A Reconnaissance of Hydrogeology and Ground Water Quality in Three Hillside Basins at the Perimeter of the Rathdrum Prairie Aquifer, Kootenai County, Idaho

Prepared for the Idaho Division of Environmental Quality

by

Deanna Clarkson
Graduate Research Assistant

and

John P. Buchanan, Ph.D.
Professor of Geology
Eastern Washington University

February 1998

A Reconnaissance of Hydrogeology and Ground Water Quality in Three Hillside Basins at the Perimeter of the Rathdrum Prairie Aquifer, Kootenai County, Idaho

Prepared for the Idaho Division of Environmental Quality

by

Deanna Clarkson
Graduate Research Assistant

and

John P. Buchanan, Ph.D.
Professor of Geology
Eastern Washington University

February 1998

Executive Summary

From July to September, 1997, a reconnaissance investigation was completed of the hydrogeology and ground water quality in three hillside basins adjoining the Rathdrum Prairie aquifer in Kootenai County, Idaho. These basins contribute recharge to the Rathdrum Prairie-Spokane Valley aquifer system, a drinking water source protected by both state and federal designations requiring maintenance of the high quality of its water. The investigation of hillside basins was implemented in response to the 1996 discovery of nitrate contamination in public drinking water supplies at the southern margin of the Rathdrum Prairie in South Post Falls, Idaho. Nitrate contamination is linked to septic discharge and fertilizers, and causes a potentially fatal illness in infants. To assess the quality of ground water in the hillside regions, three study areas were chosen to represent basins of relatively high, intermediate, and low residential development density as measured by the number of onsite septic systems they contained. These basins were: high density, Nettleton Gulch, east of Coeur d'Alene; intermediate density, the South Greenferry Road basin south of the Spokane River; and low density, Hidden Valley, southwest of Rathdrum. Ground water samples were collected from ten existing wells in each basin.

To establish the quality of the ground water, the samples were analyzed for conductivity, temperature, pH, alkalinity, total major ions (calcium, magnesium, sodium, sulfate, chloride), total iron, and nitrite plus nitrate as nitrogen. Analysis of the ground water samples was accomplished in the field and by the Coeur d'Alene branch of the Idaho State Laboratory. Two sampling rounds were completed: in July, when the water table was high, and in September, when the water table was falling. No statistically significant differences were found between the July and September water samples. The measurements of the depth to the water table in each basin established that ground water flow in the basins was toward the Rathdrum Prairie aquifer.

The ground water in the study basins was compared with the Rathdrum Prairie aquifer water, as represented by the results of the July 1997 Panhandle Health District monitoring of 29 public drinking water wells on the Rathdrum Prairie. The ground water in the study basins and Rathdrum Prairie aquifer presented similar calcium bicarbonate major ion profiles, although in Hidden Valley and Nettleton Gulch, the ground water, as evidenced by its higher conductivity, was more mineralized than the water of the main aquifer.

In the low density development, Hidden Valley, the median nitrate concentration was the lowest of the study basins at 0.241 milligrams per liter (mg/L). The median chloride concentration in samples of Hidden Valley was 1.3 mg/L, also the lowest among the study basins. In Nettleton Gulch, where development density was high, the median nitrate was 1.09 mg/L, intermediate among the study basins, while the median chloride concentration was the highest at 4.0 mg/L. The highest nitrate concentrations were detected in the basin of intermediate development, the South Greenferry Road study basin, where the median nitrate concentration was 2.61 mg/L, and the median chloride concentration was 3.0 mg/L. The highest nitrate concentration of the study was 10.5 mg/L found in a well at the site of a small farm and commercial greenhouse in the South Greenferry Road basin. The elevated chloride and nitrate concentrations in the South Greenferry Road basin and Nettleton Gulch were suggestive of septic discharge to the ground water. In addition, fertilizer was a probable source of the unexpectedly high nitrate concentrations in the South Greenferry Road basin. The areas of the basins most vulnerable to ground water contamination are those with highly permeable, low water capacity soils.

A spreadsheet calculation program was used to project the effect of residential lot size on nitrate concentration in an aquifer underlying a development with onsite septic systems. Using Nettleton Gulch as a model, a lot size of five acres produced a predicted nitrate concentration of 1.01 mg/L from the effect of septic system discharge only. This scenario is similar to the current development status of Nettleton Gulch where the measured median nitrate concentration was 1.09 mg/L. This work supports the previous conclusion that use of a five acre lot for each septic system does not degrade ground water quality significantly. With lot size reduced to one-fifth acre, a nitrate concentration of 7.22 mg/L in ground water was projected. Approximately one-third of the main aquifer recharge may be contributed by the hillside regions. The worst-case scenario (7.22 mg/L nitrate in hillside recharge water) would result in a significant increase in the nitrate concentration in the main aquifer as a whole, where the median concentration was 0.971 mg/L in samples from the July 1997 Panhandle Health District monitoring event. The highest nitrate concentrations would be detected in the many community water supply wells at the perimeter of the Rathdrum Prairie, since the capacity of the aquifer to dilute contaminants is reduced where the aquifer is of lesser depth and the ground water flow is slow. A quantification of degradation is not possible without additional data on the mixing proportions of hillside recharge, Rathdrum Prairie aquifer throughflow, and river recharge.

An estimate of total nitrogen loading in the study basins suggests that the use of fertilizers may introduce a load at least equivalent to septic discharge. One small farm in the South Greenferry Road basin alone produces an annual nitrogen load greater than the estimated nitrogen load from the basin's total septic discharge.

The results of the current study imply that limiting the use of onsite septic systems and constructing sewers is an essential part of protecting the ground water of Kootenai County, because septic discharge is the critical component of the nitrate load that can be addressed through land use planning and regulation. Control of the additional source of nitrate contamination, fertilizer use, is dependent on the voluntary compliance of residents educated in best management practices.

Acknowledgments

The authors wish to thank Brian Painter and John Sutherland of the Idaho Division of Environmental Quality for selecting Eastern Washington University for the project and for providing assistance through the course of the study.

We thank the private landowners in the project study basins who allowed the sampling of their wells. Thanks are due to the board and customers of the Greenferry Water District for access to their well. The authors also wish to thank the staff of the Coeur d'Alene branch of the Idaho State Laboratory, and the personnel of the Panhandle Health District, the Idaho Department of Water Resources, and the Kootenai County Planning Department for providing important background information and services. The U.S. Geological Survey loaned essential field equipment and computer resources.

The authors are grateful for the careful reading and suggestions from reviewers Brian Painter, Paula Lyon, Mohammed Ikramuddin, Dick Martindale, and John Riley.

TABLE OF CONTENTS

TABLE OF CONTENTS, CONTINUED

LIST OF TABLES

LIST OF FIGURES

Introduction

This report summarizes the first published ground water quality study of hillside aquifers adjoining the Rathdrum Prairie aquifer system, Kootenai County, Idaho. The hillside basins investigated here discharge groundwater to the Spokane Valley-Rathdrum Prairie aquifer system, designated a sole source aquifer by the U.S. Environmental Protection Agency (EPA) in 1978. Figure 1 is a location map of the study areas.

Background

In the spring of 1996, routine quarterly monitoring by the Panhandle Health District revealed nitrate contamination in a community water well in South Post Falls, Idaho (Painter, 1996a) that exceeded the EPA maximum contaminant level (MCL), 10 mg/L, for public drinking water supplies (U.S. Code of Federal Regulations, 1992A). Follow-up sampling and a ground water study by the Idaho Division of Environmental Quality (DEQ) confirmed contamination in two community systems and several private wells, where nitrate levels were as high as 40 mg/L (Painter, 1996b). Elevated nitrate concentration is a ubiquitous indicator of contamination of ground water by sewage effluent, fertilizer, and animal wastes (Spalding and Exner, 1993). In South Post Falls, as in most of the hillside areas surrounding the Rathdrum Prairie, land use regulations allow small lot sizes with onsite septic systems and unsewered development has proceeded at a rapid rate following the population increase in Kootenai County.

The increasing development of the hillsides adjoining the Rathdrum Prairie has generated concern about the potential for degradation of the Rathdrum Prairie aquifer to which hillside basins discharge water at the surface and by underflow. The Spokane Valley-Rathdrum Prairie aquifer was designated a sole source aquifer by the United States Environmental Protection Agency (EPA) in 1978. Sole source status mandates the review of all federally supported projects for their impact on the aquifer water quality. The state of Idaho designated the Rathdrum Prairie aquifer as a special resource water in 1982 and a

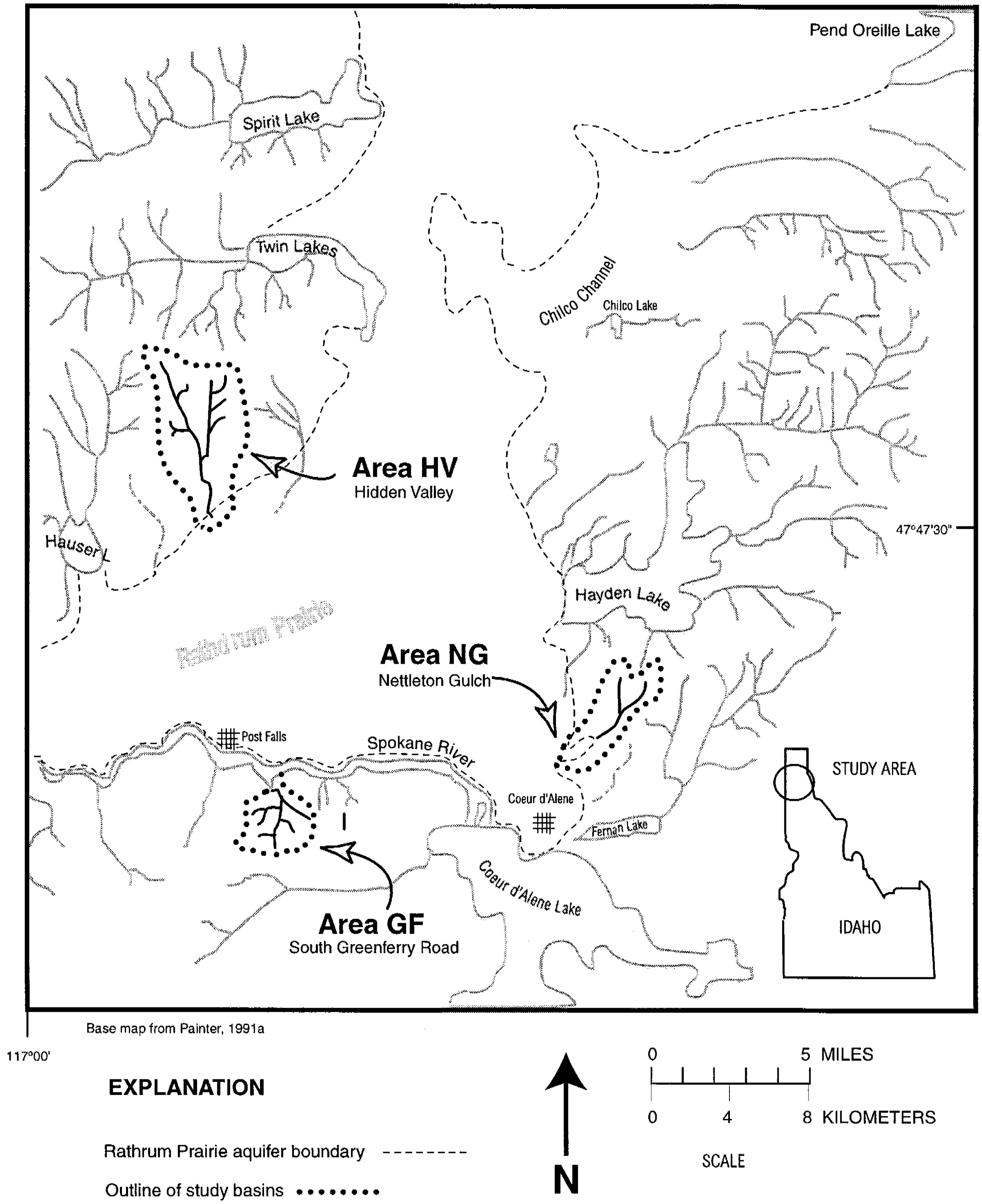


Figure 1. Location map of the three study basins. Also displayed is the boundary of the Rathdrum Prairie aquifer in Kootenai County, Idaho.

sensitive aquifer in 1997. Both designations require that the high quality of the water be maintained. Idaho also requires that land use planning consider water issues, pursuant to Idaho Code 67-6508.

The DEQ and the Panhandle Health District (PHD) of Kootenai County coordinate and staff aquifer protection projects. The Kootenai County Planning department has implemented land use restrictions over the Rathdrum Prairie aquifer. The EPA has provided grant assistance for aquifer protection programs.

Since 1975, the PHD has monitored water quality of the Rathdrum Prairie aquifer in a network of 47 wells sampled regularly for inorganic and organic constituents. Continuous records of quarterly sampling exist for 27 of the wells since at least 1980. The DEQ maintains records for 86 public water supply systems that draw drinking water from the Rathdrum Prairie aquifer (Painter, 1991a). However, no systematic investigation of the water quality of hillside areas has existed. In its 1996 plan for future work on nitrate investigation, the DEQ aquifer protection staff called for baseline assessment of water quality in hillside areas (Painter, 1996b).

Purpose and Scope of the Study

A contract was developed between Eastern Washington University and the DEQ in the spring of 1997 that established the objectives for Rathdrum Prairie Hillside Water Quality Reconnaissance project. The objectives of the project were to

- provide water quality data representative of the ground water in the tributary watersheds on the hillsides of Kootenai County surrounding the Rathdrum Prairie,
- investigate the relation of this data to natural and human-induced influences, and
- interpret the influence of hillside discharge on the Rathdrum Prairie aquifer.

The hillside areas of Kootenai county that comprise Critical Aquifer Recharge Areas (CARAs) for the Rathdrum Prairie aquifer encompass more than 300 square miles (mi^2) receiving 552 cubic feet per second of precipitation on a yearly basis. Because it was not possible to conduct screening of the entire hillside area with the funding available, three study areas were selected to study basins of high, medium, and low residential development density (Fig. 1). In this report, the basins are assigned codes. Area NG is Nettleton Gulch, a relatively highly developed basin. Area GF is the basin containing South Greenferry Road, the basin of intermediate development density. Area HV is Hidden Valley, a basin of low development density. Each study area is within the bounds of a CARA as delineated by the DEQ.

In each study basin, ten existing wells were sampled. Ground water samples were collected in all wells in July and September of 1997. These sampling events were scheduled to assess differences in the elevation of the water table and any concurrent change in water chemistry. Additional samples were taken in August, 1997, from wells where July nitrate concentrations were elevated. The depth to standing water was measured in accessible wells. Field measurements also included the temperature, pH, and conductivity of the ground water samples. The total concentrations of calcium, magnesium, sodium, chloride, sulfate, nitrite plus nitrate, and iron, and the alkalinity in study samples were determined by laboratory analysis.

The South Post Falls hillside area where nitrate contamination was known to exist was not considered within the scope of the hillside project because a separate investigation of this area was initiated. Hillside basins where lake subsurface discharge would dilute contaminants were excluded from study in this project.

The ground water quality in the study basins was compared to the results of PHD monitoring of the Rathdrum Prairie aquifer concurrent with this study. Further comparisons were made with previously reported ground water quality profiles of the Spokane aquifer, hillside basins discharging to the Spokane aquifer (the Forker, Northwood, and Argonne Road basins), and the Chilco Channel which discharges to the Rathdrum Prairie aquifer.

This reconnaissance level study produced data attributable to the time and place of study which may not be extrapolated to suggest long term trends. However, the information obtained in this study may be used locally for assessing the impact of development and land use on drinking water, and may be used as baseline data for evaluating trends in water degradation. Planners and development managers can benefit from a clearer understanding of both water quality and water quantity in the hillside areas. This study is instrumental to the greater goals of protection of public health and the quality of the environment, two factors very important to the economic health of the region.

Data Sources

The hydrogeologic information in this report was entirely based on available studies and maps, as well as information from well drillers' logs on file with the Idaho Department of Water Resources, and observations from field visits through the summer of 1997. The locations of the wells and the wellhead elevations were estimated by mapping on United States Geological Survey (USGS) 7.5 minute series topographic maps. The locations were verified with Global Positioning System (GPS) equipment.

The land uses were described using field observations, interviews with residents, tax assessor records, and available aerial photography. Information about the zoning of the selected basins and the restrictions on land use are from the Kootenai County Planning Department. The septic system density was established by counting systems mapped by the PHD in 1992.

The climate information was acquired from online resources of the Idaho State Climate Services, the National Oceanic and Atmospheric Administration (NOAA), and the USGS. The Kootenai County Soil Survey (Soil Conservation Service, 1981) was used to assign soil classifications to basins and for additional climate information. The data on water chemistry in other areas was extracted from existing studies and from the PHD aquifer monitoring program.

Study Design and Methods

Selection of the Three Basins

Three basins (Fig. 1) were selected that were representative of relatively low, medium, and high residential development density to study the incremental effects of land use on ground water quality. Through field reconnaissance and screening of well drillers' logs, and with input from the DEQ, basins were identified that: (a) contained hillside aquifers vulnerable to contaminants related to land use, and (b) had an adequate number of existing wells to serve as sampling points.

The ranking of residential development density was based on field reconnaissance supported by a count of onsite septic systems from maps compiled by the PHD in 1992. With 18 septic systems per square mile of drainage basin, area NG, Nettleton Gulch, was designated as the high density basin. Area GF, the South Greenferry Road drainage, with 13 septic systems per square mile, was designated the intermediate density basin. Area HV, Hidden Valley, had the lowest development density with 3 septic systems per square mile of drainage basin.

Selection of the Sampled Wells

Ten sampling points (wells) were chosen in each study basin. Because this study relied on existing wells, selection was dependent on the development patterns within selected basins and the willingness of residents to cooperate in the investigation. Within the bounds of these restrictions, the wells chosen for sampling were selected to represent points along presumed groundwater flow paths and spaced to provide adequate representation within the area. Preference was given to wells where fairly reliable drillers' logs were available, however the location of the well and willingness of residents to allow access sometimes overrode this stipulation.

Assignment of Well and Sample Codes

Each sampled well was given a code consisting of the initials representing the study basin (GF, the South Greenferry Road basin; HV, Hidden Valley; and NG, Nettleton Gulch) followed by a number. Each sample code consists of the well code followed by a number representing its order in the sequence of samples from that well. For example, GF-4-3 is the third sample drawn from well GF-4 in the South Greenferry Road study basin. Duplicate samples and blanks for the purpose of quality control were given fictitious codes.

Some wells that were located in the field and used for construction of hydrogeologic sections, but were not sampled, are given a code consisting of the initials representing the study basin followed by a letter, for examples, NG-A, a well in area NG, Nettleton Gulch.

Appendix 1 contains the drillers' logs for the wells used in the study. The logs are annotated with their assigned codes.

Sample Collection and Well Sounding

Water samples were collected following the recommendations and the standard procedures of the DEQ and the Coeur d'Alene branch of the Idaho State Laboratory. Appendix 2 is a detailed description of the field procedures and equipment.

Before obtaining a sample, most of the wells were purged of at least one well volume, and all wells were purged until at least two of the three field parameters were stable. Because the wells, with the exception of the Greenferry Water District community well, are fairly low yield, domestic wells in daily use, it was deemed unnecessary to pump the recommended three well volumes for purging of monitoring wells, in which water stands stagnant for long periods.

The field measurements were recorded at the time of the collection of each sample. The samples were collected in new, one liter polyethylene "cubitainer" bottles, obtained from the laboratory. The bottles were rinsed with well water prior to collection of the sample. The samples were drawn from outside taps as close to the wellhead as possible, and sample containers were labeled with a unique sample code in indelible ink. The samples were placed on ice in a cooler immediately after collection. Consistent with ongoing aquifer monitoring programs in the region, no other field preservation was employed. At all times the samples were within sight of the sampling personnel or in a locked vehicle. The samples were delivered to the laboratory by the sampling personnel within 24 hours of collection. At the lab, the transfer of samples to the laboratory personnel was recorded on sample log sheets, which established a chain of custody.

Measurement of the depth to the static water level (SWL) was completed where the wells were physically accessible and where the owner did not object to the opening of the well cap. The SWL was measured before the sample was collected. The SWL was measured using an electric tape well sounder following a standard operating procedure (Appendix 2). The depth to water was recorded to one-tenth of a foot (or one-hundredth of a meter). The sounding tape was raised and lowered two to three times to verify that the measurement obtained was reproducible.

