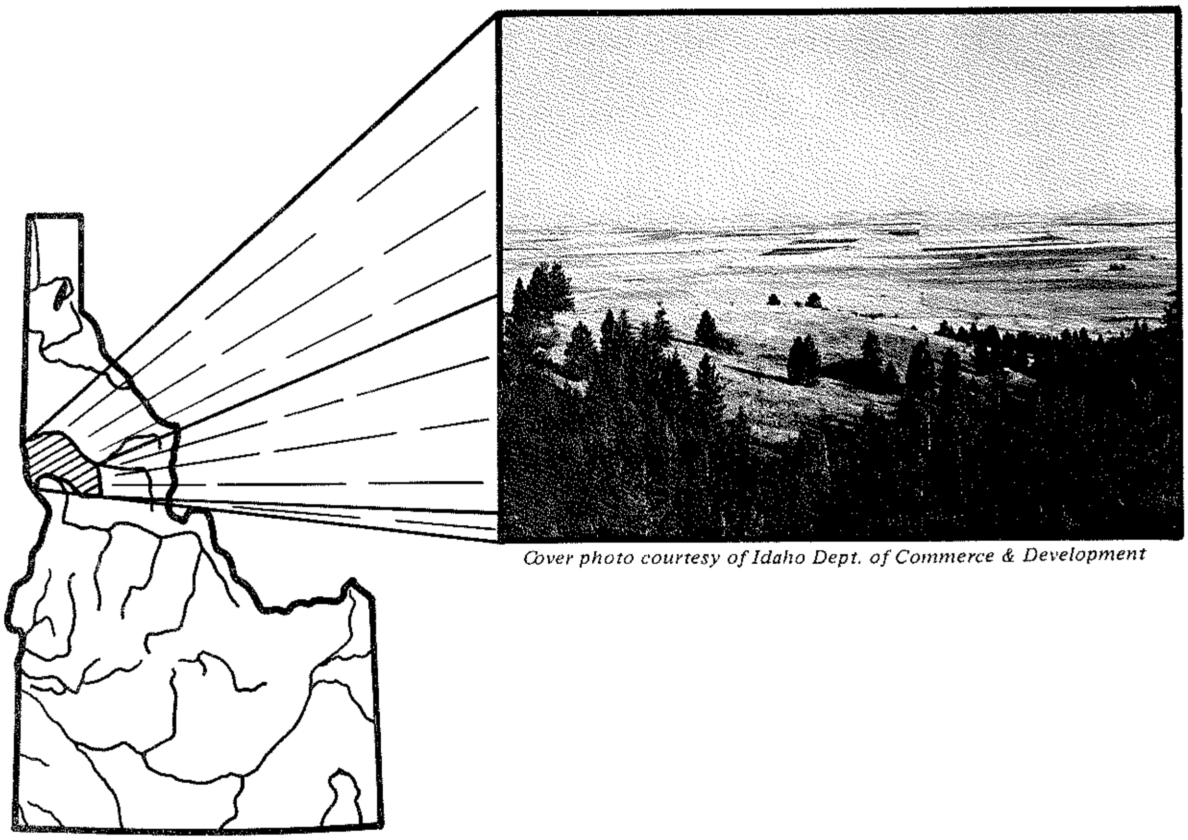
A RECONNAISSANCE OF THE WATER RESOURCES OF THE CLEARWATER PLATEAU, NEZ PERCE, LEWIS AND NORTHERN IDAHO COUNTIES, IDAHO



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IDAHO DEPARTMENT OF WATER RESOURCES
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by

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TABLE OF CONTENTS

TABLES

ILLUSTRATIONS

APPENDICES

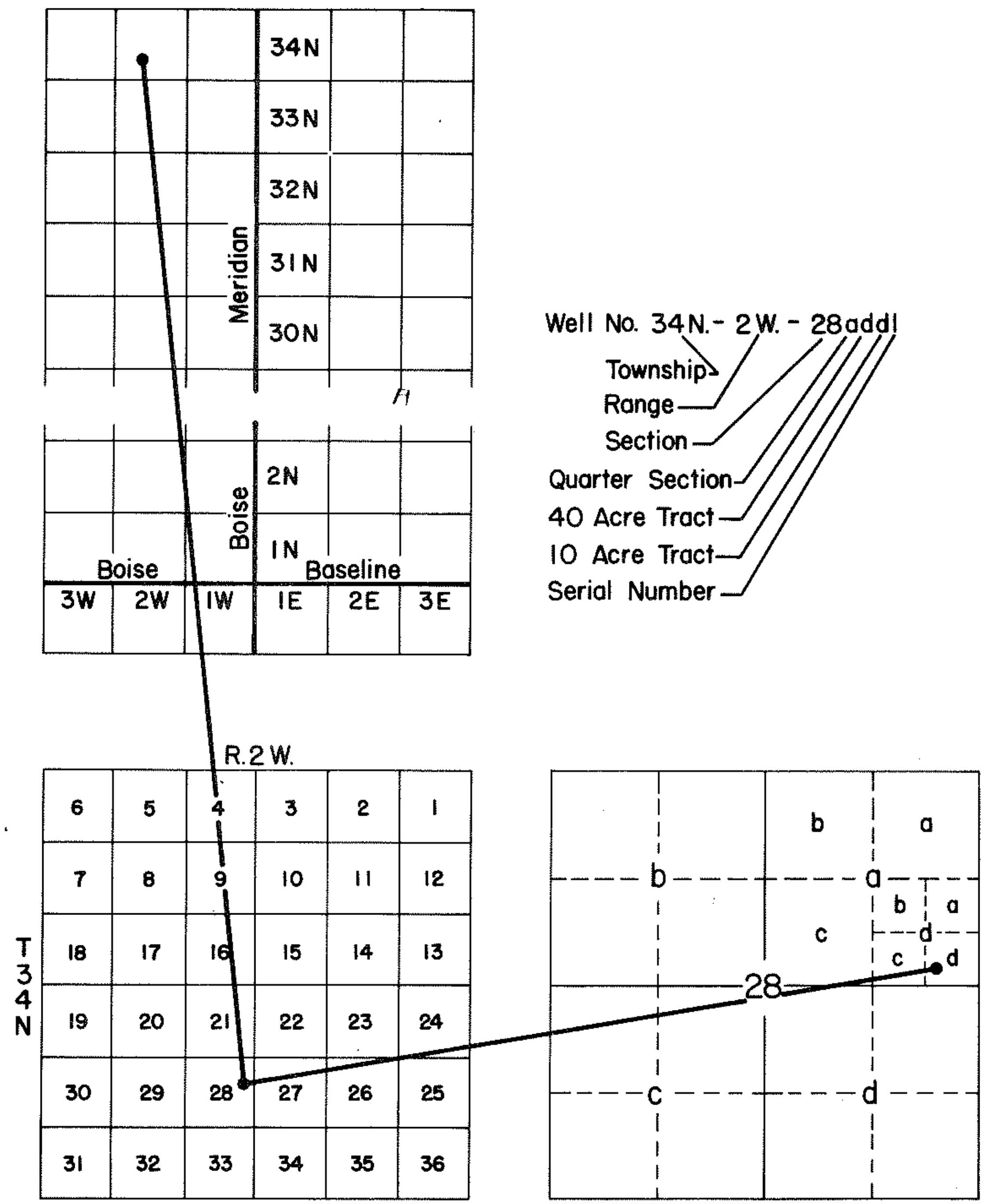


FIGURE 2. Well numbering system.

INTRODUCTION

Purpose and Objectives

An area of the state which has received little attention to date with regard to its water resources is the Clearwater Plateau area between Lewiston and Grangeville, Idaho. Since so little was known of the water resources of this important agricultural area, a reconnaissance-level investigation was proposed with the following objectives:

1) Determine the geologic control and occurrence of the groundwater resource in the area of investigation;

2) Determine the relationship of the groundwater system to the principal streams in the area;

3) Determine the quality of the ground and surface water and its suitability for irrigation and other uses for which it may be obtained;

4) Determine the present level of ground and surface water development and the potential for future development;

5) Establish a base of hydrologic information to which future data may be compared;

6) Identify representative wells for addition to the cooperative groundwater observation well network.

Location and Extent of Area

The Clearwater Plateau area is in the northwest central portion of Idaho, bounded on the north by the Clearwater River, on the east by the South Fork of the Clearwater River, on the south by Mt. Idaho and the Salmon River, and on the west by the Snake River. The area includes all or portions of Nez Perce, Lewis, Idaho and Clearwater counties. Figure 1 indicates the location and approximate extent of the study area within the state. For some aspects of the study, including discussion of surface water flows and quality, the bounds of the study area have been expanded to include the Snake, Salmon and Clearwater rivers.

Previous Investigations

One of the earliest investigations in the area was done by Israel C. Russell in 1901. Russell's primary emphasis was on locating an artesian groundwater supply for the Lewiston area. Virgil Kirkham in 1927 studied the water resource possibilities in the Lapwai and Orofino areas. Jesse Strand in 1949 described various geologic forces as those acting upon the Lewiston Plateau. As part of a statewide survey, Philip T. Kinnison in 1955 described the geologic features of the area with respect to groundwater. Charles R. Hubbard in 1956 completed a study of the geology and mineral resources of Nez Perce County. Kenneth M. Hollenbaugh in 1959 completed a geologic report on the geology of Lewiston and vicinity. John G. Bond in 1963 completed a comprehensive study of the geology of the entire area. Other investigators have done specialized work in limited areas of the region.

Acknowledgments

The Department of Water Resources and the author wish to acknowledge the assistance of the many agencies and individuals who willingly shared their knowledge and expertise.

Of particular value was the assistance of D. Thurston Coons, Lewiston Water Superintendent, and his staff; Arthur Van't Hul, at that time Public Health Engineer, Idaho Department of Health and Welfare; Roy Bean, U. S. Soil Conservation Service; Donald Reeder, Lewiston Orchards Irrigation District; and Tom Hardtrich, U. S. Public Health Service, Lapwai.

The friendly cooperation extended by the residents of the area who allowed free access to their land and wells, and assisted in many other ways, is also greatly appreciated.

The Nez Perce Tribal Executive Council graciously allowed free access to all tribal lands for the purposes of this study and otherwise gave much support for its completion. In addition, the work performed by IDWR staff personnel William Ondrechen and James Winner on streamflow forecasting and water quality, respectively, is gratefully acknowledged. The assistance of Lee Sisco, IDWR staff member, in many phases of the field work associated with the study is also very much appreciated.

Well Numbering System

The well numbering system used in this report indicates the location of wells within the official rectangular subdivision of the public lands, with reference to the Boise Baseline and Meridian. The first two segments of the number designate the township and range. The third segment includes the section number, and three letters and a numeral, which indicate the quarter section, the 40-acre tract, the 10-acre tract, and the serial number of the well within the tract, respectively. Quarter sections are lettered a, b, c and d in counterclockwise order from the northeast quarter of each section. Within the quarter sections, 40-acre and 10-acre tracts are lettered in the same manner. Well 35N-3W-21cac1 is in the SW¼NE¼SW¼ of Section 21, Township 35 North, Range 3 West, and was the first well inventoried in that tract.

Springs located by this method will have a capital "S" following the serial number, for example: 36N-1W-3cba-1S. Figure 2 illustrates how this system is used.

GEOGRAPHY AND ECONOMY

Physical Features

Included within the 1,700 square-mile area of the region is a variety of landforms. The Clearwater Mountains are a prominent feature to the south of Grangeville in the extreme southeast portion of the region, Cottonwood and Mason buttes are isolated mountain peaks in the south-central part of the region, and Craig Mountain occupies a significant area southeast of Lewiston. The mountainous portion covers approximately one-third of the total area; the remaining two-thirds is predominantly basalt plateau dissected by streams.

The northwest-sloping land surface southeast of Lewiston is commonly called the Lewiston Plateau. The extensive, gently-sloping plateau forming the eastern two-thirds of the area is known as the Camas Prairie, and is characterized by moderately undulating topography. For this report, and to avoid confusion with the Camas Prairie area in southern Idaho, the entire study area is referred to as the Clearwater Plateau.

Besides the major streams, the Snake, Salmon, and Clearwater rivers, numerous other smaller streams drain the area, among them Lawyers, Big Canyon, Little Canyon, Cottonwood, Lapwai, and Rock creeks. The streams are usually deeply entrenched in basalt and their canyons are characterized by steeply sloping to vertical walls and relatively flat floors.

Natural Resources

The natural resources of the area are abundant and include timber, soils, water, minerals, and recreation potential.

Timber is the basis for a thriving lumbering industry. Potlatch Forests, Inc., a large wood products operation at Lewiston, uses a significant amount of water in its manufacturing processes. Sawmills are a feature of virtually every small town in the region.

The rich soils of the region are either derived directly from the underlying bedrock, or are transported by wind from areas to the west or northwest. They are generally fine-grained and have good moisture-retention characteristics. They are the basis of a profitable agricultural industry.

Minerals, generally described as being either metallic or non-metallic, do not comprise a large natural resource, but deposits of clay and limestone contribute somewhat to the economy. Metallic minerals, such as gold, silver, and copper have been found, but not in concentrations economical to mine. Crushed rock and gravel, while technically not classified as minerals, do constitute a valuable resource, especially for road construction material.

Water, as a natural resource, is abundant and invaluable to the economy of the area. Precipitation alone usually supplies enough moisture for most crops, with supplemental irrigation desirable during the driest months of dry years. Numerous small lakes and reservoirs are present in the study area, among them Mann Lake, Soldiers Meadow Reservoir, Winchester Lake, and Waha Lake. Mann Lake, Waha Lake and Soldiers Meadow Reservoir are all managed by the Lewiston Orchards Irrigation District as a community water supply. A filtration and chemical treatment plant for the system is located between Mann Lake and Lewiston Orchards. As of April 1972, the Lewiston Orchards Irrigation District supplied water for about 3,740 irrigated acres and 4,090 domestic users.

Rivers bounding the study area discharge a tremendous quantity of water annually, (see Table 7) much of which is available for development. Streams draining the plateau itself discharge much less water, and seasonal flows vary widely. Groundwater sources in some parts of the area supply adequate water for various uses; in others the supply is virtually unknown. The ground and surface water resources of the area will be discussed in more detail in later sections of the report.

