 | FE | Empire Creek | Curlew Creek | 38 33 03 NE NW | @ access road | Curlew 15' | 8/3/85 | 0.1300 | Bucket |
| 00269 | 60 | FE | Empire Creek | Curlew Creek | 38 33 03 NE NW | @ access road | Curlew 15' | 9/13/85 | 0.1700 | Bucket |
| 00269 | 60 | FE | Empire Creek | Curlew Creek | 38 33 03 NE NW | @ access road | Curlew 15' | 7/28/86 | 0.2000 | |
| 00269 | 60 | FE | Empire Creek | Curlew Creek | 38 33 03 NE NW | @ access road | Curlew 15' | 6/22/88 | 0.3200 | |
| 00269 | 60 | FE | Empire Creek | Curlew Creek | 38 33 03 NE NW | @ access road | Curlew 15' | 7/20/88 | 0.0400 | |
| 00269 | 60 | FE | Empire Creek | Curlew Creek | 38 33 03 NE NW | @ access road | Curlew 15' | 8/9/88 | 0.0200 | |
| 00269 | 60 | FE | Empire Creek | Curlew Creek | 38 33 03 NE NW | @ access road | Curlew 15' | 6/21/89 | 0.4100 | |
| 00269 | 60 | FE | Empire Creek | Curlew Creek | 38 33 03 NE NW | @ access road | Curlew 15' | 7/19/89 | 0.1100 | |
| 00269 | 60 | FE | Empire Creek | Curlew Creek | 38 33 03 NE NW | @ access road | Curlew 15' | 8/29/89 | 0.0600 | |
| 00269 | 60 | FE | Empire Creek | Curlew Creek | 38 33 03 NE NW | @ access road | Curlew 15' | 6/27/90 | 1.2200 | |
| 00269 | 60 | FE | Empire Creek | Curlew Creek | 38 33 03 NE NW | @ access road | Curlew 15' | 7/16/90 | 0.6900 | |

## Database of Ecology Stream Measurements
## Kettle River Watershed (WRIA 60)

| Point Number | WRIA | County | Source | Tributary | Location TO RA SE Quarters | Point of Measurement | USGS Map | Date | Flow (cfs) | Flow Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 00269 | 60 | FE | Empire Creek | Curlew Creek | 38 33 03 NE NW | @ access road | Curlew 15' | 8/29/90 | 0.2800 | |
| 00270 | 60 | FE | St. Peters Creek | Curlew Creek | 38 33 24 NE NW | @ confluence | Curlew 15' | 6/22/88 | 0.8200 | |
| 00270 | 60 | FE | St. Peters Creek | Curlew Creek | 38 33 24 NE NW | @ confluence | Curlew 15' | 7/20/88 | 0.5400 | |
| 00270 | 60 | FE | St. Peters Creek | Curlew Creek | 38 33 24 NE NW | @ confluence | Curlew 15' | 8/9/88 | 0.0580 | |
| 00270 | 60 | FE | St. Peters Creek | Curlew Creek | 38 33 24 NE NW | @ confluence | Curlew 15' | 6/21/89 | 1.2700 | |
| 00270 | 60 | FE | St. Peters Creek | Curlew Creek | 38 33 24 NE NW | @ confluence | Curlew 15' | 7/19/89 | 0.8700 | |
| 00270 | 60 | FE | St. Peters Creek | Curlew Creek | 38 33 24 NE NW | @ confluence | Curlew 15' | 8/29/89 | 1.2600 | |
| 00270 | 60 | FE | St. Peters Creek | Curlew Creek | 38 33 24 NE NW | @ confluence | Curlew 15' | 6/27/90 | 7.4500 | |
| 00270 | 60 | FE | St. Peters Creek | Curlew Creek | 38 33 24 NE NW | @ confluence | Curlew 15' | 7/16/90 | 2.0800 | |
| 00270 | 60 | FE | St. Peters Creek | Curlew Creek | 38 33 24 NE NW | @ confluence | Curlew 15' | 8/29/90 | 1.6600 | |
| 00271 | 60 | FE | Curlew Creek | Kettle River | 38 33 15 NE NE | @ private park | Curlew 15' | 9/4/86 | 2.5700 | |
| 00271 | 60 | FE | Curlew Creek | Kettle River | 38 33 15 NE NE | @ private park | Curlew 15' | 9/10/86 | 1.8900 | |
| 00271 | 60 | FE | Curlew Creek | Kettle River | 38 33 15 NE NE | @ private park | Curlew 15' | 9/11/86 | 1.8700 | |
| 00271 | 60 | FE | Curlew Creek | Kettle River | 38 33 15 NE NE | @ private park | Curlew 15' | 9/16/86 | 2.8300 | |
| 00271 | 60 | FE | Curlew Creek | Kettle River | 38 33 15 NE NE | @ private park | Curlew 15' | 9/17/86 | 3.0000 | |
| 00271 | 60 | FE | Curlew Creek | Kettle River | 38 33 15 NE NE | @ private park | Curlew 15' | 9/29/86 | 5.2000 | |
| 00271 | 60 | FE | Curlew Creek | Kettle River | 38 33 15 NE NE | @ private park | Curlew 15' | 10/22/86 | 4.1600 | |
| 00271 | 60 | FE | Curlew Creek | Kettle River | 38 33 15 NE NE | @ private park | Curlew 15' | 4/27/87 | 19.9000 | |
| 00271 | 60 | FE | Curlew Creek | Kettle River | 38 33 15 NE NE | @ private park | Curlew 15' | 7/6/87 | 2.8300 | |
| 00271 | 60 | FE | Curlew Creek | Kettle River | 38 33 15 NE NE | @ private park | Curlew 15' | 7/21/87 | 1.1700 | |
| 00271 | 60 | FE | Curlew Creek | Kettle River | 38 33 15 NE NE | @ private park | Curlew 15' | 8/13/87 | 1.3300 | |
| 00271 | 60 | FE | Curlew Creek | Kettle River | 38 33 15 NE NE | @ private park | Curlew 15' | 9/9/87 | 0.7600 | |
| 00271 | 60 | FE | Curlew Creek | Kettle River | 38 33 15 NE NE | @ private park | Curlew 15' | 5/15/88 | 8.4800 | |
| 00271 | 60 | FE | Curlew Creek | Kettle River | 38 33 15 NE NE | @ private park | Curlew 15' | 6/22/88 | 6.2600 | |
| 00271 | 60 | FE | Curlew Creek | Kettle River | 38 33 15 NE NE | @ private park | Curlew 15' | 7/20/88 | 1.7800 | |
| 00271 | 60 | FE | Curlew Creek | Kettle River | 38 33 15 NE NE | @ private park | Curlew 15' | 8/9/88 | 1.0000 | |
| 00271 | 60 | FE | Curlew Creek | Kettle River | 38 33 15 NE NE | @ private park | Curlew 15' | 5/14/89 | 3.3700 | |
| 00271 | 60 | FE | Curlew Creek | Kettle River | 38 33 15 NE NE | @ private park | Curlew 15' | 6/22/89 | 2.9400 | |
| 0271 | 60 | FE | Curlew Creek | Kettle River | 38 33 15 NE NE | @ private park | Curlew 15' | 7/20/89 | 2.4700 | |
| 00271 | 60 | FE | Curlew Creek | Kettle River | 38 33 15 NE NE | @ private park | Curlew 15' | 8/23/89 | 1.7600 | |