Water Quality Analysis

All the samples collected for the study were analyzed at the Coeur d'Alene branch of the Idaho State Laboratory by EPA approved methods. The Coeur d'Alene branch of the Idaho State Laboratory is certified for drinking water analysis by the Idaho Bureau of Laboratories. For the analysis of sulfate only, samples were shipped to the Idaho State Laboratory in Boise, because the Coeur d’Alene branch does not have the recommended method for analysis of sulfate in drinking water. Table 1 is a list of the constituents measured in the study samples, and the standard methods employed, and includes the reporting unit, the detection limit, the preservation, and the holding time for each analytical method.

Table 1. Methods of laboratory analysis of the study water samples.

Constituent	Method (EPA)	Reporting Unit	Detection Limit (mg/L)	Preservation	Maximum Holding Time
Calcum	3111B Flame atomic absorption	mg/L	0.5	Acidified to pH <2.0 with nitric acid, refrigerated 4° C	6 months
Magnesium			0.1		
Potassium			0.1		
Sodium			0.1		
Iron			0.02		
Chloride	325.3 Titration	mg/L	0.5	None required	28 days
Nitrite + Nitrate	353.2 Colorimetry	mg/L as nitrogen	0.010	Acidified to pH<2.0 with sulfuric acid, refrigerated 4° C	28 days
Sulfate	375.4 Titration	mg/L	2.0	Refrigerated 4° C	28 days
Alkalinity	310.1 Titration	mg/L as $CaCO_3$	2	Refrigerated 4° C	14 days

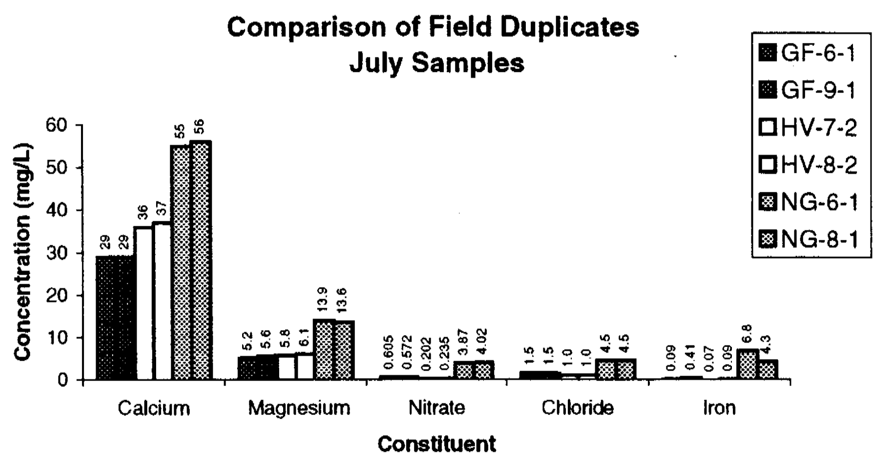
The temperature, the conductivity, and the pH of the samples were measured in the field using instruments that were calibrated at least daily. The field instruments are described in Appendix 2. All the wells were sampled once in July, 1997, and once in September, 1997. These two sampling events were employed to assess seasonal differences in the elevation of the water table and any concurrent variation in water chemistry. Calcium, magnesium, chloride, and nitrite plus nitrate in ground water were determined at least twice in samples from all wells. All constituents were determined as total concentrations. To establish a more complete characterization of ground water, alkalinity and three additional major ions, potassium, sodium, and sulfate, were determined in three samples from each basin. Analysis of total iron was completed for all wells at least once. In areas HV and GF, the analysis of iron concentrations was not repeated. In these two study areas, the first analyses for iron revealed most values were very near or below the detection limit.

Seven wells showed evidence of elevated nitrate concentrations in the first sampling round. Additional samples were collected from these wells in August, 1997. Nitrate concentrations were measured in all of these samples, and in one, total potassium and sulfate were also measured. In order not to over-represent these wells in the statistical summary, these additional analyses were not included in the statistical treatment of water quality data.

Three types of quality control samples were prepared: field duplicates, a trip blank, and an equipment blank. Field duplicates were submitted for approximately ten percent of the samples collected. In this study, a field duplicate is defined as a second sample obtained at the well immediately succeeding the first, then labeled with a fictitious code. Field duplicates provided an indication of the precision of sampling procedures and the reproducibility of laboratory results. The analysis of field duplicate samples indicated that field and laboratory procedures had minimal effect on the measurement of calcium, magnesium, nitrate, and chloride. The results of the analysis of the duplicate samples are listed in Table 2, and displayed graphically in Figure 2. Duplicate

Table 2. Quality control field samples. Includes duplicate samples and blanks. All concentrations in mg/L. Bold type: concentration was at or below this detection limit. Blank: no data.

Sample number	Sample type	Calcium	Magnesium	Iron	Nitrate	Chloride
GF-6-1	sample	29	5.2	0.09	0.605	1.5
GF-9-1	duplicate	29	5.6	0.41	0.572	1.5
% difference		0.0	3.7	64.0	2.8	0.0
GF-6-2	sample	28	4.9		0.692	1.5
GF-9-2	duplicate	27	5.2		0.737	1.5
% difference		1.8	3.0		3.1	0.0
NG-6-1	sample	55	13.9	6.8	3.87	4.5
NG-8-1	duplicate	56	13.6	4.3	4.02	4.5
% difference		0.9	1.1	22.5	1.9	0.0
NG-6-3	sample	50	13.3	0.38	3.90	5.5
NG-8-2	duplicate	51	13.0	0.05	2.97	5.5
% difference		1.0	1.1	76.7	13.5	0.0
HV-7-1	sample	36	5.8	0.07	0.202	1.0
HV-8-1	duplicate	37	6.1	0.09	0.235	1.0
% difference		1.4	2.5	12.5	7.6	0.0
HV-7-2	sample	34	5.2		0.230	1.5
HV-8-2	duplicate	35	5.6		0.287	1.5
% difference		1.4	3.7		11.0	0.0
GF-11-1	field blank	**0.5**	**0.1**	**0.02**	**0.010**	**0.5**
GF-12-1	equipment blank				**0.010**	



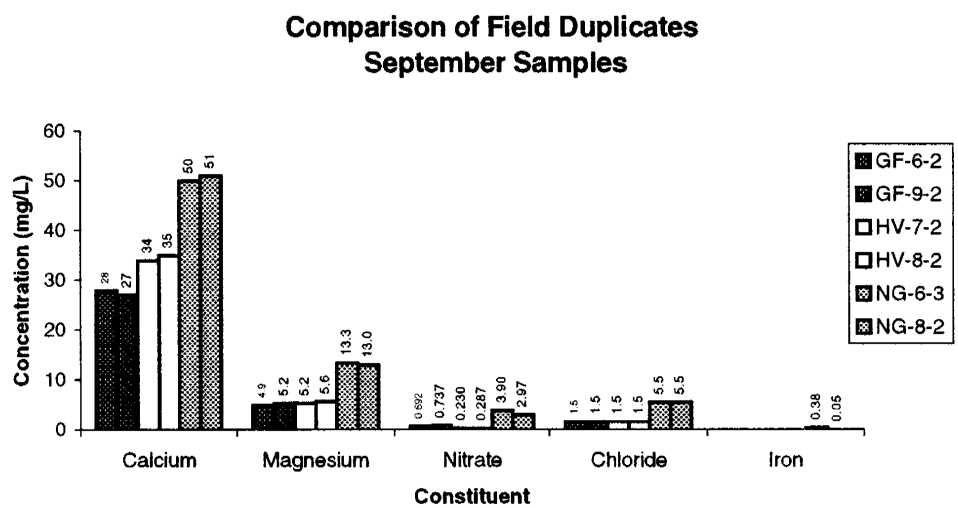


Figure 2. Comparison of the results of field duplicate analyses. Duplicate pairs have the same first two letters in the sample code: GF=South Greenferry Road basin, HV=Hidden Valley, NG=Nettleton Gulch. Note: September samples of areas GF and HV were not analyzed for iron.

and sample concentrations differed less than 20 percent in measurements of calcium, magnesium, nitrate, and chloride. Twenty percent is the maximum allowable statistical difference between duplicates and samples recommended for most DEQ ground water projects in the Ground Water and Soils Quality Assurance Project Plan Development Manual (Winter, 1993). For iron, some differences in the measured concentrations of duplicate pairs are significantly greater than 20 percent. These differences are likely the result of (a) the presence of sediment in samples or (b) measurement at extremely low concentrations. One trip blank consisting of a container of deionized water obtained from the laboratory and kept sealed in the field was submitted for analysis. The reported concentrations of calcium, magnesium, iron, nitrate, and chloride in the trip blank were at or below detection limits, indicating no contamination of the blank took place in the field or laboratory. One equipment blank was submitted for determination of nitrate concentration. The equipment blank was deionized water obtained from the laboratory, subjected to field measurement procedures, and transferred to a sample container. The nitrate concentration of the equipment blank was at or below the detection limit.

Data analysis

Statistical and graphical methods were used to analyze the data. In charts illustrating water quality and well characteristics, lines were plotted representing the range of the middle 50 percent of data (25^{th} to 75^{th} quartile). A tick mark along each line represents the median value. These plots illustrate the spread of the data, and in side by side plots, offer a visual impression of how the data sets compare.

The central tendencies in the data were described using the median rather than the mean (average) because this statistic is less sensitive to extreme values. For small data sets, the median is more representative of the data when the data set includes extreme measurements (outliers). Nonparametric statistics have been used to describe water quality data and to estimate correlations between water quality and causative factors (Saad, 1997; Mueller and others, 1995). Nonparametric statistical procedures provide robust techniques that are not sensitive to outliers and do not require the assumption of normal distribution of data. For differences between basins in this study, the Kruskal-Wallis test (Conover, 1980, p. 229-237) was used to determine the statistical significance of differences in ground water contamination as expressed by nitrate concentration, and differences in the geochemical character of the ground waters as expressed by calcium-magnesium ratios. These tests were performed to establish whether differences between study basins could be considered more than accidental occurrences. The Wilcoxon signed ranks test (Conover, 1980, p.282-288) was used to test for differences between sampling events within each study basin. This test was performed to lend statistical support for establishing whether relatively high and low ground water conditions affected ground water chemistry. Relationships between nitrate concentration and well depth and depth to the open interval in sample wells were investigated using the Spearman correlation coefficient (Spearman's rho, r_s) (Conover, 1980, p. 252-256).

For concentrations of chemical constituents reported at or below the detection limit, the detection limit concentration was used in calculations.

Description of Hillside Basins

The three study basins are located on the perimeter of the Rathdrum Prairie in Kootenai County, in the northern Idaho Panhandle (Fig. 1). Kootenai County is in the northern Rocky Mountains physiographic region with a minor embayment of the Columbia River Basin in its far southwest corner (Bayer, 1983).

General Geology and Climate

Three general divisions of aquifer framework material in the study basins may be identified: (a) Precambrian basement rock, (b) isolated remnants of the Miocene Columbia River Basalt Group, and (c) a regolith composed of Quaternary alluvial deposits, unconsolidated sediments deposited by Pleistocene glacial outburst floods, and decomposed bedrock.

The bedrock of all of the study areas is extremely ancient metamorphic rock most often assigned to the Prichard Formation of the Belt Supergroup (Anderson, 1940; Griggs, 1973). The Belt Supergroup is a extensive sequence of sedimentary rock formed of sediments deposited during the late Proterozoic era of geologic time. Belt Supergroup rocks are, in general, only weakly metamorphosed. The bedrock of the selected basins has undergone different degrees of metamorphism. Weakly metamorphosed argillite is a dominant bedrock east of the Rathdrum Prairie. The gneissic bedrock south and west of the Prairie exhibits amphibolite facies metamorphism (Joseph,1990). The gneiss of these areas has been assigned a Belt Supergroup protolith by Griggs (1973), but may predate the Belt Supergroup (Weis, 1968).

The Rathdrum Prairie is contained within the Purcell Trench, a structural low extending north-northeast into Canada. One hypothesis suggests that the Purcell Trench formed along the axis of low angle normal faulting of eastward dip during unroofing of the igneous intrusive core of Selkirk Mountains. During this event Belt Supergroup strata which had overlain the metamorphic core of the Selkirks, were displaced. Stratigraphic evidence of the date of this event has been obscured by basalt flows and glacial flood deposits, but it is likely to have occurred in the Cretaceous or Eocene during a period of crustal extension. The fault is expressed in the mylonitic zones in bedrock on the eastern slopes of the Selkirk Mountains (Rhodes and Hyndman, 1988).

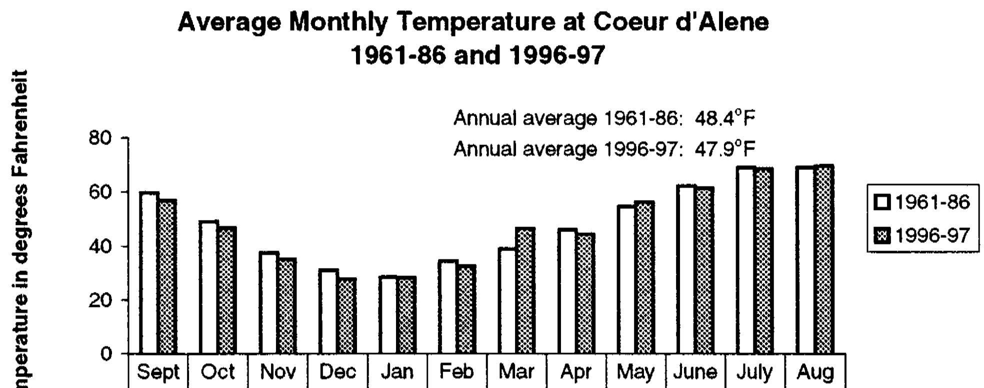
During the Miocene, flows of the Columbia River Basalt Group extended into the ancestral Rathdrum Prairie valley to an elevation of about 2200 ft (670 m) (Griggs, 1976). Isolated remnants of Columbia River Basalt exist in the subsurface of two of the study basins, areas GF and NG, according to drillers' logs.

The geologic evolution of the landforms of portions of Idaho, Washington, and Oregon by Glacial Lake Missoula outburst flooding is a unique story first detailed by Bretz (1923). Graham (1994) provides an extensive review of the effects of these events on the Rathdrum Prairie. In brief, from about 15,300 to

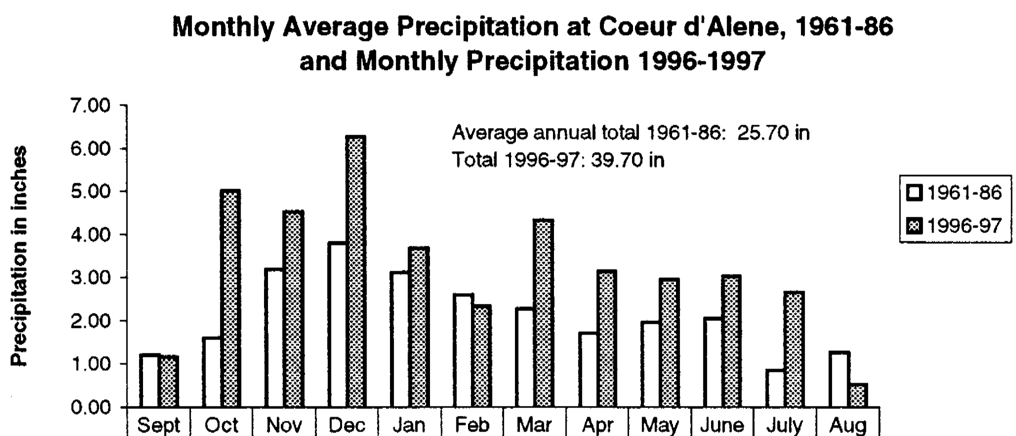
12,700 before present (B.P.) multiple catastrophic outburst floods from Glacial Lake Missoula coursed through the ancestral Rathdrum valley (Waitt, 1985). Glacial Lake Missoula at its greatest extent was about the size of Lake Ontario. The lake was impounded by the Purcell Trench lobe of the Cordilleran ice sheet at the site of present-day Pend Oreille Lake. The breaching of the ice dam resulted in the largest floods in the geologic record worldwide. Many hundreds of feet of coarse, washed, sand and gravel were deposited in the ancestral Rathdrum Prairie valley. The open framework nature of these flood deposits is responsible for the prodigious yield and ground water velocity of the Rathdrum Prairie aquifer, and its vulnerability to pollutants introduced at the Prairie surface. Unconsolidated deposits beneath the valley floor extend to a depth of greater than 1000 ft (300 m) two miles (3.2 km) east of the Idaho-Washington state line, as inferred from seismic profiles by the U.S. Army Corps of Engineers (1951). The high stages of Glacial Lake Missoula floods deposited ice-rafted erratic boulders and flood bars which extend up into the hillside valleys surrounding the Rathdrum Prairie to elevations of greater than 2620 ft (800 m) (O'Connor and Baker, 1992).

General Climate The study basins are in Kootenai County, where warm to hot summers are cooler in the mountains. Where cold air drainage is in effect in winter, the valleys are colder than the lower slopes of the mountains (Soil Conservation Service, 1981). The average monthly temperature and precipitation at the Coeur d'Alene station of the NOAA climate network in Kootenai County are presented in Figure 3 and Table 3. The average yearly temperature for the period 1961-1986 was 48.4°F (9.1°C). Temperature extremes were from -26°F to 109°F (-32.2°C to 42.7°C) for this same period. Monthly temperature averages in the year of the study were approximately equivalent to the long term averages (Fig. 3), with an average for the year at 47.9°F (8.8°C) (Idaho State Climate Services, 1997).

The average yearly precipitation (Table 3, Fig. 3) at Coeur d'Alene for the period 1961-1986 was 25.70 in (652 mm). The bulk of precipitation, about



	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug
1961-86	59.8	49.2	37.6	31.0	28.6	34.5	38.9	46.1	54.7	62.2	69.0	69.0
1996-97	57.0	46.8	35.1	27.8	28.3	32.5	46.6	44.4	56.2	61.6	68.5	69.9



	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug
1961-86	1.21	1.62	3.20	3.80	3.12	2.60	2.28	1.71	1.97	2.05	0.86	1.28
1996-97	1.17	5.01	4.53	6.28	3.69	2.34	4.34	3.15	2.96	3.03	2.67	0.53

Figure 3. Temperature and precipitation in the study basins. Mean monthly temperature and precipitation at Coeur d'Alene, Idaho, for the period 1961-1986 compared to monthly precipitation and average monthly temperatures for the year of the Hillside Project, September 1996 to August 1997 (Idaho State Climate Services, 1997).

Table 3. Temperature and precipitation of the study basins. Average monthly temperature and precipitation at Coeur d'Alene for the period 1961-1986 and for the year of the study, 1996-1997 (Idaho State Climate Services, 1997).

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual Average
TEMPERATURE													
1961-1986													
Fahrenheit	28.6	34.5	38.9	46.1	54.7	62.2	69	69	59.8	49.2	37.6	31	48.4
Celsius	-1.9	1.4	3.8	7.8	12.6	16.8	20.6	20.6	15.4	9.6	3.1	-0.6	9.1
1996-1997													
Fahrenheit	28.3	32.5	46.6	44.4	56.2	61.6	68.5	69.9	57.0	46.8	35.1	27.8	47.9
Celsius	-2.1	0.3	8.1	6.9	13.4	16.4	20.3	21.1	13.9	8.2	1.7	-2.3	8.8

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual Total
PRECIPITATION													
1961-1986													
Inches	3.12	2.60	2.28	1.71	1.97	2.05	0.86	1.28	1.21	1.62	3.20	3.80	25.70
Millimeters	79	66	58	43	50	52	22	33	31	41	81	97	653
Snowfall (in)	19.3	7	3.4	0.6	0	0	0	0	0	0.1	6	15.8	52.2
1996-1997													
Inches	3.69	2.34	4.34	3.15	2.96	3.03	2.67	0.53	1.17	5.01	4.53	6.28	39.70
Millimeters	94	59	110	80	75	77	68	13	30	127	115	160	1008

64 percent, occurred from October to March. Precipitation in the year of the study was 39.70 in (1008 mm), more than 50 percent above the long term average (Fig. 3) (Idaho State Climate Services, 1997). According to the Soil Conservation Service (1981), average yearly precipitation in the study basins ranges from 22 to 28 in (569 to 710 mm), with higher values occurring at higher elevations.

