A Reconnaissance of Nitrite/Nitrate in Camas Prairie Ground Water
Volume I
Lewis and Idaho County, Idaho

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ABSTRACT

In 1998, the Division of Environmental Quality (DEQ), Lewiston Regional Office proposed to investigate the shallow and deep aquifers underlying the Camas Prairie and larger Clearwater Plateau. Concentrations of nitrite plus nitrate were used as the single parameter to further define ground water conditions (nitrite plus nitrate is assumed as nitrate for convenience purposes in this report). The study was a reconnaissance level effort designed to address a broad geographical area with hopes of providing additional insight into the regional ground water conditions. Ground water data for the Camas Prairie is limited; thus, the collection of additional ground water data was deemed beneficial and valuable for current and future needs.

The specific objectives include:

(1) describe nitrate concentrations from aquifers underlying the Camas Prairie,
(2) provide additional information to the Statewide Ambient Ground Water Monitoring Network,
(3) identify nitrate areas of concern,
(4) provide ground water data to determine additional monitoring needs,
(5) reconnaissance of potential nitrate sources.

The Camas Prairie is part of the 1700 square mile Clearwater Plateau (Figure 1) which is bordered by the Clearwater River to the north and northeast, Mount Idaho and the Salmon River to the south, the Snake River and Craig Mountains to the west and the South Fork of the Clearwater River and Clearwater Mountains to the east. The Camas Prairie covers a portion of the Clearwater Plateau and (Figure 5) is demographically bound by Craigmont, Idaho to the northwest, Nezperce, Idaho to the northeast and Grangeville, Idaho to the southeast. Geologically, the Clearwater Plateau is comprised of faulted layers of Miocene Columbia River basalt bounded by igneous and metamorphic outcroppings such as the Idaho Batholith and Cottonwood Butte. The topography overlaying the basalt flows is typified by gently rolling loess slopes with steep breaks in the landscape where streams and channels occur.

The ground water samples collected (55 samples) suggest that the Camas Prairie aquifers are experiencing elevated nitrate levels, in particular the surficial water bearing zones. Nitrate concentrations ranged from non-detectable limits to a high of 77.1 mg/L. Seventy-five percent of the sites sampled had nitrate concentrations exceeding 2 mg/L, or in other words, seventy-five percent of the sites demonstrated human influence based on a background level of 2 mg/L.

Based on the results of this study, recommendations are as follows:

- Discourage the consumptive use of shallow wells, unless monitored on a regular basis.
- Encourage well owners to provide an adequate buffer zone around their well head.
- Encourage well owners to assess local land use and identify nitrogen sources.
- Provide additional technical assistance and ground water sampling to well owners with nitrate concentrations exceeding the drinking water standard of 10 mg/L.
- Provide additional investigation into nitrate priority sites and areas (Figure 10).

INTRODUCTION

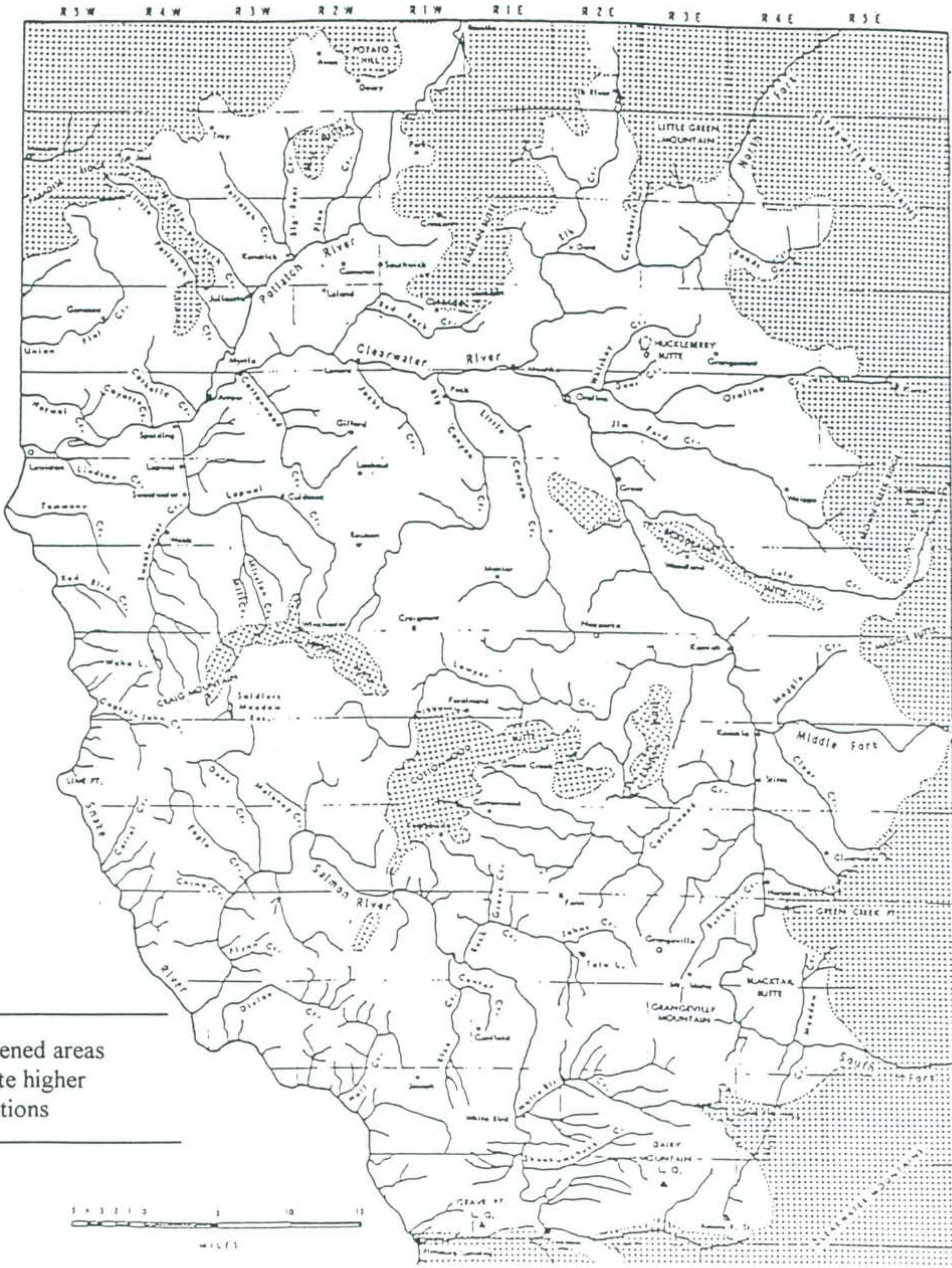
The Camas Prairie is located in North Central Idaho and is part of the larger Clearwater Plateau. The majority of the Clearwater Plateau (Figure 1) is bordered by the Clearwater River to the north and northeast, Mount Idaho and the Salmon River to the south, the Snake River and Craig Mountains to the west, and the South Fork of the Clearwater River and Clearwater Mountains to the east. The geographically smaller Camas Prairie (Figure 2) is located in the central part of the Clearwater Plateau and is geologically bound by Cottonwood Butte and the Salmon River Canyon to the west, the South Fork of the Clearwater River to the east, the Cottonwood divide to the north and Mount Idaho to the south.

The surface landscape of the Clearwater Plateau and Camas Prairie are relatively diverse. The topography on the Camas Prairie is typified by gently rolling to irregular loess slopes with steep breaks in the landscape where streams and other channels occur. Land west and northwest of the prairie is more mountainous with increasing elevation transiting into steeper slopes, increased vegetation and more elevated levels of precipitation. Geologically, the plateau is comprised of faulted layers of Miocene Columbia River basalt and is bounded by igneous and metamorphic outcroppings such as the Idaho Batholith to the south and Cottonwood Butte to the west. In result, the Camas Prairie and larger Clearwater Plateau represent a diverse geologic and topographic setting.

In addition, the Camas Prairie can be characterized by large tracts of agricultural land, rural residents and small communities. The prairie residents largely subsist on agriculture with intermix of forestry, small industry and other small businesses. The prairie is primarily used for the agricultural production of dry-land crops, such as wheat, barley and peas, along with other smaller scale crops. Livestock is also raised on the Camas Prairie, which includes range cattle, dairy cows and hogs.

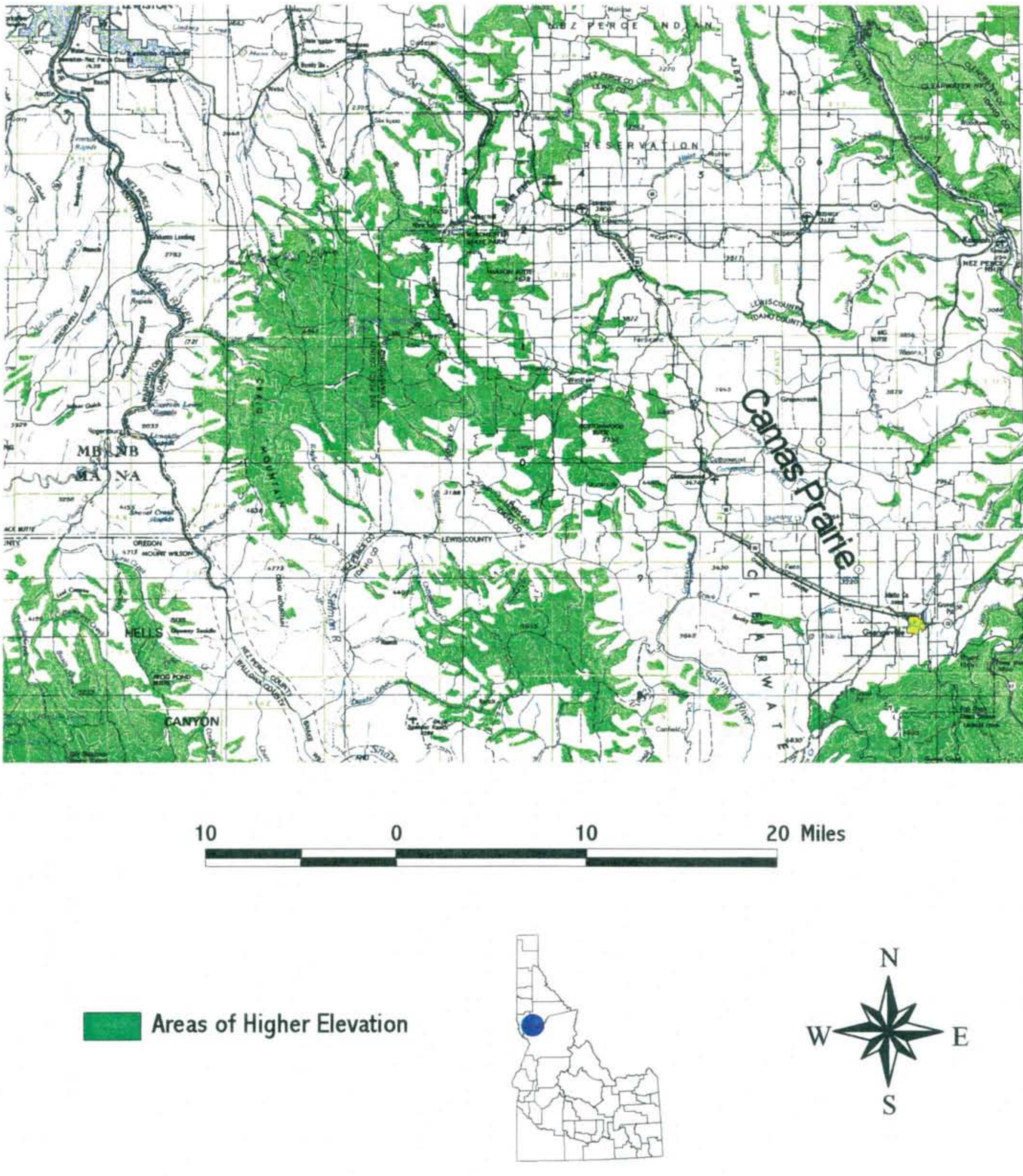
In 1998, the DEQ proposed to investigate the ground water quality of the Camas Prairie. The proposal was to use nitrite plus nitrate concentrations as the single indicator for evaluating ground water quality (nitrite plus nitrate is assumed as nitrate for convenience purposes in this report). At the conception of the study, data was very limited for the Camas Prairie. The two existing nitrate data sources were the Statewide Ambient Ground Water Network and data from public water systems administered by the Division of Environmental Quality (DEQ) and the North-Central District Health Department. All available current and historic data was collected before the acquisition of any new data. The focus and goal of this study was to collect nitrate data from available sources and sample additional private wells for the purpose of ground water quality assessment.

Figure 1. General Map of the Clearwater Plateau (after Bond, 1963)



Darkened areas denote higher elevations

Figure 2. General Location Map of the Camas Prairie



PURPOSE AND OBJECTIVES

The purpose of this study was to assess Camas Prairie ground water quality. Nitrate was the contaminant of concern.

The specific objectives of this study include:

(1) Describe nitrate concentrations from aquifers underlying the Camas Prairie,
(2) Provide additional information to the Statewide Ambient Ground Water Monitoring Network,
(3) Identify nitrate areas of concern,
(4) Provide ground water data to determine additional monitoring needs,
(5) Reconnaissance of potential nitrate sources,
(6) Inform prairie residents of drinking water quality.

LITERATURE REVIEW AND DATA SOURCES

Ground water studies and available literature for the Camas Prairie and Clearwater Plateau are limited at this time. A few reports have been compiled, but few reports exist that address nitrate contamination. The following is a synopsis of the studies reviewed.