| Point Number | WRIA | County | Source | Tributary | Location TO RA SE Quarters | Point of Measurement | USGS Map | Date | Flow (cfs) | Flow Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 00271 | 60 | FE | Curlew Creek | Kettle River | 38 33 15 NE NE | @ private park | Curlew 15' | 7/16/90 | 29.0000 | |
| 00271 | 60 | FE | Curlew Creek | Kettle River | 38 33 15 NE NE | @ private park | Curlew 15' | 8/29/90 | 7.3500 | |
| 00272 | 60 | FE | Lone Ranch Creek | Kettle River | 40 34 24 NW | @ dirt road | Togo Mtn. | 7/31/84 | 2.6000 | No meas. 1.2-2.0/ 9.8-10.7 |
| 00272 | 60 | FE | Lone Ranch Creek | Kettle River | 40 34 24 NW | @ dirt road | Togo Mtn. | 9/7/84 | 1.2200 | No meas. 1.3-1.8, 7.8-9.7 |
| 00272 | 60 | FE | Lone Ranch Creek | Kettle River | 40 34 24 NW | @ dirt road | Togo Mtn. | 6/26/85 | 2.9100 | None |
| 00272 | 60 | FE | Lone Ranch Creek | Kettle River | 40 34 24 NW | @ dirt road | Togo Mtn. | 8/8/85 | 0.5900 | No meas. 0.8-1.6, 6.1-7.5 |
| 00272 | 60 | FE | Lone Ranch Creek | Kettle River | 40 34 24 NW | @ dirt road | Togo Mtn. | 9/6/85 | 0.3800 | No meas. 1.0-2.1, 5.1-7.0 |
| 00272 | 60 | FE | Lone Ranch Creek | Kettle River | 40 34 24 NW | @ dirt road | Togo Mtn. | 6/27/86 | 2.9300 | None |
| 00272 | 60 | FE | Lone Ranch Creek | Kettle River | 40 34 24 NW | @ dirt road | Togo Mtn. | 7/30/86 | 1.5800 | |
| 00272 | 60 | FE | Lone Ranch Creek | Kettle River | 40 34 24 NW | @ dirt road | Togo Mtn. | 7/7/87 | 2.4000 | |
| 00272 | 60 | FE | Lone Ranch Creek | Kettle River | 40 34 24 NW | @ dirt road | Togo Mtn. | 8/11/87 | 0.1700 | |
| 00272 | 60 | FE | Lone Ranch Creek | Kettle River | 40 34 24 NW | @ dirt road | Togo Mtn. | 9/9/87 | 0.0900 | Creek dry 3/4 mile below POM. |
| 00272 | 60 | FE | Lone Ranch Creek | Kettle River | 40 34 24 NW | @ dirt road | Togo Mtn. | 6/22/88 | 1.5400 | |
| 00272 | 60 | FE | Lone Ranch Greek | Kettle River | 40 34 24 NW | @ dirt road | Togo Mtn. | 7/20/88 | 0.1800 | |
| 00272 | 60 | FE | Lone Ranch Creek | Kettle River | 40 34 24 NW | @ dirt road | Togo Mtn. | 8/9/88 | 0.1000 | |
| 00272 | 60 | FE | Lone Ranch Creek | Kettle River | 40 34 24 NW | @ dirt road | Togo Mtn. | 6/21/89 | 2.4800 | |
| 00272 | 60 | FE | Lone Ranch Creek | Kettle River | 40 34 24 NW | @ dirt road | Togo Mtn. | 7/19/89 | 1.1400 | |
| 00272 | 60 | FE | Lone Ranch Creek | Kettle River | 40 34 24 NW | @ dirt road | Togo Mtn. | 8/29/89 | 0.6200 | |
| 00272 | 60 | FE | Lone Ranch Creek | Kettle River | 40 34 24 NW | @ dirt road | Togo Mtn. | 6/28/90 | 10.1000 | |
| 00272 | 60 | FE | Lone Ranch Creek | Kettle River | 40 34 24 NW | @ dirt road | Togo Mtn. | 7/17/90 | 3.3900 | |
| 00272 | 60 | FE | Lone Ranch Creek | Kettle River | 40 34 24 NW | @ dirt road | Togo Mtn. | 8/28/90 | 1.6700 | |
| 00273 | 60 | FE | Lone Ranch Creek (N.Fork) | Lone Ranch Creek | 40 34 23 N2 NE | @ dirt road before Y | Togo Mtn. | 7/31/84 | 1.7300 | Bucket |
| 00273 | 60 | FE | Lone Ranch Creek (N.Fork) | Lone Ranch Creek | 40 34 23 N2 NE | @ dirt road before Y | Togo Mtn. | 9/7/84 | 0.4900 | |
| 00273 | 60 | FE | Lone Ranch Creek (N.Fork) | Lone Ranch Creek | 40 34 23 N2 NE | @ dirt road before Y | Togo Mtn. | 6/26/85 | 0.4700 | Bucket |