The recreation potential of an area has to be considered a natural resource in that it has a direct bearing on the rate, degree, and type of development, much as a mineral deposit or source of water. Outdoor sports are emphasized, with water-based activities such as boating, water skiing and fishing predominant. Hunting in the fall for upland game birds and big game is another popular mode of recreation. The development of summer home areas, especially along the Clearwater River and Craig Mountain areas, will bring increased development of available ground and surface water resources of water.

Culture

Most cities and towns in the study area are quite small, as shown by the accompanying table. Population figures shown in Table 1 are for 1970, with the percentage change since 1960 indicated.

TABLE 1

POPULATIONS OF CLEARWATER PLATEAU CITIES AND TOWNS

Area	1970 Population	Percent Change	Area	1970 Population	Percent Change
Lewiston	26,068	+105.4	Lapwai	400	-20.0
Grangeville	3,636	-0.2	Winchester	274	-35.8
Kamiah	1,307	+5.0	Peck	238	+28.0
Cottonwood	867	-19.8	Culdesac	211	+1.0
Kooskia	809	+1.0	Ferdinand	157	-10.8
Nezperce	555	-16.8	Reubens	81	-28.3
Craigmont	554	-21.2			

The annexation of Lewiston Orchards by Lewiston City in December 1969, is the reason in part for the apparent large increase in Lewiston's population. Overall, the area shows a net population loss. Other small towns and hamlets, such as Keuterville, Waha, Sweetwater, Jacques Spur, Spalding, Gifford, Green Creek, Mount Idaho, Myrtle, and Webb contain only a few tens of people each. Many people live outside the urban or townsite areas, usually on moderate-sized farms averaging between 600-1,000 acres.

Economy

The economy of the area is highly dependent upon agriculture-related industry. Crops such as wheat, Austrian winter peas, barley, oats,and alfalfa are of major importance to the region and to the state. Table 2 lists production of wheat in the area in a representative year.

TABLE 2

ACREAGE AND PRODUCTION OF NON-IRRIGATED WHEAT, 1970

	Acres Planted	Total Wheat Production
Nez Perce County	58,100	3,291,000 bu.
Lewis County	42,100	2,442,000 bu.
Idaho County	45,400	2,526,000 bu.
State	701,000	25,792,000 bu.

The total production of non-irrigated wheat from Nez Perce, Lewis and Idaho counties constitutes about 31 percent of the entire state total and is the primary cash crop in the study area.

While most of the area is dry-farmed, many farmers indicated that if an economical source of water was made available, they would be interested in supplemental irrigation of their crops during the often dry summer months.

About 339,000 acres have been identified as having potential for irrigation within Nez Perce and Lewis counties, (Idaho Water Resource Board, 1970), with an additional 224,000 acres in Idaho County, only a portion of which would lie within the study area.

The lumbering industry has a significant effect upon the economy of the area, not so much from the standpoint of timber cutting, but because of Potlatch Forests, Inc., and smaller lumber mills employ a large number of people from the region. The Craig Mountain area is a primary source of timber within the area.

Small manufacturing firms, primarily in the Lewiston area, contribute to the health of the economy, as do numerous cattle feed lots. Large areas of good pasture land for livestock exist along the drainages of the Snake, Clearwater, and Salmon rivers where the steep, rugged terrain is impossible to cultivate.

Perhaps one of the most significant economic factors in the area is the growth of a vigorous tourism and recreation industry. Its effects have been felt for some time with regard to water-based recreation. Water skiing, boating and white-water jet boat trips have been, and are becoming, even more popular. Land-based recreation includes winter snow skiing and snowmobiling and involves an ever increasing number of summer homes and cabins. This accelerating use of land and water resources will bring about many changes in the methods and emphasis of water management in the region.

TABLE 3

MEAN MONTHLY PRECIPITATION AND TEMPERATURE AT NATIONAL WEATHER SERVICE STATIONS ON AND ADJACENT TO THE CLEARWATER PLATEAU

Station	Grangeville		Kooskia		Lewiston		Nezperce		Orofino		Winchester	
Elevation	3355		1261		1413		3220		1027		3950	
Month	Precip. (in.)	Temp. (°F)	Precip. (in.)	Temp. (°F)	Precip. (in.)	Temp. (°F)	Precip. (in.)	Temp. (°F)	Precip. (in.)	Temp. (°F)	Precip. (in.)	Temp. (°F)
January	1.38	27.7	1.93	30.3	1.10	29.5	1.53	26.0	2.79	31.0	2.02	26.1
February	1.52	31.5	1.86	36.0	0.97	36.6	1.45	30.4	2.61	36.4	1.81	30.3
March	2.05	36.9	2.39	43.0	1.18	42.0	1.78	37.0	2.63	43.2	2.10	33.7
April	2.68	44.9	2.82	50.9	1.14	50.4	2.13	44.9	2.06	51.9	2.39	42.3
May	3.30	52.2	3.05	58.5	1.55	58.4	2.75	52.2	2.27	59.6	3.15	49.5
June	3.04	57.9	2.89	64.3	1.73	64.7	2.66	57.7	2.29	65.8	2.93	55.0
July	0.88	67.0	0.85	71.8	0.43	73.1	0.86	65.4	0.60	73.8	0.77	63.6
August	0.76	65.9	0.74	69.6	0.43	70.8	0.71	64.5	0.47	71.7	0.85	62.0
September	1.51	58.1	1.50	62.4	0.90	63.5	1.35	57.2	1.43	63.5	1.66	55.3
October	2.20	47.8	2.46	51.5	1.21	51.4	1.95	47.8	2.36	52.0	2.17	46.1
November	1.82	36.4	2.24	39.0	1.23	39.8	1.83	36.3	3.05	39.7	2.16	35.1
December	1.51	31.3	1.99	33.5	1.37	35.2	1.70	30.6	3.37	34.1	2.15	30.5
ANNUAL	22.65	46.5	24.72	50.9	13.24	51.3	20.70	45.8	25.93	51.9	24.16	44.1

Data from climatological Handbook, Columbia Basin States, Pacific Northwest River Basins Commission; Vol. 1, Part A and Vol. 2.

Climate

The area is unusual in that its climate is highly diverse, ranging from warm, mild conditions in the lower canyons to alpine conditions in the mountainous regions. Elevations in the area range from a low of about 730 feet above mean sea level (MSL) at Lewiston to elevations in excess of 5,000 feet in the Craig Mountains and at Mount Idaho south of Grangeville.

Average annual precipitation for stations in the area range from a low of 13.24 inches at Lewiston to a high of 27.44 inches at Winchester. Average annual temperatures range from a low of 42.7°F at Winchester to a high of 51.9°F at Orofino. Basic climatological data for the area is given in Table 3.

Average annual precipitation and temperature vary with elevation, precipitation generally increasing and temperature decreasing with an increase in elevation. A water yield map (Figure 5) of the area graphically depicts the variation of water yield with elevation. The water yield map is useful in estimating peak flows and water yields of drainage basins, as is described in the section of the report having to do with surface water.

The growing season varies in different parts of the area, ranging from only 146 days at Cottonwood to 211 days at Lewiston. The growing season is generally determined on the basis of the spring and fall freezing thresholds. The spring and fall thresholds are based on the 50 percent probability of a killing (28°F) freeze occurring on or after a particular date in the spring or on or before a particular date in the fall. Table 4 lists the lengths of growing seasons for the immediate surrounding four stations for which data were available, and lists the mean date of last occurrence in spring and first occurrence in fall for 28°F temperatures, usually associated with some freezing damage to most plants.

TABLE 4

DATE OF LAST OCCURRENCE IN SPRING AND FIRST OCCURRENCE IN FALL FOR MODERATE FREEZING TEMPERATURES (28°F) AND LENGTHS OF GROWING SEASONS

Stations	Spring	Fall	Length of Growing Season (days)
Cottonwood	May 7	October 1	146
Grangeville	April 26	October 9	165
Kooskia	April 13	October 18	187
Lewiston	April 2	October 30	211

From Climatological Handbook, Columbia Basin States, Pacific Northwest River Basins Commission; Vol. 1, Part A, Temperature; 1969.

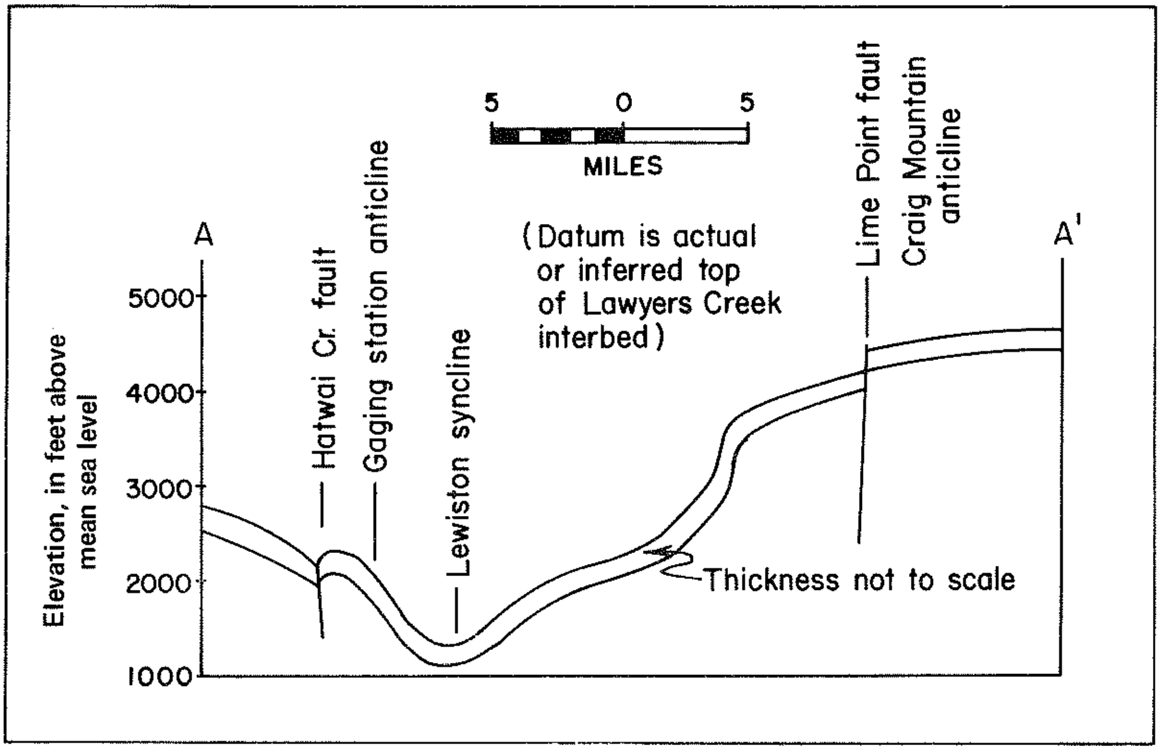


FIGURE 3. Structural cross-section of the Lewiston Monocline as far south as Craig Mountain anticline (after Bond, 1963).

GEOLOGIC FRAMEWORK

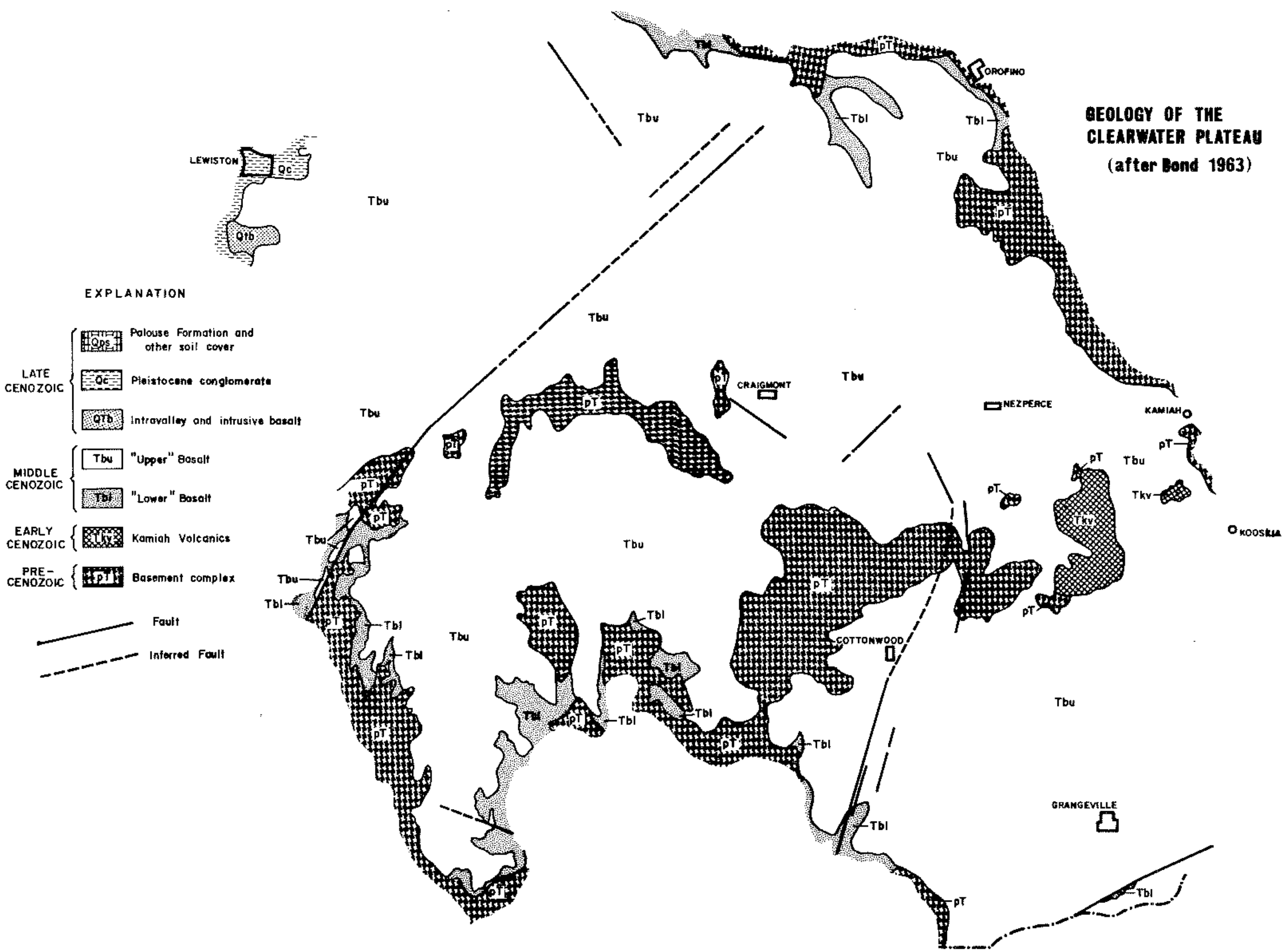
The geologic history of the area is, in general, quite simple. During mid-Tertiary time, beginning some 34-40 million years ago and continuing until perhaps as late as 10 million years ago, magma of basaltic composition was extruded from vents to the west in Washington and Oregon in a succession of flows. These flows, spreading eastward into the study area, partially submerged foothills and highlands whose relief probably exceeded 4,000 feet. The upland areas prior to the basalt flooding were deeply incised by streams and were composed of three major rock groups: rocks of Belt Supergroup, primarily sedimentary and metamorphosed sedimentary rocks; rocks of the Seven Devils Volcanics, primarily andesites; and rocks of the Idaho Batholith, primarily of granite and related rocks.