Castelin (1976) produced a reconnaissance of the water resources on the Clearwater Plateau. His report contained several objectives relevant to this study. The two objectives included determining the geologic control and occurrence of ground water resources on the plateau, and the identification of representative wells for addition to the Cooperative Ground Water Observation Well Network (Idaho Department of Water Resources (IDWR) network). His report provided valuable information on the hydrogeologic make-up of the plateau, which included the identification of water bearing zones. However, the study did not provide any sort of regional water table map due to the lack of sufficient ground water data.

Ralston, Sprenke, Dansart and Rember (1993) compiled a report on the ground water resources around the City of Grangeville, Idaho. Their report included three primary sections: the geologic setting of the Camas Prairie, the hydrogeology of the Grangeville area, and the analysis of ground water development potential. The section pertaining to the geologic setting presented the most relevant and valuable information. It provided information on the pre-basalt time, the basalt period and the post-basalt period. In addition to narrative information, their report provided a geologic map of the Camas Prairie from just south of Grangeville north to the city of Cottonwood.

Mahler, Brusven, and Rasmussen (1993) compiled a report on the Big Canyon Watershed north of Craigmont, Idaho. Their report addressed several environmental parameters in the watershed including the condition of ground water resources. They sampled domestic wells for nitrate and the levels ranged from 0-5 parts per million (ppm); five of the forty-two wells had nitrate values exceeding two, or in other words, twelve percent of the wells surveyed demonstrated human influence (Mahler et. al., 1993). Based on this data, they concluded that in relation to the rest of the state, ground water quality in the Big Canyon Watershed was in relatively good condition. Even though much of the Big Canyon Watershed falls north of the Camas Prairie study area, the data and conclusions were of value in assessing ground water quality as it pertains to this report.

Crockett (1995) supplied a summary of the Statewide Ground Water Quality Monitoring Program. The objectives of her report were to document the general statewide ground water quality, determine trends, identify areas needing additional monitoring, determine background levels and determine ground water suitability for drinking, agricultural and industrial purposes. Her report was broad in scope, but it covered identified regions in the state including the Clearwater Plateau. Her report provided some valuable nitrate information on the general ground water quality of the Clearwater Plateau (Figure 3 and Table 1).

PUBLIC WATER SYSTEM DATA

All public water system data for the Camas Prairie was compiled prior to any sampling of private water systems. Public water systems are broken into two categories: systems with greater than twenty-five connections and systems with less than twenty-five connections. Systems greater than twenty-five are administered and monitored by the DEQ, while systems of twenty-five or less fall under the jurisdiction of the North Central District Health Department.

The public water system data collected for this report was tabulated and summarize in order to identify any apparent trends in nitrate concentrations. The data was also used for the purpose of identifying areas where additional ground water sampling was needed. A summary of the data is provided in the *Results and Discussion* section of this report, while additional well information is presented in Appendix A.

AMBIENT GROUND WATER MONITORING NETWORK DATA

All relevant data was compiled from the Ambient Ground Water Monitoring Network prior to any sampling of new wells. The Idaho Department of Water Resources (IDWR) has analyzed samples collected from twenty-two private wells within and around the study area (Figure 4). Of the twenty-two wells, two (P-50 and P-45) were selected, sampled and analyzed for this study (Figure 4). The statewide monitoring data provided information for defining priority areas experiencing nitrate levels near or in excess of the Environmental Protection Agency's (EPA) Maximum Contaminant Level (MCL) of 10 mg/L. However, the data points are scattered over a large geographic area, so additional data is needed to draw any substantial conclusions regarding regional ground water conditions on the Camas Prairie. A synopsis of the nitrate data is provided in the *Results and Discussion* section of this report. Attributes of wells selected for sampling can be found in *Appendix B.*

Figure 3. Generalized Nitrate Concentrations for Statewide Hydrogeologic Subareas (Crockett, 1995)

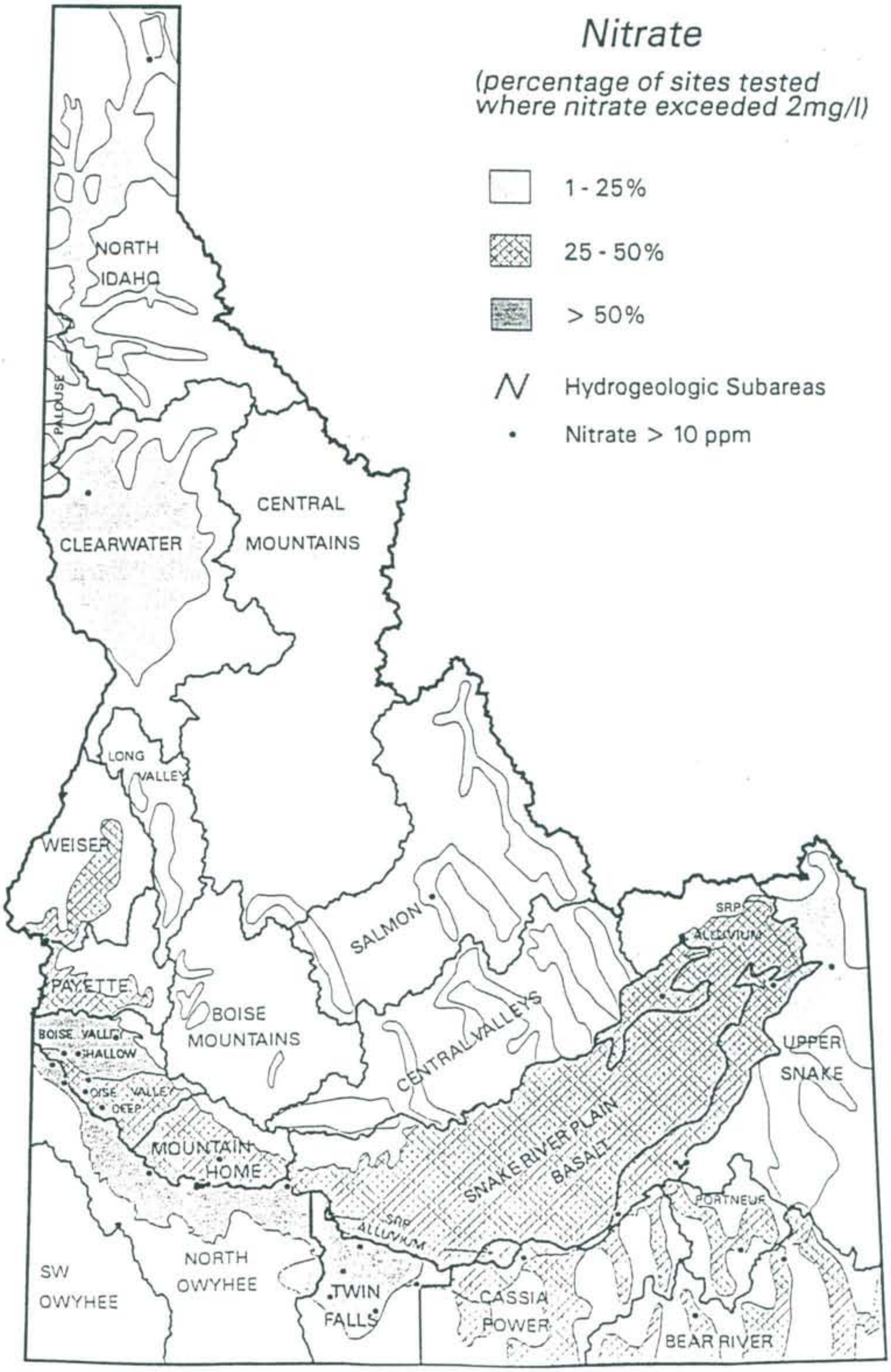
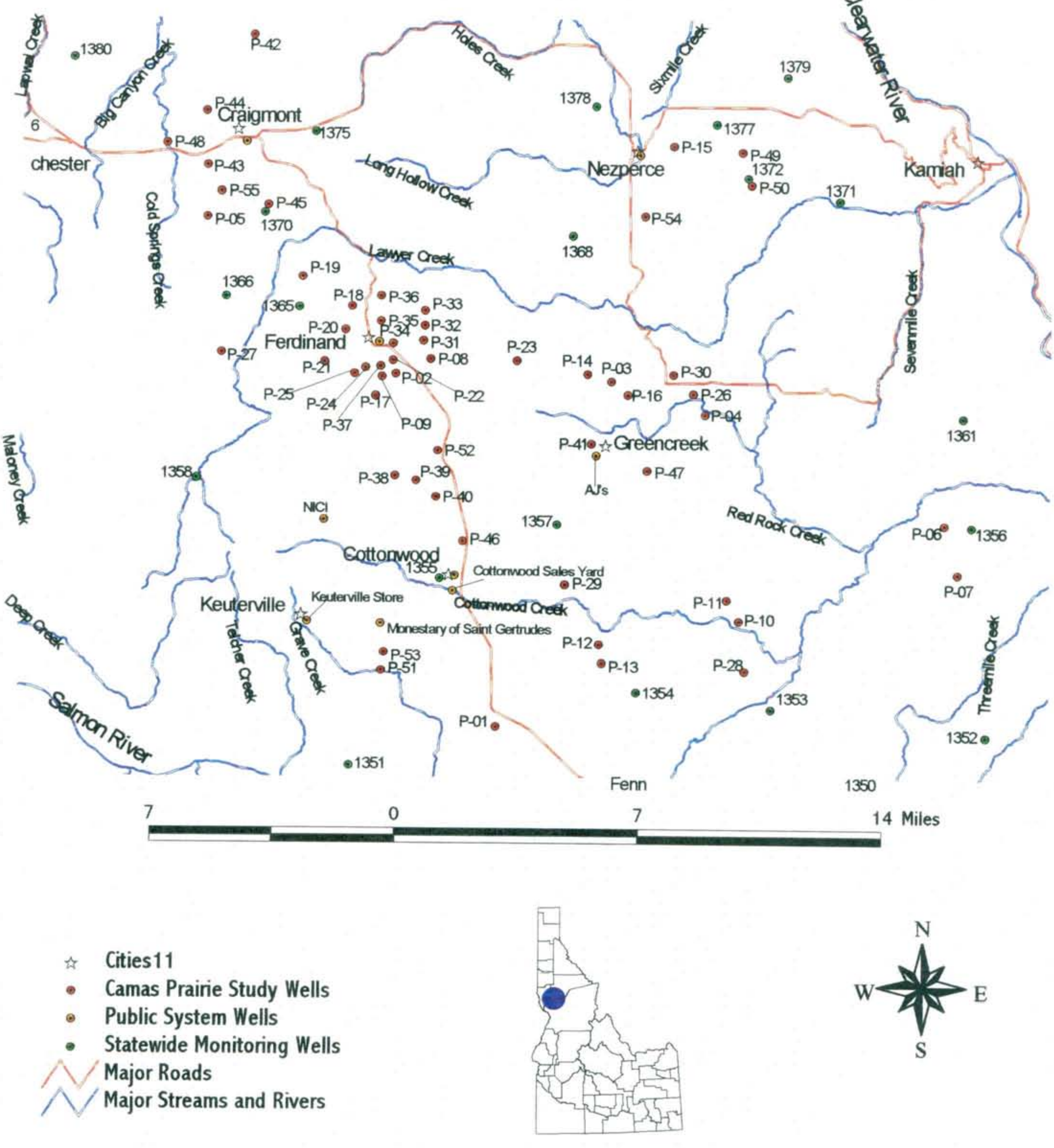


Table 1. Idaho Statewide Ground Water Quality Monitoring Program Hydrogeologic (Crockett, 1995)

Hydrogeologic Subarea	Nitrate (mg/l) range median 95% CI median # ≥ MCL, %	Nitrite (mg/l) range median	Ammonia (mg/l) range median	Phosphorus (mg/l) range median
North Idaho	<0.05 to 16 0.13 0.06 -> 0.19 1, 1%	<0.01 to 0.03 <0.01	<0.01 to 1.10 0.010	<0.01 to 0.29 <0.01
Palouse	<0.05 to 5.1 0.06 <0.05 -> 0.24 none	<0.01	<0.01 to 0.170 0.010	<0.01 to 0.17 0.055
Clearwater	<0.05 to 19 0.38 0.14 -> 0.71 1, 2%	<0.01 to 0.02 <0.01	<0.01 to 0.290 0.010	<0.01 to 0.28 0.05
Long Valley	<0.05 to 4.0 0.065 <0.05 -> 0.23 none	<0.01 to 0.02 <0.01	<0.01 to 0.76 0.020	0.01 to 0.97 0.06
Weiser	<0.05 to 19 0.44 0.07 -> 1.60 2, 9%	<0.01 to 0.02 <0.01	<0.01 to 2.40 0.020	<0.01 to 0.31 0.06
Payette	<0.05 to 12 0.77 0.06 -> 1.70 1, 3%	<0.01 to 0.04 <0.01	<0.01 to 8.0 0.030	<0.01 to 0.35 0.075
Boise Valley Shallow	<0.05 to 15 3.20 2.60 -> 3.70 3, 3%	<0.01 to 0.05 <0.01	<0.01 to 2.80 0.010	<0.01 to 1.6 0.04
Boise Valley Deep	<0.05 to 21 1.50 0.73 -> 1.90 3, 3%	<0.01 to 0.02 <0.01	<0.01 to 4.0 0.020	<0.01 to 0.19 0.02
Mountain Home	<0.05 to 16 1.40 0.79 -> 1.70 2, 5%	<0.01	<0.01 to 0.38 0.010	<0.01 to 1.10 0.02
North Owyhee	<0.05 to 110 2.40 <0.05 -> 4.3 8, 29%	<0.01 to 0.35 <0.01	<0.01 to 3.7 0.10	<0.01 to 0.10 0.02

Figure 4. Location of Existing Domestic Water Wells Selected for Sample Collection



STUDY AREA

The Camas Prairie is part of the 1700 square mile Clearwater Plateau (Castelin, 1976). The study area covers much of the Camas Prairie and is demographically represented by Craigmont, Idaho to the northwest, Nez Perce, Idaho to the northeast and Cottonwood, Idaho to the southwest (Figure 5). The study area covers parts of both Lewis and Idaho County (Figure 5). The major streams within the study area (Figure 5) include Lawyers Creek, Red Rock Creek and Cottonwood Creek. Elevations range from approximately 2601 to 3771 feet, while elevations in the surrounding Craig, Clearwater and Salmon River mountains reach 5000 (Castelin, 1976).