| Point Number | WRIA | County | Source | Tributary | Location TO | RA | SE | Quarters | Point of Measurement | USGS Map | Date | Flow (cfs) | Flow Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 00273 | 60 | FE | Lone Ranch Creek (N.Fork) | Lone Ranch Creek | 40 | 34 | 23 | N2 NE | @ dirt road before Y | Togo Mtn. | 8/8/85 | 0.2200 | Bucket |
| 00273 | 60 | FE | Lone Ranch Creek (N.Fork) | Lone Ranch Creek | 40 | 34 | 23 | N2 NE | @ dirt road before Y | Togo Mtn. | 9/6/85 | 0.3100 | Bucket |
| 00273 | 60 | FE | Lone Ranch Creek (N.Fork) | Lone Ranch Creek | 40 | 34 | 23 | N2 NE | @ dirt road before Y | Togo Mtn. | 6/27/86 | 0.5400 | |
| 00273 | 60 | FE | Lone Ranch Creek (N.Fork) | Lone Ranch Creek | 40 | 34 | 23 | N2 NE | @ dirt road before Y | Togo Mtn. | 7/30/86 | 0.9100 | |
| 00273 | 60 | FE | Lone Ranch Creek (N.Fork) | Lone Ranch Creek | 40 | 34 | 23 | N2 NE | @ dirt road before Y | Togo Mtn. | 7/7/87 | 0.2600 | |
| 00273 | 60 | FE | Lone Ranch Creek (N.Fork) | Lone Ranch Creek | 40 | 34 | 23 | N2 NE | @ dirt road before Y | Togo Mtn. | 8/11/87 | 0.0800 | |
| 00273 | 60 | FE | Lone Ranch Creek (N.Fork) | Lone Ranch Creek | 40 | 34 | 23 | N2 NE | @ dirt road before Y | Togo Mtn. | 9/9/87 | 0.0800 | |
| 00273 | 60 | FE | Lone Ranch Creek (N.Fork) | Lone Ranch Creek | 40 | 34 | 23 | N2 NE | @ dirt road before Y | Togo Mtn. | 6/22/88 | 0.0130 | |
| 00273 | 60 | FE | Lone Ranch Creek (N.Fork) | Lone Ranch Creek | 40 | 34 | 23 | N2 NE | @ dirt road before Y | Togo Mtn. | 7/20/88 | 0.0000 | |
| 00273 | 60 | FE | Lone Ranch Creek (N.Fork) | Lone Ranch Creek | 40 | 34 | 23 | N2 NE | @ dirt road before Y | Togo Mtn. | 8/9/88 | 0.0000 | |
| 00273 | 60 | FE | Lone Ranch Creek (N.Fork) | Lone Ranch Creek | 40 | 34 | 23 | N2 NE | @ dirt road before Y | Togo Mtn. | 6/21/89 | 0.0800 | |
| 00273 | 60 | FE | Lone Ranch Creek (N.Fork) | Lone Ranch Creek | 40 | 34 | 23 | N2 NE | @ dirt road before Y | Togo Mtn. | 7/19/89 | 0.0300 | |
| 00273 | 60 | FE | Lone Ranch Creek (N.Fork) | Lone Ranch Creek | 40 | 34 | 23 | N2 NE | @ dirt road before Y | Togo Mtn. | 8/29/89 | 0.0400 | |
| 00273 | 60 | FE | Lone Ranch Creek (N.Fork) | Lone Ranch Creek | 40 | 34 | 23 | N2 NE | @ dirt road before Y | Togo Mtn. | 6/28/90 | 1.4600 | |
| 00273 | 60 | FE | Lone Ranch Creek (N.Fork) | Lone Ranch Creek | 40 | 34 | 23 | N2 NE | @ dirt road before Y | Togo Mtn. | 7/17/90 | 1.0000 | |
| 00273 | 60 | FE | Lone Ranch Creek (N.Fork) | Lone Ranch Creek | 40 | 34 | 23 | N2 NE | @ dirt road before Y | Togo Mtn. | 8/28/90 | 0.3900 | |
| 00274 | 60 | FE | July Creek | Kettle River | 40 | 34 | 04 | SE | @ road | Curlew 15' | 6/27/86 | 2.7000 | None |
| 00274 | 60 | FE | July Creek | Kettle River | 40 | 34 | 04 | SE | @ road | Curlew 15' | 7/30/86 | 0.3100 | |