Soils The soils of ground water recharge areas are important to an understanding of the potential for contamination. Table 4 describes soil hydrologic classes devised by the Soil Conservation Service (1981) and used in this report, and lists the predominant soil series of the study basins by class.

Land Use A qualitative reconnaissance of land use for each area was performed as part of this study. The descriptions of study areas include the land use zones as established in the Kootenai County comprehensive plan. Table 5 is an abbreviated explanation of pertinent zoning information and regulations.

Table 5. Summary of zoning categories and pertinent regulations.

Regulatory category	Impact
EPA Sole Source Aquifer status	Requires review of federally supported projects to prevent ground water degradation
Idaho Special Resource Water status Idaho Sensitive aquifer	Quality of water must not be lowered unless demonstrated necessary and justifiable for social or economic development
PHD septic system restrictions	Minimum lot size without sewer: 5 acres over Rathdrum Prairie aquifer
Agricultural / suburban zone, Kootenai county	Minimum lot size: 1/5 acre, 3/4 with livestock
Rural zone, Kootenai county	Minimum lot size: 5 acres
Agricultural zone, Kootenai county	No subdivision

The individual characteristics of the study basins are detailed in the sections that follow. A summary of the characteristics of the three study basins is presented in Table 6.

Table 4. Soil hydrologic classes in the study basins. The soil series listed are representative of the predominant soils in the study basins (Soil Conservation Service, 1981).

Soil class	Soil series in the study basins	Permeability (in/hr)	Description
A	Kootenai	0.6 to >20	High infiltration rate when thoroughly wet. Low run-off. Deep well- to excessively-drained soils, usually sand and gravel. High rate of water transmission
	McGuire	2.0 to >20	
B	Avonville	0.6 to >20	Medium infiltration rate when thoroughly wet. Moderately deep to deep, moderately- to well-drained soils, moderately fine to moderately coarse. Moderate rate of water transmission
	Vassar	0.6 to 2.0	
	Rathdrum	0.6 to 2.0	
C	Ramsdell	0.6 to 2.0	Slow rate of infiltration when thoroughly wet. Often a layer that impedes downward movement, or fine texture. Slow rate of water transmission
D	Potlatch	0.2 to <0.6	Very slow infiltration rate when thoroughly wet. High potential for run-off. Clay soils, a clay layer, or shallow soil over impermeable material. Very slow rate of water transmission

Table 6. Characteristics of the three study basins. Area and length digitized from USGS 7.5' series maps. Well characteristics as described on drillers' logs. Soil classification from Soil Survey of Kootenai County, 1981.

Descriptor	**Units**	**Area GF** **South Greenferry Road**	**Area HV** **Hidden Valley**	**Area NG** **Nettleton Gulch**
Area	mi^2	3.26	9.56	2.85
	acres	2,086	6,120	1,820
	hectares	844	2,480	740
Basin length	mi	2.23	4.7	3.16
	m	3,590	7,560	5,090
	ft	11,770	24,820	16,700
Range of elevation	ft	2,130 - 4,122	2,120 - 5,003	2,200 - 4,102
	m	649 - 1.256	646 - 1,525	670 - 1,250
Land use		Residential, farming, greenhouse	Residential, livestock, farming, logging	Residential, livestock
Surface water		Intermittent and Spokane River	Intermittent and Lost Creek	Intermittent
Bedrock		Banded gneiss, deep decomposed zones	Gneiss, mylonitic zones	Argillite, basalt
Predominant soils	see Table 4	A, B	A, D	A, C
Count of septic systems mapped by PHD in 1992		41	28	50
Septic density	# / mi^2	13	3	18
Depth to open interval in sampled wells	Range (ft)	0 - 551	84 - 500	0 - 350
	Median (ft)	132	216	177
Static water level in sampled wells	Range (ft)	12 - 140	45 - 470	20 - 155
	Median (ft)	93	171	135
Depth of sampled wells	Range (ft)	20 - 551	216 - 500	20 - 335
	Median (ft)	200	363	209
Yield of sampled wells	Range (gpm)	4 - 600	3 - 50	8 - 60
	Median (gpm)	20	8	14

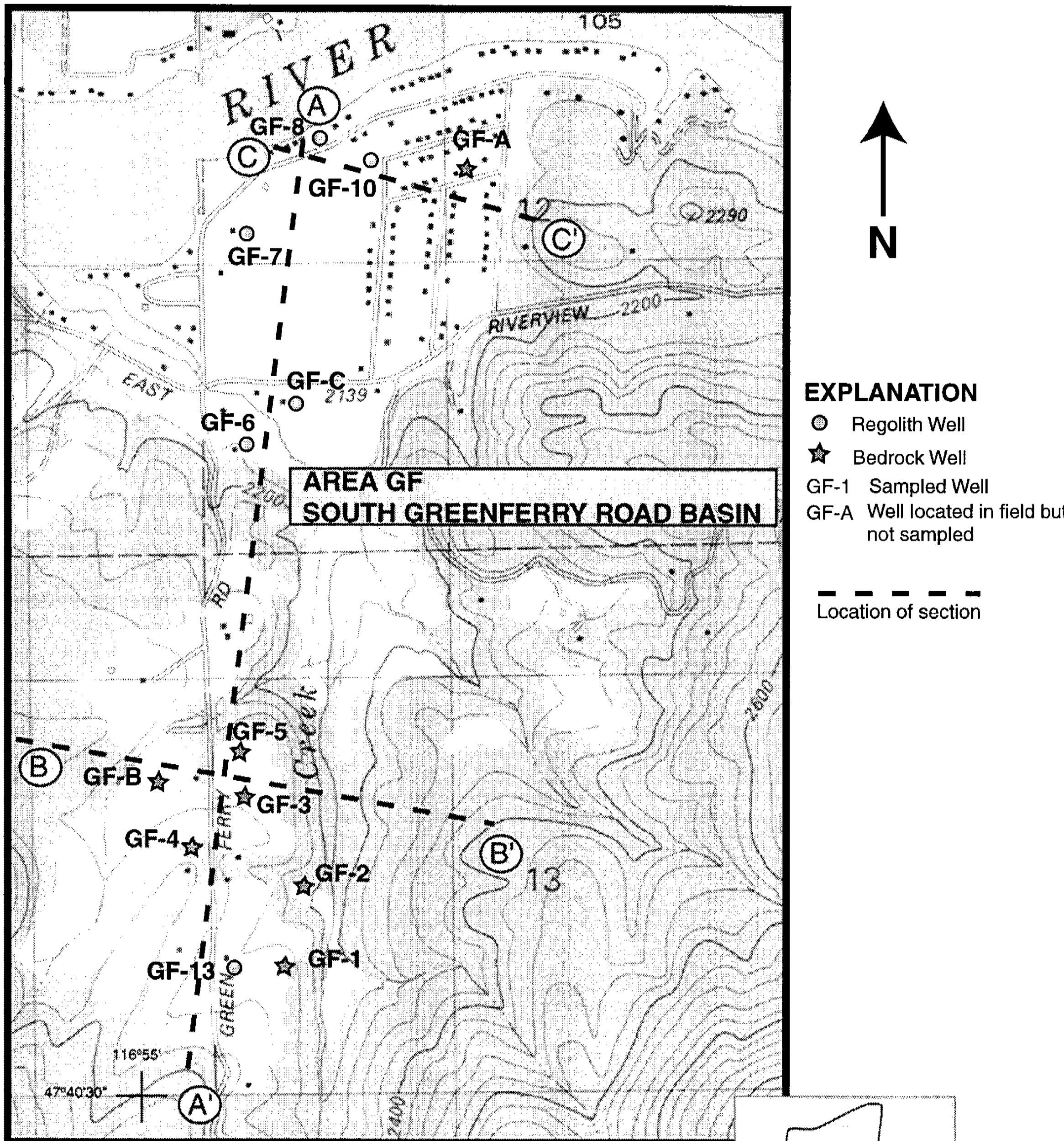
Area GF: The South Greenferry Road Basin

Intermediate Development Density

Area GF (Fig. 1 and Fig. 4) covers approximately 3.26 mi^2 or 844 hectares (ha). Area GF is south of the Spokane River about 1.7 mi (2.7 km) east, along East Riverview Drive, from the city of Post Falls. The basin of area GF contains the South Greenferry Road neighborhood and is the drainage basin of an intermittent stream, Cedar Creek. The northern boundary of area GF is the Spokane River, and the basin extends south to the Cedar Hill divide above Bunn Road. At the mouth of the basin, area GF is bounded on the east by Kelly Avenue and on the west by Snowshoe Drive.

The topography of area GF is characterized by steep ravines in the upper reaches, an upland bench midway along the axis of the valley, a dissected bar or fan at the valley mouth, and a rolling, low relief terrace along the Spokane river at the base of the valley. Intermittent streams carry surface runoff that percolates into a depression just south of East Riverview Drive. The land surface elevations range from about 2,130 ft to 4,122 ft (649 to 1,256 m). The length of the basin is about 2.23 mi (3.6 km). The bedrock in area GF is highly fractured and contorted gneiss correlated with the Hauser Lake Gneiss (Rhodes and others, 1989). The bedrock is identified as granite in well drillers' logs. Visible in outcrop are roughly vertical bands of segregated felsic rock with high quartz content and what was probably mafic rock containing iron and magnesium, now weathered to clay rich zones. Also exposed are zones of granular, permeable weathered bedrock. Aerial photography compiled in the orthophotoquad map of the area reveals intersecting systems of lineations apparent in vegetation patterns, suggesting the existence of extensive joint systems in the bedrock.

Figures 5a and 5b are hydrogeologic sections depicting the aquifer framework and water levels of area GF. Interfingering strata of sand, gravel, and clay, with the coarsest material underlying clay in drillers' logs, suggest



Base Map U.S. Geological Survey 7.5 Minute Series, Post Falls, Idaho

0 1/2 mile

1/2 kilometer

SCALE

Contour interval 40 feet

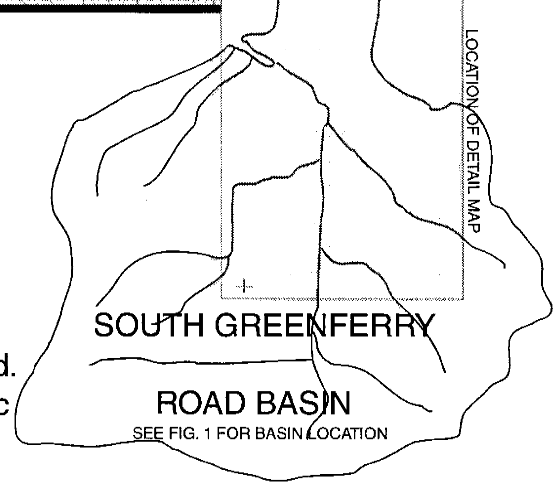


Figure 4. Area GF, South Greenferry Road. Locations of study wells and hydrogeologic sections.

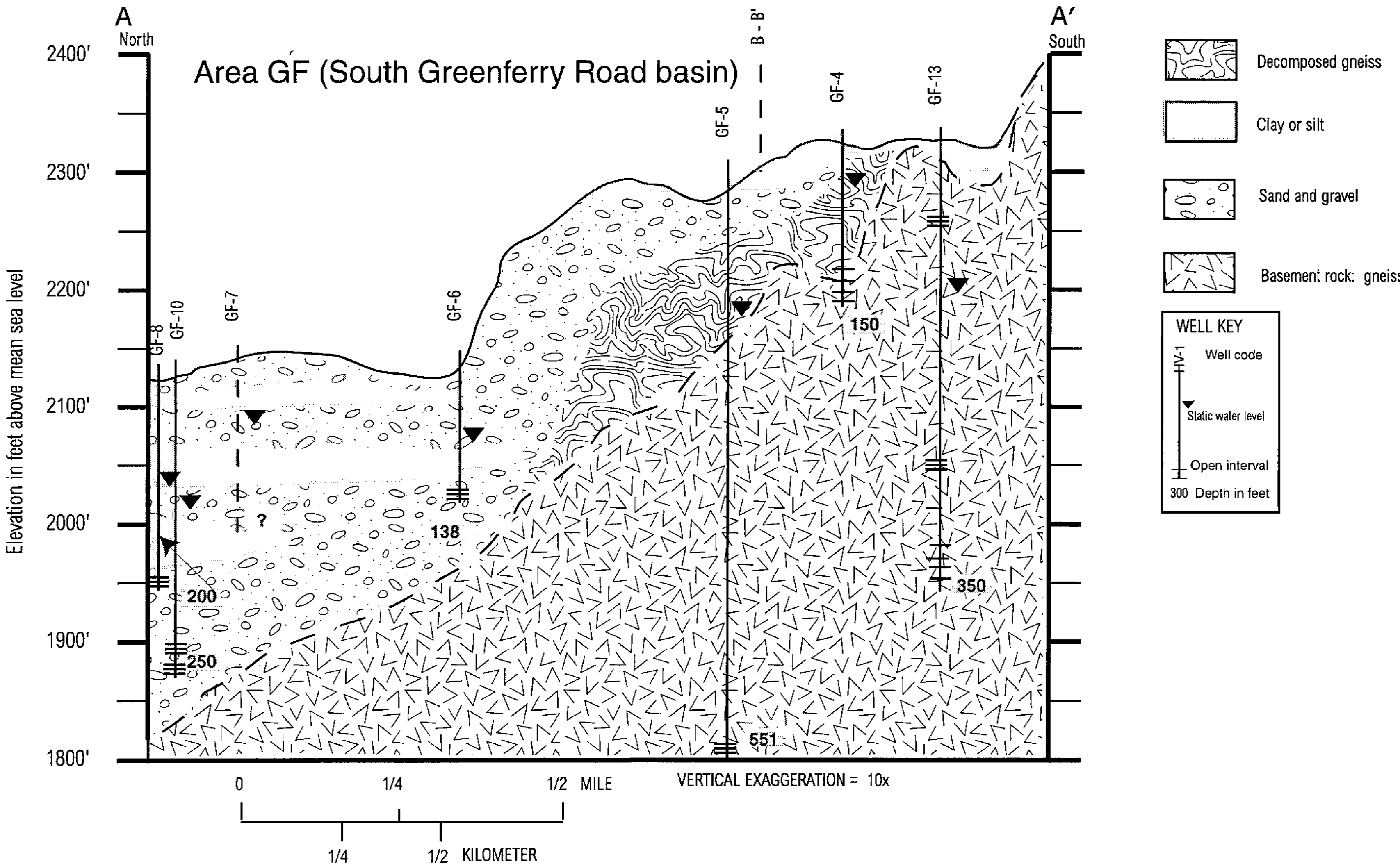


Figure 5a. Hydrogeologic section A - A' for area GF, South Greenferry Road basin. See Figure 4 for location.

AREA GF (SOUTH GREENFERRY ROAD BASIN)

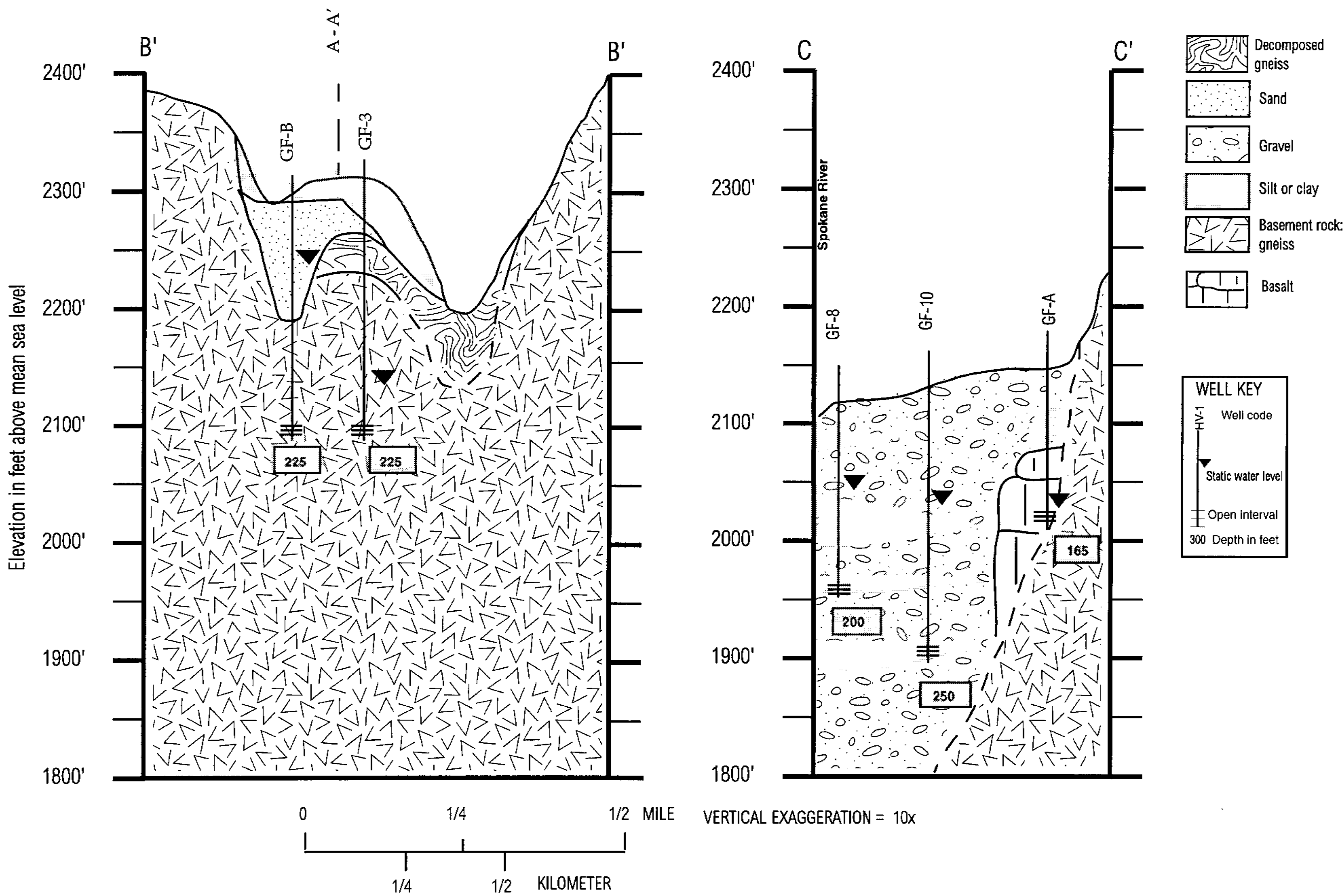


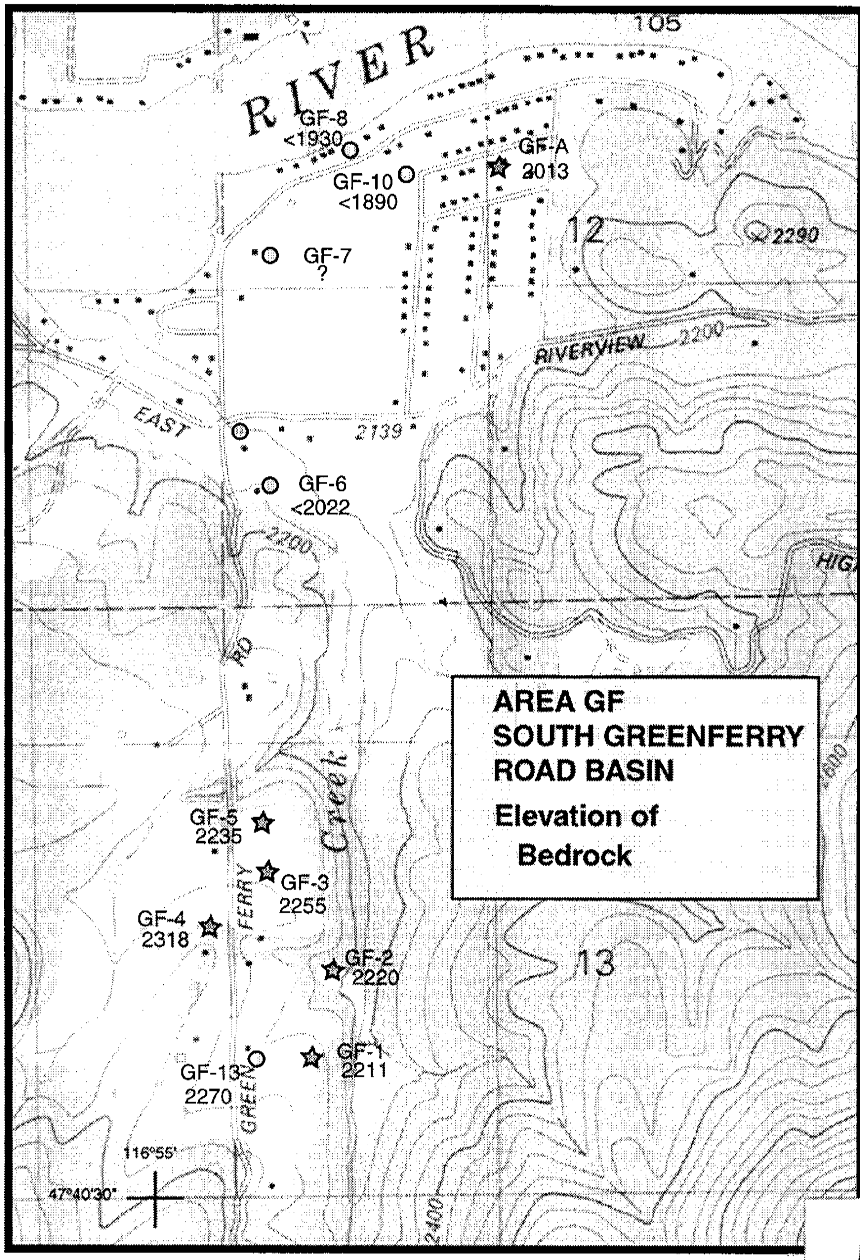
Figure 5b. Hydrogeologic sections B-B', C-C' for area GF, South Greenferry Road basin. See Figure 4 for location of sections.

deposition by debris flow in a fan structure. Also apparent in drillers' log descriptions of lithology are the deep weathered zones in bedrock characteristic of this area.