CLIMATE

Average annual precipitation on the prairie ranges from a low of approximately 20 inches to a high of 24 inches (Castelin, 1976). Average annual temperatures range from a low of 42 degrees Fahrenheit to a high of 48 degrees. The annual frost free days vary from 100 days to 150 days (Barker et. al., 1983). Most of the precipitation on the prairie falls between the months of March and June, with precipitation also increasing between the months of September and December (Castelin, 1976). The winters and springs are fairly precipitous into the month of June while the summers and early falls are generally dry. Summer precipitation normally comes in the form of thunder showers and generally contributes minimal amounts of precipitation to the ground water system.

ECOREGION

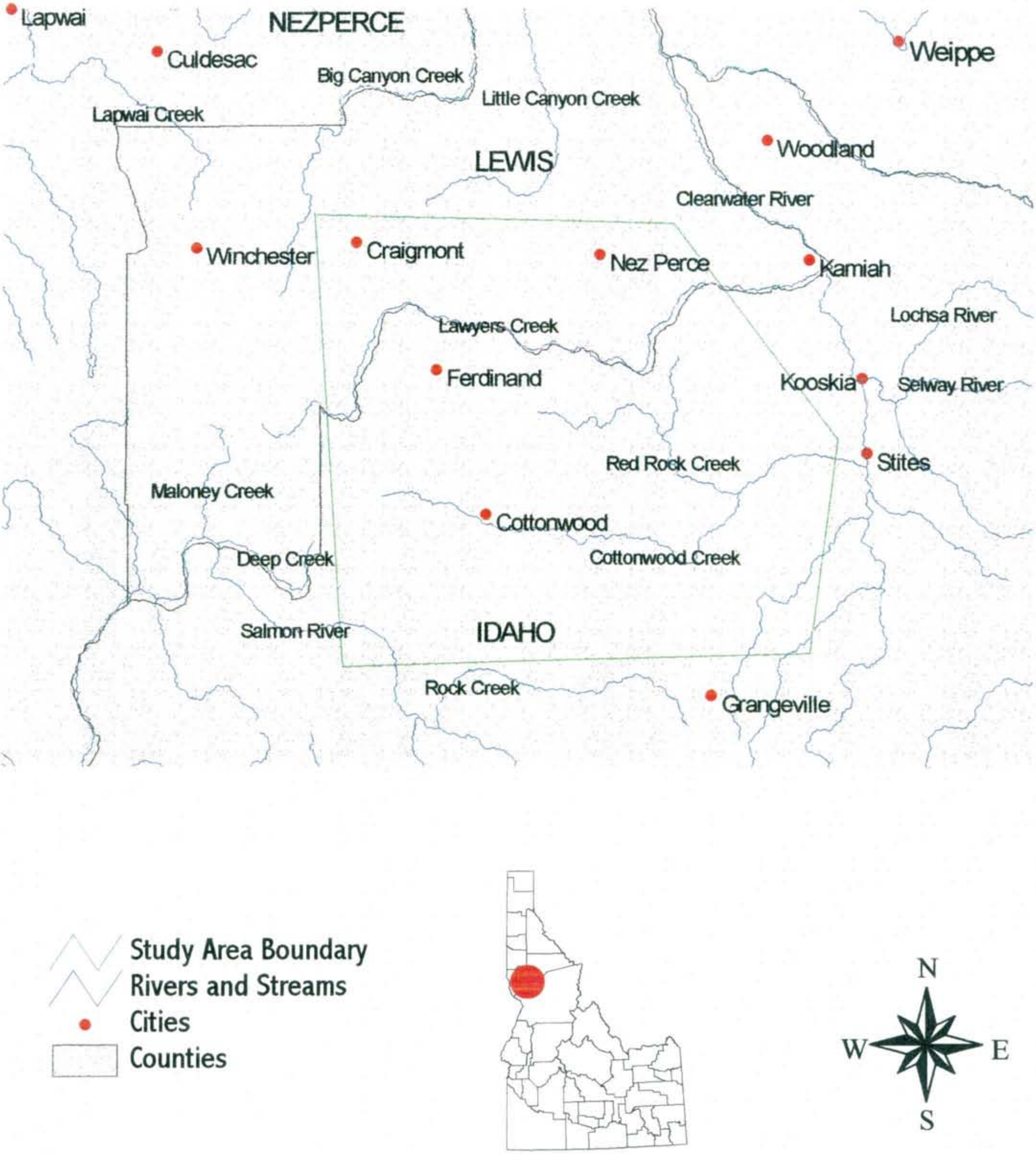
The Camas Prairie study area is considered part of the Columbia Basin Ecoregion. The Columbia Basin is surrounded by high mountain ranges including the Northern Rockies, the Blue Mountains and the Wallowa Mountains (Omernik and Gallant, 1986). The ecoregion is generally typified by deep, dry channels cut into the Columbia River Basalt formations with a landscape comprised of irregular plains, tablelands and moderate mountains (Omernik and Gallant, 1986).

River bodies in this ecoregion originate primarily in the adjacent mountainous regions with smaller streams forming from precipitation and ground water. Natural lakes are few and scattered while reservoirs exist primarily on the main river bodies (Omernik and Gallant, 1986).

The Columbia Ecoregion supports several natural vegetation species. The regional vegetation includes sagebrush/wheat grass steppe and grasslands of wheat grass, bluegrass and fescue (Omernik and Gallant, 1986).

Soils in the Columbia Ecoregion consist predominately of Xerolls, Haploxerolls and Argixerolls (Omernik and Gallant, 1986). Loess deposits overlay the basalt deposits throughout the region and can be identified by their gentle and irregular forming hills.

Figure 5. Study Area



SOILS

The soils on the Camas Prairie and surrounding highlands vary with topographic and elevation changes. There are six soil series that occur within the study area; they include the Flybow, Southwick, Nez Perce, Gwin, Klickson and Westlake series (Barker et. al., 1983). The soil units for these particular types are described topographically as gently slopping to hilly uplands, moderately sloping to steep canyons and nearly level bottom lands. The drainage class for these soils vary from somewhat poorly drained to well drained. These soils have a hydraulic conductivity that ranges from approximately 10^{-4} to 10^{-9} cm/sec (Fetter, 1980). Land use for these particular soils include woodland, non-irrigated cropland, rangeland, hay and pasture.

The *Nez Perce* is the most prominent soil series within the study area and has the following characteristics:

- Fine, montomorillonitic, mesic Xeric Argialbolls; very dark top layer of silt loam; underlain by a layer of dark silty clay and brown silty clay loam (Figure 6). This particular soil is the primary base for non-irrigated crops on the prairie and is moderately well drained.

Secondary soils include:

- Fine-silty, mixed mesic Argiaquic Xeric Argialbolls; moderately well drained; gently sloping to hilly uplands; woodland and non-irrigated cropland.

- Loamy-skeletal, mixed, mesic Lithic Typic Argixerolls; well drained; moderately sloping to steep canyons; rangeland.

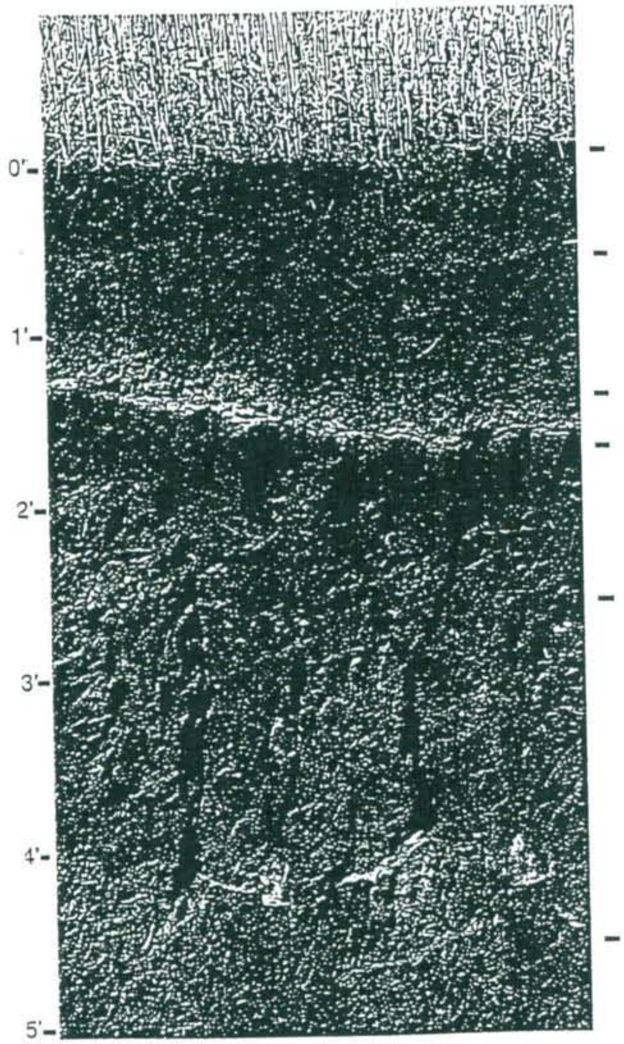
- Loamy-skeletal, mixed, frigid Ultic Argixerolls; well drained; moderately steep to very steep canyons; woodland, hay and pasture.

- Fine-silty, mixed, frigid Cumulic Ultic Haploxerolls; somewhat poorly drained, bottom lands; hay and pasture.

GEOLOGY

The Camas Prairie is characterized by what are now known as the Columbia River basalt flows. Approximately 34-40 million years ago during the mid-Tertiary period, three basalt flows (Imnaha, Grande Ronde, and Saddle Mountain) extruded east from vents in Oregon and Washington (Castelin, 1976) resulting in a succession of faulted basalt layers. The flows did not extrude in continual succession, but were deposited such that weathering took place on the layers creating interbeds of water bearing material. Figure 7 illustrates the general subsurface geology and fault zones of the study and the Clearwater Plateau.

Figure 6. Nez Perce Soil Series (Barker, McDole and Logan, 1983)



Ap—0 to 7 inches; very dark grayish brown silt loam, granular structure, medium acid.

A—7 to 16 inches; dark grayish brown silt loam, subangular blocky structure, slightly acid.

Ec—16 to 19 inches; pale brown silt loam, subangular blocky structure, iron concretions, neutral.

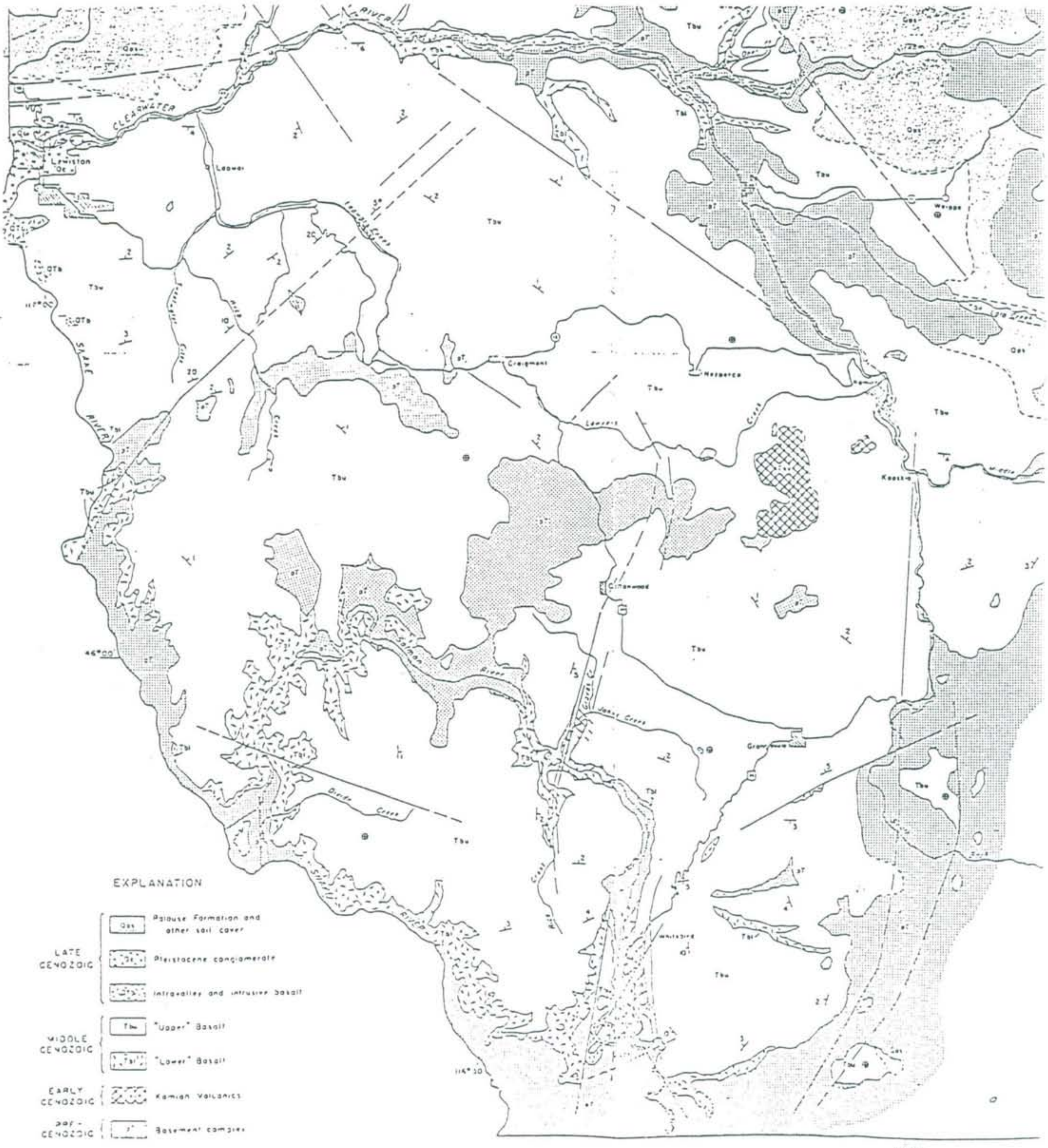
Btb—19 to 32 inches; dark brown silty clay, prismatic structure, many slickensides, neutral.