The flows of basalt, now called the Columbia River basalt, were not extruded in rapid succession, so weathering of the tops of flows often took place before they were covered by succeeding flows. At times, sediments ranging in grain size from gravel to clay were deposited in lakes formed behind lava-dammed streams, and were themselves covered by successive basalt flows.

Regional folding and subsidence that occurred when the massive volume of basalt was extruded into the area formed structures which have exerted the greatest control over the surface drainage and groundwater occurrence and movement. The most prominent of these structures is known as the Lewiston Monocline, which is a steep flexure in a thick series of basalt layers just north of the Clearwater River, especially apparent north of Lewiston. Figure 3 is a simplified structural cross-section in a northwest-southeast direction through the structure (based on Bond, 1963), showing its approximate shape and orientation. While the cross-section indicates that the basalt layers south of Lewiston are dipping to the north, the true dip is actually to the northwest.

About 14 miles southeast of Lewiston is an area of high relief known as the Craig Mountain anticline, a broad domal or ridge-like structure in basalt. Bond (1963) shows a fault having a northeasterly trend closely associated with the steep north limb of the anticline. The fault diminishes to the northeast and has not been traced beyond the general vicinity of Gifford. Faults in the area may exert significant influence on the development of surface drainage and the movement of groundwater. Other geologic features having an important effect upon the water resources of localized parts of the area are the tops of ancient mountain peaks not totally submerged by the Columbia River basalt. These include Mount Idaho, and Cottonwood, Mason, and Kamiah buttes. Figure 4 is a simplified geologic map of the area (after Bond, 1963).

FIGURE 4. Generalized geologic map of the Clearwater Plateau study area.



WATER RESOURCES

Groundwater

The ultimate source of any body of groundwater is precipitation, infiltrating downward under the influence of gravity through granular soil or rock material or fractures in unweathered rock, stopping only when its downward movement is halted by an impermeable stratum, such as dense, unfractured rock, or upon encountering a zone of water-saturated rock material. In the Clearwater Plateau area, direct infiltration of precipitation is the major source of recharge to the groundwater system.

A major source of recharge locally is by means of seepage from lakes and streams. The amount of recharge to the groundwater system from these sources is not known, but in stream reaches of highly fractured rock or coarse alluvial material, the seepage rate can be very high, to the point that the streambed may dry up completely. This could occur during the late summer months when streamflows may be less than the potential seepage rate. All streams and lakes in the area studied are subject to varying degrees of loss due to seepage.

Some relatively minor sources of recharge to the groundwater system involve the works of man. Sprinkler or flood irrigation, in the few places it occurs, contributes some recharge, while seepage losses from reservoirs, canals and ditches also augment the amount. Any such recharge is likely to be very local in extent.

Throughout the Clearwater Plateau area, groundwater is found to occur in three primary locations below the surface of the earth: 1) in fractures in rock bodies, 2) in the pore spaces of sedimentary material, and 3) in the interflow zones of basalt flows. The porosity, or the amount of space which water may occupy in the rock material, varies widely in the three situations listed. In the case of fractured rock, porosity may be increased or decreased depending upon the degree to which products of weathering of the respective rock types plug the voids. Fractures in granite and basalt would both tend to contain less available water as time progressed, since a primary weathering product from each is clay. In the case of alluvial material, various natural cements, such as calcium carbonate, often fill the pore spaces to various degrees reducing the space available for water. Within the study area, conditions vary from highly permeable unconsolidated sands and gravels to dense, relatively impermeable metamorphic and igneous rocks. Generally, the younger the rock or alluvial material the more permeable it will be, since weathering, compaction, and cementation have not acted upon them for as long a period of time as with older rocks or deposits.

Movement of water on the surface of the earth, as well as within, is controlled primarily by gravity, but modified by geology. The succession of basalt flows, interflow zones, and alluvial interbeds abutting the massive crystalline rocks of the Idaho batholith, the metamorphosed rocks of the Belt Supergroup, and the Seven Devils Volcanics creates a complex environment for the movement of groundwater within the Clearwater Plateau area. Appendix 1, graphic representations of selected well drillers logs, indicate aquifers commonly encountered.

The relatively impermeable rock masses of granite, andesite and metamorphosed sedimentary rock do not transmit water readily, either above or below the surface of the ground. As a result, above ground they act as efficient watersheds upon which a high percentage of runoff occurs, while below ground they act as effective barriers to groundwater movement. This is generally what occurs in the vicinity of Mount Idaho, Cottonwood, Mason and Kamiah buttes and Craig Mountain. Elsewhere, the rocks are more permeable (more capable of transmitting water).

Bond (1963) demonstrated, by mapping individual basalt flows, that the flows are both nearly parallel and continuous beneath the Clearwater Plateau. Faulting, and associated folding, locally disturb this continuity and may create barrier effects which could explain anomalous water levels in portions of the Clearwater Plateau, most apparent in the Reubens area. South of Reubens toward Craigmont, water levels range from about 50 feet below land surface to less than 20 feet. Northwest of Reubens, water levels drop rapidly to 246 feet and more below land surface; while to the northeast, water levels are only about 124 feet below land surface. Rolling topography appears to have only a minor effect on differences in water levels. At Summit, nearly a ghost town located 10 miles north of Reubens and near the rim of the Clearwater River canyon, a well about 600 feet deep was drilled which reportedly produced less than 10 gallons per minute (gpm) for a short period of time before going dry. Within Reubens itself, a municipal supply well in use since 1910 has a water level of about 370 feet below land surface and is apparently cased to a depth of 722 feet. The presence of perched water tables overlying a deep artesian system is one possible explanation for the variance in water levels but not enough is known at present about the subsurface geology in the area for a better answer.

Due to the relatively few wells in which water levels could be obtained in relation to the total number of wells in the study area (about a 1:4 ratio), no attempt was made to construct a regional water table map. Such a map, if attempted with the meager amount of data available, would be inconclusive and misleading. Appendix II is a summary of groundwater data gathered during the course of this study. Data presented in it should be used with caution when projections of areal water levels are attempted. In most cases, details of well construction, total depth, and rock material penetrated were not known. Each factor would have a significant bearing on any interpretation of water levels.

The presence of an apparently widespread artesian aquifer, or aquifers, is of considerable interest to water users in the northwest portion of the study area. A number of wells in the Lapwai Creek Valley from the vicinity of Jacques Spur and Culdesac to Lapwai encounter an artesian aquifer in basalt at depths from 150 to 200 feet below the valley floor. In many cases water flows at land surface or stands within a few feet of land surface. In the Tammany Creek area south of Lewiston Orchards, many artesian wells have been developed, but usually do not flow at land surface. Since drillers logs are available on so few wells, it is not known how many wells in the Tammany Creek area may be artesian. Those wells definitely known to be artesian have a piezometric head elevation of between 1,310 and about 1,450 feet above mean sea level (MSL). Artesian wells in the Lapwai-Culdesac area have a piezometric head elevation of about 1,440 feet above MSL. The difference in head elevations may indicate a number of things: 1) two separate artesian aquifers are involved with different internal pressures, or 2) one aquifer is involved with the difference in head being the result of energy loss to the system through friction due to movement of water through the pore spaces and fractures in the aquifer material. Considering the geology of the region, it is not unreasonable to postulate the existence of many artesian aquifers throughout the total depth of basalt. The city of Clarkston, Washington, has developed a number of deep artesian wells ranging in depth to 1,330 feet, in the same basalt underlying Lewiston, Lewiston Orchards and the surrounding area. These wells discharge from 1,350 to 3,200 gallons per minute (gpm), therefore, the potential for developing additional wells for municipal and irrigation uses in the Lewiston-Lapwai area is great.

Springs

Springs are a common feature throughout the area, created as a result of the intersection of numerous perched aquifers in basalt with deeply incised canyons. Spring lines can often be traced significant distances through the presence of vegetation at the same approximate elevation on the canyon walls. Most of the springs developed were for domestic and stockwater use; and some were productive enough to perhaps supply modest commercial needs, such as feedlots, dairies, and the like. Although spring flows depend upon conditions of recharge, and no long-term record of flows was obtained during this study, users indicated that spring flows were dependable for year-round supplies.

Temperature and electrical conductivity measurements were made at 120 springs which were accessible throughout the area. Many more springs were observed, but were in locations too remote to inventory. Values for electrical conductivity of spring water samples were plotted versus temperature and altitude above mean sea level, respectively, to determine if there was any apparent relationships. Temperature versus electrical conductivity fell within the limits of 100-500 micromhos at 25 degrees Centigrade (25°C), and a temperature range of 9°C (48°F) to 17°C (63°F). There were no apparent segregations which would indicate different sources of water for the springs. Electrical conductivity versus altitude showed some segregation of data. Two fields of plotted points appeared, one of which was bounded by elevations from 3,800 to 4,500 feet and electrical conductivities between 100-350 micromhos, the other by elevations from 2,700 to 3,700 and electrical conductivities between 150-500 micromhos. Remaining points plotted showed a random scatter with no apparent grouping in the field bounded by 100-800 micromhos and altitudes between 1,000 and 2,400 feet. A list of locations for 120 springs visited appears as Appendix III.

Surface Water

The surface water supplies of the Clearwater Plateau are not well documented. Only one stream, Lawyers Creek, near Nezperce, has recent streamflow data available, from 1968 to late 1974. Indirect methods, however, are available to estimate basin yields.

Water yield maps of the entire study area were constructed by Rosa (1968) using available information concerning orographic effects on precipitation and evaporation, vegetative cover types, soil characteristics, and observed water yields. Figure 5, a composite of the maps constructed by Rosa, shows contour lines joining points of equal water yield. By summing the average values for water yield within each contour interval bounded by the basin boundaries, an estimate of drainage water yield can be obtained. For instance, by assuming an average water yield of 3.0 inches in the area between the 1-inch and 5-inch contours and multiplying this value by the appropriate units of area with the boundaries (e.g. acres), a water yield value in acre-inches is obtained. Repeating this operation for the remaining contour intervals and summing the respective results produces a value for total basin yield. The following table is of estimated water yields for various representative basins in the study area:

TABLE 5

ESTIMATED WATER YIELDS

Drainage	Area (mi.^{2})	Estimated Mean Annual Yield (acre-feet)
Lapwai Cr. at Spalding	245	35,000
Cottonwood Cr. near Myrtle	63	5,200
Mission Cr. at Jacques Spur	68	9,700
Sweetwater Cr. at Lapwai Cr.	73	15,000
Lawyers Cr. at Kamiah	208	30,000

As a check on estimated values, measured values on Lawyers Creek near Nezperce, were compared with the corresponding estimates. The drainage area used in estimating the water yield for Lawyers Creeks is approximately 50 square miles larger than that for which measured flows are available. However, the contribution of the additional 50 square miles is not likely to be great, since the greatest portion of the additional area is in the lower elevation portion of the drainage where the water yield is less. Mean annual water yield measured for the years 1968 through 1972 was 36,600 acre-feet, an additional 6,600 acre-feet more than the estimate. The years 1968 through 1972 were above-average years for precipitation and would inflate the water yield figures correspondingly. Mean annual precipitation at the Nezperce station for the period 1968 through 1972 averaged 11 percent above normal, and for 1968 alone, was 7 inches above normal.

Peak flows were estimated for the above creeks using a method developed by Thomas, Harenberg, and Anderson (1973) which was derived from a regional frequency analysis. The regional analysis technique utilizes statistical analyses of flood records and generated regional frequency curves. Using these curves, one can then estimate peak flows from an ungaged basin if certain topographic, geologic and hydrologic factors are known. The factors used to estimate peak flows in the basins tabulated in Table 6 include drainage area and percentage of forest cover.

TABLE 6

ESTIMATED PEAK FLOWS

Drainage	Area (mi.^{2})	10-Yr. Peak Flow (cfs)*	25-Yr. Peak Flow (cfs)	50-Yr. Peak Flow (cfs)
Lapwai Cr. at Spalding	245	2,500	3,300	3,800
Cottonwood Cr. near Myrtle	63	910	1,200	1,400
Mission Cr. at Jacques Spur	68	810	1,100	1,200
Sweetwater Cr. at Lapwai Cr.	73	780	1,000	1,170
Lawyers Cr. at Kamiah	208	2,400	3,100	3,600

*Defined as the annual maximum peak flow that will be exceeded, on the average, once every 10 years.

Comparing the appropriate estimated peak flows with the maximum recorded flows for Lawyers Creek at Kamiah and Lapwai Creek at Spalding, it is seen that a 4,380 cubic feet per second (cfs) flow measured in Lapwai Creek on January 29, 1965, exceeded both the 25-year and 50-year peak flow estimates (the 50-year peak flow estimated for the region was found to be 1.5 times the 10-year peak flow). The highest flow observed in Lawyers Creek, 2,460 cfs on January 29, 1965, is approximately equal to the 10-year peak flow. The 10- and 25-year peak flows estimated from the 1968 to 1972 streamflow data on Lawyers Creek are very close to those estimated using the method of Thomas and others (1973). One advantage to using the regional frequency analysis is that it is developed from nearby stations with much longer periods of record, thus it is more likely to reflect the actual situation than is a gaging station with a period of record of only 6 years (Lawyers Creek near Nezperce).