The mapping of static water levels in the wells of area GF suggests hydraulic gradients in the direction of surface slopes of about 0.02 in regolith at the base of the drainage and in the regolith-bedrock aquifer at the higher elevations. The deepest static water level measured in a well in area GF was at elevation 2,015 ft (614.0 m). The depth to water in the Rathdrum Prairie aquifer north of area GF and the Spokane River is about 130 ft (39.6 m) below the land surface, at elevation 2,000 ft (609.6 m), as suggested by contouring by Painter (1991b) of USGS data (Drost and Seitz, 1978). Figures 6 and 7 depict the bedrock configuration and the ground water levels, respectively, in area GF. The configuration of the water table in Figure 7 is interpreted from data from drillers' logs and measurements performed in September, 1997, for this study.

To the west of Cedar Creek and on the flat adjacent to the Spokane River, the soils of area GF are mostly of the McGuire soil series, hydrologic type A, deep, well- to excessively drained, having permeability from 2.0 to >20 inches per hour (in/hr) (5.1 to >51 centimeters per hour, cm/hr). The east side of the basin has shallower soils of lower permeability, of the Vassar series, hydrologic type B, with permeability of 0.6 to 2.0 in/hr (1.5 to 5.1 cm/hr). Between the hillside and the Spokane River soils are of hydrologic type A, mostly of the Avonville series, with permeability of 0.6 to >20 in/hr (1.5 to >51 cm/hr) (Soil Conservation Service, 1981).

The land use is a mix of small scale farming and residential, and has included a small commercial greenhouse in operation since 1980, by the owner's report. In area GF, 41 septic systems were counted on maps of onsite septic systems compiled by the PHD in 1992. The density of septic systems is about 13 per square mile of recharge area (about 5 per square kilometer). The GF area is zoned agricultural/suburban and rural.



N

EXPLANATION

O Regolith Well

☆ Bedrock Well

GF-1 Sampled Well

GF-A Well located in field but not sampled

2000 Elevation of bedrock in feet above MSL

Base Map U.S. Geological Survey 7.5 Minute Series, Post Falls, Idaho

0 — 1/2 mile

1/2 kilometer

SCALE

Contour interval 40 feet

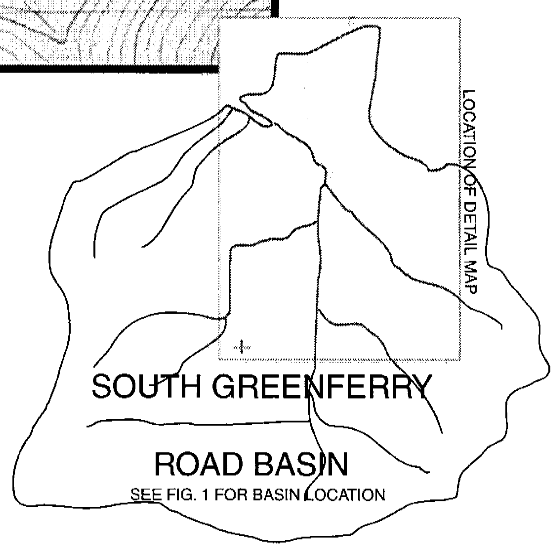
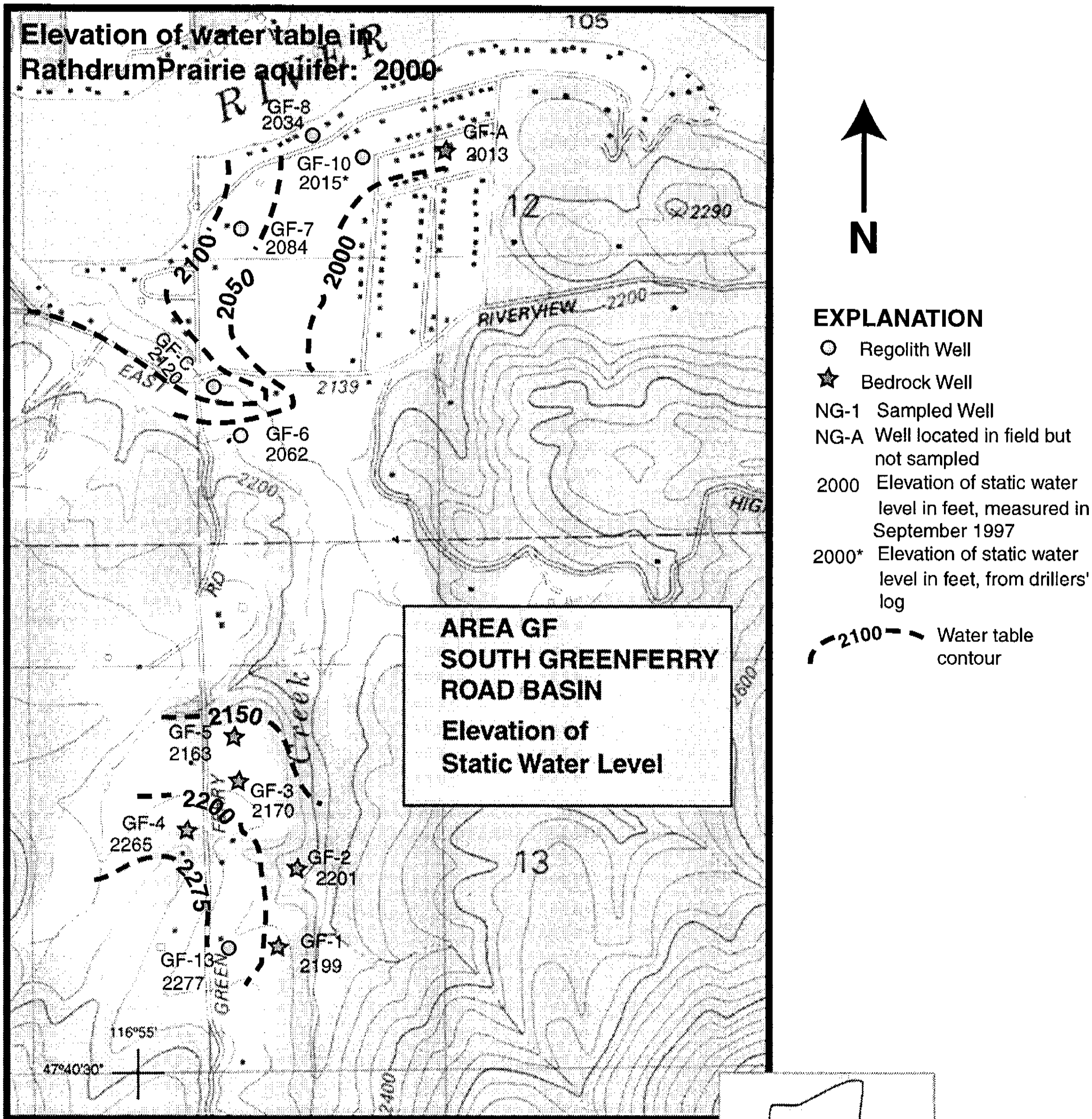


Figure 6. Elevation of bedrock in area GF, the South Greenferry Roadbasin.



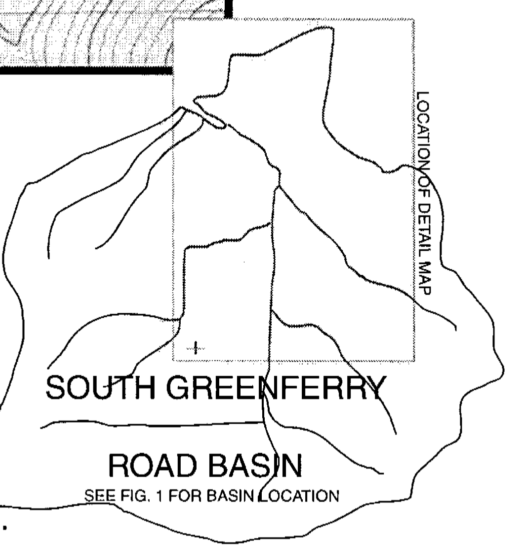


Figure 7. Elevation of static water levels in area GF, the South Greenferry Road basin.

There are no sewers serving the area. Drinking water in area GF is pumped from domestic regolith and bedrock wells, and delivered by a public water system, the Greenferry Water District. Some residents of area GF reported problems or concerns about the drinking water. The water was described as corrosive. Some residents complained of turbidity in their well water. Bacterial contamination has been an issue in the Greenferry Water District distribution system. In August, 1997, this water purveyor installed a chlorinator (personal communication with staff of the Greenferry Water District).

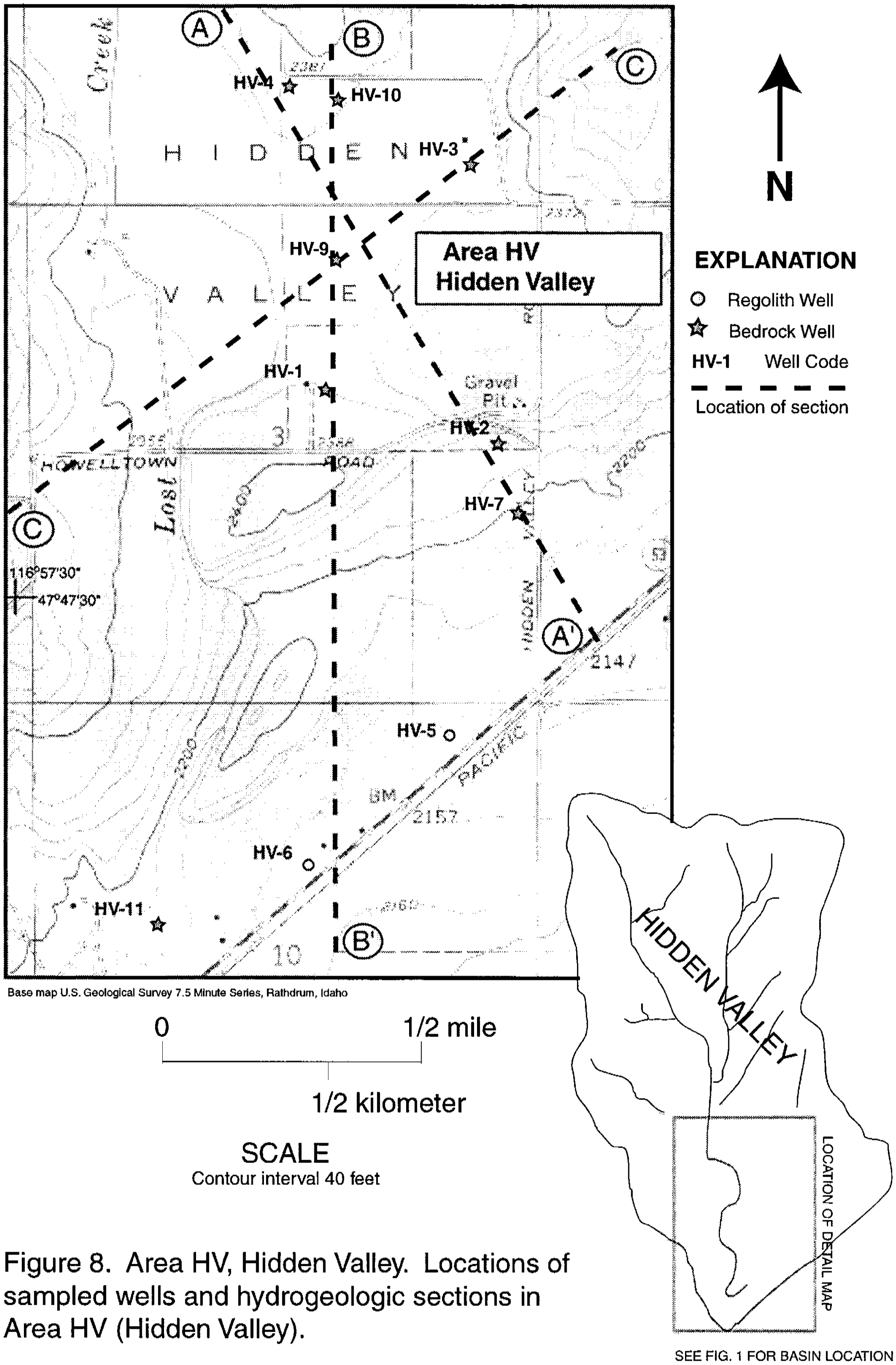
Area HV: Hidden Valley

Low Development Density

Area HV (Fig. 1 and Fig. 8) covers about 9.56 mi^2 (2,480 ha) in the Selkirk Mountains west of the Rathdrum Prairie. Area HV contains the Hidden Valley neighborhood. The drainage basin of area HV is the area drained by Lost Creek, and extends to Rathdrum Mountain to the north. Area HV is bounded to the south by Highway 53 on the Rathdrum Prairie.

The topography of the HV area basin includes steep ravines in upper reaches, but a broad, essentially flat, aggraded, valley floor standing some 200 ft (61.0 m) above the Rathdrum Prairie. A bar of sand and gravel with a slope of 30 percent toward the Prairie blocks the mouth of the basin. The outlet of the valley was blocked by this bar of poorly sorted flood deposits which may be typed as an eddy bar, defined by Baker (1973). This hanging valley may once have been a lake similar in form to Hauser Lake or Twin Lakes, also impounded behind valley-side eddy bars (Kiver and Stradling, 1982).

The upland valley floor is comprised mostly of Potlatch silt loam, hydrologic type D, where permeability is 0.2 to <0.6 in/hr (0.51 to <1.5 cm/hr), decreasing with depth. As a result runoff pools here from February through early July. Soils on coarser flood deposits in the basin are generally of the Kootenai series, hydrologic type A, having permeability in the range 0.6 to >20 in/hr (1.5 to



Base map U.S. Geological Survey 7.5 Minute Series, Rathdrum, Idaho

0 1/2 mile

1/2 kilometer

SCALE
Contour interval 40 feet

Figure 8. Area HV, Hidden Valley. Locations of sampled wells and hydrogeologic sections in Area HV (Hidden Valley).

>51 cm/hr) (Soil Conservation Service, 1981). Lost Creek flows year-round through Hidden Valley, however the stream disappears into the Rathdrum Prairie at its outlet from the basin.

The land surface elevations in area HV are from about 2,120 ft in the depression where Lost Creek disappears, to the 5,003 ft summit of Rathdrum Mountain (from 646 to 1,525 m). The length of the basin is about 4.70 mi (7.6 km).

The bedrock in the vicinity of sampled wells in area HV is gneiss, and has been identified as Hauser Lake Gneiss (Weis, 1968), correlating with the bedrock of area GF. In the area of the sampled wells, bedrock outcrops vary from massive foliated gneiss to highly fractured and mylonitic gneiss. In drillers' logs, the bedrock of Area HV is identified as granite.

Hydrogeologic sections (Fig. 9a, b, c) illustrate the subsurface lithology and water levels in area HV. Interpretation from drillers' logs suggests that a buried channel exists in the subsurface where as much as 374 ft (115 m) of sand, gravel, and silt appear to contain no viable aquifer. A stratum of silt and clay approximately 70 ft (20 m) deep lies below a surficial body of gravel in the upper valley. Figure 10 displays the bedrock configuration of area HV in the vicinity of the sampled wells.

The measurement of static water levels in the wells of area HV indicates a hydraulic gradient to the south of about 0.05 in wells terminating in bedrock. The deepest static water level measured in area HV was at elevation 2,041 ft (622.3 m). The depth to water in the Rathdrum Prairie Aquifer at the outlet of Hidden Valley is about 155 ft (47.0 m) below the land surface, elevation 1,995 ft (608.0 m), based on contouring of 1978 USGS data by Painter (1991b). Figure 11 depicts the configuration of ground water in area HV in the vicinity of the sampled wells, interpreted from September, 1997 measurements performed for this study and data from drillers' logs.

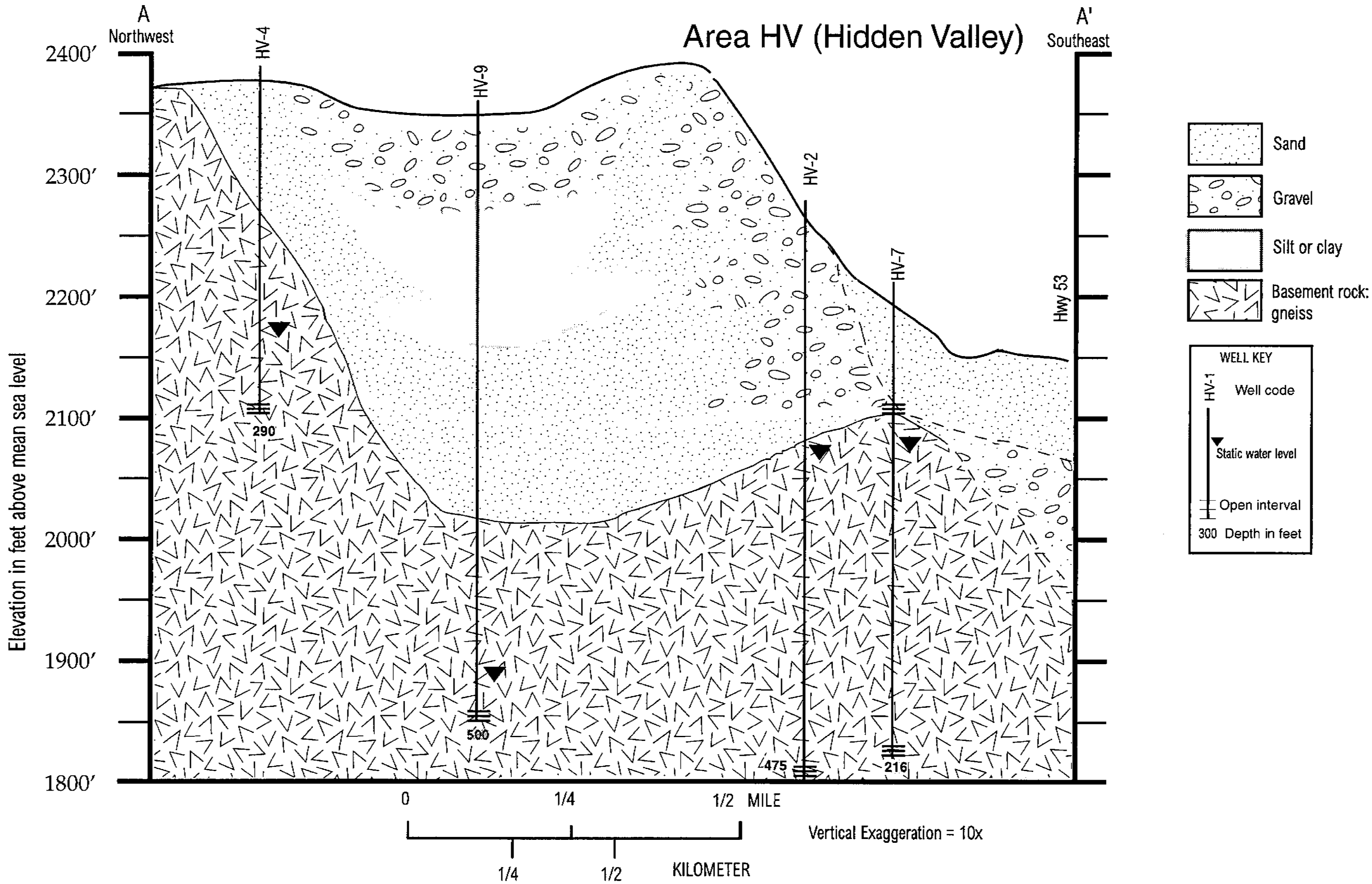


Figure 9a. Hydrogeologic Section A - A' for area HV, Hidden Valley. See Figure 8 for location.