# Database of Ecology Stream Measurements
# Kettle River Watershed (WRIA 60)

| Point Number | WRIA | County | Source | Tributary | Location TO RA SE Quarters | Point of Measurement | USGS Map | Date | Flow (cfs) | Flow Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 00274 | 60 | FE | July Creek | Kettle River | 40 34 04 SE | @ road | Curlew 15' | 7/7/87 | 3.6700 | |
| 00274 | 60 | FE | July Creek | Kettle River | 40 34 04 SE | @ road | Curlew 15' | 8/11/87 | 0.1400 | |
| 00274 | 60 | FE | July Creek | Kettle River | 40 34 04 SE | @ road | Curlew 15' | 6/21/88 | 1.5300 | |
| 00274 | 60 | FE | July Creek | Kettle River | 40 34 04 SE | @ road | Curlew 15' | 7/20/88 | 0.4300 | |
| 00274 | 60 | FE | July Creek | Kettle River | 40 34 04 SE | @ road | Curlew 15' | 8/9/88 | 0.2080 | |
| 00274 | 60 | FE | July Creek | Kettle River. | 40 34 04 SE | @ road | Curlew 15' | 6/21/89 | 3.1000 | |
| 00274 | 60 | FE | July Creek | Kettle River | 40 34 04 SE | @ road | Curlew 15' | 7/19/89 | 1.1300 | |
| 00274 | 60 | FE | July Creek | Kettle River | 40 34 04 SE | @ road | Curlew 15' | 8/29/89 | 0.4200 | |
| 00274 | 60 | FE | July Creek | Kettle River | 40 34 04 SE | @ road | Curlew 15' | 7/17/90 | 7.0100 | |
| 00274 | 60 | FE | July Creek | Kettle River | 40 34 04 SE | @ road | Curlew 15' | 8/28/90 | 2.4400 | |
| 00275 | 60 | FE | Shasket Creek (Upper) | Kettle River | 40 34 18 NE SW | @ dirt road | Curlew 15' | 7/31/84 | 0.0900 | |
| 00275 | 60 | FE | Shasket Creek (Upper) | Kettle River | 40 34 18 NE SW | @ dirt road | Curlew 15' | 6/27/86 | 0.2900 | None |
| 00275 | 60 | FE | Shasket Creek (Upper) | Kettle River | 40 34 18 NE SW | @ dirt road | Curlew 15' | 7/30/86 | 0.0600 | |
| 00275 | 60 | FE | Shasket Creek (Upper) | Kettle River | 40 34 18 NE SW | @ dirt road | Curlew 15' | 7/7/87 | 0.0700 | |
| 00275 | 60 | FE | Shasket Creek (Upper) | Kettle River | 40 34 18 NE SW | @ dirt road | Curlew 15' | 8/11/87 | 0.0100 | |
| 00275 | 60 | FE | Shasket Creek (Upper) | Kettle River | 40 34 18 NE SW | @ dirt road | Curlew 15' | 9/9/87 | 0.0100 | |
| 00275 | 60 | FE | Shasket Creek (Upper) | Kettle River | 40 34 18 NE SW | @ dirt road | Curlew 15' | 6/21/88 | 0.0930 | |
| 00275 | 60 | FE | Shasket Creek (Upper) | Kettle River | 40 34 18 NE SW | @ dirt road | Curlew 15' | 7/19/88 | 0.0100 | |
| 00275 | 60 | FE | Shasket Creek (Upper) | Kettle River | 40 34 18 NE SW | @ dirt road | Curlew 15' | 8/9/88 | 0.0020 | |
| 00275 | 60 | FE | Shasket Creek (Upper) | Kettle River | 40 34 18 NE SW | @ dirt road | Curlew 15' | 7/17/90 | 0.1840 | |
| 00276 | 60 | FE | Shasket Creek (Lower) | Kettle River | 40 34 20 SW NW | @ highway | Curlew 15' | 7/31/84 | 0.0900 | Bucket |
| 00276 | 60 | FE | Shasket Creek (Lower) | Kettle River | 40 34 20 SW NW | @ highway | Curlew 15' | 9/7/84 | 0.0300 | Bucket |
| 00276 | 60 | FE | Shasket Creek (Lower) | Kettle River | 40 34 20 SW NW | @ highway | Curlew 15' | 6/26/85 | 0.1300 | Bucket |
| 00276 | 60 | FE | Shasket Creek (Lower) | Kettle River | 40 34 20 SW NW | @ highway | Curlew 15' | 8/8/85 | 0.0000 | Dry |
| 00276 | 60 | FE | Shasket Creek (Lower) | Kettle River | 40 34 20 SW NW | @ highway | Curlew 15' | 9/6/85 | 0.0000 | Dry |
| 00276 | 60 | FE | Shasket Creek (Lower) | Kettle River | 40 34 20 SW NW | @ highway | Curlew 15' | 6/27/86 | 0.0900 | None |
| 00276 | 60 | FE | Shasket Creek (Lower) | Kettle River | 40 34 20 SW NW | @ highway | Curlew 15' | 7/30/86 | 0.0200 | |
| 00276 | 60 | FE | Shasket Creek (Lower) | Kettle River | 40 34 20 SW NW | @ highway | Curlew 15' | 7/7/87 | 0.0200 | |
| 00276 | 60 | FE | Shasket Creek (Lower) | Kettle River | 40 34 20 SW NW | @ highway | Curlew 15' | 9/9/87 | 0.0000 | |
| 00276 | 60 | FE | Shasket Creek (Lower) | Kettle River | 40 34 20 SW NW | @ highway | Curlew 15' | 6/21/88 | 0.0000 | |