Btkb—32 to 55 inches; brown silty clay, prismatic structure, many slickensides, pockets of calcium carbonate, mildly alkaline.

Btb—55 to 62 inches; brown silty clay loam, subangular blocky structure, moderately alkaline.

Soil 35 (Nez Perce Series) with ripening winter wheat. North-facing slopes in the background have soils which lack E horizons.

Figure 7. Geologic Map of the Study Area and the Clearwater Plateau (Bond, 1963)



Prior to the succession of basalt flows (approximately eighteen million years ago), the prairie was comprised of three major rock groups: rocks of the Belt Supergroup (primarily sedimentary and metamorphosed sedimentary rocks); rocks of the Seven Devils Volcanics (primarily andesites); and rocks of the Idaho Batholith (primarily granite) (Castelin, 1976). During the mid-Tertiary period, the prairie topography was consistently hilly, late mature uplands with rounded peaks of granite and metamorphic rocks (Ralston et. al., 1993). Two of the biggest rivers in Idaho did not exist during the mid-Tertiary period (the Salmon and Snake), but the South Fork of the Clearwater cut directly across what is now the Camas Prairie (Ralston et. al., 1993).

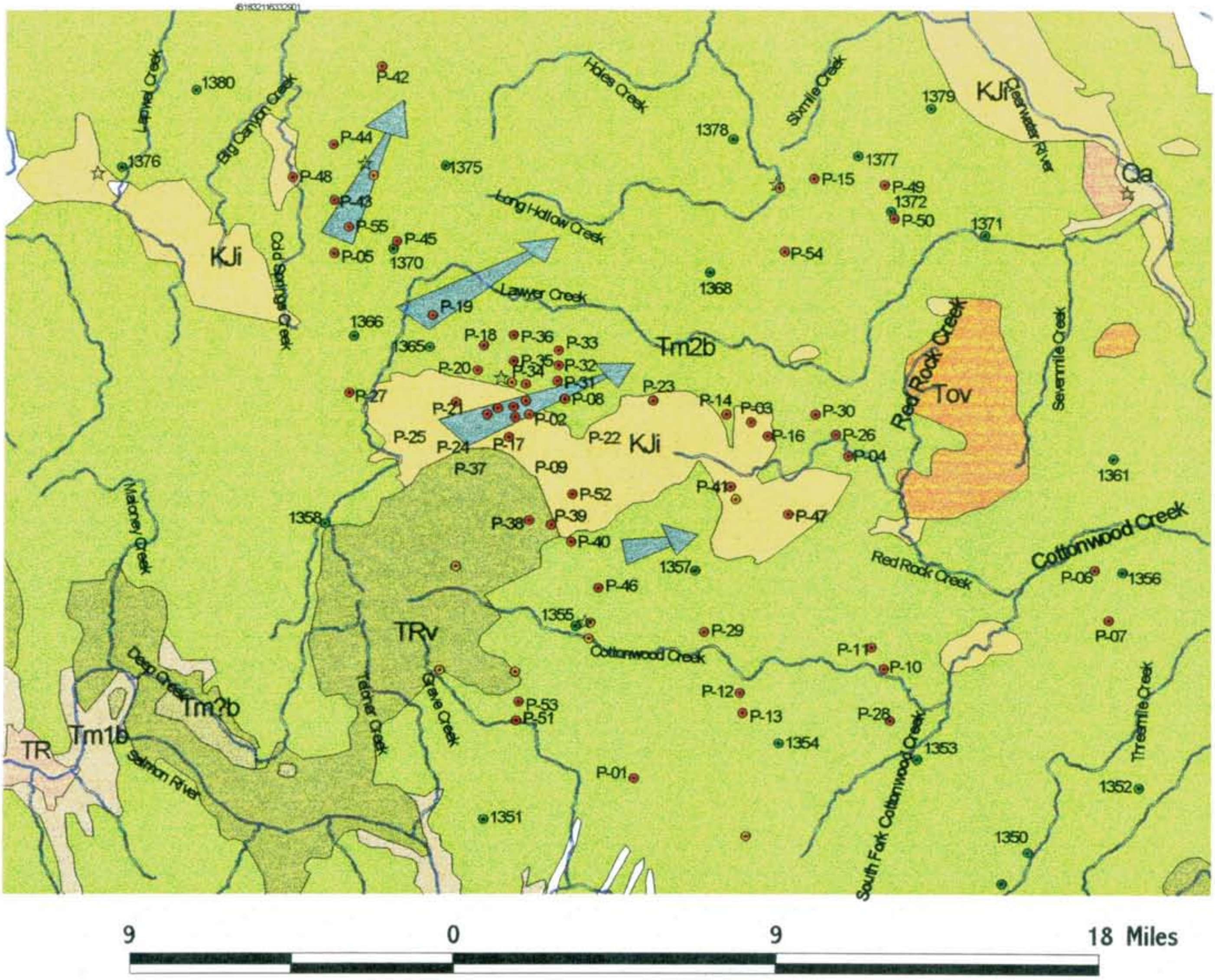
HYDROLOGY & HYDROGEOLOGY

The two major river drainages bordering the Camas Prairie are the Salmon River on the west side and the South Fork of the Clearwater River on the east side. The most significant drainage on the prairie itself is Lawyers Creek, which flows from west to east across the prairie. Most of the perennial streams on the Camas Prairie originate in the adjacent mountainous regions while intermittent streams can be found on the prairie where ground water is available for continual flow. During the late summer months some of the intermittent ground water fed streams run dry depending on ground water levels, precipitation and additional hydrologic factors.

The ground water resources on the Camas Prairie find most of their recharge in the form of direct precipitation. The areas of highest precipitation on the prairie occur in the surrounding highs, which include the Craig Mountains, Mount Idaho and Cottonwood Butte. The primary discharge areas on the prairie occur primarily at river and stream drainages, including the Salmon River, the South Fork of the Clearwater River, Lawyers Creek and other small streams. In the months of lesser precipitation, the major sources of recharge on the prairie are surface water bodies that gradually lose water to ground water seepage.

Ground water flow on the prairie varies due to the complex hydrogeologic system of faults, basaltic interbeds and other geologic factors. The general trend for ground water flow on the northern half of the prairie is in the northeasterly flow direction (Figure 8). Much of this water originates from precipitation in the Craig Mountains and Cottonwood Butte flowing northeasterly and discharging into Lawyers Creek and other discharge areas. It should be noted that the arrows on figure 8 depict a very general flow pattern and that on a localized scale ground water flow will vary considerably.

Figure 8. General Hydrogeology and Direction of Ground Water Flow (after Morrison, 1976)



☆ Cities11
Camas Prairie Study Wells
Statewide Monitoring Wells
Public System Wells
Major Streams and Rivers
Ground Water Flow Direction

Geology
KJi - Lower Cretaceous to Upper Jurassic Intrusions (Granite)
Qa - Quaternary Alluvium
Qg - Quaternary Colluvium
Qw - Quaternary Wind Blown Deposits
TR - Triassic Shalllow Marine to Non-Marine Sediments
TRv - Middle and Lower Triassic Metabasalt and Submarine Volcaniclastics
Tm1b - Miocen Basalt
Tm2b - Miocene Basalt
Tm?b - Miocene Basalt
Tov - Lower Tertiary (Mixed Volcanics)

According to Castelin (1976), the ground water on the prairie is typically found in aquifers consisting of:

(1) fractures in the rock bodies
(2) pore spaces of sedimentary material
(3) and interflow zones of basalt flows.

This hydrogeologic make-up equates to a complex system of ground water movement on the Clearwater Plateau. Contributing factors to the complexity of ground water movement include:

(1) the succession of basalt flows
(2) interflow zones
(3) alluvial interbeds
(4) massive crystalline rocks of the Idaho Batholith
(5) metamorphosed rocks of the Belt Supergroup
(6) and the Seven Devils Volcanics.

LAND USE

The Camas Prairie is primarily used for the production of dry-land crops. Primary crops include wheat, barley and peas while secondary crops include oats, canola, alfalfa and other small scale crops. Along with the production of crops, prairie farms are utilized for the purpose of raising livestock, primarily cattle and hogs.

Land use on the prairie also consists of municipal development. City populations range from 3,126 in Grangeville, Idaho to 135 in Ferdinand, Idaho (Bureau of Census, 1990) with scattered households existing outside the incorporated cities. Development within the municipalities includes residential housing, some light industry and agricultural chemical and associated industries. Residential areas on the prairie consist of sewered and non-sewered systems. The municipal wastewater treatment systems for the communities consist of wastewater lagoons located within about a mile of each city.

WATER USE

The primary ground water users on the Camas Prairie are the cities and associated industries. The prairie is dry-land farmed, so irrigation is virtually non-existent. Very little quantitative data exists pertaining to the ground water resources on the prairie.

Ralston et. al (1993) in their ground water study around Grangeville addressed the issue of ground water supply and usage. Ralston et. al (1993) concluded that the water level declines in and around the City of Grangeville ranged from 0 to 21 feet/year. They also concluded that water level decline in the Grangeville area is greater than most areas in Idaho. But according the report, much of the decline can be traced to poor well construction and penetration of multiple aquifers with deep wells.

MATERIALS AND METHODS

SITE SELECTION

Initial site selection was based on Geographical Informational System (GIS) data compiled by the DEQ Boise-Regional Office. The DEQ identified Priority Group Areas (Figure 9) and Priority Sites based on ground water data from the Ambient Ground Water Monitoring Network. From this data, two priority group areas were derived for the Camas Prairie. Sites were selected within and between the boundaries of these two priority areas.

Priority area and site designation are based on the following criteria:

(1) A1 areas require nitrate levels greater than 5 mg/L in more than 25% of the wells,
(2) A2 areas require nitrate levels greater than 2 mg/L in more than 50% of the wells,
(3) S1 sites are wells with nitrate levels exceeding 10 mg/L but not located in A1 areas,
(4) S2 sites are wells with nitrate levels greater than 5 mg/L but not located in A1or A2 areas.

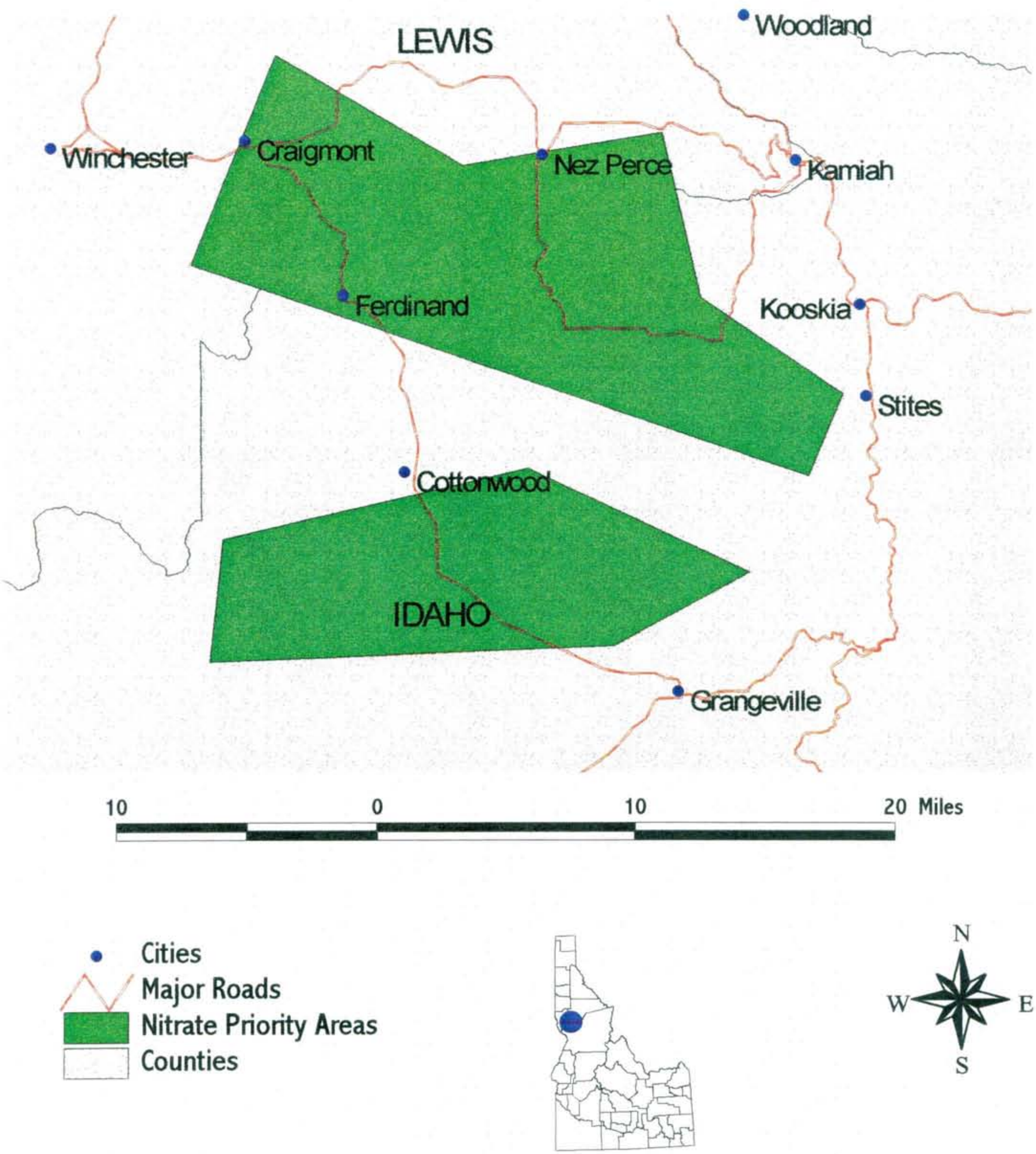
Once potential sites were identified on a topographical map, the well owners were contacted via letter (Appendix C) or telephone. Mailed responses were collected from well owners with their written permission. Verbal permission was obtained from those who failed to respond to the letter. Permission was also acquired with the help of two city officials from Craigmont and Ferdinand, Idaho.