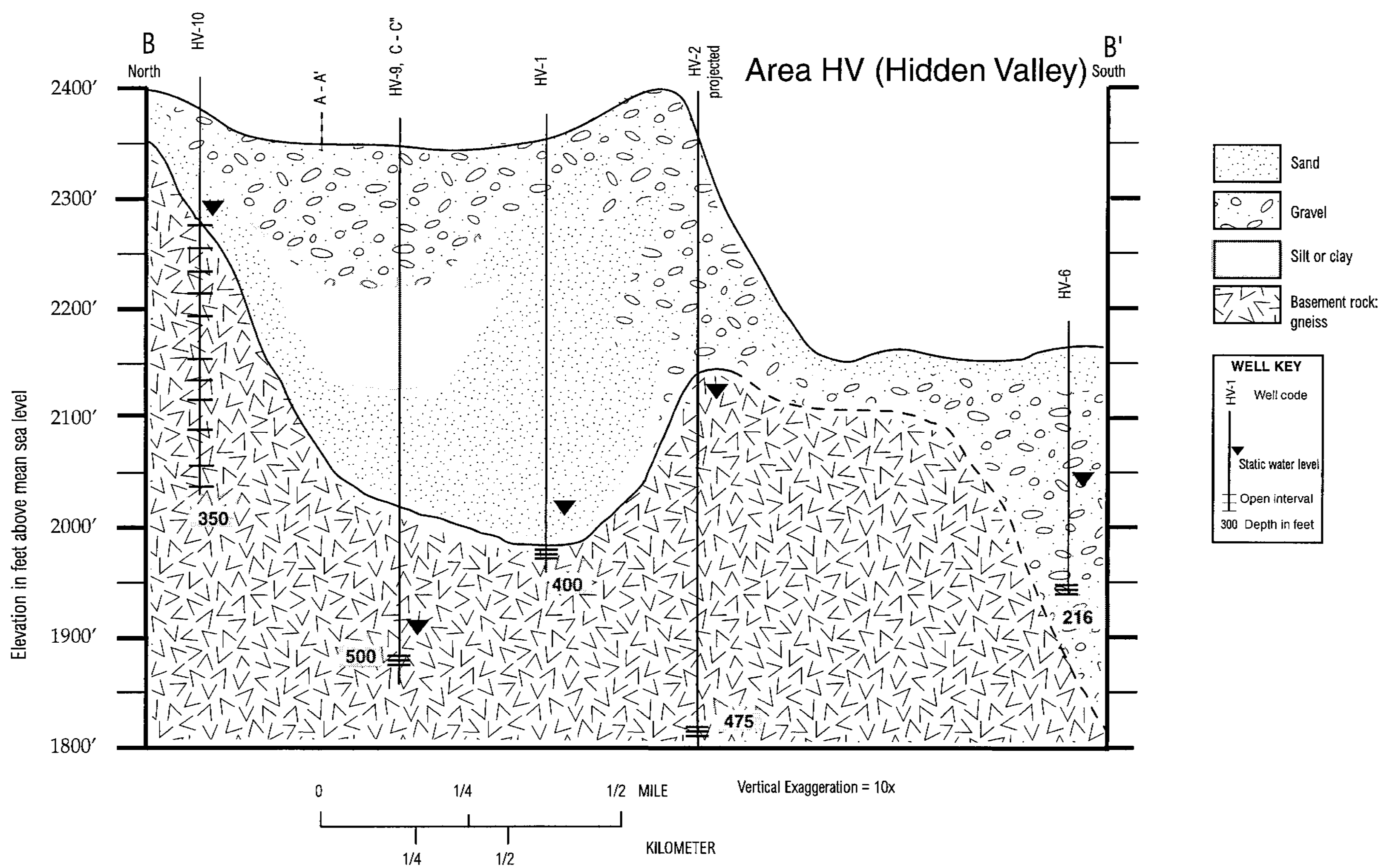


Figure 9b. Hydrogeologic Section B - B' for area HV, Hidden Valley. See Figure 8 for location.

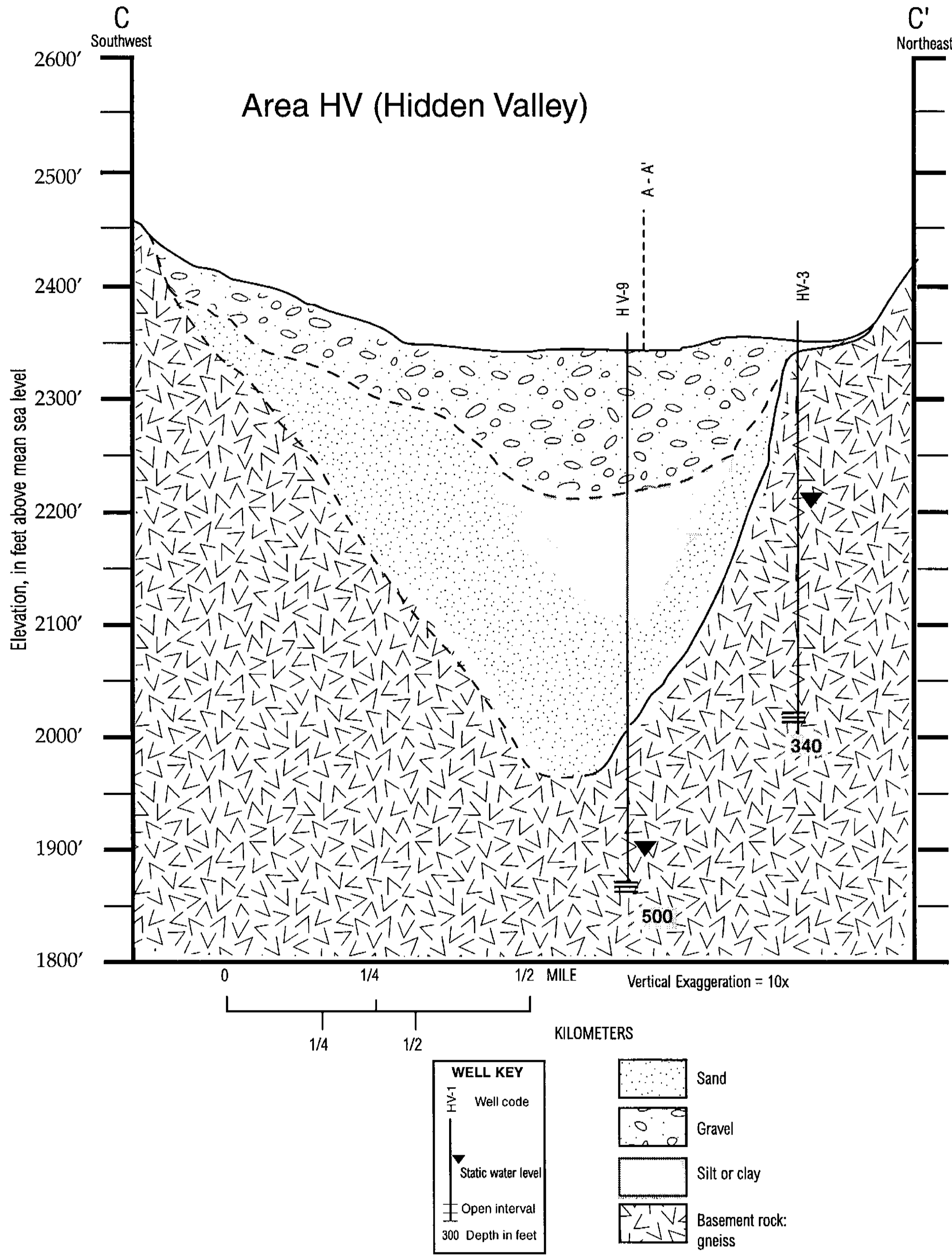


Figure 9c. Hydrogeologic Section C -C' for area HV, Hidden Valley. See Figure 8 for location.

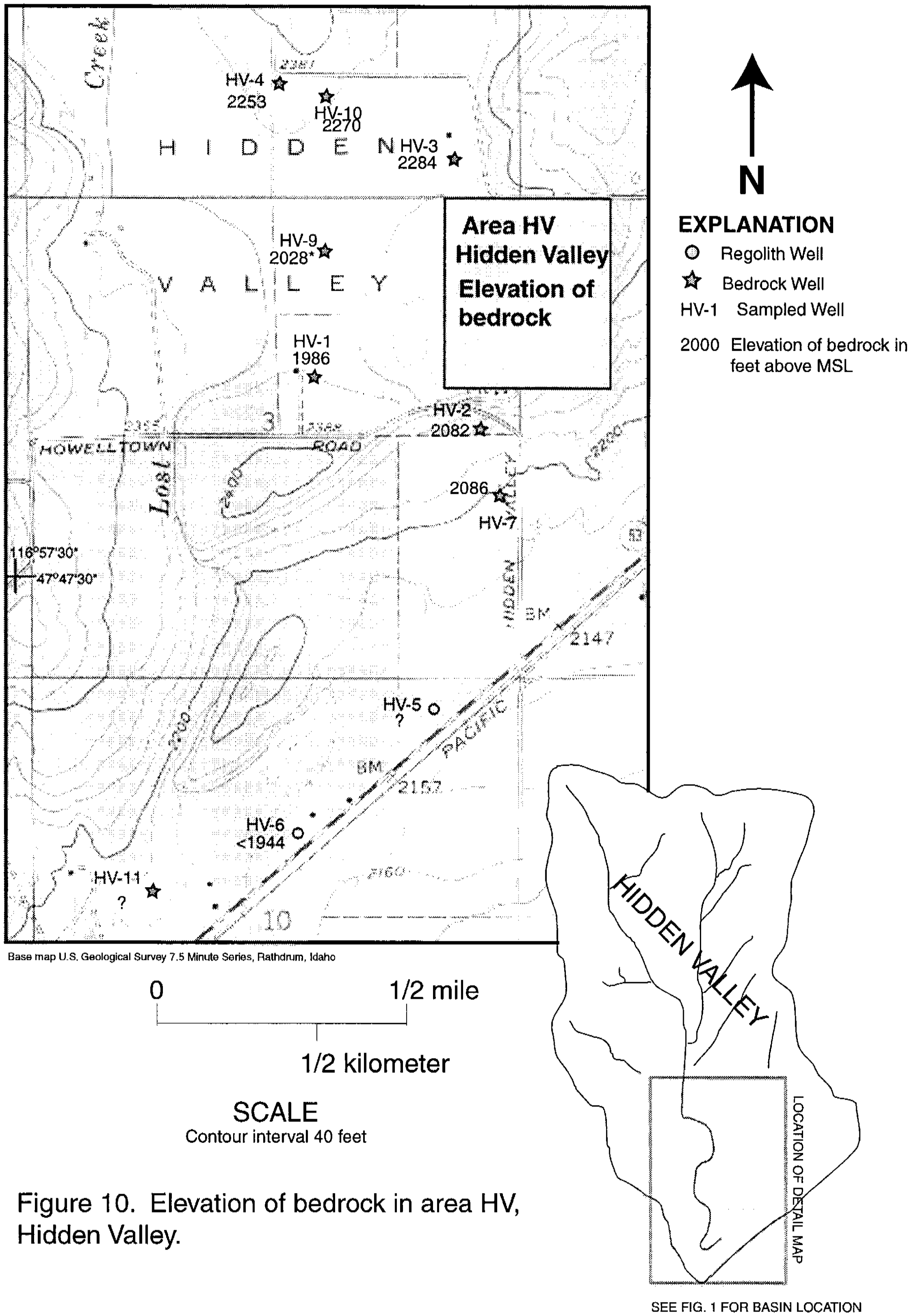


Figure 10. Elevation of bedrock in area HV, Hidden Valley.

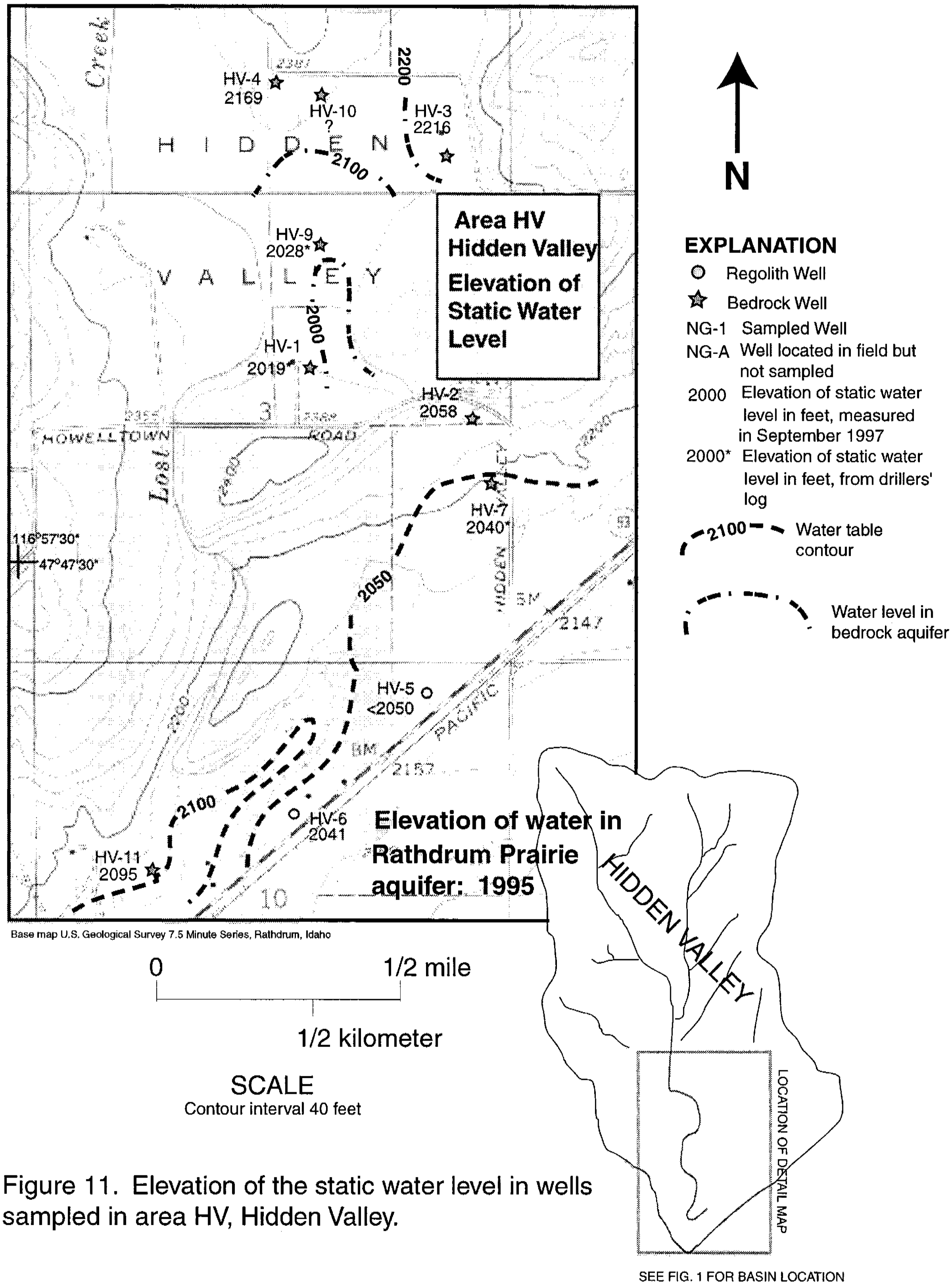


Figure 11. Elevation of the static water level in wells sampled in area HV, Hidden Valley.

The land use of area HV is residential and agricultural, and includes a recently closed gravel pit. The HV area is zoned agricultural/suburban and rural. All wastewater disposal is to onsite septic systems. In area HV, 28 septic systems were counted on maps of onsite septic systems compiled by the PHD in 1992. The density of septic systems was approximately three per square mile of recharge area (about one per square kilometer).

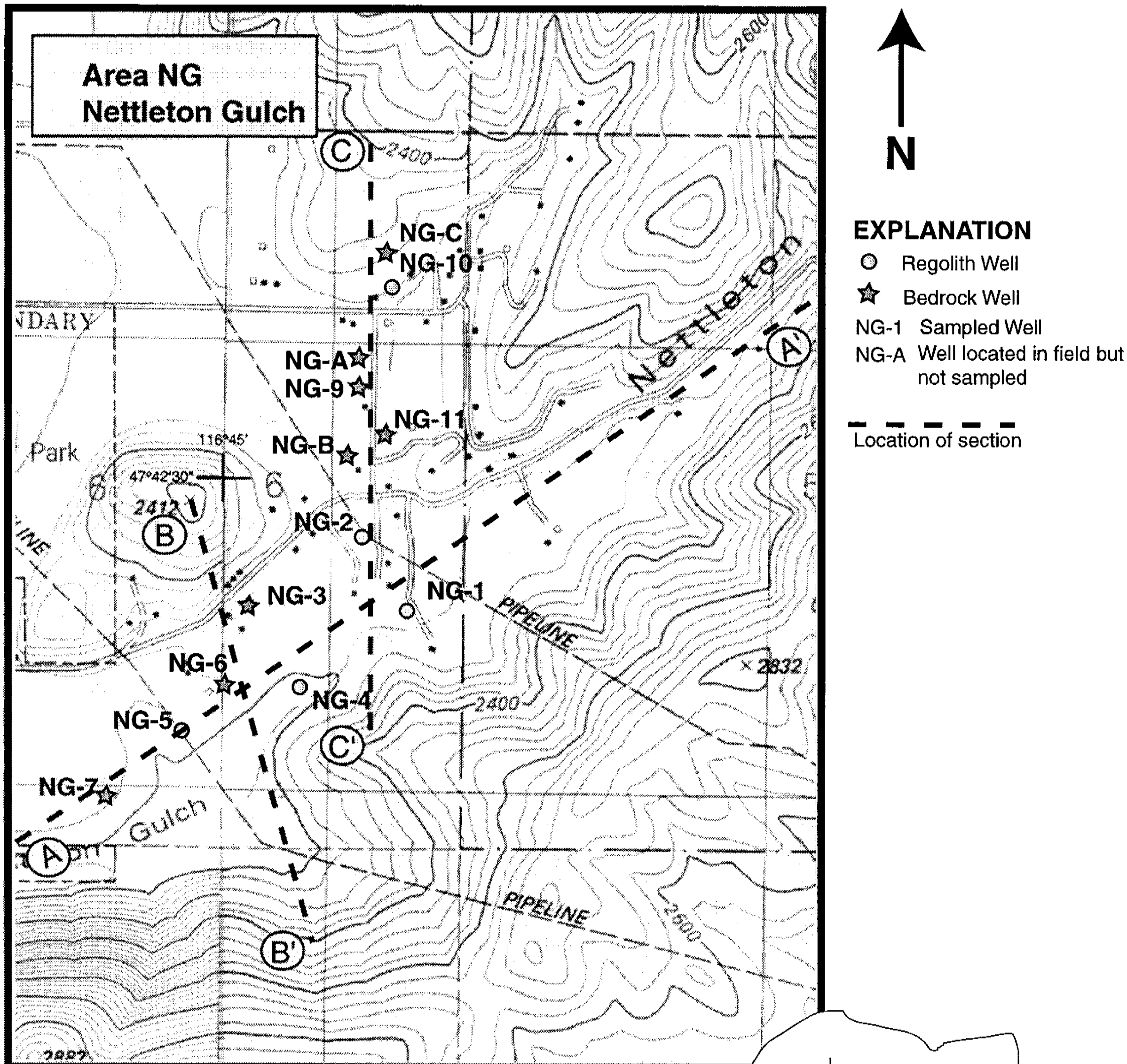
Drinking water in Hidden Valley proper is drawn from domestic wells completed in bedrock. At least two wells are shared by more than one household. Wells along Highway 53 at the outlet of the study basin are completed in bedrock or regolith. No community water system is available to Hidden Valley residents. Some residents of area HV expressed concern about the low quantity of water available in their wells. Concern exists that increasing development of the area will tax the water supply. Most residents reported good water quality. However there were complaints of intestinal distress in two households where the residents had moved to this area recently. These residents were suspect of their water, having heard that the Rathdrum area has experienced bacterial contamination in public water supplies.