Besides the gaging station on Lawyers Creek, only Mission Creek, tributary to Lapwai Creek, has a continuous record, from December 1940 to September 1945. Streamflow records can be found in U. S. Geological Survey Water Supply papers entitled, "Surface Water Supply of the United States, Part 13, Snake River Basin," for the years desired. More recently, this data has been published cooperatively with the Idaho Department of Water Resources in a series of publications entitled, "Water Resources Data for Idaho, Part 1, Surface Water Records," and in a compilation of miscellaneous measurements entitled, "Miscellaneous Streamflow Measurements in Idaho, 1894-1967." Data appearing in Table 7 is abstracted from these publications.

Much of the flow of the Clearwater River is unappropriated, and would constitute a reliable, high-quality source of water for irrigation, industrial or municipal use.

At present, Mann Lake, Waha Lake and Soldiers Meadow Reservoir supply domestic and irrigation water to the Lewiston Orchards Irrigation District. Some water is diverted out of Captain John Creek in its headwaters to Soldiers Meadow Reservoir, and some consideration has been given to impounding flows in Deer Creek, tributary to the Salmon River, for the same purpose.

TABLE 7

MEAN ANNUAL DISCHARGE OF SNAKE, SALMON

AND CLEARWATER RIVERS NEAR CLEARWATER PLATEAU

(From U. S. Geological Survey Streamflow Records)

River and Discharge Site	Mean Annual Discharge (acre-feet)	Period of Record (years)
South Fork Clearwater River at Sites	751,300	7
Clearwater River at Orofino	6,026,000	14
Clearwater River near Peck	10,940,000	6
Clearwater River at Spalding	11,100,000	48
Snake River near Clarkston	35,650,000	55
Salmon River at Whitebird	8,013,000	58

Numerous other small drainages could potentially impound supplies of irrigation and stockwater for use during the drier portion of the summer. The economic feasibility of such development is questionable, due to the cost of structures and distribution system and the usually short period of time during the growing season such irrigation is really necessary. A report prepared by the Nez Perce County Technical Action Panel (1969) does a good job of inventorying potential impoundment sites in that county as well as existing lakes, ponds, reservoirs and streams.

Groundwater/Surface Water Interrelationship

Most streams throughout the area are fed by springs, often at numerous points along their length. Springs which originate on the canyon walls frequently discharge into the loose soil and rock material covering the earth, where the water immediately infiltrates downward until it either reaches an impermeable layer or encounters the saturated portion of the alluvial fill in the valley bottom. Springs that discharge directly into the alluvial fill often contribute to the groundwater system without having any surface expression.

Where the elevation of the groundwater surface exceeds that of the water surface of the stream, water will move from the groundwater system to the stream. Reaches of gain and loss were not defined for the streams in the area.

Artesian pressures in the northwestern portion of the area are often sufficient to cause some wells in the valleys to flow. Since no confining layer in an artesian system can be expected to be truly impermeable, it is suspected that upward leakage of water from artesian aquifers may supply a quantity of water to both surface and unconfined groundwater bodies in the area.

WATER QUALITY

Introduction

Almost all the streams traversing the Clearwater Plateau have their headwaters in relatively resistant rock of the Idaho batholith, Seven Devils Volcanics or Belt Supergroup and cut impressive canyons into the basalt plateau. None of the rock types within the study area contain constituents which would be harmful to man at the concentrations normally found in nature. Since there has been little or no mining activity, no leachates from mine tailings are found, either in the surface water or groundwater. With respect to chemical composition, water quality in the Clearwater Plateau is generally excellent for current uses.

Stream channel alterations, such as in Lapwai and other smaller streams, have decreased rainbow and steelhead populations, as have some farming practices. In the lower, extensively altered reaches of many streams, rainbow and steelhead spawning areas have been eliminated. Farming practices at present and in the past have left fields bare of cover during runoff periods, with the result that runoff is increased and silt loads greatly intensified. Cottonwood Creek, near Stites, which drains agricultural land north of Grangeville, was muddy for several months during the spring of 1972 and is not the only example. A decrease of vegetation along the streams has decreased the stability of the banks contributing to erosion and has also led to increased water temperatures due to decreased shade.

Surface Water

Several streams were sampled in November 1972, and in March 1973, for bacterial and chemical indicators of contamination (Figure 6). A chemical analysis for specific ions was completed in November of 1973 on eight streams draining the Plateau. The creeks were selected to represent different parts of the Plateau and the different associated uses. Lawyers, Cottonwood "A", Butcher, and Ten Mile creeks drain the eastern portion of the Plateau and are tributary to the South Fork of the Clearwater River. Big Canyon, Lapwai, and Cottonwood "B" creeks drain the northern portion and are tributary to the main Clearwater River. Tammany and Captain John creeks drain portions of the Craig Mountain area, tributary to the Snake River. Rock Creek drains the portion between Cottonwood and Grangeville, tributary to the Salmon River. Whitebird Creek, which drains a forested, undeveloped area, was included for comparison, as were the Snake, Salmon, and Clearwater rivers.

TABLE 8

NUTRIENT CONCENTRATIONS AND COLIFORM BACTERIA COUNTS AT SELECTED SURFACE WATER SITES, CLEARWATER PLATEAU, IDAHO

(Nutrient analyses by U. S. Bureau of Reclamation; coliform counts and specific conductance by IDWR)

Location	Date Collected	Ortho-Phosphate (PO_4)	Ammonia NH_3	Nitrite NO_2	Nitrate NO_3	Organic N	Temperature (°C)	Coliform Bacteria Per 100 ml		Specific Conductance (µmhos)
								Total	Fecal	
Butcher	11-15-72	0.09	0.00	0.00	0.15	0.18	6.0	12*	2*	205
	3-9-73	0.06	0.00	0.00	3.65	0.37	3.5	34	1*	95
Cottonwood	11-15-72	0.12	0.00	0.00	0.01	0.29	9.0	160	80	341
	3-9-73	0.18	0.00	0.01	3.05		5.0	244	169	170
Lawyers	11-15-72	0.10	0.00	0.00	0.02	0.24	7.0	60	29	240
	3-9-73	0.15	0.00	0.00	2.35	0.38	5.0	68	16	115
Big Canyon	11-15-72	0.15	0.00	0.00	0.34	0.20	9.0	7*	0	210
	3-7-73	0.16	0.01	0.01	5.50	0.34	8.7	35	0	142
Lapwai	11-15-72	0.08	0.00	0.00	0.55	0.24	10.0	37	19	262
	3-7-73	0.11	0.00	0.01	2.35	0.27	11.5	78	32	140
Tammany	11-15-72	0.35	0.00	0.02	3.70	0.76	10.5	300	180	950
	3-7-73	0.13	0.00	0.03	3.25	0.81	13.0	332	116	620
Ten Mile	11-17-72	0.05	0.00	0.00	1.65	0.36	6.0	220	80	470
	3-8-73	----	----	----	----	----	----	----	----	----
Captain John	11-17-72	0.03	0.00	0.00	0.07	0.26	7.0	200	42*	220
	3-7-73	0.05	0.01	0.01	0.16	0.12	7.0	34	1*	95
Rock	11-16-72	0.11	0.00	0.00	0.12	0.24	9.0	800	320	210
	3-6-73	0.08	0.06	0.01	2.34	0.47	10.0	82	8*	105
Whitebird	11-16-72	0.03	0.00	0.00	0.01	0.18	8.0	96	4*	105
	3-6-73	0.04	0.00	0.00	0.12	0.19	7.0	178	58	45
Clearwater** (at Spalding)	11-21-70	0.05	----	----	0.10 ($NO_3 + NO_2$)		3.5	----	----	36
Snake**	9-24-71	0.06	----	----	0.31 ($NO_3 + NO_2$)		17.5	1600	47	322
Salmon** (at Whitebird)	9-2-71	0.04	----	----	0.04 ($NO_3 + NO_2$)		17.0	----	----	159

*Estimate
** USGS 1971
---- Not sampled

Water from these streams was analyzed for orthophosphates, ammonia, nitrite, nitrate, and organic nitrogen (Table 8) by the U. S. Bureau of Reclamation Regional Soil and Water laboratories in Boise, as were the chemical constituents listed in Table 9. Electrical conductivity, temperature, and coliform bacteria were determined in the field.

Phosphorus in surface water may occur as a leachate from native rock minerals, but is more often the result of the activities of man. Probably the most common source on the Clearwater Plateau would be through application of phosphate fertilizers to the soil. Phosphorus ions in solution usually recombine rapidly to form other minerals or are strongly absorbed by clay minerals. As a result, phosphate concentrations are usually low in surface water. In November 1972, only Tammany Creek contained high concentrations of phosphates, during which time considerable turbidity also was evident.

Nitrogen, which is abundant in nature and constitutes 78 percent by volume of the atmosphere, occurs to a greater extent in soil and biological material, but in only small amounts in rock material. Sources of nitrate in surface water include nitrate fertilizers, feedlot wastes, nitrogen-fixing bacteria, and the decay of vegetation (Hem, 1970). Nitrates in excess of natural concentrations may occur from plant and animal waste, including human sewage, and from runoff from fertilized agricultural land. All streams sampled, with the exception of Whitebird and Captain John creeks, had nitrate concentrations higher than would be expected for streams along which development had not occurred. Nitrite and ammonia detected in Rock and Tammany creeks may reflect contamination from cattle kept on or near these streams.

Total coliform in five of the ten streams sampled exceeded the average number of total coliform and/or fecal coliform bacteria allowable under state water quality standards (Idaho State Board of Health, 1968). Tammany and Rock creeks contained the highest number of coliform bacteria of the streams sampled (Table 8). While coliform bacteria may not be harmful to man, they do act as indicators of fecal contamination. Where high numbers of coliform bacteria occur, the risk of disease-causing bacteria being present also arises. The Idaho Department of Health and Welfare (unpublished data) found 250,000 total coliform and 40,000 fecal coliform bacteria per hundred milliliters in Tammany Creek in December 1972. The presence of a number of very shallow wells in the alluvial fill of Tammany Creek may allow such contaminated water to enter the domestic water supplies of the well users. It is recommended that the county health department investigate the area and require those private wells found to be poorly constructed or otherwise subject to contamination to be modified so as to provide a safe source of water. The Idaho Department of Health also found a serious pollution problem in Lindsay Creek, which drains in part the eastern portion of Lewiston Orchards and is tributary to the Clearwater River at Lewiston. Pollution sources were attributed to agricultural, domestic, and industrial sources. Shallow private wells in the streambed of Lindsay Creek may also be subject to contamination.

Electrical conductance is defined as the ability of a substance to conduct an electric current. Specific electrical conductance values obtained in the field give a convenient, though crude, estimate of total dissolved solids in the water. A clear mountain stream above most sources of pollution may have a conductivity less than 50 μmhos while a polluted stream may have a conductivity over 1,000 μmhos. Of the streams sampled, Tammany Creek had the highest conductivity at 950 μmhos. Values for the other streams appear in Table 8.

TABLE 9

CHEMICAL ANALYSES OF WATER AT SELECTED SURFACE WATER SITES, CLEARWATER PLATEAU, IDAHO

(Chemical constituents expressed in milligrams per liter [mg/l])
(Analyses performed by U. S. Bureau of Reclamation)

No.	Location	Date Sampled	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Copper (Cu)	Manganese (Mn)	Ortho-Phosphate (PO_4)	pH	Specific Electrical Conductance (μ mhos at 25°C)
1.	Cottonwood "A" Creek[1]	10-31-73	27.6	0.01	25.05	11.31	25.52	5.08	178.76	15.37	4.25	0.25	0.28	0.04	0.00	0.00	0.29	8.01	297
2.	Cottonwood "B" Creek[2]	11-1-73	38.2	0.00	25.85	10.58	12.87	3.91	157.41	5.76	1.42	0.21	---	0.04	0.00	0.00	---	8.20	252
3.	Lawyers Creek	10-31-73	28.4	0.02	22.24	8.39	17.01	4.30	139.71	8.64	3.55	0.18	0.20	0.05	0.01	0.01	0.14	8.12	243
4.	Big Canyon Creek	11-1-73	30.8	0.00	21.84	7.78	14.02	3.51	129.95	6.24	1.42	0.14	0.64	0.05	0.00	0.00	0.17	8.50	223
5.	Lapwai Creek	11-1-73	26.0	0.01	29.86	11.07	16.09	3.91	170.22	9.12	3.55	0.19	0.74	0.05	0.01	0.01	0.11	8.22	282
6.	Tammany Creek	10-31-73	43.0	0.00	66.93	27.24	90.81	10.17	406.94	94.14	35.46	0.62	2.25	0.12	0.01	0.00	0.18	8.31	880
7.	Rock Creek	11-1-73	36.2	0.01	20.64	9.12	18.39	4.30	126.90	15.85	3.90	0.21	1.60	0.08	0.01	0.02	0.14	8.53	243
8.	Three Mile Creek	10-31-73	30.8	0.01	22.24	9.61	21.61	5.08	115.31	17.29	13.12	0.13	4.08	0.13	0.00	0.01	1.22	7.96	285

[1]Tributary to South Fork Clearwater River.

[2]Tributary to Main Clearwater River.

---- No sample taken.