Final site selection relied on the willingness of well owners to participate in this study. This approach allowed for the sampling of wells that were new, old, shallow and deep. The rationale for this well selection process was based on the quantity of well samples (fifty-five) and the reconnaissance nature of this study. The two of the primary objective of this study were to obtain a relatively large quantity of ground water data, covering a large geographic area; thus, the well selection process was justified by the broad and reconnaissance level objectives of this study.

METHODS

Samples were collected from domestic wells within the designated study area. Each well (and in one case, a spring) was purged for a minimum of five minutes prior to the water sample collection. Field parameters of specific conductance and temperature were recorded at each sampling site. Samples were then submitted to the State of Idaho, Bureau of Laboratories in Boise for analysis as nitrite plus nitrate as nitrogen.

Figure 9. Nitrate Priority Areas (Polygons Based on Data from the Statewide Ambient Ground Water Monitoring Network)



RESULTS AND DISCUSSION

PUBLIC WATER SYSTEM DATA

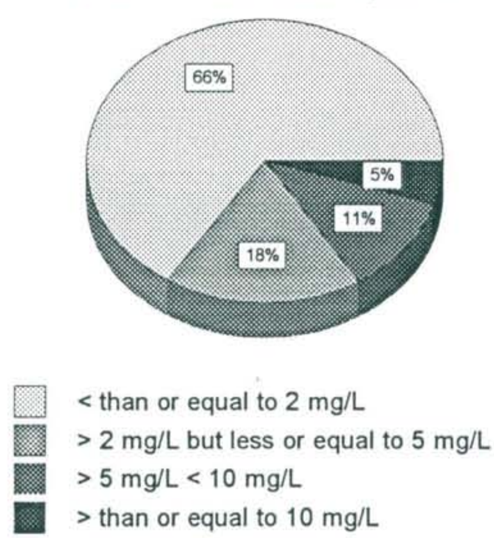
Nitrate data was collected from public water systems within the study area. The systems with greater than twenty-five connections included the Cities of Craigmont, Ferdinand, Cottonwood and Nezperce, Idaho along with the North Idaho Correctional Institute (Figure 4). The systems with less than twenty-five connections included the Monastery of Saint Gertrude's, the Keuterville Store, Cottonwood Sales Yard, AJ's in Greencreek, and the City of Fenn (Figure 4).

Nitrate concentrations (Table 2) from these wells provided some historical background for ground water conditions. Nitrate records date back to 1957, but sampling at this time was sporadic and not performed on a regular basis. This is not to say that trends cannot be identified and conclusions drawn, because it is apparent by looking at the data that some of the wells are experiencing nitrate related trends (either increasing or decreasing).

The nitrate concentration range, mean and percentages are as follows:

- Nitrate concentrations range from 42.5 mg/L to non-detect levels with a mean of 2.52 mg/L,
- Sixty-six percent of the wells were less than or equal to 2 mg/L,
- Eighteen percent were greater than 2 mg/L but less than or equal to 5 mg/L,
- Eleven percent were greater than 5 mg/L but less than 10 mg/L,
- Five percent were greater than or equal to 10 mg/L (Chart 1),
- Overall, thirty-four percent of the public wells are demonstrating human influence, while sixty-seven percent are experiencing nitrate levels below the EPA's generalized background level of 2 mg/L.

Chart 1. Public Water Systems



The City of Craigmont is currently supplemented by three wells, one of which (#3) is very deep (approximately 900 ft). Nitrate data for the other two wells (#1 and #2) show moderate nitrate levels, but data for well number one demonstrates some variation. It was also unclear by looking at the nitrate records for well one and two, whether the nitrate concentrations for 1957 and 1964 are associated with well one or two. Well number three (Table 2) beginning in 1982 and continuing to 1997 has clearly shown an increasing trend (from <.003 mg/L to 1.96 mg/L) in nitrate concentrations. Nitrate concentrations still remain low, but the increasing trend raises concern about deep aquifer contamination. Such concerns have prompted the City of Craigmont and the DEQ to develop a Wellhead Protection Plan.

The City of Ferdinand is also developing a Wellhead Protection Plan in conjunction with the DEQ. Ferdinand's primary well has been experiencing moderate to elevated levels of nitrates dating back to the early 1980s. Their nitrate levels have been hovering around the MCL for several years and do not appear to be decreasing. Historical data (Table 2) indicates some variation in nitrate levels, but levels have clearly remained above background levels.

For the purpose of this summary, the Cities of Cottonwood and Nezperce, Idaho and the North Idaho Correctional Institute will be consolidated because of their similarities in nitrate concentrations. Nitrate concentrations for these three sites are low and warrant little need for concern. For the most part, nitrate levels have remained below the background level of 2 mg/L and in some cases below the detection level (.005 mg/L). Historical data (Table 2) conveys some variation, but there does not appear to be any indication of consistent increases in nitrate levels.

Public systems with less than twenty-five connections indicate that nitrate levels within those systems are low to moderate. Cottonwood Sales Yard, AJ's and Fenn (Table 2) warrant very minimal concern. Most of the nitrate data falls below 1 mg/L and numerous samples fell below the detection level.

The Monastery of Saint Gertrude's and the Keuterville Store (Table 2) paint a little different picture. The Monastery has experienced some variation with levels clearly higher today than fifteen to twenty years ago. The Keuterville Store is currently just above the background level, but since 1980, nitrate levels have been on a slow but increasing trend.

TABLE 2. NITRATE CONCENTRATIONS FOR THE PUBLIC WATER SYSTEMS

CRAIGMONT	**1997**	**1995**	**1994**	**1986**	**1985**	**1982**	**1972**	**1964**	**1957**	
NORTH WELL #1		0.7	3.51				**17**	5	2.2	
EAST WELL #2	8.03	6.1	6.29				**42.5**	5	2.2	
SOUTH WELL #3	1.96	0.4	<.1	0.017	0.003	<.003				
FERDINAND	**1997**	**1996**	**1988**	**1985**	**1982**	**1983**	**1972**			
NORTH WELL										
EAST WELL	5.6	8.5	**10.5**	5.95	5.38	0.5				
SOUTH WELL							0.2			
COTTONWOOD	**1997**	**1996**	**1995**	**1993**	**1991**	**1976**	**1974**	**1972**	**1964**	
WELL #2	1.3	0.9	0.8	0.906		2.7	2.1	1.9	0.2	
WELL #3	0.8		<.1	0.892	<.05	0.02		0.4		
WELL #4	ND	ND	<.1	<.005						
NEZ PERCE	**1997**	**1996**	**1995**	**1994**	**1975**	**1966**	**1966**			
WELL #1	ND	3.78	0.3	<.5			<.01			
WELL #2				4.4			2			
WELL #4	0.3	3.73	3		**14.4**	0				
NORTH IDAHO CORRECTIONAL INSTITUTE										
Well #5	0.2	0.378	0.331	0.43						
	1997	**1997**	**1995**	**1994**	**1993**	**1993**	**1992**	**1986**	**1982**	**1979**
MON. OF ST. GERTRUDE'S	2.9	7.3	3.54	1.62	2.08	<.01	2.14	0.14	0.5	0.27
KEUTERVILLE STORE	**1997**	**1993**	**1981**	**1980**						
	2.3	1.36	1.35	0.066						
COTTONWOOD SALES YARD	**1997**	**1996**	**1993**	**1989**						
	ND	0.77	6.27	3.45						
AJ'S--GREENCREEK	**1997**	**1996**	**1994**	**1983**						
	ND	ND	0.43	0.056						
FENN	**1997**	**1996**	**1995**	**1995**	**1993**	**1989**	**1986**	**1983**	**1979**	
	0.11	0.11	<.10		<.10	0.028	0.044	0.05	.09	

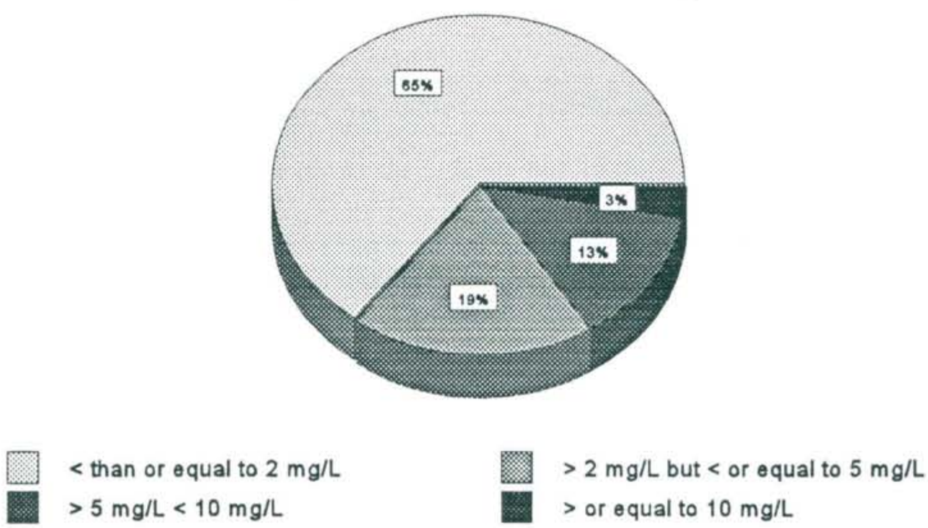
AMBIENT MONITORING NETWORK DATA

Nitrate data for twenty-two wells (Table 3) was extracted from the Ambient Ground Water Monitoring Network for the purpose of this study. All of these private wells were sampled between 1990 and 1994, with some of the being resampled in 1995 and 1997.

The nitrate concentration range, mean and percentages are as follows:

- Of all the wells resampled during 1995 or 1997, every well except number 1352 showed an increase in nitrate concentration,
- The wells ranged from a low of <.05 to a high of 45 mg/L with a mean of 3.43 mg/L,
- Sixty-five percent were less than or equal to 2 mg/L,
- Nineteen percent were greater than 2 mg/L but less than or equal to 5 mg/L,
- Thirteen percent were greater than 5 mg/L but less than 10 mg/L, and three percent were greater than or equal to 10 mg/L (Chart 2).

Chart 2. Ambient Ground Water Monitoring Network



Over half of the wells have a nitrate concentration of 2 mg/L or less. This indicates that most of the wells remain below the generalized background level of 2 mg/L, but thirty-five percent of the wells sampled are experiencing nitrate levels said to be under human influence. These particular data points are sparse and cover a large geographic region. More nitrate data is needed in order to thoroughly address the regional ground water conditions. Additional data is provided from the Camas Prairie wells.

Table 3. Nitrate Data from the Ambient Ground Water Monitoring Network

NUMBER	NITRATE (90-94)	NITRATE (95)	NITRATE (97)	NITRATE (98)
1350	<.050			
1351	2	3		
1352	<.05	<.05		
1353	4.3	6.5		
1354	5.4			
1355	<.05	0.61	0.704	
1356	4.5			
1357	0.65			
1358	<.05			
1361	0.39			
1365	0.71		1.03	
1366	3.4		3.94	
1368	6	45		
1370	1.2			
1371	0.1			
1372	8.5			65.0
1375	3.7			
1376	<.05			
1377	0.24			
1378	1.4	1.7		
1379	0.27			
1380	0.87			

CAMAS PRAIRIE DATA

A total of fifty-five samples were collected within the study area. Wells were selected and sampled covering a large geographic area (Figure 4) and a diverse mixture of hydrogeologic sources. Sampled wells included ones penetrating the first water bearing zone, while others penetrated multiple aquifers. Well depths ranged from forty feet to six hundred and forty feet. In addition, two springs were sampled for nitrate concentrations. Well attributes are provided in Appendix E. It should also be noted that hard copies of all the data collected for each well site is provided in **Volume II** of this report.