Area NG: Nettleton Gulch

High Development Density

Area NG (Fig. 1 and Fig. 12) comprises a drainage basin of about 2.85 mi^2 (7.4 ha). Area NG includes Nettleton Gulch, directly east of the eastern limit of the city of Coeur d'Alene and directly north of Best Hill. The basin of area NG extends up into the hills to East and West Canfield Buttes. Included in this study area, in addition to Nettleton Gulch, is a draw that branches from Nettleton Gulch to the northeast and contains Maple Leaf Road, part of the Thomas Lane neighborhood, and Shaw Loop Drive.

The topography in area NG is characterized by steep ravines and a flat, aggraded valley bottom. The land surface elevations in area NG range from about 2,200 to 4,102 ft (670 to 1,250 m). The length of the basin is about 3.16 mi



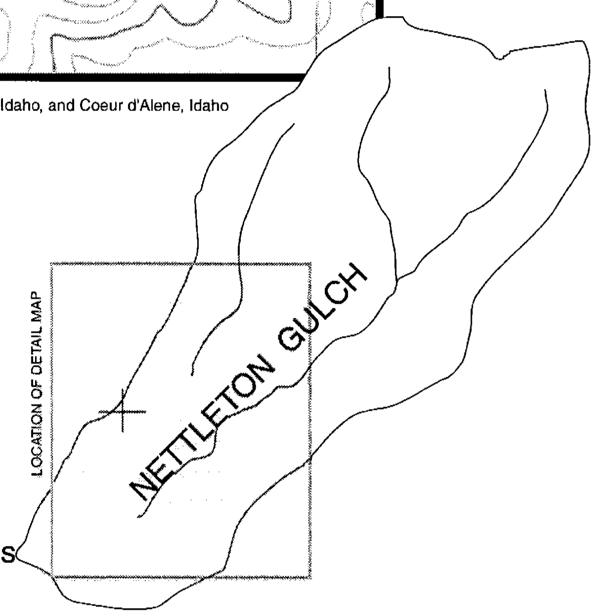
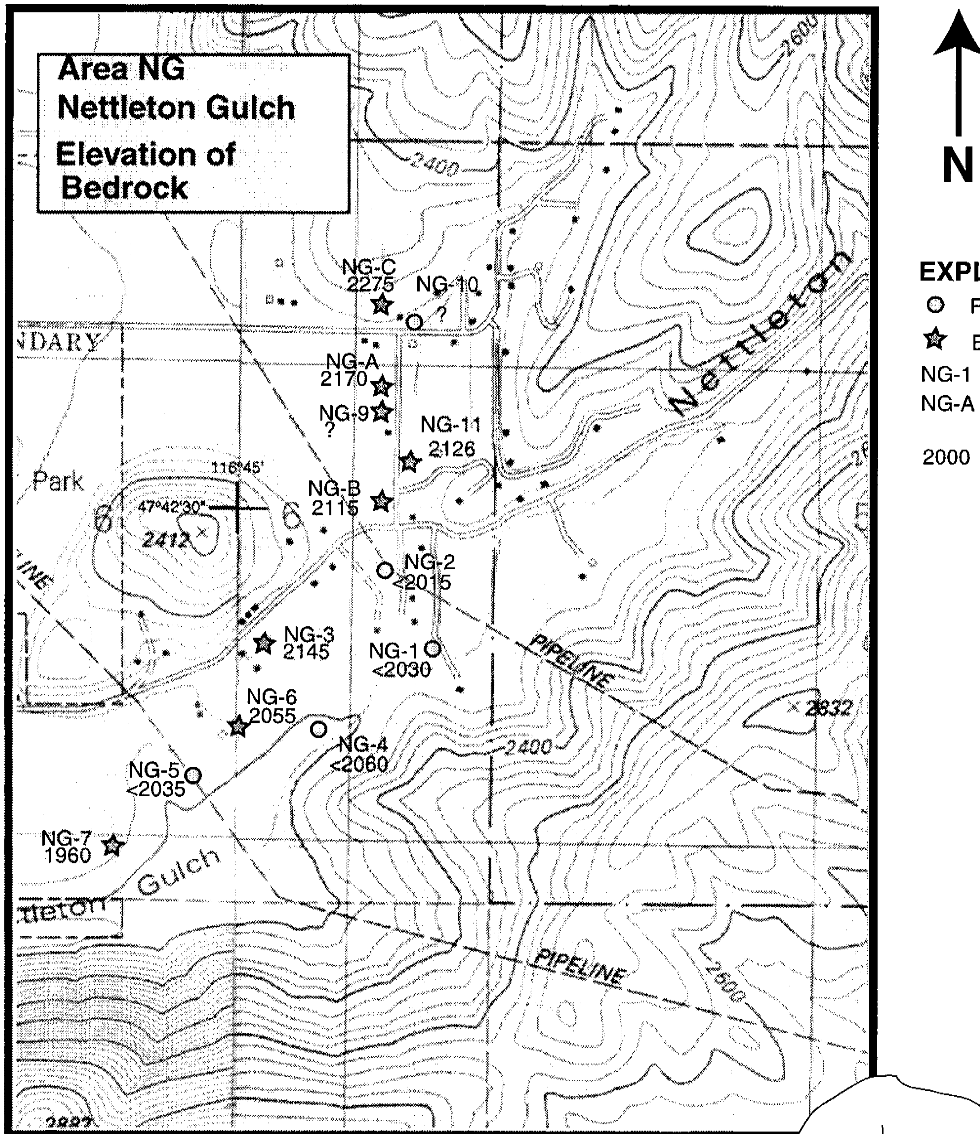


Figure 12. Locations of sampled wells and hydrogeologic sections in Area NG (Nettleton Gulch).

(5.1 km). Intermittent surface streams disappear into the valley bottoms in the Maple Leaf Road subbasin and in Nettleton Gulch. The bedrock in area NG is primarily argillite of the lower Prichard Formation, having a distinctive rusty red weathering rind as a result of disseminated pyrrhotite, an iron sulfide mineral (Griggs, 1973). Argillite is a finer-grained rock than the bedrock of the other study basins. The argillite formed from deep burial of fine-grained sedimentary rocks, and is identified in well drillers' logs as shale. A contact between onlapping Columbia River Basalt and argillite may be inferred by a change in the composition of rock debris from basalt to argillite on the hill north of the mouth of Nettleton Gulch. Some well drillers' logs in area NG indicate basalt in the subsurface. Figure 13 illustrates the bedrock surface of area NG. Area NG contains surficial glacial flood deposits of silty sand to a depth of 100 ft (31 m). Nettleton Gulch proper has basal sedimentary deposits of coarse, cemented gravel. These are overlain by sand and layers of clay. These finer sediments may have been deposited by low energy glacial flood waters that washed over a divide between what now the Thomas Lane neighborhood and the Rathdrum Prairie.

Figures 14a and 14b are hydrogeologic sections illustrating the aquifer framework and ground water levels in area NG. Discontinuous clay deposits and cemented gravels retard vertical movement of ground water. Faults were mapped by Anderson (1940) along the axes of Nettleton Gulch and the Thomas Lane subbasin. The presence of faults in area NG contributes to the difficulty of interpreting ground water flow, as faults may impede or facilitate movement of ground water.



EXPLANATION

- ○ Regolith Well
- ☆ Bedrock Well
- NG-1 Sampled Well
- NG-A Well located in field but not sampled
- 2000 Elevation of bedrock in feet, estimated from drillers' logs

Base Maps U.S. Geological Survey 7.5 Minute Series, Fernan Lake, Idaho, and Coeur d'Alene, Idaho

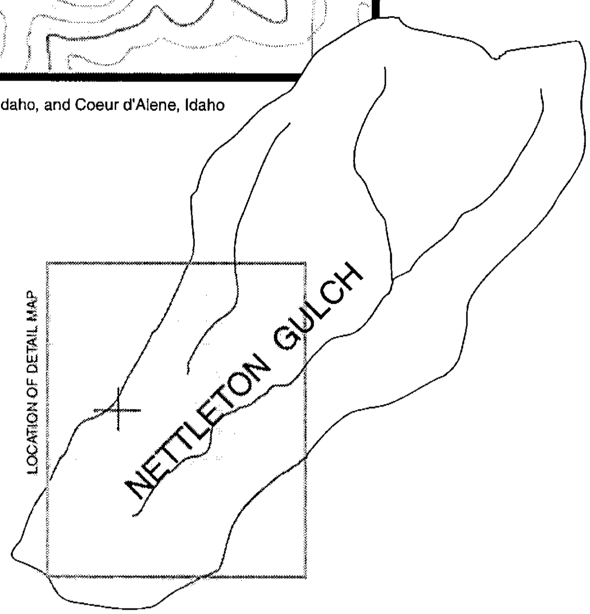
0 1/2 mile

1/2 kilometer

SCALE

Contour interval 40 feet (20 feet in western part of map)

Figure 13. Elevation of bedrock in area NG, Nettleton Gulch.



SEE FIG. 1 FOR BASIN LOCATION

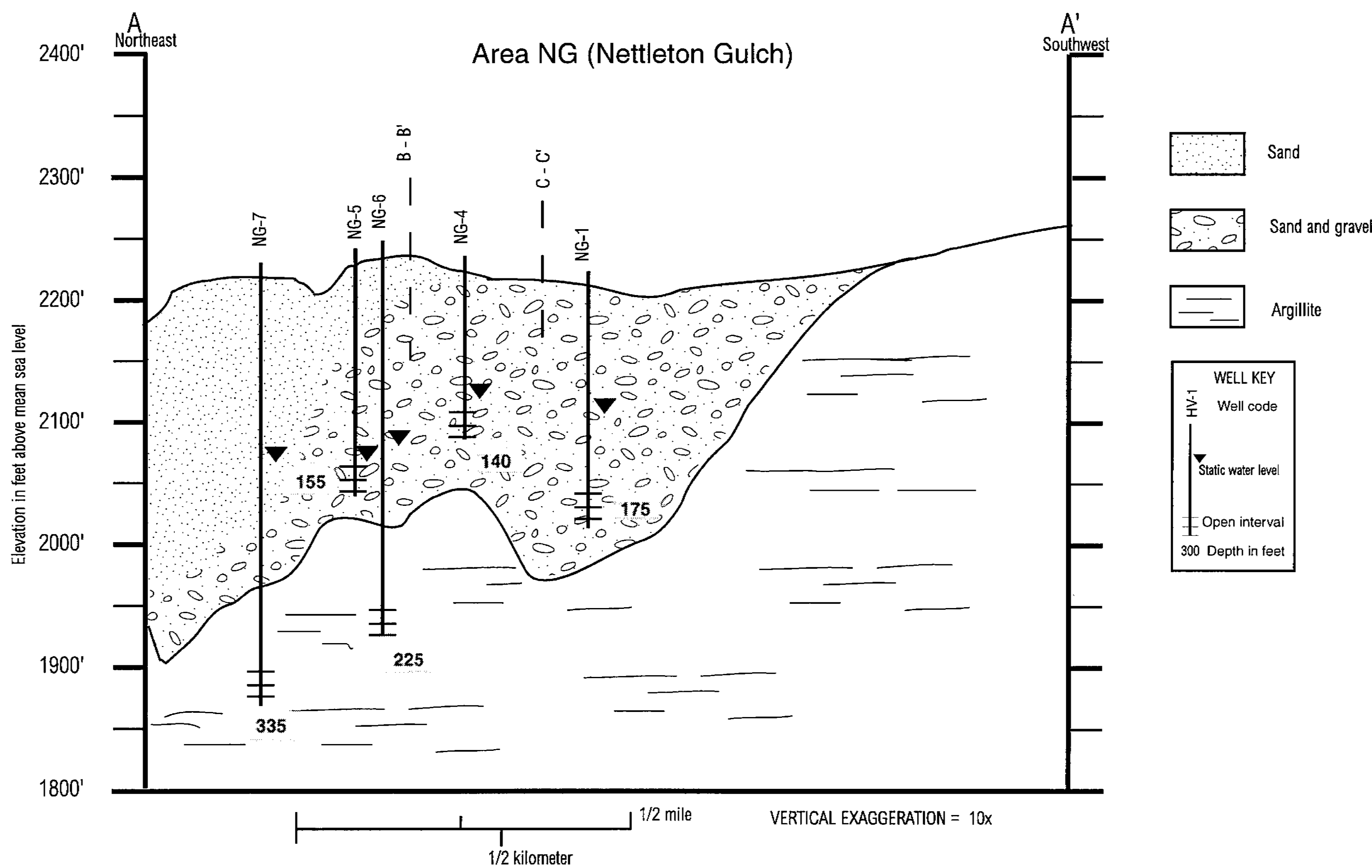
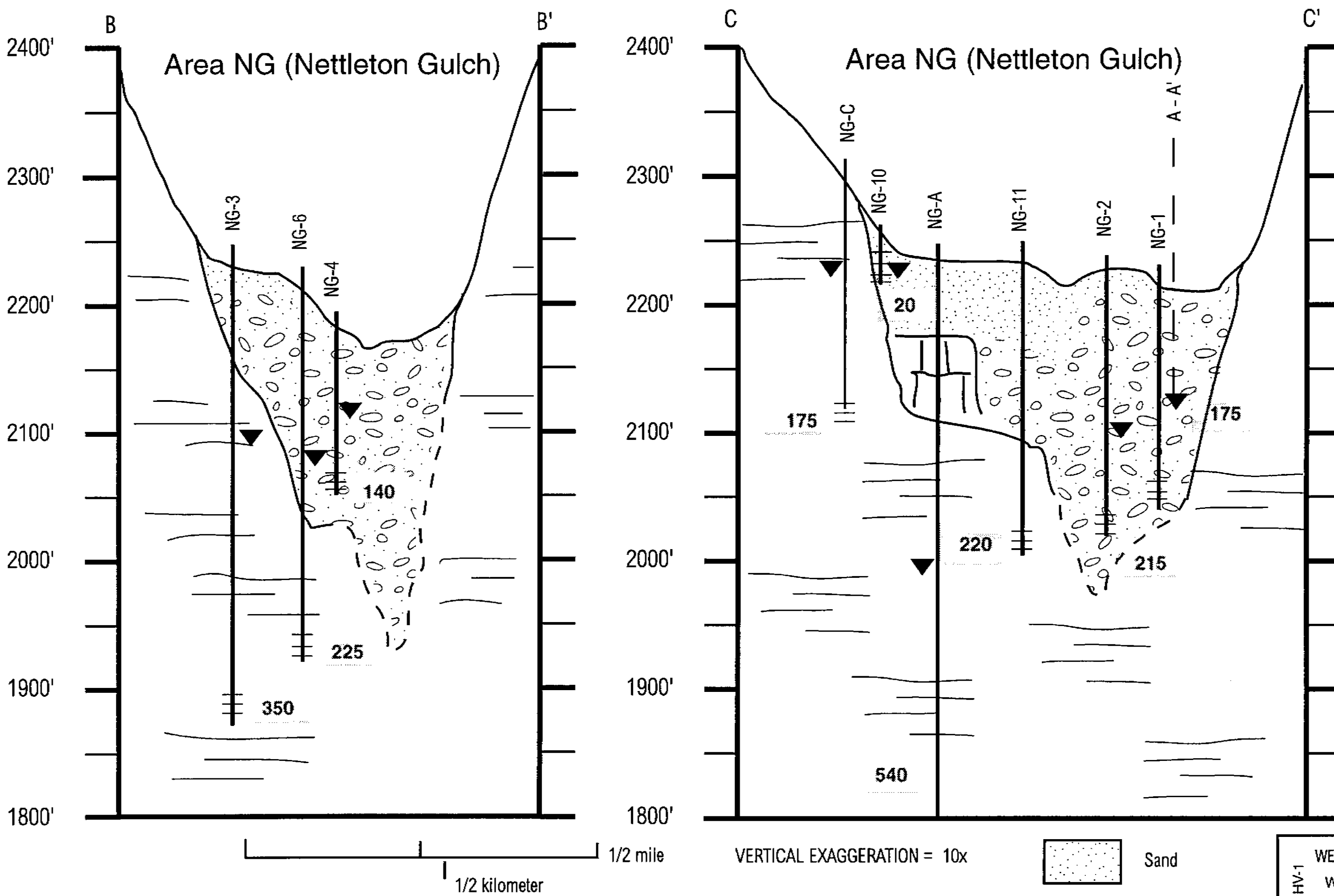


Figure 14a. Hydrogeologic section A - A' for area NG, Nettleton Gulch. See Figure 12 for location.



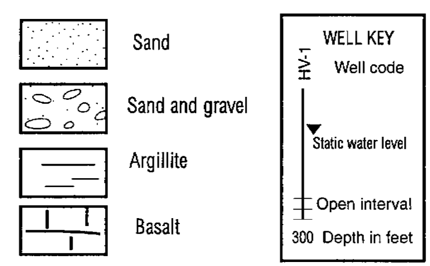


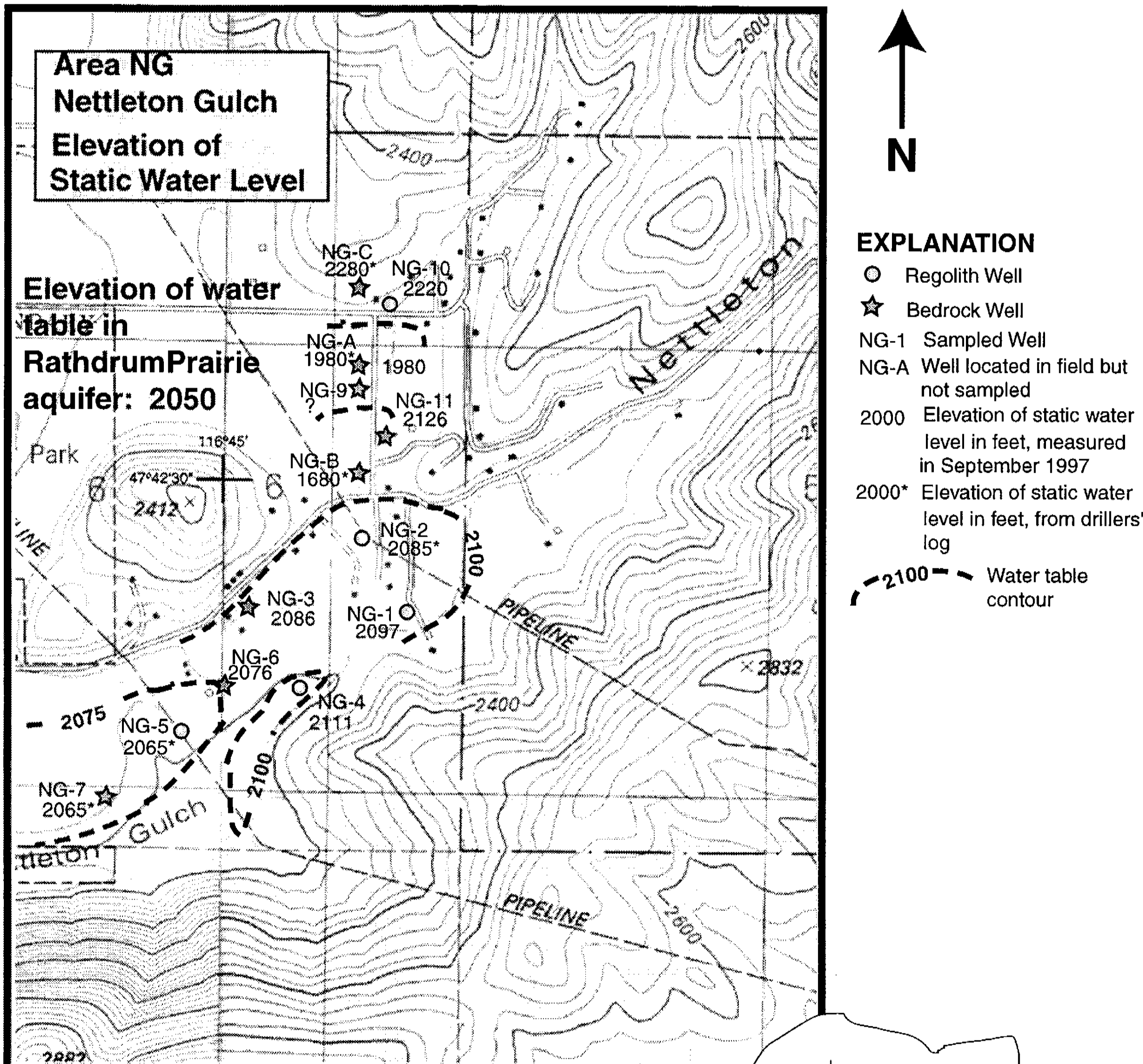
Figure 14b. Hydrogeologic Sections B - B', C - C' for area NG, Nettleton Gulch. See Figure 12 for location.