# Database of Ecology Stream Measurements
# Kettle River Watershed (WRIA 60)

| Point Number | WRIA | County | Source | Tributary | Location TO RA SE Quarters | Point of Measurement | USGS Map | Date | Flow (cfs) | Flow Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 00276 | 60 | FE | Shasket Creek (Lower) | Kettle River | 40 34 20 SW NW | @ highway | Curlew 15' | 8/9/88 | 0.0000 | |
| 00276 | 60 | FE | Shasket Creek (Lower) | Kettle River | 40 34 20 SW NW | @ highway | Curlew 15' | 6/20/89 | 0.0000 | |
| 00276 | 60 | FE | Shasket Creek (Lower) | Kettle River | 40 34 20 SW NW | @ highway | Curlew 15' | 7/19/89 | 0.0000 | |
| 00276 | 60 | FE | Shasket Creek (Lower) | Kettle River | 40 34 20 SW NW | @ highway | Curlew 15' | 8/29/89 | 0.0000 | |
| 00276 | 60 | FE | Shasket Creek (Lower) | Kettle River | 40 34 20 SW NW | @ highway | Curlew 15' | 6/28/90 | 0.3900 | |
| 00276 | 60 | FE | Shasket Creek (Lower) | Kettle River | 40 34 20 SW NW | @ highway | Curlew 15' | 7/17/90 | 0.1060 | |
| 00276 | 60 | FE | Shasket Creek (Lower) | Kettle River | 40 34 20 SW NW | @ highway | Curlew 15' | 8/28/90 | 0.0330 | |
| 00277 | 60 | FE | Goosmus Creek | Kettle River | 40 34 30 NE | @ highway | Curlew 15' | 6/26/85 | 2.2400 | No meas. 2.9-3.2, 6.8-8.3 |
| 00277 | 60 | FE | Goosmus Creek | Kettle River | 40 34 30 NE | @ highway | Curlew 15' | 8/8/85 | 1.0400 | No meas. 1.5-27, 5.7-6.7 |
| 00277 | 60 | FE | Goosmus Creek | Kettle River | 40 34 30 NE | @ highway | Curlew 15' | 9/6/85 | 1.3000 | No meas. 1.4-2.0, 5.6-6.5 |
| 00277 | 60 | FE | Goosmus Creek | Kettle River | 40 34 30 NE | @ highway | Curlew 15' | 6/27/86 | 2.5000 | None |
| 00277 | 60 | FE | Goosmus Creek | Kettle River | 40 34 30 NE | @ highway | Curlew 15' | 7/30/86 | 1.4100 | |
| 00277 | 60 | FE | Goosmus Creek | Kettle River | 40 34 30 NE | @ highway | Curlew 15' | 7/7/87 | 1.9400 | |
| 00277 | 60 | FE | Goosmus Creek | Kettle River | 40 34 30 NE | @ highway | Curlew 15' | 8/11/87 | 0.7200 | Veg.@ LEW & REW |
| 00277 | 60 | FE | Goosmus Creek | Kettle River | 40 34 30 NE | @ highway | Curlew 15' | 6/21/88 | 1.4400 | |
| 00277 | 60 | FE | Goosmus Creek | Kettle River | 40 34 30 NE | @ highway | Curlew 15' | 7/19/88 | 0.7800 | |
| 00277 | 60 | FE | Goosmus Creek | Kettle River | 40 34 30 NE | @ highway | Curlew 15' | 8/9/88 | 0.5100 | |
| 00277 | 60 | FE | Goosmus Creek | Kettle River | 40 34 30 NE | @ highway | Curlew 15' | 6/20/89 | 1.9100 | |
| 00277 | 60 | FE | Goosmus Creek | Kettle River | 40 34 30 NE | @ highway | Curlew 15' | 7/19/89 | 1.2900 | |
| 00277 | 60 | FE | Goosmus Creek | Kettle River | 40 34 30 NE | @ highway | Curlew 15' | 8/29/89 | 0.8300 | |
| 00277 | 60 | FE | Goosmus Creek | Kettle River | 40 34 30 NE | @ highway | Curlew 15' | 6/28/90 | 5.2800 | |
| 00277 | 60 | FE | Goosmus Creek | Kettle River | 40 34 30 NE | @ highway | Curlew 15' | 7/17/90 | 2.4300 | |
| 00277 | 60 | FE | Goosmus Creek | Kettle River | 40 34 30 NE | @ highway | Curlew 15' | 8/28/90 | 1.8900 | |
| 00278 | 60 | FE | Little Goosmus Creek | Kettle River | 40 34 30 S2 SW | @ highway | Curlew 15' | 6/27/86 | 0.5000 | |
| 00278 | 60 | FE | Little Goosmus Creek | Kettle River | 40 34 30 S2 SW | @ highway | Curlew 15' | 7/30/86 | 0.2700 | |
| 00278 | 60 | FE | Little Goosmus Creek | Kettle River | 40 34 30 S2 SW | @ highway | Curlew 15' | 7/7/87 | 0.1100 | |
| 00278 | 60 | FE | Little Goosmus Creek | Kettle River | 40 34 30 S2 SW | @ highway | Curlew 15' | 8/11/87 | 0.0500 | |
| 00278 | 60 | FE | Little Goosmus Creek | Kettle River | 40 34 30 S2 SW | @ highway | Curlew 15' | 6/21/88 | 0.2000 | |