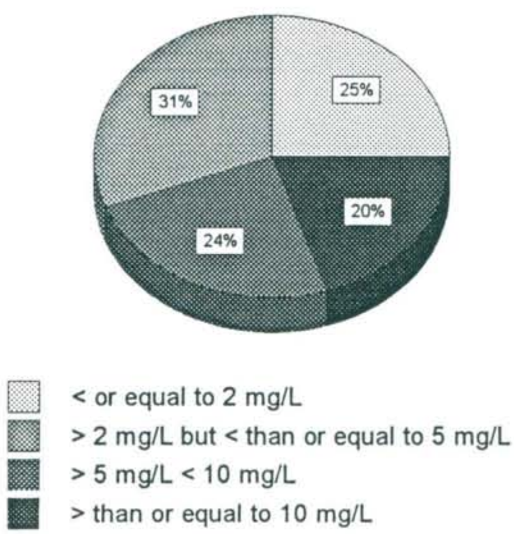
Nitrite/Nitrate

Background concentrations for nitrate range from below the detection limit of .005 mg/L to 2 mg/L. The figure of 2 mg/L is generally accepted as the threshold for natural occurrence of nitrate in ground water. Thirteen percent of the wells sampled fell below the detection limit, which could signify that .005 mg/L is representative of background levels. Available historic data is not adequate to confirm this, but historic data does indicate that most nitrate concentrations fall below 2 mg/L. Not enough data exists to confirm the background level for nitrate, but available data and sources suggest that it falls between .005 mg/L and 2 mg/L.

The nitrate concentration range, mean and percentages are as follows:

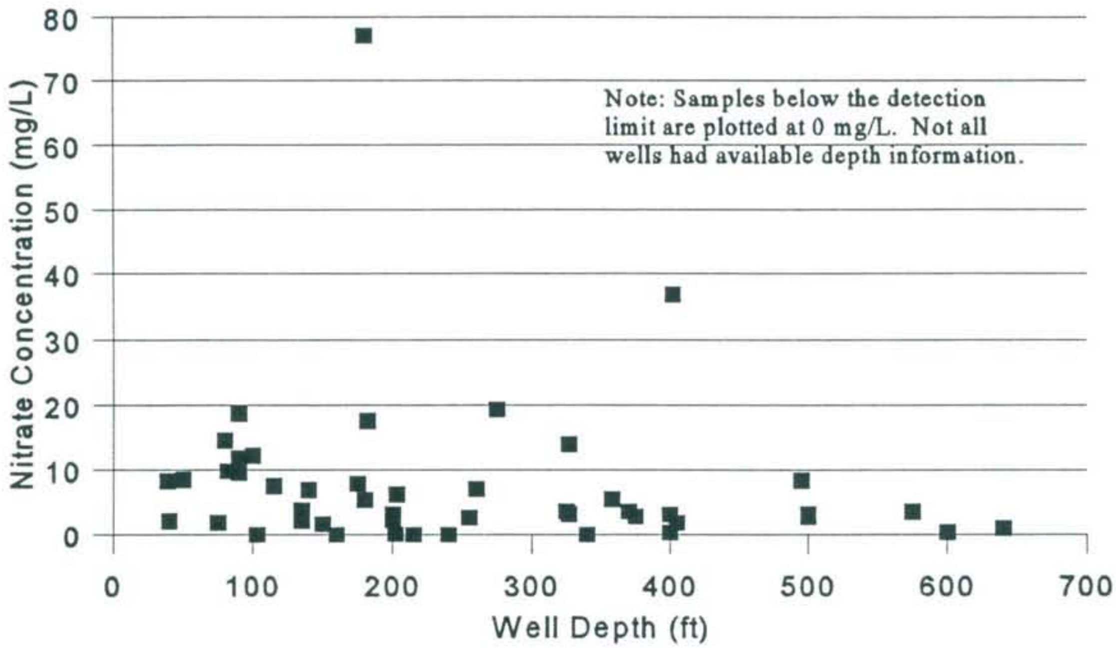
- Nitrate concentrations ranged from non-detectable limits to a high of 77.1 mg/L (Table 3) with a mean of 7.45 mg/L,
- Twenty-five percent were less than or equal to 2 mg/L,
- Thirty-one percent were greater than 2 mg/L but less than or equal to 5 mg/L,
- Twenty-four percent were greater than 5 mg/L but less than 10 mg/L,
- Twenty percent were greater than or equal to 10 mg/L (Chart 3).

Chart 3. Camas Prairie Data



The results from this study are significantly higher in relation to both the public water system data and the ambient monitoring network data. The greatest percentage (31%) of sampled wells are greater than 2 mg/L but less than or equal to 5 mg/L (chart 3); where as with the public and ambient data sources, the highest percentage (66 and 65) of the wells were less than or equal to 2 mg/L (Chart 1 and 2). The most profound increase occurs with nitrate levels exceeding the 10 mg/L MCL. Twenty percent of the new data points had nitrate concentrations exceeding the 10 mg/L MCL; where as the public wells and ambient wells had percentages of three and five respectively. For further analysis, nitrate concentrations were compared to well depth (Chart 4).

Chart 4. Nitrate vs Well Depth



The nitrate versus well depth results are as follows:

- Of the twelve sites with nitrate concentrations of 2 mg/L or less, eight of those were greater than 200 feet deep, and five of those eight were greater than 300 feet deep,
- Of the twelve sites with nitrate concentrations between 5 mg/L and 10 mg/L, eight of those were less than or equal to 200 feet, and four of those eight were less than 100 feet,
- Of the nine sites with nitrate concentrations equal to or exceeding 10 mg/L, six of those were less than or equal to 200 feet, while four of those six were less than or equal to 100 feet.

As expected, there is a negative correlation between nitrate concentrations and well depth (as nitrate increases, well depth decreases and vice versa), but this relationship does not hold true for all wells. A minority of the wells demonstrated positive correlations between nitrate concentration and well depth.

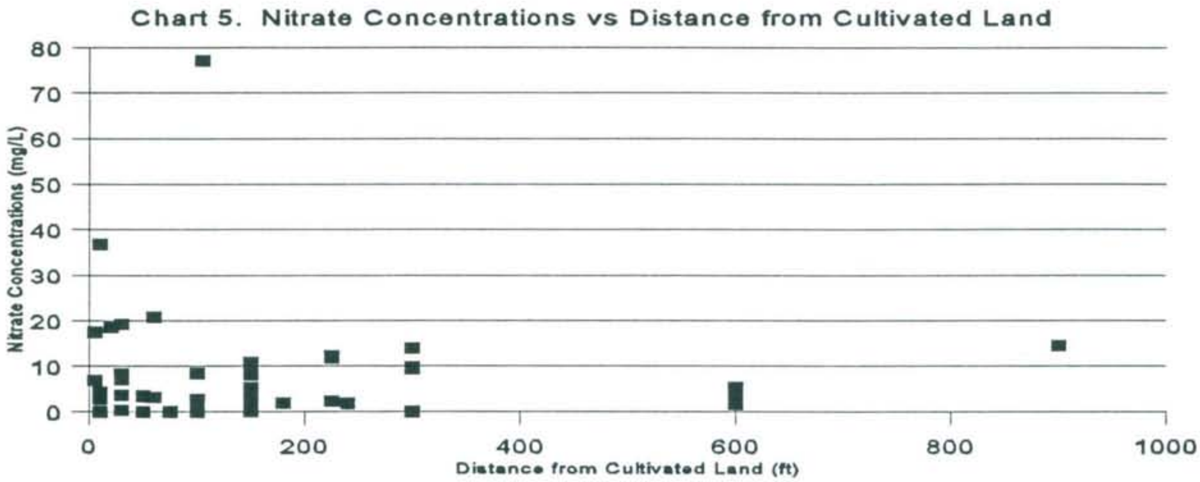
Table 4. Camas Prairie Data

Number	Depth	Distance From Cultivated Land	Nitrate 98
001	495	30 feet	8.35
002	600	30 feet	0.318
003	402	10 feet	36.8
004	275	30 feet	19.3
005	575	50 feet	3.57
006	358	?	5.48
007	260	30 feet	7.02
008	175	30 feet	7.83
009	202	150 feet	0.112
010	100	225 feet	12.2
000	240	100 feet	<.005
012	215	300 feet	0.005
013	90	300 feet	9.46
014	115	?	7.48
015	375	150 feet	2.83
016	640	100 feet	0.968
017	500	50 feet	3.24
018	160	300 feet	<.005
019	327	300 feet	13.9
020	82	300 feet	9.8
021	203	?	6.19
022	400	150 feet	0.338
023	75	240 feet	1.84
024		150 feet	10.8
025		600 feet	5.42
026	135	150 feet	3.77
027	340	75 feet	<.005
028	182	5 feet	17.5
029	200	150 feet	2.2
030	255	100 feet	2.66
031	39	150 feet	8.25
032	50	100 feet	8.45
033	40	150 feet	2.09
034	60		<.005
035	140 ?	5 feet	6.91
036	135	600 feet	2.15
037	370	30 feet	3.63
038	325	30 feet	3.62
039	400	600 feet	3.12
040	200	225 feet	2.29
041	327	60 feet	3.17
042	180	150 feet	5.4
043	90	225 feet	11.8
044		150 feet	4.43
045	405	180 feet	1.87
046	500	10 feet	2.72
047	103	10 feet	<.005
048	400	60 feet	20.8
049	192	50 feet	<.005
050	180	105 feet	77.1
051	150	600 feet	1.66
052	80	900 feet	14.5
053	200		3.22
054		10 feet	4.4
055	90	20 feet	18.6

VULNERABILITY

One of the reasons for conducting this study was to determine if ground water contamination has occurred. Thus, the occurrence of ground water contamination or the degree at which it occurs is an indication of ground water susceptibility to contamination.

A land use evaluation was conducted at each site upon collection of a nitrate sample. A local land use form (Appendix F) was used to assess the land use within one-half mile of the well. Also, distances from wells were estimated for feedlots, pastures, and distances from cultivated land (Table 3 and Appendix G) were recorded for each well site. The distances were not calculated with any measuring device, so all distances are purely estimations.



The results of the nitrate versus distance from cultivated land are as follows:

- Seven of the eleven wells exceeding the MCL fall within 200 feet of cultivated land, and five of the seven are under 60 feet,
- All of the wells with the most extreme nitrate concentrations fell within a 100 feet of cultivated land,
- Of the 10 sites with nitrate concentrations greater than 5 mg/L but less 10 mg/L, seven of those are within 200 feet of cultivated land; five of those seven are within 100 feet of cultivated land; and four of those five are within 50 feet,
- Of the thirteen sites less than or equal 2 mg/L, 9 of those were within 200 feet of cultivated land, while only four of those thirteen exceeded 200 feet.

It is evident that the majority of wells (72%) fall within 200 feet of some sort of cultivated land. These include wells with both high and low nitrate concentrations. One can discern from this data that most, if not all well sites are being heavily influenced by one or multiple nitrogen sources. In addition to the application of inorganic fertilizers, nitrate contamination could be traced to localized problems such as septic/drain fields; animal waste application and disposal; and poor well construction, like a faulty or inadequate seal. So, based on the diversity of contaminant sources and the insufficiency of data at this point, it is not possible to draw precise conclusions on contaminant sources. One can only concluded that the Camas Prairie ground water appears vulnerable to nitrate contamination.

CONCLUSIONS

The primary purpose of this study was to assess the Camas Prairie ground water quality as it relates to nitrate concentrations. One must keep in mind that this study was a reconnaissance level effort, which means that more investigation and monitoring is needed to fully address the regional ground water conditions. The sheer size and hydrogeologic complexity of the study warrants more data. It should also be noted that no conclusions can be or will be drawn about any point sources for contamination.

The elevated nitrate concentrations, when compared with public wells and the data from the Statewide Ambient Ground Water Monitoring Network, suggest that the samples collected for this study had significantly higher nitrate concentrations. What makes the data significantly different are the percentages of samples with nitrate concentrations less than or equal to 2 mg/L and nitrate concentrations exceeding the MCL of 10 mg/L. The public system and ambient data have percentages of sixty-six and sixty-five percent respectively of samples less than or equal to 2 mg/L. The concentrations measured in domestic well samples collected for this study have only twenty-five percent falling at 2 mg/L or less. Twenty percent of the private wells sampled for this study exceeded the MCL. Three and five percent exceeded the MCL for the public wells and ambient network wells. Overall, the percentage of samples occurring in the 5 mg/L to 10 mg/L range appear to be increasing based on the fifty-five well sites sampled for this study. The average nitrate concentration of 7.45 mg/L and percentages in chart 3 attest to this conclusion.

Nitrate concentrations versus well depth revealed that there is a negative correlation. Meaning that as a general trend, nitrate concentrations decrease as well depth increases. The consumptive use of wells drilled in the surficial aquifer should be discouraged, but if used, these wells should be monitored on a regular basis. This is not to say that the deep wells are isolated from nitrate contamination, because the second highest nitrate concentration (36.8 mg/L) found in this study was taken from a 402 foot well. All wells with nitrate concentrations exceeding the MCL should be monitored on a regular basis.

Land use was recorded for each well site, which included identifying approximate distances of cultivated land from the well sites. Land uses impacting the Camas Prairie ground water include primarily dry-crop farming and pasture with some feedlots, ag-chemical and other light industry. Septic systems also present a threat to local ground water conditions. Based on the land use data, seventy-two percent of the wells fall within 200 feet of some sort of cultivated land. These include wells with both high and low nitrate concentrations. All of the most elevated nitrate concentrations fall within 100 feet of cultivated land. The fact that so many wells are within agricultural impacted areas indicates that the ground water resources are certainly vulnerable to nitrate contamination. Seventy-five percent of the sites sampled exceed 2 mg/L, or in another words, seventy-five percent of the wells demonstrate human induced impacts, which further enhances the vulnerability for ground water contamination.