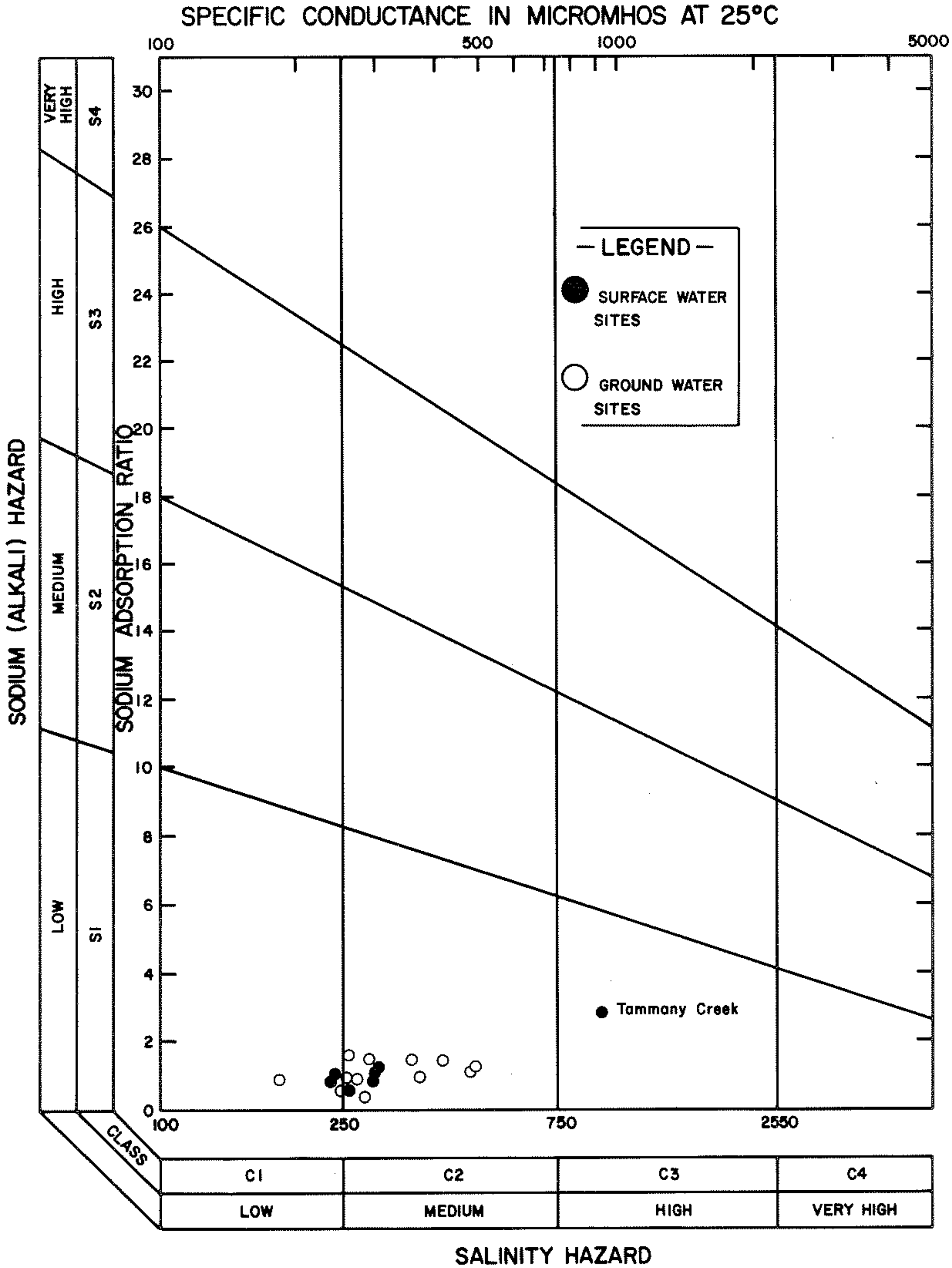


FIGURE 7. Classification of water as to its suitability for irrigation.

TABLE 10

CHEMICAL ANALYSES OF WATER AT SELECTED GROUNDWATER SITES, CLEARWATER PLATEAU, IDAHO

(Data from files of the Idaho Department of Health and Welfare)
(Results expressed in milligrams per liter [mg/l])

No.	Location	Total Solids	Alkalinity ($CaCO_3$)	Hardness ($CaCO_3$)	Calcium (Ca)	Magnesium (Mg)	Iron (Fe)	Manganese (Mn)	Sodium (Na)	Chloride (Cl)	Sulphate (SO_4)	Nitrate (NO_3)	Phosphate (PO_4)	Silica (SiO_2)	Fluoride (F)	Ammonia (N)	Zinc (Zn)	Copper (Cu)	Cadmium (Cd)	Lead (Pb)	Potassium (K)	Date Sampled	Sodium Adsorption Ratio (SAR)
1.	Lewiston well No.1-A	292	96	72	19	6	.10	.02	40	8	6	3.8	.04	13.6	.67	.20	.002	.001	.019	.01	2.7	6-22-73	2.05
2.	Lewiston well No. 2	460	104	124	37	8	.23	.05	76	26	62	0.8	.05	9.7	.84	.30	.009	.001	.008	.01	4.8	6-22-73	2.95
3.	Lewiston well No. 3	144	60	48	11	5	.14	.01	12	8	6	1.9	.02	4.1	1.24	.30	.002	.001	.008	.01	1.0	6-22-73	0.75
4.	Lewiston well No. 4	380	136	116	24	13	.22	.01	54	26	44	4.0	.08	14.1	.29	.20	.005	.001	.006	.01	4.1	6-22-73	2.21
5.	Lewiston well No. 5	284	124	56	14	5	.24	.02	52	16	3	0.1	.01	23.2	.98	.10	.001	.001	.009	.01	3.8	6-22-73	3.04
6.	City of Nez Perce No. 4	296	92	184	42	19	.20	.01	12	13	3	0.0	.17	--	.90	.50	.07	.01	.01	--	--	10-66	0.39
7.	City of Craigmont No. 1	320	180	144	35	13	.01	.01	33	5	3	17.0	.07	153.0	.74	.10	.011	.002	--	.10	3.0	7-19-72	1.21
8.	City of Craigmont No. 2	420	200	212	58	16	.01	.01	38	22	8	42.5	.02	137.5	.49	.40	.036	.002	--	.01	3.6	7-19-72	1.14
9.	Lapwai well	288	160	120	27	12	.15	.02	6	4	3	5.2	.15	106.0	.53	.20	--	--	--	--	0.4	8-14-72	0.24
10.	Winchester old well No. 1	308	160	112	34	7	.02	.01	34	3	9	0.1	.01	84.0	.24	.10	.289	.002	--	.12	2.2	7-19-72	1.39
11.	Winchester old well No. 2	340	240	180	42	18	.08	.01	42	4	3	1.2	.01	98.0	.26	.20	.059	.002	--	.01	3.0	7-19-72	1.37
12.	Winchester new well	252	148	124	26	14	.35	.03	18	3	2	0.1	.02	135.5	.26	.10	.42	.002	--	.01	1.3	7-19-72	0.71
13.	Winchester well No. 2	--	140	128	35	19	.19	.01	27	1	4.2	1.0	--	.7	.30	.50	.042	.007	.001	.01	3.4	2-13-74	0.91
14.	Winchester well No. 4	--	116	116	22	14	.12	.06	11	1	2.7	.2	--	.6	.28	.3	.109	.005	.001	.01	2.9	2-13-74	0.45
15.	Reubens R.R. well	312	176	128	29	15	.05	.01	40	6	5	.2	.13	49.1	.69	.2	--	--	--	--	3.2	2-6-73	1.50
16.	Cottonwood well No. 2	288	132	100	21	12	.01	.01	18	6	1	1.9	.09	118.5	.76	.3	--	--	--	--	1.9	2-25-72	0.78
17.	Cottonwood well No. 3	348	188	148	37	13	.27	.01	22	10	7	0.4	.07	115.5	.78	.4	--	--	--	--	2.8	2-25-72	0.79
18.	Culdesac reservoir	212	108	80	18	9	.03	.02	14	4	3	4.4	.04	160.5	.36	.3	.026	.002	--	.01	1.1	7-27-72	0.67

-- No sample taken.

As an indication of a water's suitability for irrigation, its sodium adsorption ratio (SAR) is calculated using the following equation:

$$SAR = \frac{(Na+)}{\sqrt{\frac{(Ca^{+2}) + (Mg^{+2})}{2}}}$$

and is plotted versus its specific conductance. The resulting chart, Figure 7, indicates that most of the water has a very low sodium hazard and a low-to-medium salinity hazard; the only exception being Tammany Creek. Thus, the waters sampled are highly suited to irrigation use.

The significance of nitrate and phosphate concentrations in the streams may become more apparent, now that Lower Granite Reservoir on the Snake River below Lewiston has been formed. Nitrates and phosphates are prime nutrients for algae and other aquatic plant life. An increase in nutrient concentration in the reservoir may lead to nuisance blooms of odor-causing algae. Control of contamination by bacteria will become more important since the reservoir will be used for body-contact recreation such as swimming and water skiing. It would be far easier to control minor water quality problems now than to control the resulting pollution in the reservoir.

The aquatic environment in the Clearwater Plateau is not as bad as some of these data might indicate. Problems with industrial effluents are almost nonexistent and most towns either have adequate sewage facilities or plans to construct such facilities. Several steps could be taken, however, to decrease silt loads and lower temperatures in streams:

1) Increased use of strip cropping;

2) Allow buffer strips of grass and brush in natural drainage ditches and along streams;

3) Construct small dams to catch runoff and release it slowly;

4) Keep large numbers of livestock away from streams;

5) Discourage construction of buildings in the flood plains of all streams.

Groundwater

Chemical analyses of water from the public water supplies of most cities and towns in the study area are routinely done by the Idaho Department of Health and Welfare. Table 10, which lists the constituents sampled in a number of wells, is based on files from IDHW. The following tabulation, included for purposes of comparison, lists the maximum limits for various substances in public water supplies and is abstracted from the Idaho Drinking Water Standards, 1964, of the Idaho Department of Health and Welfare.

The standards state (p. 11, paragraph 3.2.1) that:

The following chemical substances should not be present in a water supply in excess of the listed concentrations where, in the judgment of the Department of Health, other more suitable supplies are or can be made available:

Substance	Concentration (mg/l)
Alkyl benzene sulfonate (ABS)	0.5
Arsenic (As)	0.01
Chloride (Cl)	250.
Copper (Cu)	1.
Carbon chloroform extract (CCE)	0.2
Cyanide (CN)	0.01
Fluoride (F)	-----
Iron (Fe)	0.3
Manganese (Mn)	0.05
Nitrate (NO_3)	45.
Phenols	0.001
Sulfate (SO_4)	250.
Total dissolved solids (TDS)	500.
Zinc (Zn)	5.

The presence of the following substances in excess of the concentrations listed shall constitute ground for rejection of the supply:

Substance	Concentration (mg/l)
Arsenic (As)	0.05
Barium (Ba)	1.0
Cadmium (Cd)	0.05
Chromium (hexavalent (Cr^{+6})	0.05
Cyanide (CN)	0.2
Fluoride (F)	----
Lead (Pb)	0.05
Selenium (Se)	0.01
Silver (Ag)	0.05

The recommended concentration of fluoride is temperature-dependent, based upon the annual average of maximum daily air temperatures. For Lewiston, with the highest annual average maximum temperature at 62.7° F, fluoride concentrations should not exceed 1.3 milligrams per liter (mg/l); for Winchester, with an annual average maximum temperature of 56.3° F, the fluoride concentration should not exceed 1.5 mg/l.

It can be readily seen that the groundwater of the Clearwater Plateau, on the basis of the samples shown, is chemically suitable for human consumption. The water is, however, quite hard and may require some conditioning for specific uses. The hardness of water is attributable to the presence of calcium and magnesium which react with soap to form various insoluble compounds (Hem, 1970, p. 224).

Besides chemical quality parameters, the Idaho Department of Health and Welfare also monitors organic quality indicators as were outlined in the section on surface water quality. Generally, only a few reports of water supply contamination have been received, and these episodes of pollution have been localized and short-lived. The communities of Sweetwater and Lapwai have had recurring episodes of groundwater contamination. Adequate sewage treatment facilities for these and other communities have been under consideration for some time. Other small communities not on sewer and water systems apparently have not had these problems, probably because of their locations on the plateau out of the alluvial fill of the valleys.

WATER RIGHTS

Water rights, including licenses, decrees, claims, and applications for permit to appropriate water which are on file with the Idaho Department of Water Resources are tabulated in summary form in Table 11.

TABLE 11

SUMMARY OF WATER RIGHTS

(Quantities are in cubic feet per second)

	Surface Water	Groundwater	Total
Licenses/Decrees	4,793.40	12.95	4,806.35
Claims/Permits	48.06	32.72	80.78
TOTAL	4,841.46	45.67	4,887.13

It should be emphasized that the above table does not account for all existing water rights in the area, but only those with some written record. To establish a water right prior to May 20, 1971, for surface water or March 25, 1963, for groundwater, it was necessary only to divert the water and apply it to a beneficial use, which required no written account of such diversion and use. Subsequent to the above dates, however, the Idaho Legislature enacted laws which made it necessary to follow a mandatory permit procedure in order to develop a water right. Exceptions to this law apply to domestic and stockwater wells. Further details are available from any Department of Water Resources office.

SUMMARY AND CONCLUSIONS

The thick sequence of basalt flows forming the Clearwater Plateau creates a multitude of perched aquifers, many of rather limited extent. Such perched aquifers, if within a reasonable depth from land surface, would probably provide dependable supplies of water for domestic and stock use, but may not be adequate for municipal use, based upon the limited knowledge of subsurface geology in much of the area.

To a limited degree, the ground and surface water resources of the plateau are interrelated. Many perched aquifers in the interflow zones of basalt sequences form springs where they intersect canyon walls. Such springs maintain streamflows after runoff in the spring. Generally, this springflow is adequate to maintain streamflows, but during late summer virtually dry streambeds are observed locally. Perched aquifers not supplying water to springs are probably very common and their development and use should have little or no effect upon streamflows.

Artesian aquifers present in parts of the area probably contribute some water to streamflows by way of vertical leakage, although no direct evidence for this was gathered during the study.

The potential for development of small reservoirs for supplemental irrigation water is good. Economic considerations are the limiting factors.

Water quality is generally good throughout and bounding the Clearwater Plateau, with the possible exception of Tammany, Rock, and Lindsay creeks. Increased concentrations of nutrients in Lower Granite Reservoir may lead to nuisance growths of algae and other aquatic plant life.

Potential for groundwater development in the Tammany Creek area, especially from deeper artesian aquifers needs further study but appears to be very good. This source would provide a constant, dependable supply of water at stable temperature and quality, which would require little or no treatment before being consumed.

RECOMMENDATIONS

1. Locate a stream gaging station at or near the mouth of Lapwai Creek to determine basin yields, amount and timing of runoff and long-term changes.

2. Establish a number of observation wells on the Plateau to monitor long-term changes in water levels.

3. A more intensive geologic and hydrologic study needs to be done in the area south and east of the Lewiston Orchards area to determine the availability of groundwater for, and the potential effects of, further development. Test drilling with a sophisticated borehole and surface geophysical logging program would probably give the best information.

4. Water quality degradation in Tammany, Rock, and Lindsay creeks, should be eliminated or minimized to help avoid health problems and eutrophication of Lower Granite Reservoir. Water quality monitoring of surface water sites should continue.