| Point Number | WRIA | County | Source | Tributary | Location TO | RA | SE | Quarters | Point of Measurement | USGS Map | Date | Flow (cfs) | Flow Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 00278 | 60 | FE | Little Goosmus Creek | Kettle River | 40 | 34 | 30 | S2 SW | @ highway | Curlew 15' | 7/19/88 | 0.0800 | |
| 00278 | 60 | FE | Little Goosmus Creek | Kettle River | 40 | 34 | 30 | S2 SW | @ highway | Curlew 15' | 8/9/88 | 0.0400 | |
| 00278 | 60 | FE | Little Goosmus Creek | Kettle River | 40 | 34 | 30 | S2 SW | @ highway | Curlew 15' | 6/20/89 | 0.3500 | |
| 00278 | 60 | FE | Little Goosmus Creek | Kettle River | 40 | 34 | 30 | S2 SW | @ highway | Curlew 15' | 7/19/89 | 0.1300 | |
| 00278 | 60 | FE | Little Goosmus Creek | Kettle River | 40 | 34 | 30 | S2 SW | @ highway | Curlew 15' | 8/22/89 | 0.0500 | |
| 00278 | 60 | FE | Little Goosmus Creek | Kettle River | 40 | 34 | 30 | S2 SW | @ highway | Curlew 15' | 6/28/90 | 2.0200 | |
| 00278 | 60 | FE | Little Goosmus Creek | Kettle River | 40 | 34 | 30 | S2 SW | @ highway | Curlew 15' | 7/17/90 | 0.6900 | |
| 00278 | 60 | FE | Little Goosmus Creek | Kettle River | 40 | 34 | 30 | S2 SW | @ highway | Curlew 15' | 8/28/90 | 0.4200 | |
| 00279 | 60 | FE | Alkali Creek | Kettle River | 39 | 33 | 12 | W2 NW | @ highway | Curlew 15' | 7/7/87 | 0.0010 | |
| 00279 | 60 | FE | Alkali Creek | Kettle River | 39 | 33 | 12 | W2 NW | @ highway | Curlew 15' | 8/11/87 | 0.0000 | Flow <0.002 |
| 00279 | 60 | FE | Alkali Creek | Kettle River | 39 | 33 | 12 | W2 NW | @ highway | Curlew 15' | 9/9/87 | 0.0300 | Diversion 10' below P.O.M. |
| 00279 | 60 | FE | Alkali Creek | Kettle River | 39 | 33 | 12 | W2 NW | @ highway | Curlew 15' | 6/21/88 | 0.0260 | |
| 00279 | 60 | FE | Alkali Creek | Kettle River | 39 | 33 | 12 | W2 NW | @ highway | Curlew 15' | 7/18/88 | 0.0280 | |
| 00279 | 60 | FE | Alkali Creek | Kettle River | 39 | 33 | 12 | W2 NW | @ highway | Curlew 15' | 8/9/88 | 0.0970 | |
| 00279 | 60 | FE | Alkali Creek | Kettle River | 39 | 33 | 12 | W2 NW | @ highway | Curlew 15' | 6/20/89 | 0.0000 | |
| 00279 | 60 | FE | Alkali Creek | Kettle River | 39 | 33 | 12 | W2 NW | @ highway | Curlew 15' | 7/19/89 | 0.0000 | |
| 00279 | 60 | FE | Alkali Creek | Kettle River | 39 | 33 | 12 | W2 NW | @ highway | Curlew 15' | 8/22/89 | 0.0000 | |
| 00279 | 60 | FE | Alkali Creek | Kettle River | 39 | 33 | 12 | W2 NW | @ highway | Curlew 15' | 6/28/90 | 0.0260 | |
| 00279 | 60 | FE | Alkali Creek | Kettle River | 39 | 33 | 12 | W2 NW | @ highway | Curlew 15' | 7/16/90 | 0.0000 | Dry |
| 00279 | 60 | FE | Alkali Creek | Kettle River | 39 | 33 | 12 | W2 NW | @ highway | Curlew 15' | 8/28/90 | 0.0230 | |
| 00280 | 60 | FE | LaFleur Creek | Kettle River | 39 | 33 | 11 | NE SE | @ highway | Curlew 15' | 8/8/85 | 0.0000 | Dry |
| 00280 | 60 | FE | LaFleur Creek | Kettle River | 39 | 33 | 11 | NE SE | @ highway | Curlew 15' | 6/27/86 | 0.0000 | Dry |
| 00280 | 60 | FE | LaFleur Creek | Kettle River | 39 | 33 | 11 | NE SE | @ highway | Curlew 15' | 7/30/86 | 0.0000 | |
| 00280 | 60 | FE | LaFleur Creek | Kettle River | 39 | 33 | 11 | NE SE | @ highway | Curlew 15' | 7/7/87 | 0.0000 | |
| 00280 | 60 | FE | LaFleur Creek | Kettle River | 39 | 33 | 11 | NE SE | @ highway | Curlew 15' | 8/11/87 | 0.0000 | |
| 00280 | 60 | FE | LaFleur Creek | Kettle River | 39 | 33 | 11 | NE SE | @ highway | Curlew 15' | 9/9/87 | 0.0000 | |
| 00280 | 60 | FE | LaFleur Creek | Kettle River | 39 | 33 | 11 | NE SE | @ highway | Curlew 15' | 6/21/88 | 0.0000 | |
| 00280 | 60 | FE | LaFleur Creek | Kettle River | 39 | 33 | 11 | NE SE | @ highway | Curlew 15' | 7/19/88 | 0.0000 | |