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

Each sample was collected in accordance with quality assurance/quality control (QA/QC) guidelines and submitted accordingly. Replicate samples were taken for approximately ten percent of the wells (five samples). Standard one liter containers and preservation techniques (2 ml sulfuric acidification and chilling to four degrees Celsius) were used for the samples sent to the laboratory. Internal laboratory QA/QC checks were performed by the State lab in accordance with their operating procedures.

Nitrate replicates were taken at several sites. A replicate sample taken at site #16 demonstrated a concentration of .968 mg/L versus .966 mg/L. Site #21 showed a concentration of 6.22 mg/L versus 6.19 mg/L. Site #037 demonstrated a concentration of 3.67 mg/L versus 3.63 mg/L. Site #40 showed an identical concentration of 2.29 mg/L. And site #50 demonstrated the greatest variability with a concentration of 82.3 mg/L versus 77.1 mg/L.

The EPA uses a relative difference value of 20% to determine precision and accuracy of duplicate samples. The highest percentage found in the study was 6% (site #50), while the lowest was 0% (site #40) difference. The EPA's relative percent difference (RPD) formula was used for each sample/duplicate combination; the formula and results can be found in *Appendix D.*

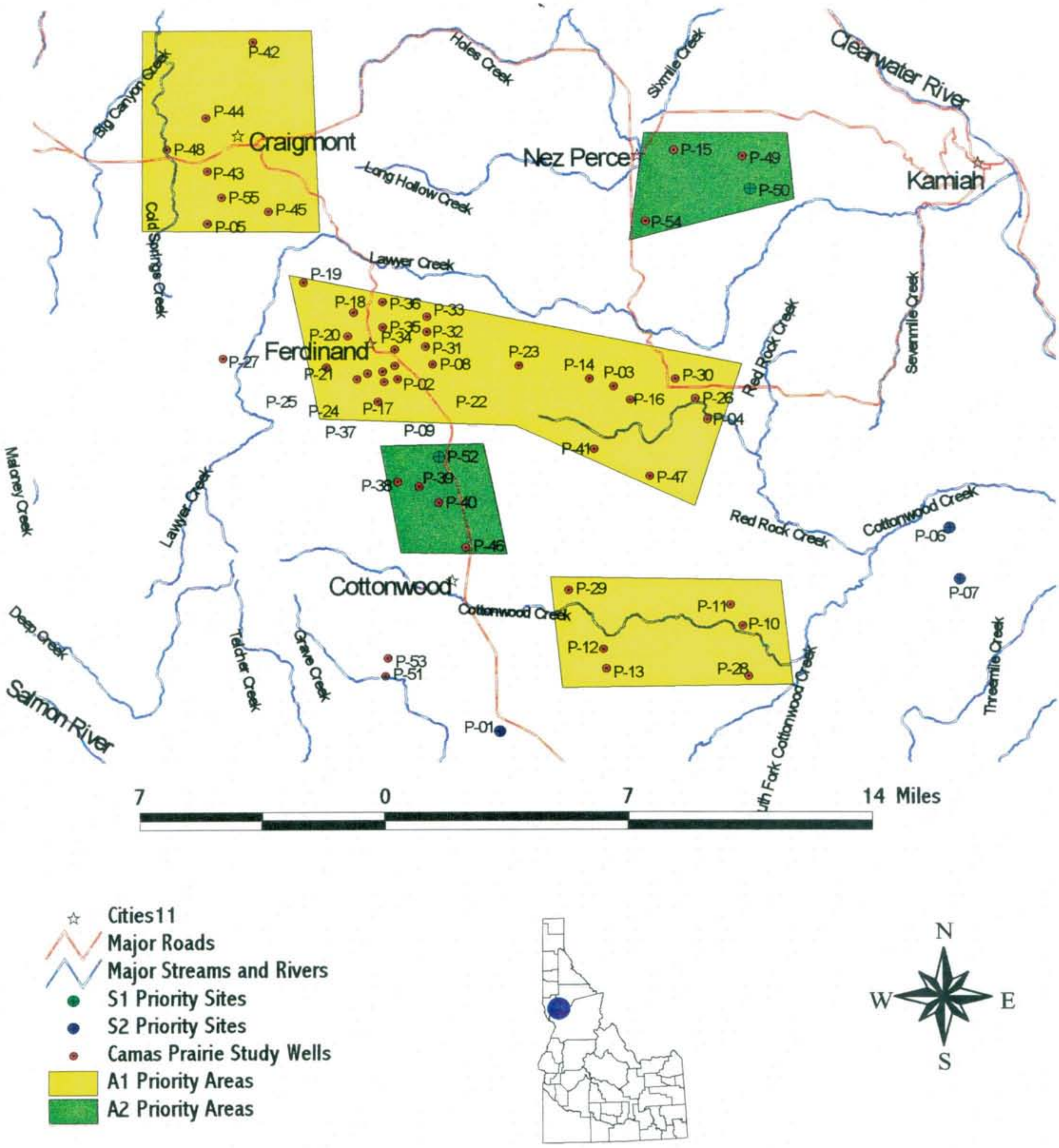
RECOMMENDATIONS

Based on the results of this study, recommendations are as follows:

- Discourage the consumptive use of shallow penetrating wells, unless monitored on a regular basis.
- Encourage well owners to provide an adequate buffer zone of at least thirty feet around their well head.
- Encourage well owners to assess local land use and identify nitrogen sources.
- Provide additional technical assistance and sampling (if possible) to well owners with nitrate concentrations exceeding the drinking water standard.
- Continue to collect nitrate samples (DEQ, IDWR, etc.) from selected and additional wells (if funding and resources allow) for future monitoring.
- Provide additional sampling and investigation into nitrate priority sites and areas (Figure 10).

This study was limited in scope and does not provide conclusive answers to all of the posed regional ground water questions. This investigation provides a foundation for further studies that should be pursued based on the availability of personnel and financial resources. Continued nitrate sampling is encouraged along with the collection of pesticide samples, nitrogen isotope samples, dissolved ions and other relevant parameters.

Figure 10. New Priority Sites and Areas (Based on nitrate data from Camas Prairie Study Wells)



LITERATURE CITED

Barker, R.J., McDole, R.E., and Logan, G.H., 1983. *Idaho Soils Atlas*, University Press of Idaho, a Division of the Research Foundation, Inc.

Bond, J.G., 1963. *Geology of the Clearwater Embayment,* Idaho Bureau of Mines and Geology, Moscow, Idaho.

Castelin, P.M., 1976. *A Reconnaissance of the Water Resources of the Clearwater Plateau, Nez Perce, Lewis and Northern Idaho Counties, Idaho*, Idaho Department of Water Resources, Water Information Bulletin No. 41.

Crockett, J.K., 1995. *Idaho Statewide Ground Water Quality Monitoring Program, Summary of Results 1991-1993*, Idaho Department of Water Resources, Water Information Bulletin No. 50, Part 2.

EPA, 1996. *Ecoregions of the Pacific Northwest*, EPA/600/3-86/033.

Fetter, C.W., 1980. *Applied Hydrogeology*, Charles E. Merrill Publishing Company, A Bell & Howell Company, Columbus, Toronto, London and Sydney.

Mahler, R.L., Brusven, M.A. and Rasmussen, L.K., 1995. *Big Canyon Creek Water Quality Report Summary*, Nez Perce Soil and Water Conservation District.

Ralston, D.R., Sprenke, K.F., Dansart, W.J. and Rember, W.C., 1993. *Evaluation of the Ground Water Resources in the Vicinity of Grangeville, Idaho*, University of Idaho, Moscow, Idaho.

U.S. Department of Commerce, Bureau of the Census, 1990. *1991 Census of Population and Housing, Summary Population and Housing Characteristics, Idaho*, CPH - 1-14.

Morrison, 1976. *Nez Perce Water Resources Investigation*, Maierle, Inc., Ground Water Chp. 5.

APPENDIX A. WELL ATTRIBUTES FOR THE PUBLIC WATER SYSTEMS

Craigmont	Twn/Rng/Sec	Depth	SWL	GPM	Casing	Lithology
NORTH WELL #1	34N/1W/33 CA	168	121	65		
EAST WELL #2	34N/1W/33 BB	123				Clay; basalt overlain by clay and silt.
SOUTH WELL #3	34N/1W/32 DD	900	536	300	60	Clay; decomposed lava; basalt; confined; water zone at 513-733; 815-840; 905
Ferdinand						
NORTH WELL	33N 1W 36 DD	100				No well log
EAST WELL	33N 1E 31 CC	242				No well log
SOUTH WELL	32N 1E 6 BB	700	110			granite overlain by 50ft clay layer; water bearing zone at 490-515
Cottonwood	31N 1E 8 AB					
WELL #2		604	500	535		Basalt; unconfined; clay; shale; water near surface and at 390ft
WELL #3		300	65	125		Clay to 50ft; hard basalt to 140ft; water at 150, 250; clay, shale, soapstone and basalt; 300 water
WELL #4		875	335	435		Clay and soft-med basalt to 88ft;basalt to 334;water @ 334-339;water @ 478-503 in basalt and shale.
Nez Perce	33N 2E 6 AD					
WELL #1		228		130		
WELL #2		265		53		
WELL #4		250		225		
North Idaho Correctional	32 N 1W 26 CC					
Well #5		750	110		270	soft soil/sand 0-275;granite 275-322;water zone 322-329; granite 329-534; water zone granite 534-750
Mon. of Saint Gertrude's	31N 01E 18 CA	450	333	60		Basalt; confined; water bearing zone from 346-450
Keuterville Store	31N 1W 10 DD					
Cottonwood Sales Yard	31N 1E 9 DD	480		300		Clay; basalt; confined; 241-260 soft/broken basalt water zone; 476-480 water bearing zone (300 gpm)
AJ's Greencreek	32N 2E 18 CC	703		25		clay; sand; granite
Fenn	30N 2E 6 CB	460		10		Basalt; confined; water zone @413-420 in basalt with green seams

APPENDIX B. WELL ATTRIBUTES FOR THE IDAHO STATEWIDE AMBIENT GROUND WATER MONITORING NETWORK

Location #	ID #	TWN/RNG/SEC	LITHOLOGY
1350	455732116054701	30N 3E 9 BBC1	Basalt; confined
1351	455828116243901	30N 01W 02AAA1	Questionable lithology(Brown turning to soft white rock)below basalt from 34-58 feet;nearby wells have lava.
1352	45590611601530	31N 3E 36 BCA1	Basalt; confined
1353	455950116093401	31N 02E 35ADB1	Black basalt; confined.
1354	460017116142101	31N 02E 29BBA1	Black basalt; confined.
1355	460314116212501	31N 01E 08ABB3	Gray basalt;confined;shallow water in basalt from 140-150 feet.
1356	460426116022101	32N 03E 35AAC1	Sand below basalt; confined.
1357	460434116171201	31N 01E 02AAA1	Basalt; confined.
1358	460548116300601	32N 1W 19DBC1	Lava; confined; shallow water
1361	460714116023801	32N 03E 11DCC1	Basalt; confined; continuous water-bearing strata from 325-430 feet.
1365	461008116262601	33N 01W 27DBC1	Granite; no water-bearing information on log; may have to drop this because of lithology.
1366	461025116290401	33N 01W 29BDD1	Wrote to driller (Uhlenkott)on 7/5/95; okay to use nearby well logs for correlation if primary well log can not be found.
1368	461155116163701	33N 01E 13CAC1	Scoria (below basalt); confined.
1370	461233116274101	33N 01W 09DCC1	Basalt; confined.
1371	461246116070201	33N 3E 7 DAD1	Basalt; unconfined to mildly confined
1372	461323116101901	33N 02E 11BAA1	Black basalt with green deposits; mildly confined.
1375	461436116255201	34N 01W 34DAD1	Basalt; confined. Well not in use two years in a row. Did not need.
1376	461437116370801	34N 2W 31 DAA1	Basalt
1377	461445116112601	34N 2E 34 BDD1	Basalt; confined
1378	46151211615460	34N 1E 25 DDD1	Basalt; possibly confined; shallow water
1379	461555116085301	34N 2E 25 ABB1	Basalt with green seams; confined
1380	461630116343201	34N 2W 22 BCC1	Basalt; confined

NUMBER	WELL DEPTH	CASING DEPTH	SWL	DEPTH TO AQ	USE	SAMPLE YEAR
1350	283	169	198		H	90,93
1351	163	31	5.30	136	H	91
1352	184	144	136	174	H	92
1353	192	192	80	107	H	91
1354	154.	18.	52.82	125.	H	94
1355	301	270	11.3	238.	P	91
1356	81	21	3.60	78.	H	93
1357	59.	58.	10.81	54.	H	94
1358	130	97	10	126	H	92
1361	430	19	178	325	H	92
1365	190	76	151		H	93
1366	160.	150	17.2		H	93
1368	396	20	204	371	H	92
1370	405.	19.	112.49	315.	H	94
1371	110	110	40	43	H	90
1372	180.	180.	133.25	150.	H	94
1375	122	122	10	106	H	91
1376	300	36	160	35	H	93
1377	154	28	70	140	H	94
1378	320	320	150	185	H	91
1379	265	23	56	202	H	93
1380	75	15	4	37	H	94

APPENDIX C. SAMPLE LETTER AND PERMISSION FORM

August 26, 1998

Dear Well Owner:

In 1989, the Idaho Legislature passed the Ground Water Quality Protection Act in order to comprehensively maintain and improve ground water quality in the state. Since 1990, the Idaho Department of Water Resources (IDWR) and the U.S. Geological Survey (USGS) has collected more than 1500 ground water samples from domestic and irrigation wells throughout the state. This data is being inputted into the Statewide Ambient Ground Water Monitoring Network for the purpose of ground water monitoring and quality assurance.