5. The economic feasibility of small storage dams for supplemental late-season irrigation water should be determined.

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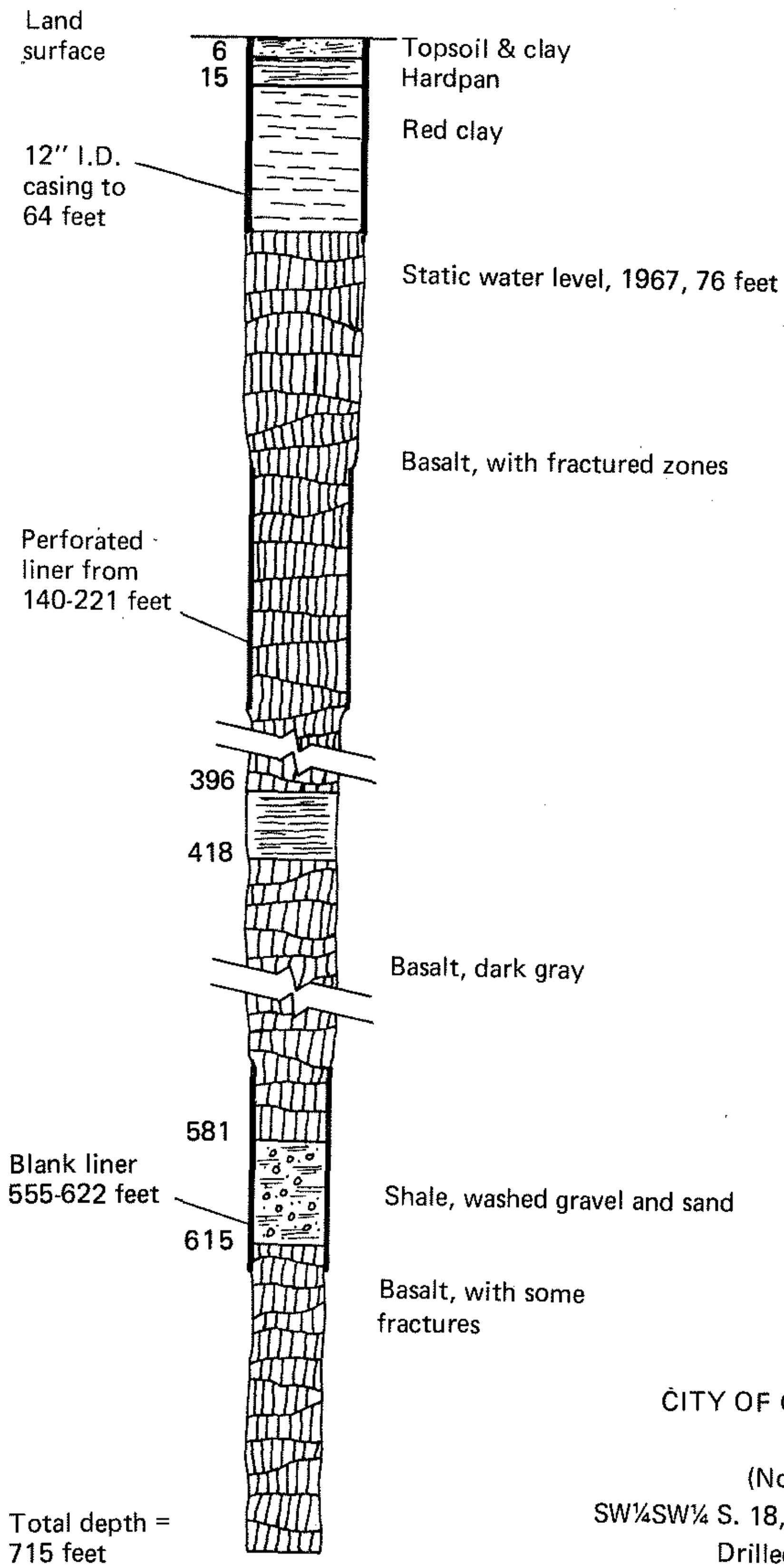
APPENDIX I

GRAPHIC REPRESENTATIONS OF DRILLERS LOGS

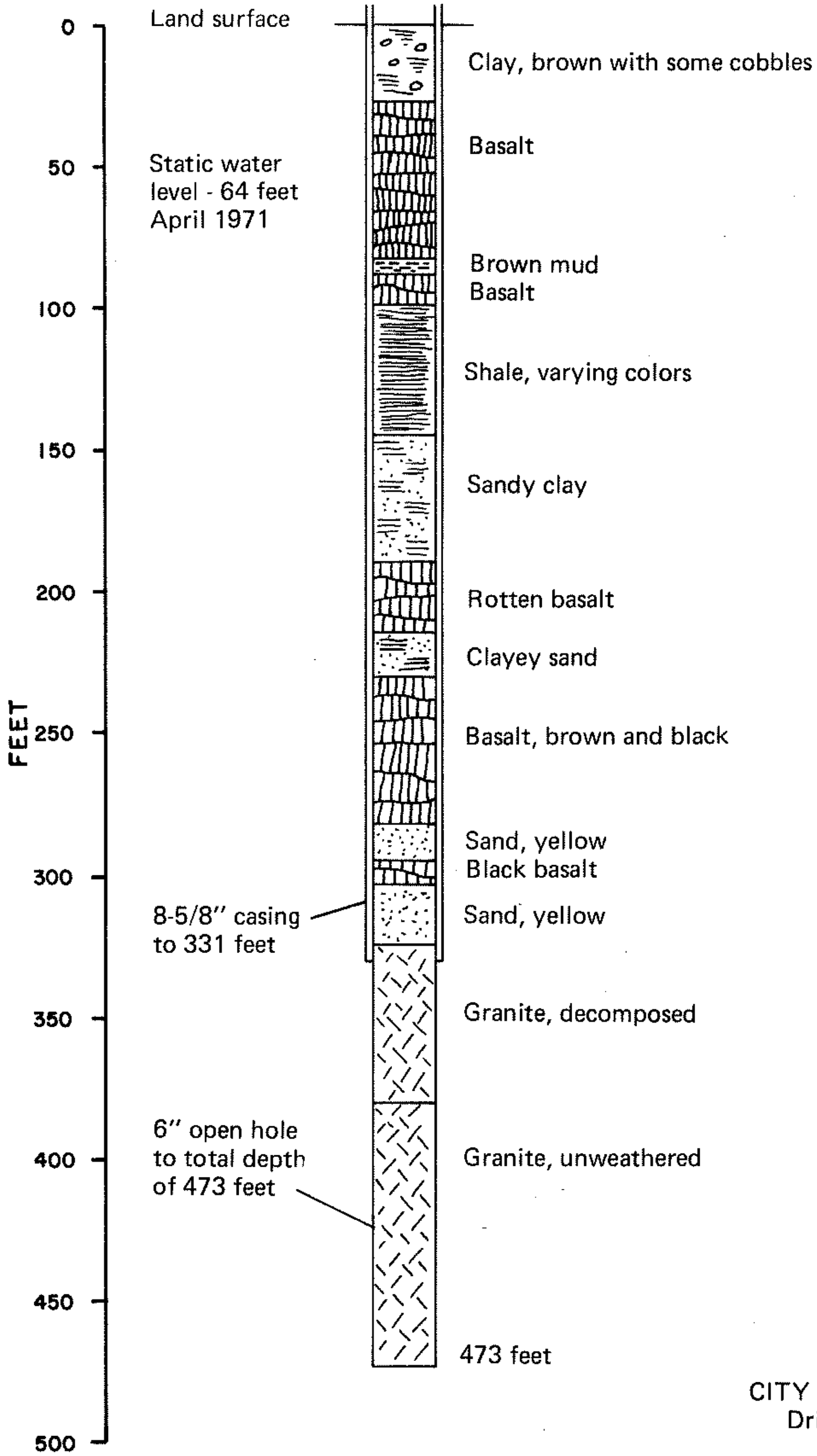
FROM SELECTED WELLS



CITY OF GRANGEVILLE

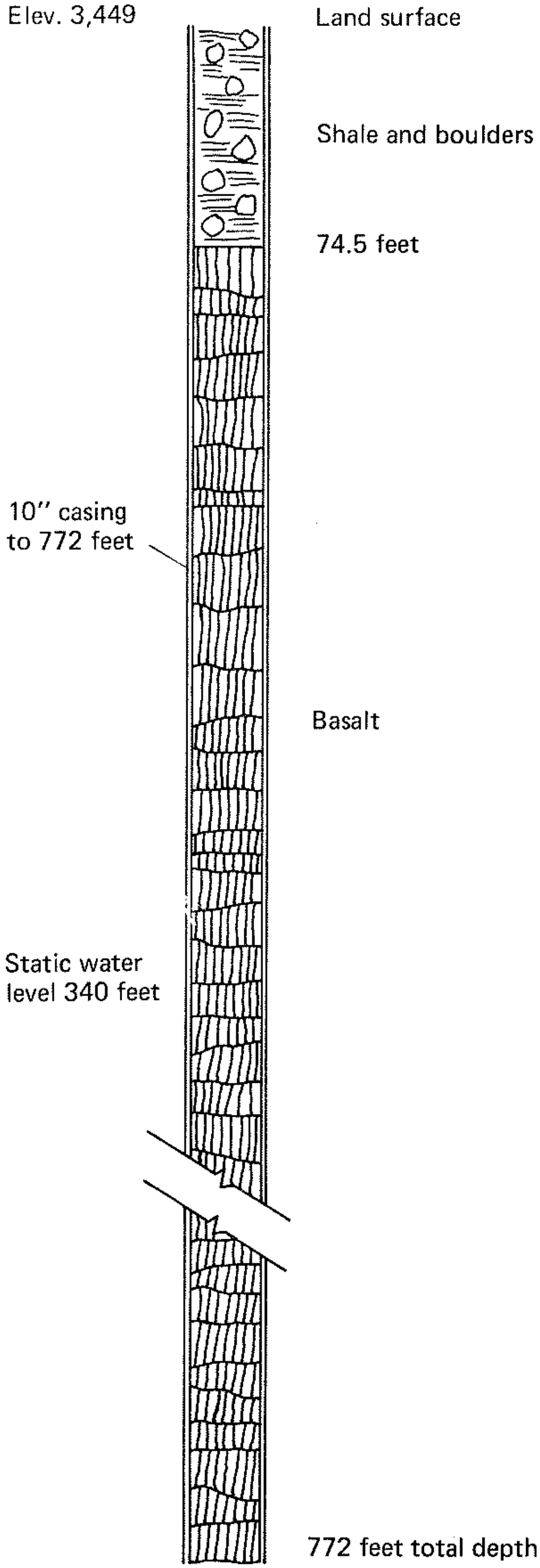
(North Well)
SW¼SW¼ S. 18, T. 30N., R. 3E., B.M.
Drilled May 1967

Vertical scale: 1" = 60'



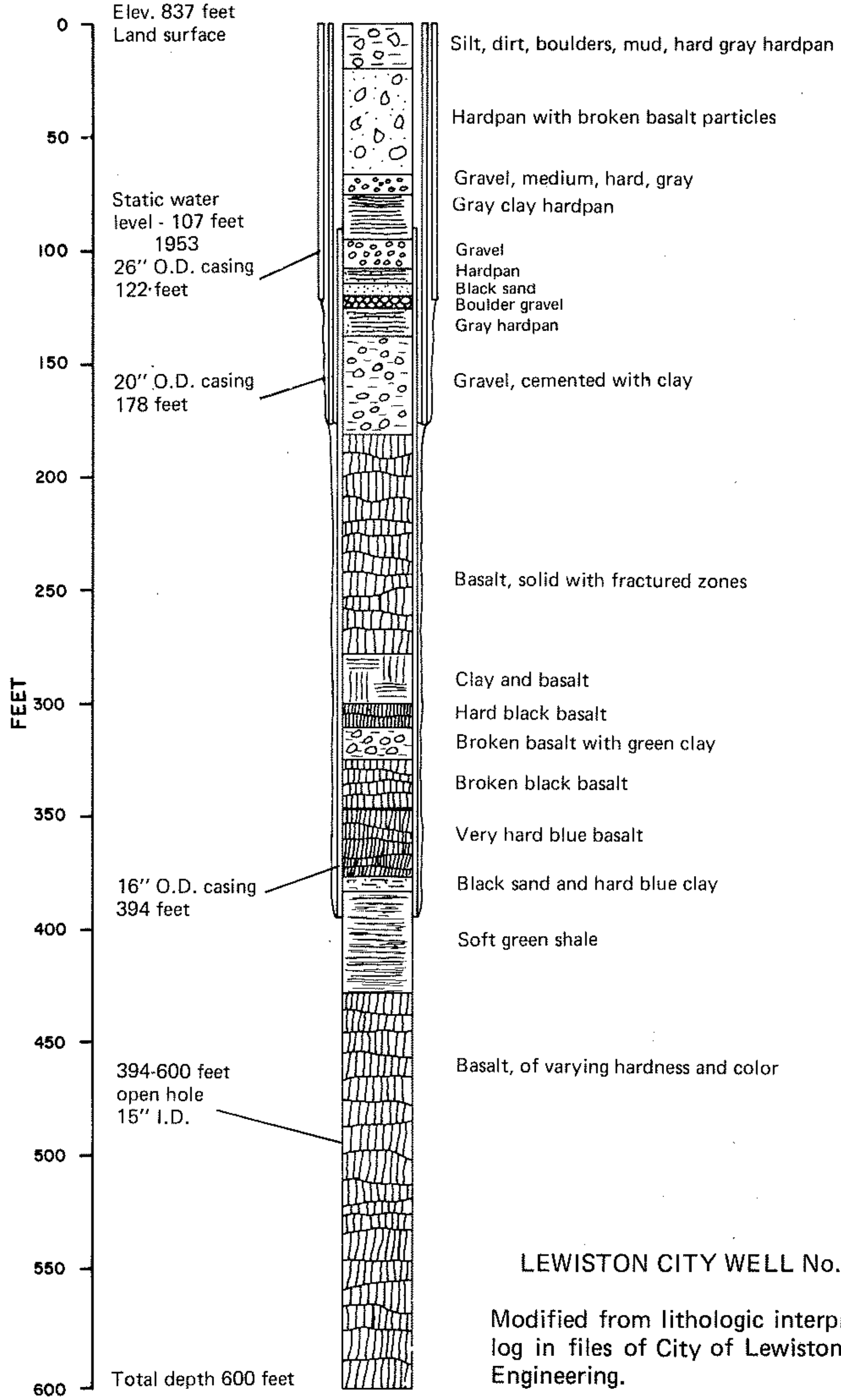
CITY OF WINCHESTER
Drilled April 1971

Vertical scale: 1" = 60'



REUBENS, RAILROAD WELL
Drilled 1910

Vertical scale: 1" = 60'



LEWISTON CITY WELL No. 3 (Cemetery)

Modified from lithologic interpretation and well log in files of City of Lewiston, Department of Engineering.