## Database of Ecology Stream Measurements
## Kettle River Watershed (WRIA 60)

| Point Number | WRIA | County | Source | Tributary | Location TO | Location RA | Location SE | Location Quarters | Point of Measurement | USGS Map | Date | Flow (cfs) | Flow Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 00280 | 60 | FE | LaFleur Creek | Kettle River | 39 | 33 | 11 | NE SE | @ highway | Curlew 15' | 8/9/88 | 0.0000 | |
| 00280 | 60 | FE | LaFleur Creek | Kettle River | 39 | 33 | 11 | NE SE | @ highway | Curlew 15' | 6/20/89 | 0.0000 | |
| 00280 | 60 | FE | LaFleur Creek | Kettle River | 39 | 33 | 11 | NE SE | @ highway | Curlew 15' | 7/19/89 | 0.3300 | |
| 00280 | 60 | FE | LaFleur Creek | Kettle River | 39 | 33 | 11 | NE SE | @ highway | Curlew 15' | 8/22/89 | 0.0000 | |
| 00280 | 60 | FE | LaFleur Creek | Kettle River | 39 | 33 | 11 | NE SE | @ highway | Curlew 15' | 6/28/90 | 1.7100 | |
| 00280 | 60 | FE | LaFleur Greek | Kettle River | 39 | 33 | 11 | NE SE | @ highway | Curlew 15' | 7/16/90 | 0.1280 | |
| 00280 | 60 | FE | LaFleur Creek | Kettle River | 39 | 33 | 11 | NE SE | @ highway | Curlew 15' | 7/25/90 | 70.0000 | |
| 00280 | 60 | FE | LaFleur Creek | Kettle River | 39 | 33 | 11 | NE SE | @ highway | Curlew 15' | 8/28/90 | 0.1200 | |
| 00281 | 60 | FE | Cottonwood Creek | Kettle River | 39 | 33 | 10 | S2 S2 | @ highway | Curlew 15' | 7/7/87 | 0.0000 | |
| 00281 | 60 | FE | Cottonwood Creek | Kettle River | 39 | 33 | 10 | S2 S2 | @ highway | Curlew 15' | 8/11/87 | 0.0000 | |
| 00281 | 60 | FE | Cottonwood Creek | Kettle River | 39 | 33 | 10 | S2 S2 | @ highway | Curlew 15' | 6/4/88 | 0.0000 | |
| 00281 | 60 | FE | Cottonwood Creek | Kettle River | 39 | 33 | 10 | S2 S2 | @ highway | Curlew 15' | 6/21/88 | 0.0000 | |
| 00281 | 60 | FE | Cottonwood Creek | Kettle River | 39 | 33 | 10 | S2 S2 | @ highway | Curlew 15' | 7/19/88 | 0.0000 | |
| 00281 | 60 | FE | Cottonwood Creek | Kettle River | 39 | 33 | 10 | S2 S2 | @ highway | Curlew 15' | 8/9/88 | 0.0000 | |
| 00281 | 60 | FE | Cottonwood Creek | Kettle River | 39 | 33 | 10 | S2 S2 | @ highway | Curlew 15' | 6/20/89 | 0.0900 | |
| 00281 | 60 | FE | Cottonwood Creek | Kettle River | 39 | 33 | 10 | S2 S2 | @ highway | Curlew 15' | 7/19/89 | 0.0000 | |
| 00281 | 60 | FE | Cottonwood Creek | Kettle River | 39 | 33 | 10 | S2 S2 | @ highway | Curlew 15' | 8/22/89 | 0.0000 | |
| 00281 | 60 | FE | Cottonwood Creek | Kettle River | 39 | 33 | 10 | S2 S2 | @ highway | Curlew 15' | 6/28/90 | 0.9200 | |
| 00281 | 60 | FE | Cottonwood Creek | Kettle River | 39 | 33 | 10 | S2 S2 | @ highway | Curlew 15' | 7/17/90 | 0.0700 | |
| 00281 | 60 | FE | Cottonwood Creek | Kettle River | 39 | 33 | 10 | S2 S2 | @ highway | Curlew 15' | 8/28/90 | 0.0000 | Dry |
| 00282 | 60 | FE | Tenas Mary Creek | Kettle River | 40 | 32 | 22 | S2 NW | @ highway | Bodie Mtn. | 6/26/85 | 0.1500 | No meas. 2.5-3.4 |
| 00282 | 60 | FE | Tenas Mary Creek | Kettle River | 40 | 32 | 22 | S2 NW | @ highway | Bodie Mtn. | 8/8/85 | 0.0000 | Dry |
| 00282 | 60 | FE | Tenas Mary Creek | Kettle River | 40 | 32 | 22 | S2 NW | @ highway | Bodie Mtn. | 9/6/85 | 0.0000 | Dry |
| 00282 | 60 | FE | Tenas Mary Creek | Kettle River | 40 | 32 | 22 | S2 NW | @ highway | Bodie Mtn. | 6/27/86 | 0.0000 | Dry |
| 00282 | 60 | FE | Tenas Mary Creek | Kettle River | 40 | 32 | 22 | S2 NW | @ highway | Bodie Mtn. | 7/30/86 | 0.0000 | |
| 00282 | 60 | FE | Tenas Mary Creek | Kettle River | 40 | 32 | 22 | S2 NW | @ highway | Bodie Mtn. | 7/7/87 | 0.0000 | No meas. due to low flow |
| 00282 | 60 | FE | Tenas Mary Creek | Kettle River | 40 | 32 | 22 | S2 NW | @ highway | Bodie Mtn. | 8/11/87 | 0.0000 | |
| 00282 | 60 | FE | Tenas Mary Creek | Kettle River | 40 | 32 | 22 | S2 NW | @ highway | Bodie Mtn. | 6/21/88 | 0.0000 | |
| 00282 | 60 | FE | Tenas Mary Creek | Kettle River | 40 | 32 | 22 | S2 NW | @ highway | Bodie Mtn. | 7/19/88 | 0.0000 | |