The Idaho Division of Environmental Quality (DEQ) is currently working on a ground water study of the Camas Prairie region. Data from the statewide monitoring network has revealed some elevated levels of nitrate in the ground water. But existing data is inadequate and incomplete to draw any conclusions or adequately evaluate the extent of nitrate in the ground water. So, the purpose of this project is to fill in data gaps in order to better assess the ground water quality of the Camas Prairie.

The study I am conducting involves compiling all available historic water-quality data, collecting water samples and summarizing my findings. I must obtain more ground water data from your region in order to complete the study and sufficiently evaluate the situation.

I would like to include your well in this study. If you grant the DEQ permission to sample your well, then a sample would be collected from an outside source on your residence. The sample then would be sent to Boise, where it would be tested for nitrate and you would receive the results, along with a letter explaining the results.

There is no associated cost with the sampling of your well, but your permission is certainly necessary. **Please return the enclosed permission sheet as soon as possible.** A postage-paid envelope has been provided for your convenience.

If you have any questions regarding the details of this project, please call me at (208) 799-4370. I will also be contacting some people by phone and if I do not hear from you (by phone or letter), I will conduct a follow-up phone call.

Thank you for your help with this study.

Sincerely,

Brandon Bentz
DEQ Intern

Permission Form for Camas Prairie Study

Date___________________________

Well Location_______________________ Total Depth________________________

Water Used For________________________(irrigation, stock, home, business, ect.)

Well Owner: Please check off one or more of the following, complete the mailing address information, and return this form to me in the attached envelope.

______I grant my permission for a water sample to be collected from my well, even if I'm not home.

______I grant permission for a water sample to be collected from my well, but call me first.

______Well information at the top of this form is not correct because______________ (well destroyed, well deepened, well not used any more, ect.)

Comments:____

Name:____

Address:____

City:____ Zip Code:_________________________

Daytime Telephone Number:___________________________________

APPENDIX D. QUALITY ASSURANCE/ QUALITY CONTROL (QA/AC) RESULTS

RELATIVE PERCENT DIFFERENCE (RPD)

RPD=[(Value A - Value B)/((Value A + Value B)/2)] x 100

Total $NO_2 + NO_3$ as N

Site #016

RPD = [(.968-.966)/((.968+.966)/2)] x 100 = .21%

Site #021

RPD = [(6.22-6.19)/((6.22+6.19)/2)] x 100 = .48%

Site #037

RPD = [(3.67-3.63)/((3.67+3.63)/2)] x 100 = 1%

Site #040

RPD = [(2.29-2.29)/((2.29+2.29)/2)] x 100 = 0%

Site #050

RPD = [(82.3-77.1)/((82.3+77.1)/2)] x 100 = 6%

APPENDIX E. WELL ATTRIBUTES FOR THE CAMAS PRAIRIE DATA

Number	Twn	Rng	Sec	Depth	SWL	Casing Depth	GPM	Use	Date Drilled
001	31N	1E	27 CB	495	296	18	20	Domestic	3/26/92
002	32N	1E	6 CD	600	390	58		Domestic	5/25/95
003	32N	2E	6 DD	402	25	57	4	Domestic	10/9/86
004	32N	2E	10 CC	275	61	38	60	Domestic	7/3/92
005	33N	1W	18 BA	575	350	18	15	Domestic	9/15/92
006	32N	3E	34 DD	358	190	29	7	Domestic	1968 ?
007	31N	3E	2 DC	260		16	1	Domestic & Stock	4/1/68
008	32N	1E	5 AC	175	50	19	60	Domestic	9/8/77
009	32N	1E	6 BC	202	53	18	6	Stock	9/22/94
010	31N	2E	14 BB	100				Domestic	
000	31N	2E	10 DD	240				Domestic	
012	31N	2E	18 CB	215	142	115.5	32	Domestic & Stock	9/10/69
013	31N	1E	24 AA	90	50		12	Domestic	
014	32N	1E	1 CD	115	62	46	5	Domestic	10/16/91
015	33N	2E	4 BB	375	152	25	3	Domestic	5/28/97
016	32N	2E	7 DD	640	12	168	6	Domestic	9/8/94
017	32N	1W	12 BB	500	74	38	7	Domestic	1/9/95
018	33N	1W	35 SE NE	160				Domestic	1977
019	33N	1W	22 DC	327				Domestic & Stock	Early 1900s
020	33N	1W	35 AD	82	34.5	18 & 82	30	Domestic	10/20/94
021	32N	1W	3 AC	203	10	38	5	Domestic	8/26/91
022	32N	1E	6 BB	400	200	18	2	Domestic	7/1/97
023	32N	1E	3 DD	75	10	38	50	Domestic	7/20/96
024									
025									
026	32N	2E	9 AD	135	40	44/135	120	Domestic	1/8/97
027	32N	1W	5 BB	340	275	21	18	Domestic	10/16/97
028	31N	2E	23 CB	182	96	26.5	12	Stock	11/13/69
029	31N	1E	12 BB	200	71	18	10	Domestic	12/29/95
030	32N	2E	4 CD	255	116	18	40	Domestic	9/19/94
031	33N	1E	32 CB	39				Domestic	Very Old
032	33N	1E	32 NW SW	50				Domestic	
033	33N	1E	29 CC	40				Domestic	
034	33N	1E	31 CC	60				Industrial	
035	33N	1W	36 AA	140 ?	53.4			Domestic	
036	33N	1W	25 DD	135	21	138	18	Domestic	6/15/68
037	32N	1W	1 AC	370	60	76 & 300	15	Domestic	2/25/85
038	32N	1E	19 BD	325	2	38	3	Domestic	4/29/95
039	32N	1E	19 DB	400	44	18	5	Domestic	12/7/95
040	32N	1E	29 BD	200	90	18	20	Domestic	6/20/95
041	32N	1E	13 CC	327	6	79	4	Domestic	9/12/88
042	34N	1W	16 CC	180	43	19/180		Domestic	4/15/92
043	33N	1W	6 DA	90	19			Domestic	1948
044	34N	1W	31 AA						
045	33N	1W	9 DC	405	300	19/405	30	Domestic	7/28/92
046	32N	1E	32 CA	500	340	38	15	Business	11/7/94
047	32N	1E	20 BD	103	70	103	60	Domestic	9/10/92
048	33N	2W	1 AA	400	20			Domestic	
049	33N	2E	2 BC	192	61			Domestic	
050	33N	2E	11 AB	180	132	18	7.5	Domestic	12/14/88
051	31N	1W	24 AB	150	110	18	20	Domestic	5/2/96
052	32N	1E	20 BA	80	25	18	12	Domestic	9/19/94
053	31N	1W	13 DD	200		19.5		Domestic	7/1/91
054	33N	2E	17 AB					Domestic	
055	33N	1W	8 BC	90				Domestic	1985 ?

Number	Lithology	Temp (°C)	Spec. Conductance
001	Basalt; confined; water zone @ 465-485 in basalt with green seams	17	350
002	Mildly confined; 0-60 sandy clay;6-340 decomposed granite;water @ 340 and 560	13	180
003	Clay 0-3; granite with seams 3-402; water @ 350-400	12	600
004	Basalt; confined; water zone @ 225-275 in basalt with green seems	12	600
005	Basalt with interbeds of scoria; water zone in scoria 520-565	12	250
006	Confined; basalt; water zones @ 200-225 & 300-329	12	350
007	Basalt, clay, & shale; unconfined; water zone @ 6-35 in basalt	17	380
008	Basalt; confined; water zone @ 150-175 in basalt with green seams	16.5	465
009	Granite; confined; water zone @ 155-202 in fractured granite	16	200
010	Basalt; confined	13	295
000		14	330
012	Clay 0-115; basalt 115-183;water zone in porous basalt 183-215	14	245
013		13	395
014	Basalt & clay; confined; water zone @ 70-112 in fractured basalt	16	500
015	Basalt & clay; confined; water zone @ 175-210 in basalt	16	390
016	Granite; clay; water zone in decomposed granite @ 337-340 & 538-540	15	235
017	Unconfined; granite 0-500; water @ 150-175, 300-305, 350-355, 440-456	15	205
018		12	250
019		12	355
020	Basalt; confined; water zone @ 65-79 in fractured basalt	12	370
021	Unconfined; decomposed granite 0-120; water @ 120-173 in soft granite	18	245
022	Granite; confined; water zone @ 200-400 in decomposed granite	12.5	250
023	Basalt; unconfined; water zone @ 60-65 in fractured basalt	10	650
024	Spring	19	420
025	Spring	15	330
026	Basalt; confined & unconfined; two water zones at 20-33 & 115-130 in fractured basalt	12	335
027	Basalt; confined; water zone @ 327-333 in fractured basalt	15	135
028	Basalt; confined; water zone @ 160-178 in sandy white clay	17	800
029	Basalt; confined; water zone @ 125-130 & 170-179 in fractured basalt	17	420
030	Basalt; confined; water zone @ 127-255 in basalt with green seams	16	460
031		14	490
032		17	600
033		14	600
034		14	375
035	Basalt; confined	12	400
036	Basalt; confined; water zone @ 122-135 interbed of sandy clay	20	700
037	Granite; confined; water zone @ 200-370 in granite	17	400
038	Granite; confined; water zone @ 113-145; 243-248; 271-275 in decomposed granite	12	140
039	Granite; confined; water zone @ 350-375 in granite	15	185
040	Basalt; confined; water zone @ 170-190 in seamed basalt	12	200
041	Granite; unconfined; water zone @ 105-327 in granite	13	420
042	Basalt; confined; water zone @ 150-180 in fractured basalt	11	225
043		11	320
044		11	280
045	Basalt; confined; water zone @ 315-357 in fractured basalt	13	265
046	Basalt; confined; water zone @ 450-495 in green seamed basalt	14	270
047	Basalt; unconfined; water zone @ 92-102 in seamed basalt	12	350
048		14	450
049		13	315
050	Basalt; confined; water zone @ 145-180 in basalt with green seams	11	1000
051	Basalt; confined; water zone @ 135-145 in seamed basalt	15	210
052	Granite; mildly confined; water zone @ 18-49 in decomposed granite	11.5	465
053	Basalt; confined; water zone @ 168-200 in basalt	17	140
053	Basalt; confined; water zone @ 168-200 in basalt	17	140
054		20	350
055		14	350

APPENDIX F. WELL INVENTORY AND LAND USE FORMS

T-R-S__________________ GWSI ID. NO.____________

WELL INFORMATION: DATE INVENTORIED__________ BY_____________

INVENTORY BY: WELL LOG PHONE BOOK TELEPHONE SITE VISIT

SOURCE OF DEPTH DATA: DRILLER OWNER OTHER:

WATER USE____________________

DEPTH_______ DIAMETER OF CASING________ DATE DRILLED_______

OWNERS NAME__________________________ PHONE_____________

ADDRESS ________________________________

________________________________ ZIP CODE____________

<u>ATTACH DRILLER'S LOG AND COPY OF 7.5 MINUTE MAP</u>

Change in well construction or ownership:

Original Depth and Date_________________ Deepened Depth and Date____________

Original Owners Name________________________________

SKETCH OF WELL AND SAMPLE POINT LOCATION

LOCAL LAND USE --WITHIN ABOUT 1/2 MILE OF THE WELL **(CIRCLE CHOICES)**

..........PASTURE ....FEEDLOT....................DRY CROP (NO IRR)...................... IRRIGATED CROP.............

...........RURAL -SUBURBAN(SEPTIC TANK, NO FARMING).............RURAL FARM OR LIVESTOCK..................

...........URBAN RESIDENTIAL(SEWER)............URBAN COMMERCIAL...................FOREST.................................

..........SUMMER HOME................UNDEVELOPED.......................OTHER..

If agriculture, what crops?

How far is nearest cultivated land from well?

How is nearby cultivated land irrigated?--center pivot? wheel-line? gravity?

Source of irrigation water?

Nearby ditch/canal? lined or unlined?

irrigation drain-well(s) nearby?

COMMENTS:

SKETCH OF LAND USE WITHIN 1/2-MILE OF WELL ((1 mile x 1 mile section))

APPENDIX G. LAND USE ACTIVITIES NEAR WELL OR SPRING

LAND USE	WITHIN 20'	WITHIN 100'	WITHIN 200'	WITHIN ½ MILE
Cultivated Land	3, 28, 35, 46, 47, 54, 55	1, 2, 4, 5, 7, 8, 11, 16, 17, 27, 30, 32, 37, 38, 41, 48, 49	9, 15, 22, 24, 26, 29, 31, 33, 42, 44, 45, 50	10, 12, 13, 18, 19, 20, 23, 25, 36, 39, 40, 43, 51, 52,
Dry Crop	28, 3, 35, 46, 47, 54, 55	11, 4, 30, 27, 5, 7, 1, 37, 8, 17, 2, 32, 48, 49, 41, 38	24, 26, 29, 33, 31, 15, 22, 50, 44, 42, 45	10, 25, 23, 34, 18, 6, 19, 14, 12, 13, 21, 36, 9, 20, 40, 43, 51, 39, 52, 53
Pasture	21, 8, 9, 52	11, 29, 18, 19, 15, 16, 47	27, 23, 22, 50, 38	30, 12, 3, 17, 2, 20, 42, 48, 51, 39, 53
Feedlot		4		10, 7, 1, 36, 35
Fertilizer Elevator				22, 35, 34