Vertical scale: 1" = 60'

APPENDIX II

SUMMARY OF WELL DATA

CLEARWATER PLATEAU OBSERVATION WELL NETWORK

BASIC DATA

Well Number	Ownership	Altitude of L.S.D.[1] (feet)	Year Drilled	Use of Well[2]	Depth of Well (feet)	Depth Cased (feet)	Perforations	Well Diameter (inches)	Water Level (feet)[3]	Date Measured	Well Log Yes	Well Log No	Well Yield (gpm)	Drawdown (feet)
30N-1E-12dba1	Meyer	3,290		D	>400			4	398.94	9-18-72		X		
27cbd1	Wilkins	3,555		D,S				8	167.19	9-18-72		X		
30N-2E-25bcb1	Grangeville Country Club	3,480	1957	D	302	89	None	6	153.07	9-18-72	X		15	160
31N-1E- 2aa1	K. Vonbargen	3,200	1971	D	59				9.20	6-28-72		X		
5ba1	E. Arnzen	3,635		D	60			4	29.91	9-19-72		X		
31N-2E- 4bc1	Terhaars	3,050		D	63			6	14.25	9-19-72		X		
5ab1	Terhaars	3,140		D	117			6	45.14P	9-19-72		X		
8cbd1	C. Vonbargen	3,060		D	90			6	13.15	9-19-72		X		
10ccc1	C. D. Lance	2,960		D					10.24	9-19-72		X		
23cb1	Len Koole	3,109	1969	S	182	26	None	6	89.35	9-19-72	X		12	
25db1	H. Kingma	3,070	1968	D	102	41	None	6	63.92	9-19-72	X		35	
31N-3E- 2ca1	V. Workman	2,880	1968	D,S	260	16	None	6	56.17	9-20-72	X		1	
10ac1	M. Wilkins	2,920	1971	D	370	370	310-370 ft.	6	97.53	9-20-72	X		5	
20ad1	G. Mires	2,830		D					2.07	9-20-72		X		
32N-1E- 3bc1	M. Arnzen	3,390	1972	D	90			6	27.63	9-19-72		X		
13acd1	G. Stolz	3,280		D	26				4.33	9-19-72		X		
13dd1	A. Arnzen	3,190	1969	D	220	172	None	6	16.58RP	9-19-72	X		2	
21bc1	J. Sonnen	3,500	1971	D	102	82	48-80 ft.	6	20.00	9-19-72	X		6	
22da1	H. Riener	3,425		D	125			6	75.44	9-19-72		X		
24aa1	Wassmuth	3,180		D	252			6	74.27	9-19-72		X		
30db1	D. Duclos	3,800	1970	D,S	203	36	None	6	57.07	9-20-72	X		10	
31bcc1	V. Schmidt	3,935	1938	D	80				5.04	9-19-72		X		
32bc1	L. Schmidt	3,720	1970	D,S	168	19	None	6	+0.39	9-19-72	X		110	
32N-2E-10cc1	Hinkleman	3,060		D	80			6	75.64	9-19-72		X		
11ca1	S. Wemhoff	3,110	1968	D	342	?		8	165.04	9-19-72	X		20	
14db1	S. Wemhoff	2,960	1971	D	65	19	None	6	26.63	9-19-72	X		50	
18aa1	Sonnen	3,155	1964	D	74				23.07	9-19-72		X		
19bb1	School Dist.	3,190	1968	D	502	122	None	6	6.07	9-19-72	X		12	
30aa1	R. F. Terhaar	3,370		D	211			6	40.88	9-19-72		X		
31dd1	W. C. Jessup	3,130		D				6	32.54	9-19-72		X		
32N-3E- 6dd1	E. Westman	3,140		D	243			6	171.76	9-20-72		X		
17dd1	W. Bailey	3,000		D	165			6	34.73	9-20-72		X		
19ca1	Lustig	3,070		D	320			6	151.91	9-20-72		X		

CLEARWATER PLATEAU OBSERVATION WELL NETWORK

BASIC DATA (Continued)

Well Number	Ownership	Altitude of L.S.D.[1] (feet)	Year Drilled	Use of Well[2]	Depth of Well (feet)	Depth Cased (feet)	Perforations	Well Diameter (inches)	Water Level (feet)[3]	Date Measured	Well No. Yes	Well No. No	Well Yield (gpm)	Drawdown (feet)
32N-3E-35aa1	R. Pratt	2,820	1970	D	81	21	None	6	10.61	9-20-72	X		45	
33N-1E- 1ad1	D. Johnson	3,300		D	234			6	93.48	9-20-72		X		
12cd1	P. Ingram	3,470	1967	D	396	20	None	6	94.14	9-20-72	X		32	
33N-2E- 1ad1	L. Marker	2,970	1968	D,S	241	20	None	6	20.95	9-20-72	X		9	
1bd1	M. McFerson	2,995		D				6	18.68	6-17-72		X		
2bc1	M. Syron	3,070		D	192			6	61.35	9-20-72		X		
9cb1	D. Johnson	3,250		D	115			6	47.47	9-20-72		X		
10bc1	K. B. Giles	3,120		D	74			6	2.24	9-20-72		X		
35bd1	W. Rosenau	3,120		D	171.5			6	50.23	9-20-72		X		
33N-3E-31bb1	H. Schaefer	3,270	1968	D	518	42	None	6	110.2	6-16-72	X		4	
34N-1E- 7cbb1	D. Meacham	3,340		D				6	34.24	9-20-72		X		
18bba1	Unknown	3,445		D				6	31.51	9-20-72		X		
29cc1	John Hart	3,500		D				4	2.0	6-19-72		X		
31bbb1	Joe Zenner	3,605		D				4 in 6	38.35	7-19-72		X		
35N-1E-22acd1	Unknown	3,105		D	150			4	66.55	9-20-72		X		
28ca1	G. Ragan	3,100		D	267			6	198.31	6-20-72		X		
35db1	E. Langdon	3,060		D	141			6	71.0	6-20-27		X		
31N-1W-12dad1	A. Sprute	3,875	1964	D	8	8	Conc. Curb.	30	3.13	9-18-72		X		
13bcb1	R. Orr	4,225	1960	D	130				Flows	7-25-72		X		
13cac1	George Geis	3,990		D	109				66.90RP	9-18-72		X		
15bbd1	G. Goeckner	4,220	1950	D	105			6	26.02	9-18-72		X		
32N-2W- 4ddc1		4,365		D				6	13.95	9-19-72		X		
33N-1W- 3cbb1	Joe Lauer	3,700		D				4	30.99	9-19-72		X		
6dab1	E. Tatko	3,855	1948	D	90			6	19.00	9-19-72		X		
20bbb1	Don Pratt	4,005	1970	D	305	55	None	6	88.95	9-19-72	X		6	10
25cbc1	Schaffer	3,770		D	129			6	55.55	9-19-72		X		
27ccd1	M. Jackson	3,840	1971	D	60			6	27.65	9-19-72		X		
29bcc1	F. Wayne	4,040	1970	S	303	20	None	6	190	10-15-70	X		1.5	
35bdd1	J. R. Frei	3,860						8	31.1	7-27-72		X		
33N-2W- 3aad1	Randall	3,920		D	60				3.26	9-19-72		X		
3aca1	R. Renner	3,930		D	80			6	15.81	9-19-72		X		
3bda1	M. Jarnagin	3,905	1922	D	164			6	10.98	9-19-72		X		
5bbb1	Winchester[4]	3,985	1910(?)	PS	388			6	53.49	9-22-72		X		
12bbd1	D. Southern	3,955	1925	D	98			5	67.65	9-19-72		X		

33N-4W- 8dda1	Unknown	3,620		PS				6	188.13	9-21-72		X		
9cbd1	Hull/Hendrix	3,440	1956	PS	606			10	>486	9-21-72		X		
16dad1	Unknown	3,450		D				6	32.14	5-24-72		X		
34N-1W-12cca1	M. Marshall	3,440		D	49			6	Flows	9-19-72		X		
15aad1	W. Wagner	3,580		D				6	55.51	9-19-72		X		
30aab1	Unknown	3,700		D			Rock Crib	36+	1.16	9-19-72		X		
34N-2W- 2abd1	City of Reubens[4]	3,660	1910(?)	PS	467(?)			4	371.24	9-20-72		X		
6dba1	P. Pentzer	3,680		D	348			6	44.30	9-20-72		X		
10aad1	T. Armstrong	3,615		D				6	46.26	7-12-72		X		
11dca1	Unknown	3,640		D			Rock Crib	48	5.03	9-20-72		X		
26abb1	Unknown	3,715		D				6	16.76	9-20-72		X		
26bdd1	____ Paul	3,765		D				6	22.91	9-20-72		X		
27bba1	Coldsprings	3,805		PS				6	34.37	9-20-72		X		
28add1	Unknown	3,865		D				6(?)	25.84	9-20-72		X		
30bca1	A. G. Flory	4,040	1958	D	90	70(?)	70-90ft.	6	34.44	9-20-72		X		
31cba1	M. Mathison	4,025	1922(?)	D	36	10			18.9	5-25-72		X		
31dbc1	Winchester[4]	4,000	1971	PS	473	331	None	8	68.28	9-22-72		X		
32aaa1	W. A. Bovey	3,850	1939	D	75			8	9.67	9-19-72		X		
34N-3W- 4ddc1	L. Hasenoehrl	1,840	1972	D	90	69	69-90 ft.	8	13.00	9-20-72	X		18	47
34N-4W- 5bbc1	Branom	1,825		S	84			6	17.33	9-21-72		X		
6baa1	O. Konen	1,760	1954	D	400+			6	300(RPTD)	5-16-72		X		
35N-1W- 7adb1	R. Lowary	3,360	1967	D	509			6	110.40	7-18-72		X		
14acc1	Sam Boyer	3,200	1952	D	305			6	183.18RP	9-21-72		X		
17bbb1	Loren Crow	3,320	1950	D	398			6	110.34	7-18-72		X		
32acd1	V. Swearinger			D				6	83.08	9-19-72		X		
35N-2W- 2acc1	E. Steinbruck	3,400		D			Brick Crib	6′ x 6′	1.35	9-20-72		X		
2acc2	E. Steinbruck	3,410		D			Brick Crib	?	7.65	9-20-72		X		
2acc3	E. Steinbruck	3,415		D			Brick Crib	36	13.71	9-20-72		X		
35N-2W-17dad1	____ Scott	3,245		D	200±5			6	169.51	9-20-72		X		
21dca1	Unknown	3,600		D			Rock Crib	48	7.07	9-20-72		X		
34ddd1	O. Bishop	3,605		D	247+			6	246.54RP	9-20-72		X		
36acb1	Sam Quinn	3,460		D	180(?)			6	123.65	9-20-72		X		
35N-3W-17dda1	A. Heitstuman	1,400	1955	D	110	110	None	8	26.67	9-20-72		X		
19cbd1	Ernie Wolf	1,270	1962	D	105			6	25.40RP	9-21-72		X		
21bbb1	Coy Allen	1,400	1969	D	112	37		6	13.14	9-20-72	X			
21cac1	D. E. Law	1,460		D				8	10.77	9-20-72		X		
21cac2	D. E. Law	1,455	1972	D	122	18		6	Flows	5-23-72		X	1	
33bab1	H. Zenner	1,590		D	176			6	133.52	6-19-72		X		
35N-4W- 2bad1	D. Halfmoon	950		D				6	6.65	9-21-72		X		
2cdb1	Lapwai[4]	970	1946	PS	204			6	73.74 WPN	9-21-72		X	50	32
11ac1	Nez Perce	1,005	1962	REC.				6	7.38	9-21-72		X		
12bb1	D. Hamilton	1,080	1966	D	170			8	123	9-21-72		X		
13bcc1	Jack Seely	1,060	1964	D	40			6	7.68	9-21-72		X		
14dad1	F. Paisano	1,110	1966	D	77	61		6	15.20	9-21-72	X			
14ddb1	Cliff Allen	1,110	1965	D	118	47	None	6	16.32	9-21-72	X		5	
23aba1	A. Taylor	1,130	1962	D	61	33	None	6	8.26	9-21-72	X		5	17
23adb1	Ferwalt, Inc.	1,150	1969	D	89			6 in 8	17.17RP	9-21-72	X			
23bda1	J. Jackson	1,140	1962	D	93	18		6	9.70RP	9-21-72	X		20	35

CLEARWATER PLATEAU OBSERVATION WELL NETWORK

BASIC DATA (Continued)