The mapping of static water levels in the wells of area NG indicated hydraulic gradients to the west of 0.02 in bedrock. All static water levels measured in regolith wells stood at an elevation of about 2,100 ft (640 m). The lowest static water level measured in area NG was at elevation 2,065 ft (629.3 m). Figure 15 displays the configuration of the water table in the vicinity of the sampled wells in area NG, as interpreted from September, 1997 measurements and data from drillers' logs. The depth to water in the Rathdrum Prairie aquifer at the outlet of Nettleton Gulch is at about 100 ft (31 m) below the land surface, at elevation 2,050 ft (625.0 m), as suggested by contouring of 1978 USGS measurements by Painter (1991b).

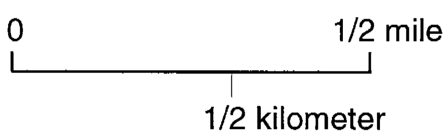
The soils of the lower elevation of area NG are mostly of the McGuire series, hydrologic type A, where permeability ranges from 2.0 to >20 in/hr (5.1 to >51 cm/hr). Where a seasonal high water table exists at the lowest elevation in Nettleton Gulch, the soil is of the Ramsdell series, hydrologic type C, with permeability from 0.6 to 2.0 in/hr (1.5 to 5.1 cm/hr) (Soil Conservation Service, 1981).

The land use in area NG is predominantly residential. All sewage disposal is to onsite septic systems. Fifty septic systems were counted from 1992 PHD maps. The density of septic systems was approximately 18 per square mile of recharge area (about 7 per square kilometer). Area NG is zoned suburban/agricultural. The boundary of the Rathdrum Prairie/Spokane aquifer protection zone extends into the mouth of Nettleton Gulch.

Drinking water in area NG is supplied by domestic wells completed in bedrock and regolith, and by the Coeur d'Alene City Water Department. Some of the residents of area NG were concerned about the quality of their drinking water. One household has been told that their well, well NG-6, is installed in the site used for waste disposal by the ranch that once occupied the valley. In another household, the site of well NG-2, the residents reported their water tastes bitter. Several residents reported that rusty stains develop on fixtures and on fences that intercept irrigation water.



Base Maps U.S. Geological Survey 7.5 Minute Series, Fernan Lake, Idaho, and Coeur d'Alene, Idaho



SCALE

Contour interval 40 feet (20 feet in western part of map)

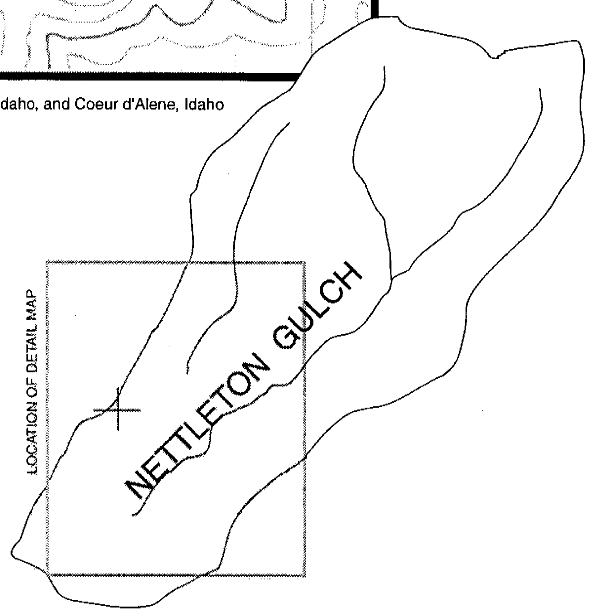


Figure 15. Elevation of static water levels in area NG, Nettleton Gulch.

SEE FIG. 1 FOR BASIN LOCATION

Description of the Sampled Wells in All Basins

The construction details and ground water conditions as indicated on drillers' logs for the 30 sampled wells are summarized in Table 7. No monitoring wells were drilled for this study.

The sampled wells were originally installed as drinking water sources, although a few of these wells (GF-2, GF-8, GF-13, NG-1, NG-10) are now used only for irrigation where community water systems became available or another well was installed. The Greenferry Water District well, GF-10, is a community well serving approximately 800 people. Three of the other wells (HV-2, HV-10, and GF-5) serve two or more households. The dates of installation of the sampled wells ranged from 1973 to 1994. Bedrock wells comprised 18 of the sampled wells; the remaining 12 wells were completed in regolith.

Figure 16 is a chart comparing by study basin the yield, depth, static water level (SWL), and depth to the first open interval of the wells sampled in the study. This chart depicts the characteristic middle 50 percent of data and the medians of each property.

The yields estimated by well drillers for the sampled wells with available drillers' logs ranged from 3 gallons per minute (gpm) in a bedrock well of area NG to more than 600 gpm in the Greenferry Water District community well. The median yield for all sampled wells was 15 gpm. In general, in area HV the well yields were the lowest of the three basins, with a median yield of 8 gpm. Area GF had the highest yields, with a median yield of about 20 gpm. The median yield in area NG was 14 gpm.

The range of depth for all wells of the study was from about 20 to 551 ft (6.0 to 167.9 m). The median depth of all wells in the study was 225 ft (68.6 m). The depth of the wells in area HV was greatest of the three selected basins and

Table 7. Characteristics of the sampled wells in all study basins. Data is from drillers' logs unless otherwise indicated. Regolith wells include those terminating in sand and gravel. Remarks: (a) no log--description by owner's report (b) no log--description from interpolation from water chemistry. Blank= no data. GF=South Greenferry Road basin, HV=Hidden Valley, NG=Nettleton Gulch.

Well Code	Date of installation	Public land system location (field identified)	Elevation of wellhead above MSL (field identified)		Depth of well		Bedrock (B) Regolith (R)	Casing depth		Depth to water at time of installation		Depth to top of open interval		Yield (gpm)	Remarks
			ft	m	ft	m		ft	m	ft	m	ft	m	ft	
GF-1	08/23/77	T50N R5W Sec 13 CBBD	2290	698.2	350	106.7	B	79	24.1	92	28.0	79	24.1	4	
GF-2	04/28/74	T50N R5W Sec 13 BCDC	2220	676.8	115	35.1	B	100	30.5	10	3.0	100	30.5	30	
GF-3	04/25/86	T50N R5W Sec 13 BCBC	2310	704.3	225	68.6	B	225	68.6	150	45.7	225	68.6	25	
GF-4	04/08/80	T50N R5W Sec 14 ADDD	2340	713.4	150	45.7	B	126	38.4	40	12.2	126	38.4	50	
GF-5	08/08/91	T50N R5W Sec 13 BCBC	2300	701.2	551	168.0	B	551	168.0	100	30.5	551	168.0	16	
GF-6	05/12/92	T50N R5W Sec 12 CCBD	2160	658.5	138	42.1	R	132	40.2	98	29.9	132	40.2	20	
GF-7		T50N R5W Sec 12 CBBB	2140	652.4			R								a
GF-8	09/30/88	T50N R5W Sec 12 BCBD	2130	649.4	200	61.0	R	195	59.5	132	40.2	195	59.5	15	
GF-10	12/08/89	T50N R5W Sec 12 BDBC	2140	652.4	250	76.2	R	225	68.6	125	38.1	225	68.6	600	
GF-13		T50N R5W Sec 13 CBBD	2290	698.2	20	6.1	R	0	0.0			0	0.0		a
HV-1	08/30/76	T51N R5W Sec 3 ACCA	2360	719.5	400	122.0	B	374	114.0	350	106.7	374	114.0	3	
HV-2	06/19/87	T51N R5W Sec 3 DAAB	2260	689.0	475	144.8	B	475	144.8	200	61.0	475	144.8	5	
HV-3	12/31/85	T52N R5W Sec 34 DDCD	2360	719.5	340	103.7	B	84	25.6	70	21.3	84	25.6	8	
HV-4	10/21/86	T52N R5W Sec 34 DCBA	2380	725.6	290	88.4	B	280	85.4	130	39.6	280	85.4	8.5	
HV-5		T51N R5W Sec 10 AABD	2150	655.5			R								b
HV-6	02/14/94	T51N R5W Sec 10 ACBC	2160	658.5	216	65.9	R	216	65.9	140	42.7	216	65.9	50	
HV-7	10/27/73	T51N R5W Sec 3 DADA	2180	664.6	375	114.3	B	95	29.0	140	42.7	95	29.0	8	
HV-9	07/13/84	T51N R5W Sec 3 ABBD	2350	716.5	500	152.4	B	500	152.4	470	143.3	500	152.4	9	
HV-10	09/22/88	T52N R5W Sec 34 DCAB	2370	722.6	350	106.7	B	100	30.5			100	30.5	5	
HV-11		T51N R5W Sec 10 BDCB	2140	652.4			B								b
NG-1	08/17/88	T50N R3W Sec 6 DACA	2210	673.8	175	53.4	R	170	51.8	150	45.7	170	51.8	10	
NG-2	10/15/84	T50N R3W Sec 6 DACA	2230	679.9	209	63.7	R	209	63.7	145	44.2	209	63.7	60	
NG-3	10/19/94	T50N R3W Sec 6 DBDA	2230	679.9	350	106.7	B	350	106.7	180	54.9	350	106.7	12	
NG-4	03/05/92	T50N R3W Sec 6 DDBC	2200	670.7	140	42.7	R	140	42.7	120	36.6	140	42.7	15	
NG-5	08/14/90	T50N R3W Sec 6 DCAC	2220	676.8	187	57.0	R	182	55.5	155	47.3	182	55.5	8	
NG-6	06/14/91	T50N R3W Sec 6 DCAB	2220	676.8	225	68.6	B	171	52.1	120	36.6	171	52.1	30	
NG-7	04/02/91	T50N R3W Sec 6 DCCD	2200	670.7	335	102.1	B	335	102.1	135	41.2	335	102.1	20	
NG-9	1974	T50N R3W Sec 6 ADBD	2230	679.9	240	73.2	B					240	73.2		a
NG-10		T50N R3W Sec 6 AACD	2240	682.9	20	6.1	R					0	0.0		a
NG-11	08/29/85	T50N R3W Sec 6 ADBC	2230	679.9	220	67.1	B	200	61.0	100	30.5	200	61.0	7	

CHARACTERISTICS OF THE SAMPLED WELLS

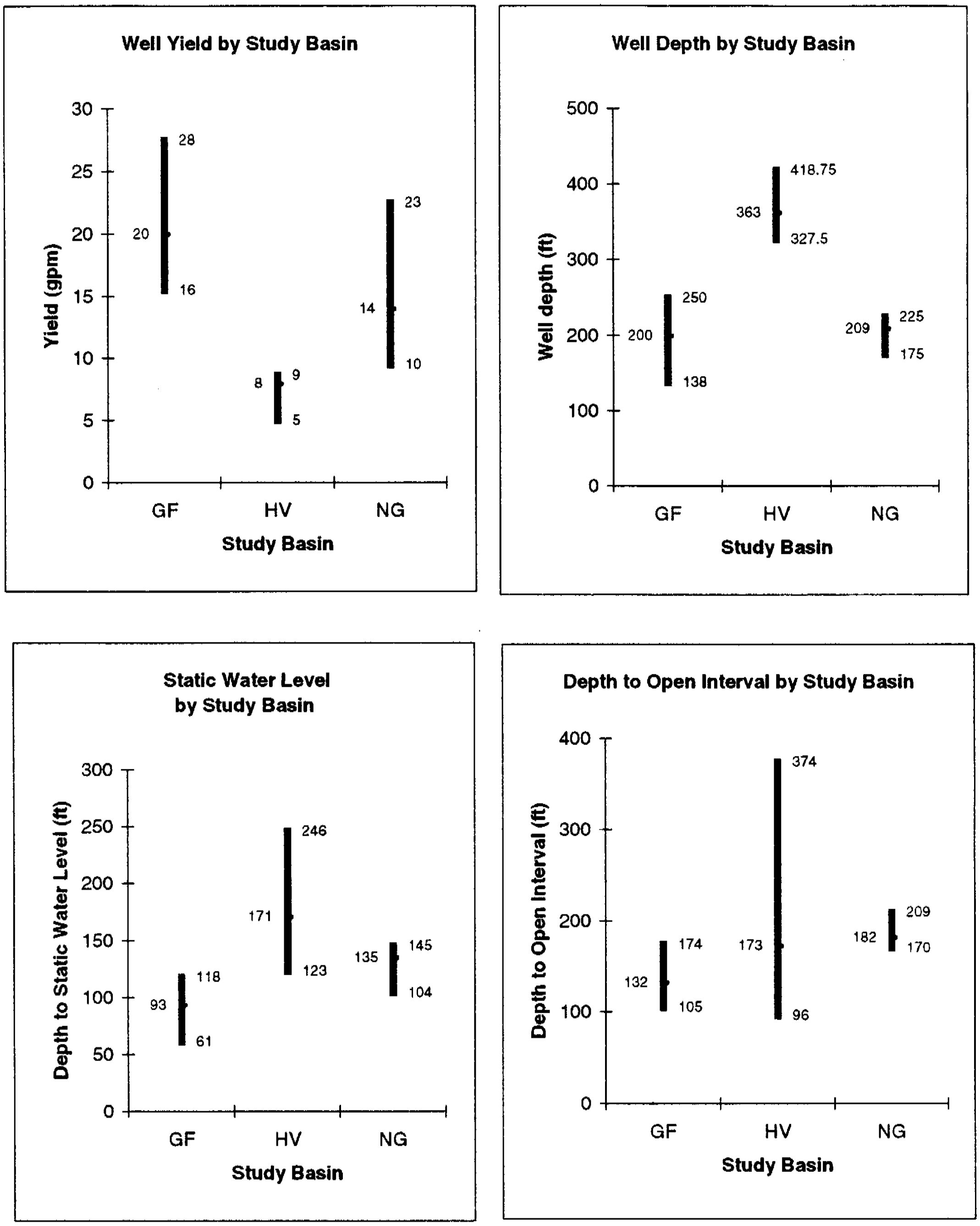


Figure 16. Characteristics of sampled wells in all study basins. Data is from drillers' logs. Lines represent the middle 50 percent of data; the tick marks are the median values. GF=the South Greenferry Road basin, HV=Hidden Valley, NG=Nettleton Gulch.

of a narrower range, with a median in this area of 363 ft (110.6 m). In area GF and area NG, the median well depths were similar, 200 ft (61.0 m) and 209 ft (63.6 m), respectively.

The static water level (SWL) in sampled wells ranged from 10 to 470 ft below land surface (3.0 to 143.0 m). The median SWL in the sampled wells was 125 ft (38.0 m) below land surface. The median depth to the SWL was greatest in area HV at 171 ft (52.0 m). The median SWLs in areas GF and NG are 93 ft (28.3m) and 135 ft (41.0 m), respectively. Of the 30 wells, 19 were accessible to sounding. The SWLs in the remaining wells were obtained from drillers' logs.The range of depth to the first open interval of the sampled wells of the three selected basins was from 0 to 451 ft below the surface (0 to 137.3 m). The median depth to the open interval for all sampled wells was 155 ft (47.3 m). The estimates of depth to the first open interval were extracted from well drillers' logs where available, with the exception that for the two dug wells, the well was considered to be open along the entire depth. The median depth to the first open interval was greatest in area NG at 182 ft (55.6 m). The median depth to the first open interval, 173 ft (52.6 m), was similar in area HV. The median depth to the first open interval, 132 ft (40.3 m), was least in area GF.

Results of Water Quality Analysis

A total of 75 water samples were analyzed for the study. The chemical constituents and properties measured in the samples are listed and defined in Table 8. The results of all analyses and field measurements of ground water samples are presented in Tables 9a, 9b, and 9c.

Conductivity, pH, and temperature were measured in the field for all samples. All other constituents were determined in the laboratory. The samples collected in the first sampling round, July, 1997, were analyzed for calcium, magnesium, chloride, nitrate, and iron. In August, 1997, additional samples were drawn from seven wells showing evidence of contamination. Six of these samples were analyzed for nitrate; one of these samples was analyzed for

Table 8. Chemical constituents and properties measured in study samples. Regulatory limits listed as maximum contaminant level (MCL) or secondary maximum contaminant level (SMCL) as established by the EPA for public drinking water supplies. SMCL's are established for aesthetic reasons only (references: Hem, 1985; EPA, 1996).

FIELD MEASUREMENTS

Property	Source or cause	MCL or (SMCL)	Range in sampled wells	Significance
Conductivity	Capability of a substance to conduct a current. Results from dissolved constituents in water	None	103-407 µs/cm	Indicates the degree of mineralization; the greater the mineral content, the higher the conductivity
pH	Hydrogen ion activity	None	5.4-8.3	Measures the acidity or alkalinity of water. Most ground water is between pH 6.5-8.5. Water of low or high pH may be corrosive
Temperature	Influenced by mean annual surface temperature, geothermal gradient, source of recharge waters	None	7.8-16.9°C 46.0 to 62.4°F	Average annual surface temperature of the study areas is about 9.1°C (48.4°F)

LABORATORY MEASUREMENTS

Constituent	Source or cause	MCL or (SMCL)	Range in sampled wells	Significance
Calcium	Soils and rocks, soil amendments (lime)	None	12-55 mg/L	Major contributor to hardness
Magnesium	Dark iron-containing minerals, fertilizer	None	2.1-20.8 mg/L	With calcium, causes hardness. Usually found at a much lower concentration than calcium
Chloride	Soil and rocks, sewage and road deicers	(250 mg/L)	0.5 -8.0 mg/L	Occurs naturally at very low concentrations in ground water. Elevated concentrations are a common indicator of wastewater contamination
Nitrate	Decaying organic material, sewage, animal and chemical fertilizer	10 mg/L	<0.010-10.5 mg/L	Human health hazard established at >10 mg/L
Iron	Soils and rocks, well casings and pumps, bacterial action	(0.03 mg/L)	<0.02-20.8 mg/L	Concentrations above 0.1 mg/L cause staining of fixtures and laundry and produce objectionable taste and odor
Sodium	Soils and rocks, sewage, industrial wastes	None	2.3-80 mg/L	High concentrations are a concern for human health and for agriculture
Potassium	Rocks, fertilizer	None	0.8-2.4 mg/L	May indicate contamination by agricultural land uses
Sulfate	Weathering of sulfide minerals, fertilizer	(250 mg/l)	<2.0-18.2 mg/L	High concentrations impart a bitter taste in drinking water
Alkalinity	Bicarbonate and carbonate minerals	None	60-193 mg/L as $CaCO_3$	High alkalinity water is corrosive and contributes to scaling in pipes and boilers

Table 9a. Water quality data for samples in area GF (the South Greenferry Road basin). Concentrations of all chemical parameters in milligrams per liter. Italics, in Depth to water column: information is from drillers' well logs. Blank cell: no data. Bold type: Concentration was at or below this detection limit.