# Database of Ecology Stream Measurements
# Kettle River Watershed (WRIA 60)

| Point Number | WRIA | County | Source | Tributary | Location TO RA SE Quarters | Point of Measurement | USGS Map | Date | Flow (cfs) | Flow Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 00282 | 60 | FE | Tenas Mary Creek | Kettle River | 40 32 22 S2 NW | @ highway | Bodie Mtn. | 8/9/88 | 0.0000 | |
| 00282 | 60 | FE | Tenas Mary Creek | Kettle River | 40 32 22 S2 NW | @ highway | Bodie Mtn. | 6/20/89 | 0.0000 | |
| 00282 | 60 | FE | Tenas Mary Creek | Kettle River | 40 32 22 S2 NW | @ highway | Bodie Mtn. | 7/16/89 | 0.0000 | |
| 00282 | 60 | FE | Tenas Mary Creek | Kettle River | 40 32 22 S2 NW | @ highway | Bodie Mtn. | 8/22/89 | 0.0000 | |
| 00282 | 60 | FE | Tenas Mary Creek | Kettle River | 40 32 22 S2 NW | @ highway | Bodie Mtn. | 6/29/90 | 1.5100 | |
| 00282 | 60 | FE | Tenas Mary Creek | Kettle River | 40 32 22 S2 NW | @ highway | Bodie Mtn. | 7/17/90 | 0.6400 | |
| 00282 | 60 | FE | Tenas Mary Creek | Kettle River | 40 32 22 S2 NW | @ highway | Bodie Mtn. | 8/28/90 | 0.0810 | |
| 00283 | 60 | FE | Catherine Creek | Kettle River | 40 32 15 NE NW | @ highway | Bodie Mtn. | 6/26/85 | 0.0900 | None |
| 00283 | 60 | FE | Catherine Creek | Kettle River | 40 32 15 NE NW | @ highway | Bodie Mtn. | 8/8/85 | 0.0700 | Bucket |
| 00283 | 60 | FE | Catherine Creek | Kettle River | 40 32 15 NE NW | @ highway | Bodie Mtn. | 9/6/85 | 0.1300 | |
| 00283 | 60 | FE | Catherine Creek | Kettle River | 40 32 15 NE NW | @ highway | Bodie Mtn. | 6/27/86 | 0.1500 | None |
| 00283 | 60 | FE | Catherine Creek | Kettle River | 40 32 15 NE NW | @ highway | Bodie Mtn. | 7/30/86 | 0.0300 | |
| 00283 | 60 | FE | Catherine Creek | Kettle River | 40 32 15 NE NW | @ highway | Bodie Mtn. | 7/7/87 | 0.1500 | |
| 00283 | 60 | FE | Catherine Creek | Kettle River | 40 32 15 NE NW | @ highway | Bodie Mtn. | 8/11/87 | 0.0000 | |
| 00283 | 60 | FE | Catherine Creek | Kettle River | 40 32 15 NE NW | @ highway | Bodie Mtn. | 6/21/88 | 0.0000 | |
| 00283 | 60 | FE | Catherine Creek | Kettle River | 40 32 15 NE NW | @ highway | Bodie Mtn. | 7/19/88 | 0.0000 | |
| 00283 | 60 | FE | Catherine Creek | Kettle River | 40 32 15 NE NW | @ highway | Bodie Mtn. | 8/9/88 | 0.0000 | |
| 00283 | 60 | FE | Catherine Creek | Kettle River | 40 32 15 NE NW | @ highway | Bodie Mtn. | 6/20/89 | 0.1900 | |
| 00283 | 60 | FE | Catherine Creek | Kettle River | 40 32 15 NE NW | @ highway | Bodie Mtn. | 7/19/89 | 0.0000 | |
| 00283 | 60 | FE | Catherine Creek | Kettle River | 40 32 15 NE NW | @ highway | Bodie Mtn. | 8/22/89 | 0.0000 | |
| 00283 | 60 | FE | Catherine Creek | Kettle River | 40 32 15 NE NW | @ highway | Bodie Mtn. | 6/29/90 | 1.9500 | |
| 00283 | 60 | FE | Catherine Creek | Kettle River | 40 32 15 NE NW | @ highway | Bodie Mtn. | 7/17/90 | 1.0800 | |
| 00283 | 60 | FE | Catherine Creek | Kettle River | 40 32 15 NE NW | @ highway | Bodie Mtn. | 8/28/90 | 0.2260 | |
| 00300 | 60 | FE | Trout Creek | Curlew Lake | 37 33 05 SW SE | @ Black's Beach | Republic 15' | 6/22/89 | 2.6700 | |
| 00300 | 60 | FE | Trout Creek | Curlew Lake | 37 33 05 SW SE | @ Black's Beach | Republic 15' | 7/19/89 | 1.3300 | |
| 00300 | 60 | FE | Trout Creek | Curlew Lake | 37 33 05 SW SE | @ Black's Beach | Republic 15' | 8/23/89 | 0.0650 | |
| 00300 | 60 | FE | Trout Creek | Curlew Lake | 37 33 05 SW SE | @ Black's Beach | Republic 15' | 6/29/90 | 16.9000 | |
| 00300 | 60 | FE | Trout Creek | Curlew Lake | 37 33 05 SW SE | @ Black's Beach | Republic 15' | 7/18/90 | 6.4200 | |
| 00300 | 60 | FE | Trout Creek | Curlew Lake | 37 33 05 SW SE | @ Black's Beach | Republic 15' | 8/29/90 | 1.8300 | |
| 00305 | 60 | FE | Curlew Creek | Kettle River | 38 33 21 SW NE | @ intersection | Curlew 15' | 5/14/89 | 14.2800 | |

## Database of Ecology Stream Measurements
## Kettle River Watershed (WRIA 60)

| Point Number | WRIA | County | Source | Tributary | Location TO RA SE Quarters | Point of Measurement | USGS Map | Date | Flow (cfs) | Flow Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| 00305 | 60 | FE | Curlew Creek | Kettle River | 38 33 21 SW NE | @ intersection | Curlew 15' | 6/22/89 | 10.6000 | |
| 00305 | 60 | FE | Curlew Creek | Kettle River | 38 33 21 SW NE | @ intersection | Curlew 15' | 7/20/89 | 4.1400 | |
| 00305 | 60 | FE | Curlew Creek | Kettle River | 38 33 21 SW NE | @ intersection | Curlew 15' | 8/23/89 | 1.7200 | |
| 00305 | 60 | FE | Curlew Creek | Kettle River | 38 33 21 SW NE | @ intersection | Curlew 15' | 7/16/90 | 35.8000 | |
| 00305 | 60 | FE | Curlew Creek | Kettle River | 38 33 21 SW NE | @ intersection | Curlew 15' | 8/29/90 | 5.4300 | |
| 00306 | 60 | FE | Curlew Creek | Kettle River | 39 33 14 NE SW | @ road | Curlew 15' | 6/22/89 | 4.7600 | |
| 00306 | 60 | FE | Curlew Creek | Kettle River | 39 33 14 NE SW | @ road | Curlew 15' | 7/20/89 | 2.7100 | |
| 00306 | 60 | FE | Curlew Creek | Kettle River | 39 33 14 NE SW | @ road | Curlew 15' | 8/23/89 | 2.7700 | |
| 00306 | 60 | FE | Curlew Creek | Kettle River | 39 33 14 NE SW | @ road | Curlew 15' | 7/16/90 | 42.8000 | |
| 00306 | 60 | FE | Curlew Creek | Kettle River | 39 33 14 NE SW | @ road | Curlew 15' | 8/29/90 | 14.9000 | |
| 00353 | 60 | FE | Curlew Creek at CR 570 | Kettle River | 39 33 14 SE SW | @ CR 570 Bridge | Curlew 15' | 8/23/94 | 6.1800 | PM measurement |
| 00353 | 60 | FE | Curlew Creek at CR 570 | Kettle River | 39 33 14 SE SW | @ CR 570 Bridge | Curlew 15' | 9/23/94 | 7.3900 | |