Well Number	Ownership	Altitude of L.S.D.[1] (feet)	Year Drilled	Use of Well[2]	Depth of Well (feet)	Depth Cased (feet)	Perforations	Well Diameter (inches)	Water Level (feet)[3]	Date Measured	Well Log Yes	Well Log No	Well Yield (gpm)	Drawdown (feet)
35N-4W-27bcd1	W. H. Ferwalt	1,315		D	80			6	13.40	9-21-72		X		
35N-5W- 4ac1	Bill Wolff	925	1967	D	14	14	Conc. Curb.	78	12.02	5-17-72		X		
21ccc1	K. Felton	1,150		D	20+		Conc. Curb.	30	6.72	9-21-72		X		
23cd1	J. Konen	1,405	prior 1933	I	2,700+			16	93.60	9-21-72		X		
25aca1	W. A. Greene	1,485		D	50(?)			6	30.81	9-21-72		X		
25bab1	J. Theissen	1,450		D			Conc. Curb.	30+	9.00	9-21-72		X		
26cba1	M. Theissen	1,520	1954	I	180	150		8	48.78	9-21-72		X		
26bc2	A. Theissen	1,465	1904	S	35	35	None	6	9.11	9-21-72		X		
36N-1W- 3dba1	B. Lougee	985	1972	D	62			6	9.21	9-21-72		X		
3dbd1	B. Ankney	985	1972	D	300	21	None	6	6.97	9-21-72	X		7.5	
3ddd1	H. Cardwell	980		D				6	8.18	7-19-72		X		
5aaa1	Nick Smith	950		PS	185			6	37.71	9-21-72		X		
5ab1	J. Novack	960	1969	D	77	62	None	8	41.54	9-21-72	X		14	0
5aba1	D. Brock	950	1971	D	162			6	33.07	7-19-72		X		
36N-2W- 6adc1	George Dau	2,000		D	180			8	66.19	6-17-72		X		
9cba1	L. Summers	2,445		D	158			6	142.38	9-20-72		X		
23ccb1	T. Southern	2,960		D				6	71.94	9-20-72		X		
26bab1	R. Johnson	2,955	1910	PS	190			6	152.16	9-20-72		X		
28adb1	W. English	2,780	1948	D			Brick Crib	36+	8.86	9-20-72		X		
36N-3W- 3bcc1	Cottonwood Cr. Church	900	pre-1957	INST.	?		Conc. Curb.	30	4.70	9-20-72		X		
8dcc1	C. Graham		1971	D	230			6	129.45	6-15-72		X		
10add1	R. Yochum	1,000		D			Conc. Curb.	36	13.44	9-20-72		X		
24cab1	P. Blewett	1,205		D	18	18	Conc. Curb.	36	14.36	9-20-72		X		
36N-4W- 22add1	N.P.N.H.P.[5]	805		I, REC.				6	18.16	9-21-72		X		
22daa1	N.P.N.H.P.[5]	805		REC.				6	15.83P	9-21-72		X		
22caa1	N.P.N.H.P.[5]	795	1963	D	120	39		6	16.11	5-25-72	X			
22cbc1	O. Bronsheau	790		D				6	24.20P	9-22-72		X		
22dba1	N.P.N.H.P.[5]	810		D				6	25.90	9-22-72		X		
26bca1	M. Johnson	850	1962	D	66	66	None	6	18.80	5-25-72	X		10	22
26ccd1	J. Showers	910		D				6	37.69P	9-21-72		X		
35ac1	H. Presnell	890	1969	D	70	38	None	8	30.13P	9-21-72	X		26	0
35baa1	N. Huddleston	875	1960	D	72			6	22.63	5-25-72		X		
35bbd1	B. Rogers	910	1932	D	34	34	Conc. Curb.	24	13.77RP	6-13-72		X		

35ca1	Cochrane	910		D				6	12.83	9-21-72		X
35cdc1	R. Slickpoo	915	1964	D	147	44	None	6	6.60	6-13-72	X	
35cdd1	M. Andrews	915		D	32	32	None	6	5.20	5-24-72	X	
35dc1	P. Calkins	920		D				6	36.09	9-21-72		X
36aad1	D. Williams	1,115	1965	D				8	34.71	9-21-72		X

[1]L.S.D. - land surface datum estimated from USGS 7.5-min. and 15-min. quadrangles.

[2]D - domestic, S - stockwater, PS - public supply, I - irrigation, INST. - institutional, REC. - recreational.

[3]Depth to water surface from land surface; P - measured while pumping; RP - measured shortly after pumping ceased; WPN - well pumping nearby; and no notation - static water level. Positive numbers indicate artesian water levels above land surface.

[4]Municipal supply wells for the community indicated.

[5]N.P.N.H.P. - Nez Perce National Historical Park.

APPENDIX III

LIST OF SPRING LOCATIONS, TEMPERATURES AND SPECIFIC CONDUCTIVITIES

APPROXIMATE LOCATION OF SPRINGS,

CLEARWATER PLATEAU

No.	Location	EC/Temp. °F	Approx. Topo. Elev.	No.	Location	EC/Temp. °F	Approx. Topo. Elev.
1	29N-2E- 1bc	220/53°	4,160	31	32N-1E-20bb	500/56°	3,610
2	30N-1E-36ad	220/60°	3,320	32	32N-1E-21da	355/56°	3,480
3	30N-1E-36ba	220/58°	3,400	33	32N-1E-29cd	285/56°	3,690
4	30N-2E-31bb	220/59°	3,280	34	32N-2E-23db	285/55°	2,790
5	30N-3E- 2aa	175/53°	2,280	35	32N-2E-26bb	430/48°	2,850
6	30N-3E-15bc	200/54°	3,200	36	32N-2E-26bc	430/48°	2,910
7	30N-3E-24cc	180/54°	3,180	37	32N-2E-31dc	440/56°	3,110
8	31N-1E- 2ac	310/56°	3,240	38	32N-3E- 5db	310/60°	2,880
9	31N-1E- 2ba	300/56°	3,250	39	32N-3E-10db	780/58°	2,780
10	31N-1E- 7cbc	135/56°	3,840	40	32N-3E-20bd	285/55°	3,050
11	31N-1E-18dd	240/59°	3,680	41	32N-3E-31dc	395/53°	2,880
12	31N-1E-20bb	255/54°	3,590	42	33N-1E-21aa	400/61°	3,320
13	31N-1E-20cd	240/54°	3,600	43	33N-2E-11ba	475/56°	2,960
14	31N-2E- 4dc	330/58°	3,040	44	33N-2E-25ad	310/58°	3,080
15	31N-3E- 1bb	275/58°	2,650	45	33N-3E- 4cd	210/56°	2,760
16	31N-3E-15cc	340/57°	2,830	46	33N-3E- 9cc	240/58°	1,440
17	31N-3E-16dd	170/58°	2,925	47	33N-3E-15ca	230/58°	1,480
18	31N-3E-17ba	375/54°	2,960	48	33N-3E-34dd	280/58°	2,840
19	31N-3E-18aa	430/54°	2,880	49	33N-3E-35dd	280/56°	2,760
20	31N-3E-18ba	395/55°	2,800	50	34N-1E-33ba	215/59°	3,060
21	31N-3E-23cc	320/58°	2,800	51	34N-2E-21dc	280/56°	2,720
22	32N-1E- 1db	470/52°	3,320	52	36N-1E- 5bcc	100/59°	1,440
23	32N-1E- 3cc	335/53°	3,480	53	36N-1E- 7ccb	140/53°	1,760
24	32N-1E- 3da	435/50°	3,450	54	36N-1E-13ba	180/57°	3,960
25	32N-1E-11dd	400/52°	3,500	55	31N-1W- 9bac	220/51°	4,440
26	32N-1E-12bb	460/51°	3,500	56	31N-1W-11cdb	140/54°	4,135
27	32N-1E-13da	340/61°	3,190	57	31N-1W-12bdd	110/52°	3,965
28	32N-1E-15cc	470/56°	3,580	58	31N-1W-12aca	105/51°	3,910
29	32N-1E-17cd	375/55°	3,660	59	31N-1W-12dad	135/56°	3,865
30	32N-1E-18bab	140/54°	3,900	60	31N-1W-15baa	235/61°	4,140

APPROXIMATE LOCATION OF SPRINGS,

CLEARWATER PLATEAU (Continued)

No.	Location	EC/Temp. °F	Approx. Topo. Elev.	No.	Location	EC/Temp. °F	Approx. Topo. Elev.
61	31N-1W-16bdd	255/54°	4,120	91	33N-4W- 3aabS1	290/48°	3,140
62	31N-1W-16dab	265/53°	4,100	92	33N-5W-13aabS1	270/52°	2,780
63	31N-1W-18caa	160/54°	4,365	93	33N-5W-14bddS1	495/54°	2,675
64	31N-1W-19bda	170/54°	4,210	94	34N-4W- 6cdc	580/58°	1,920
65	31N-1W-20cac	150/55°	4,280	95	34N-4W-18cac	600/60°	2,375
66	31N-1W-23adb	110/56°	3,835	96	34N-4W-30bb	390/54°	2,280
67	31N-1W-24bab	185/56°	3,820	97	34N-5W-12cac	800/58°	2,180
68	31N-1W-25baa	125/56°	3,790	98	35N-3W- 6ada	380/61°	1,400
69	32N-1W- 1bad	275/53°	3,860	99	35N-3W- 8bbc	450/54°	1,600
70	32N-1W- 2bbb	340/56°	3,870	100	35N-4W-22bdc	410/58°	1,675
71	32N-1W- 2bca	300/56°	3,970	101	35N-4W-22dbb	400/56°	1,485
72	32N-1W- 4cdb	230/57°	3,955	102	35N-4W-26acb	460/62°	1,435
73	32N-1W- 5bba	270/51°	4,060	103	35N-4W-26cbb	390/54°	1,775
74	32N-1W-11bdc	275/58°	4,180	104	35N-4W-26dca	440/54°	1,575
75	32N-1W-12aca	250/54°	4,000	105	36N-1W- 3cbc	180/57°	1,000
76	32N-1W-13bbd	160/50°	4,115	106	36N-1E- 6bcc	100/59°	1,740
77	32N-1E-19bba	140/54°	4,030	107	36N-1W-10cab	155/60°	1,940
78	32N-1W-23bcb	170/49°	4,070	108	36N-1W-10ddb	175/56°	1,330
79	32N-1W-23cac	135/54°	4,180	109	36N-1W-12daa	140/53°	1,980
80	32N-1W-25cdb	140/52°	4,220	110	36N-1W-14dcd	130/50°	1,560
81	32N-1W-28ddd	170/48°	4,700	111	36N-1W-15bab	160/60°	1,900
82	32N-1W-32dcc	180/52°	4,685	112	36N-1W-15aad	150/51°	2,110
83	32N-1W-36bad	130/52°	4,075	113	36N-1W-17bca	200/50°	2,160
84	33N-1W- 1bdc	290/53°	3,595	114	36N-1W-23acd	110/54°	1,880
85	33N-1W-32ccd	250/52°	4,025	115	36N-2W- 5dcc	220/60°	2,140
86	33N-2W- 8acd	165/44°	4,000	116	36N-2W- 6ccc	300/56°	1,600
87	33N-2W-11bbb	210/54°	3,930	117	36N-3W-19ba	410/62°	1,440
88	33N-2W-17ccb	260/49°	4,325	118	36N-3W-19daa	480/56°	1,280
89	33N-2W-23dbc	220/55°	4,075	119	36N-3W-30abc	330/62°	1,310
90	33N-4W- 3aadS1	300/52°	3,260	120	36N-4W-25cdd	430/59°	1,140

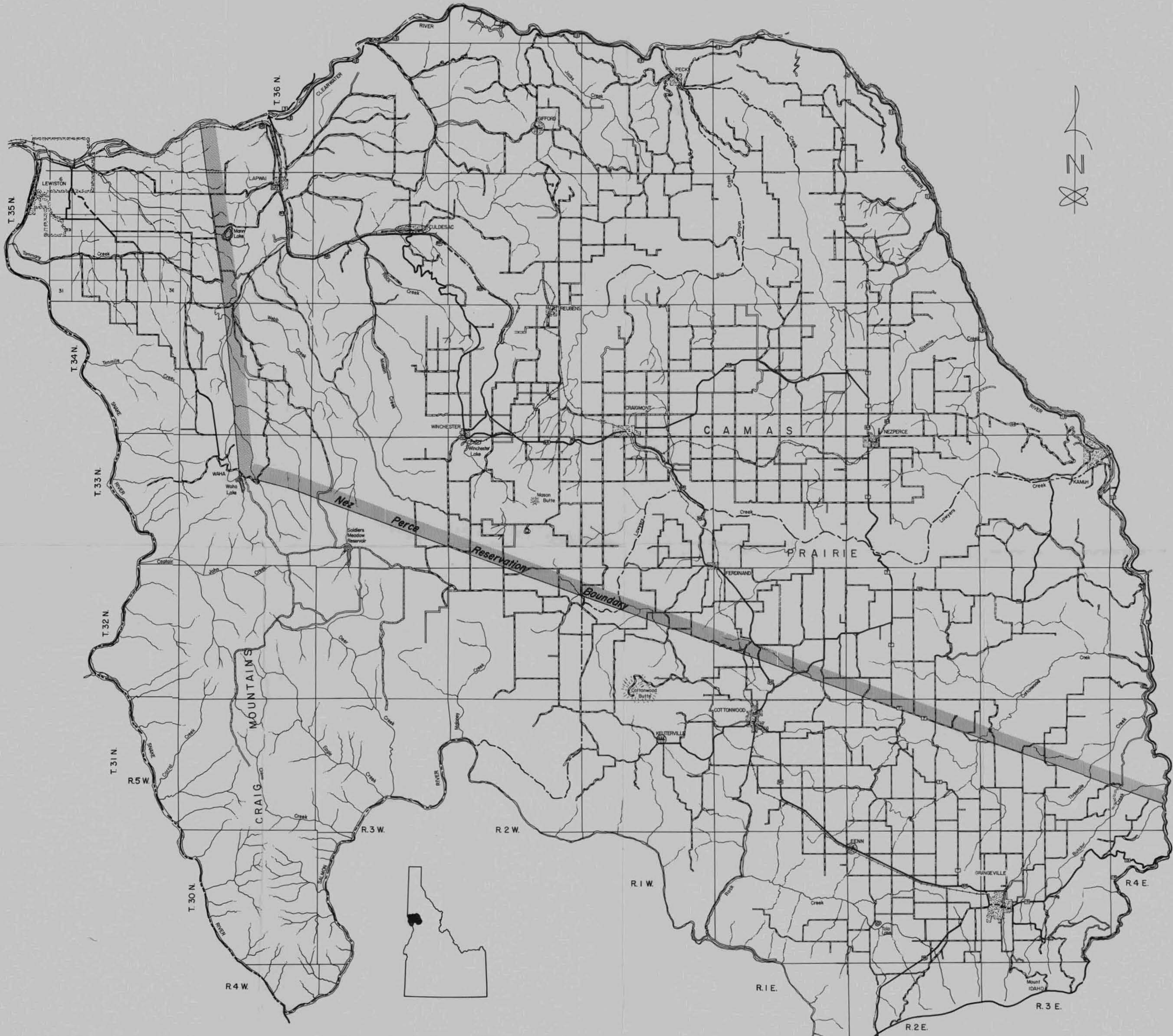


FIGURE 1 - Location and extent of Clearwater Plateau study area within Idaho.

FIGURE 5 - Water yield map of Clearwater Plateau study area.

FIGURE 6 - Map of study area showing location at surface water quality sampling sites.