Sample number	Sample date	Depth to water (ft)	Temperature (°C)	Conductivity (µS/cm at 25° C)	pH (standard units)	Calcium	Magnesium	Iron	Nitrate as N	Chloride	Sodium	Potassium	Sulfate	Alkalinity (as $CaCO_3$)	Hardness (as $CaCO_3$)
GF-1-1	07/07/97	89.7	12.3	137	6.5	16	3.4	0.04	2.34	4.0					54
GF-1-2	09/16/97	90.9	11.7	138	5.8	15	3.2		2.61	4.5					51
GF-2-1	07/07/97	12.1	10.1	190	6.3	25	4.2	**0.02**	4.40	7.0					80
GF-2-2	08/18/97	18.5	9.9	201	6.4				4.97						
GF-2-3	09/16/97	19.2	12.9	212	6.0	27	4.7		5.35	7.5					87
GF-3-1	07/07/97	139.6	11.2	247	6.4	32	6.9	0.15	8.02	4.0					108
GF-3-2	08/18/97	*150*	11.0	293	5.5				6.37						
GF-3-3	09/16/97	*150*	10.6	244	6.7	29	7.0		7.12	4.0					101
GF-4-1	07/07/97	68.3	10.6	187	5.7	19	4.4	0.04	10.0	3.5					66
GF-4-2	08/18/97	92.9	10.6	188	5.9				10.5			1.4	6.03		
GF-4-3	09/16/97	74.6	11.9	194	6.2	19	4.3		8.62	4.5	8.0	1.5	6.70	72	65
GF-5-1	07/07/97	134.7	13.6	198	7.1	25	2.1	**0.02**	0.723	1.5					71
GF-5-2	09/16/97	137	15.0	199	7.2	24	2.5		0.944	2.0					70
GF-6-1	07/07/97	*98*	10.5	201	6.0	29	5.2	0.09	0.605	1.5					94
GF-6-2	09/16/97	*98*	10.2	191	6.7	28	4.9		0.692	1.5	4	1.6	5.49	88	90
GF-7-1	07/07/97	59.2	14.2	103	6.2	13	3.0	16.9	0.519	2.0					45
GF-7-2	09/16/97	56.4	14.4	113	6.3	15	3.3		0.563	2.5					51
GF-8-1	07/07/97	60.7	16.6	140	6.5	19	4.0	0.14	0.596	2.0					64
GF-8-2	09/16/97	96.2	16.9	140	6.7	19	3.7		0.572	1.5	2.3	1.5	4.97	60	63
GF-10-1	07/10/97	*125*	13.8	142	7.4	24	3.8	**0.02**	0.852	1.5					76
GF-10-2	09/22/97	*125*	15.8	161	7.8	24	3.7		0.784	3.0					75
GF-13-1	08/18/97		12.4	144	5.5				1.94						
GF-13-2	08/21/97								2.34						
GF-13-3	09/16/97	12.5	12.4	141	5.4	17	3.8		3.64	5.5					58

Table 9b. Water quality data for samples in area HV (Hidden Valley). Concentrations of chemical parameters in milligrams per liter. Italics, in Depth to water column: information is from drillers' well logs. Blank cell: no data. Bold type: concentration was at or below this detection limit.

Sample number	Sample date	Depth to water (ft)	Temperature (°C)	Conductivity (µS/cm at 25° C)	pH (standard units)	Calcium	Magnesium	Iron	Nitrate as N	Chloride	Sodium	Potassium	Sulfate	Alkalinity (as $CaCO_3$)	Hardness (as $CaCO_3$)
HV-1-1	07/13/97	*350*	9.7	192	6.3	28	4.7	0.15	0.253	2.0					89
HV-1-2	09/22/97	*350*	10.0	293	8.3	32	6.8		**0.010**	**0.5**					108
HV-2-1	07/13/97	*200*	11.9	236	6.7	31	6.4	**0.02**	0.651	1.0					104
HV-2-2	09/17/97	201.5	10.2	230	7.7	30	5.2		0.552	1.0					96
HV-3-1	07/13/97	125.2	12.8	116	6.1	13	2.3	0.03	0.859	1.0					42
HV-3-2	09/17/97	144.3	12.7	138	7.3	17	2.4		0.543	1.0	7.1	1.3	**2.00**	61	52
HV-4-1	07/13/97	211.1	11.9	261	6.3	42	5.4	**0.02**	0.316	2.0					127
HV-4-2	09/17/97		10.1	264	7.7	43	5.7		0.418	3.0					131
HV-5-1	07/13/97		8.4	221	6.5	37	5.3	0.13	0.222	1.0					114
HV-5-2	09/15/97		7.8	206	7.2	35	5.7		0.296	1.0					111
HV-6-1	07/16/97	116.1	8.6	112	7.4	15	3.2	20.8	0.038	2.0					51
HV-6-2	09/17/97	119	9.2	135	7.4	18	3.7		0.039	1.5	4.3	1.4	**2.00**	68	60
HV-7-1	07/16/97	*140*	12.5	252	6.7	36	5.8	0.07	0.202	1.0					114
HV-7-2	09/17/97	*140*	11.5	248	7.4	34	5.2		0.230	1.5					106
HV-9-1	07/16/97	*470*	11.8	402	6.8	12	3.0	0.14	**0.010**	1.5					42
HV-9-2	09/17/97	*470*	10.3	407	8.2	12	2.8		**0.010**	1.5	80	1.3	2.75	193	41
HV-10-1	07/16/97		11.2	193	7.0	24	4.2	**0.02**	1.50	1.5					77
HV-10-2	09/17/97		11.7	208	7.7	26	4.0		0.611	1.5					81
HV-11-1	07/16/97	43	9.0	244	6.7	33	6.8	0.46	**0.010**	**0.5**					110
HV-11-2	09/15/97	44.5	9.0	219	7.1	29	6.7		**0.010**	1.0					100

Table 9c. Water quality data for samples in area NG (Nettleton Gulch). Concentrations of all chemical parameters in milligrams per liter. Italics, in Depth to water column: information is from drillers' well logs. Blank cell: no data. Bold type: concentration was at or below this detection limit.

Sample number	Sample date	Depth to water (ft)	Temperature (°C)	Conductivity (µS/cm at 25° C)	pH (standard units)	Calcium	Magnesium	Iron	Nitrate as N	Chloride	Sodium	Potassium	Sulfate	Alkalinity (as $CaCO_3$)	Hardness (as $CaCO_3$)
NG-1-1	07/10/97	107.4	7.8	160	6.8	20	5.3	0.89	0.662	4.0					72
NG-1-2		113.4	10.6	159	6.0	19	5.5	1.36	1.31	4.0					70
NG-2-1	07/10/97	*145*	9.0	221	7.0	28	8.0	0.05	1.51	4.5					103
NG-2-2	09/15/97	*145*	8.9	207	6.1	26	7.5	0.05	1.31	4.0					96
NG-3-1	07/10/97	139.8	10.8	205	7.3	23	6.8	**0.02**	0.393	1.5					85
NG-3-2	09/15/97	144.1	11.9	212	7.0	22	6.0	**0.02**	0.019	1.0	11.2	0.8	18.2	85	80
NG-4-1	07/10/97	83.0	9.1	175	6.7	18	6.7	0.94	1.28	4.5					72
NG-4-2	08/18/97	131.6	11.3	168	5.5				1.10						
NG-4-3	09/15/97	89.3	11.5	212	5.8	17	5.6	1.78	1.15	4.5	6.7	1.7	9.01	62	65
NG-5-1	07/10/97	*155*	11.7	310	6.8	42	11.6	0.06	2.83	5.0					153
NG-5-2	08/18/97	*155*	10.7	280	6.4				2.27						
NG-5-3	09/15/97	*155*	13.4	264	6.4	33	9.6	0.05	1.72	5.5					122
NG-6-1	07/10/97	145	9.6	372	6.9	55	13.9	6.8	3.87	4.5					194
NG-6-2	08/18/97		10.3	347	5.7				3.33						
NG-6-3	09/15/97	144	9.5	337	6.6	50	13.3	0.38	3.90	5.5	5.7	2.4	14.0	158	179
NG-7-1	07/10/97	*135*	12.1	241	7.4	31	11.2	1.1	0.102	2.0					123
NG-7-2	09/15/97	*135*	10.8	232	6.9	27	10.7	3.19	0.174	2.5					111
NG-9-1	07/14/97		9.5	364	7.0	41	20.8	0.06	0.741	7.5					188
NG-9-2	09/15/97		10.3	369	6.8	39	20.5	0.07	0.784	8.0					182
NG-10-1	07/14/97		15.9	308	7.7	45	12.4	**0.02**	1.45	3.0					163
NG-10-2	09/15/97		14.4	283	7.4	39	13.8	**0.02**	1.31	4.0					154
NG-11-1	07/14/97	103.5	9.9	261	7.6	35	8.6	**0.02**	1.03	4.0					123
NG-11-2	09/15/97	103.7	10.4	236	7.6	31	7.2	**0.02**	1.02	3.5					107

nitrate, potassium, and sulfate. In the second sampling round in September, 1997, all samples from all wells were again analyzed for calcium, magnesium, chloride, and nitrate. Iron analysis was repeated in area NG only. In nine samples of the September sampling round, three in each basin, sodium, potassium, sulfate, and alkalinity were also determined.

Table 10 is a summary of median values by study basin for the constituents and properties measured in all samples. Comparison between study basins yielded statistically significant differences (Kruskal-Wallis test, 95 percent confidence level) in the level of impact on the ground water by anthropogenic pollutants, as indicated by nitrate concentrations, and the general chemistry of the water as suggested by calcium-magnesium ratios. Therefore, the study basins were considered separately in statistical treatment. However, no statistically significant difference (Wilcoxon signed ranks test, 95 percent confidence level) in water chemistry was found between the two sampling rounds, therefore the samples from the two sampling rounds within each study basin were grouped for statistical treatment.

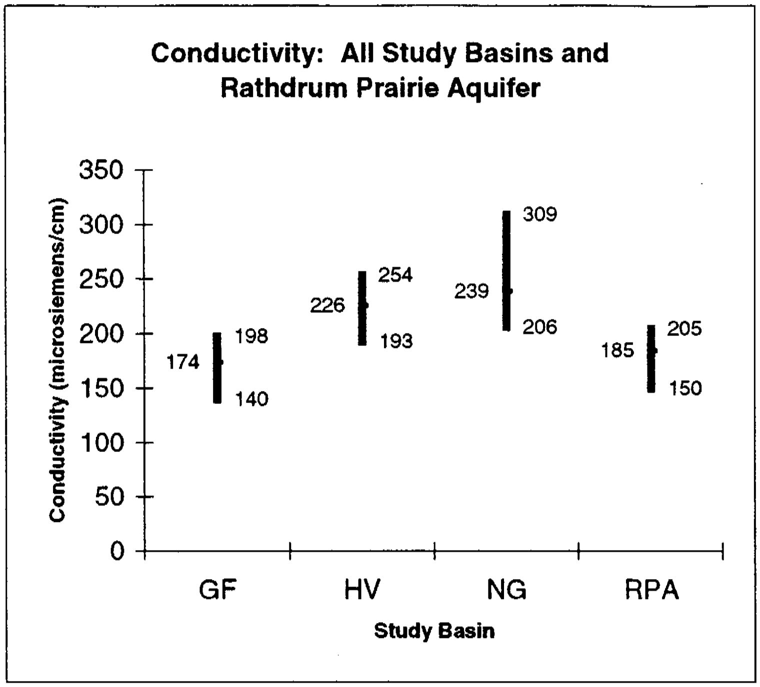
For comparison Table 10 displays the median values for constituents and properties measured during the July 1997 PHD monitoring of the Rathdrum Prairie aquifer (unpublished PHD data report). The Rathdrum Prairie aquifer data is listed in Appendix 3. In the following summaries of field and laboratory measurements, the data cited for the Rathdrum Prairie aquifer were also from the July 1997 PHD monitoring event.

Summary of Field Measurements

Conductivity measured slightly higher in study samples than in the Rathdrum Prairie aquifer (Fig. 17). Conductivity in the study basins ranged from 103 to 407 microsiemens/centimeter (μs/cm). Area NG had the highest median conductivity at 239 μs/cm, area GF, the lowest, at 174 μs/cm. Area HV was

Table 10. Median concentrations for selected parameters in the three study basins and the Rathdrum Prairie aquifer. GF=South Greenferry Road basin, HV=Hidden Valley, NG=Nettleton Gulch, RPA=Rathdrum Prairie aquifer. Blank: no data.

Constituent or property	GF	HV	NG	RPA
	All wells	**All wells**	**All wells**	**PHD wells**
	July and September samples			**July 1997 samples**
	MEDIAN VALUES			
	(n=19)	(n=20)	n=20	(n=29)
Calcium (mg/L)	24	30	31	29
Magnesium (mg/L)	4.0	5.2	9.1	9.5
Iron (mg/L)	0.04	0.09	0.06	
Nitrate (mg/L)	2.61	0.242	1.09	0.971
Chloride (mg/L)	3.0	1.3	4.0	2.0
Hardness (mg/L $CaCO_3$)	66.0	98.0	117.0	113.0
Conductivity (ms/cm)	174	226	239	185
Temperature °C (°F)	12.4 (54.3)	10.25 (50.5)	10.5 (50.9)	14.0 (57.2)



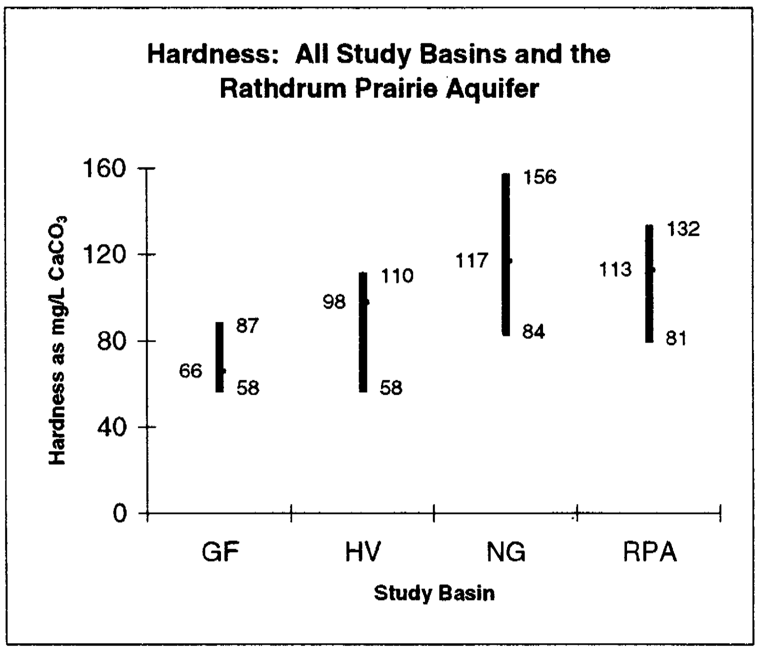


Figure 17. Conductivity and hardness, all basins and the Rathdrum Priarie aquifer. Bar represents the middle 50 percent of data (25th percentile to 75th percentile). The tick mark is the median. GF=the South Greenferry Road basin, HV=Hidden Valley, NG=Nettleton Gulch, RPA=Rathdrum Prairie aquifer.

intermediate at 226 μs/cm. In the Rathdrum Prairie aquifer, the range of conductivity was from 30 to 260 μs/cm, with a median at 185 μs/cm.

The pH in all study basins was generally similar to the pH of the Rathdrum Prairie aquifer. The range of pH for all study basins was 5.4 to 8.3 (standard units). In the Rathdrum Prairie aquifer, the range of pH was from 5.9 to 7.7.

The temperature of samples from the study basins was lower than the temperature of the Rathdrum Prairie aquifer ground water. The range of temperature in the study samples was 7.8 to 16.9°C (46.0 to 62.4°F), with a median at 11.0°C (51.8°F). The samples from area GF had the highest temperatures, with a median at 12.4°C (54.3°F), about 2°C degrees higher than the medians of area HV, 10.3°C (50.5°F), and area NG, 10.5°C (50.9°F). In the Rathdrum Prairie aquifer samples, the median temperature was 14.0°C (57.2°F), with a range of 10.0 to 20.0°C (50 to 68°F). The average annual temperature of Coeur d'Alene, is 9.1°C (48.4°F) (Idaho Climate Services).

Summary of Laboratory Measurements

Calcium and magnesium concentrations in the study samples were similar to those determined in the Rathdrum Prairie aquifer samples. The range of calcium concentrations in all study basins was from 12 to 55 mg/L. The median calcium concentration was lowest in area GF, at 24 mg/L. Similar median calcium concentrations were identified in area HV, area NG, and the Rathdrum Prairie aquifer. The median calcium concentration in area HV was 30 mg/L. The median calcium concentration in area NG was 31 mg/L. The median calcium concentration in Rathdrum Prairie aquifer samples was 29 mg/L, and the range was from 6 to 46 mg/L.

The range of magnesium in all study basins was from 2.1 to 20.8 mg/L. The median magnesium concentration was lowest in area GF at 4.0 mg/L. The median magnesium concentration in Area HV was 5.2 mg/L. The magnesium concentration was highest in area NG at 9.1 mg/L, where it was similar to the Rathdrum Prairie aquifer median concentration of 9.5 mg/L. The range of magnesium concentration in the Rathdrum Prairie aquifer was 0.6 to 19.0 mg/L.

Hardness was calculated (Lloyd and Heathcote, p. 98) from the concentrations of calcium and magnesium ions in the study water samples and the samples from the Rathdrum Prairie aquifer. Ground water of the study areas was moderately hard (Table 11), similar to the ground water in the Rathdrum Prairie aquifer (Fig. 17). The range of hardness of the study samples was from 41 to 194 mg/L $CaCO_3$. Area NG had the highest median hardness at 117 mg/L $CaCO_3$, and the highest hardness value overall of 194 mg/L $CaCO_3$. The median hardness in area GF was 66 mg/L $CaCO_3$. In area HV, the median hardness was 98 mg/L $CaCO_3$. In the Rathdrum Prairie aquifer, the range of hardness was 22 to 179 mg/L $CaCO_3$ with a median of 113 mg/L $CaCO_3$.

Table 11. Classification of hardness (Durfur and Becker, 1964)

Concentration, mg/L $CaCO_3$	Classification
0 - 60	Soft
61 - 120	Moderately hard
121- 180	Hard
180 +	Very hard

Sodium was measured for three wells in each study basin. The range of sodium concentrations in all study basins was from 2.3 to 80 mg/L. In two deep wells competed in bedrock, NG-3 and HV-9, relatively high sodium concentrations were detected. Sodium concentration was 11 mg/L in a sample from well NG-3. The sodium concentration in a sample from well HV-9 was 80 mg/L. The median value for sodium concentration in the Rathdrum Prairie aquifer samples was 2.9 mg/L, while the range of sodium determined was from 1.7 to 5.4 mg/L.

Potassium concentrations were measured in three wells in each study basin. The range of potassium values in the study was from 0.8 to 2.4 mg/L.

The range of potassium concentrations in the Rathdrum Prairie aquifer was 0.8 to 2.8 mg/L, with a median of 1.8 mg/L.

Chloride was above Rathdrum Prairie aquifer levels in area NG. Chloride concentrations of the three study basins and the Rathdrum Prairie aquifer are compared in Figure 18. The range of chloride in all study basins was 0.5 to 8 mg/L. Area NG had the highest median concentration of chloride, 4 mg/L, and the highest chloride value overall, 8 mg/L. Median chloride in area GF was 3.0 mg/L. In area HV, the median chloride concentration was lowest at 1.3 mg/L. The range of chloride in the Rathdrum Prairie aquifer was 0.5 to 5.0 mg/L, with a median of 2.0 mg/L.

Sulfate was measured in three wells in each study basin. The range of sulfate was from less than 2.0 mg/L, the detection limit, to 18.2 mg/L. Sulfate concentrations were highest in area NG, ranging from 9.01 to 14.0 mg/L. In area HV the lowest sulfate concentrations were detected, with two of the samples at or below the detection limit of 2.0 mg/L. Area GF presented intermediate sulfate concentrations, ranging from 4.97 to 6.70 mg/L. The detection limit for analysis of Rathdrum Prairie aquifer samples was 10 mg/L. Approximately half of the samples were below this value. Sulfate concentrations ranged from less than 10 to 18 mg/L in the Rathdrum Prairie aquifer.

Alkalinity was measured for three wells in each study basin. Alkalinity for all samples ranged from 60 to 193 mg/L $CaCO_3$. Differences among the study basins were not apparent, but alkalinity in two deep bedrock wells, NG-6 and HV-9, was more than twice that of the other study wells. In well NG-6, the alkalinity was 158 mg/L $CaCO_3$. In well HV-9, the alkalinity was 193 $CaCO_3$. Alkalinity was not measured for the Rathdrum Prairie aquifer as part of the in July, 1997 PHD monitoring activities. Past measurement (Drost and Seitz, 1978) of samples from wells in the Rathdrum Prairie region yielded a range of alkalinity, 60 to 202 mg/L $CaCO_3$, similar to the alkalinity detected in samples from the study basins. Alkalinity in water of pH <9 , like that of the study basins and the Rathdrum Prairie aquifer, is almost identical with the bicarbonate concentration

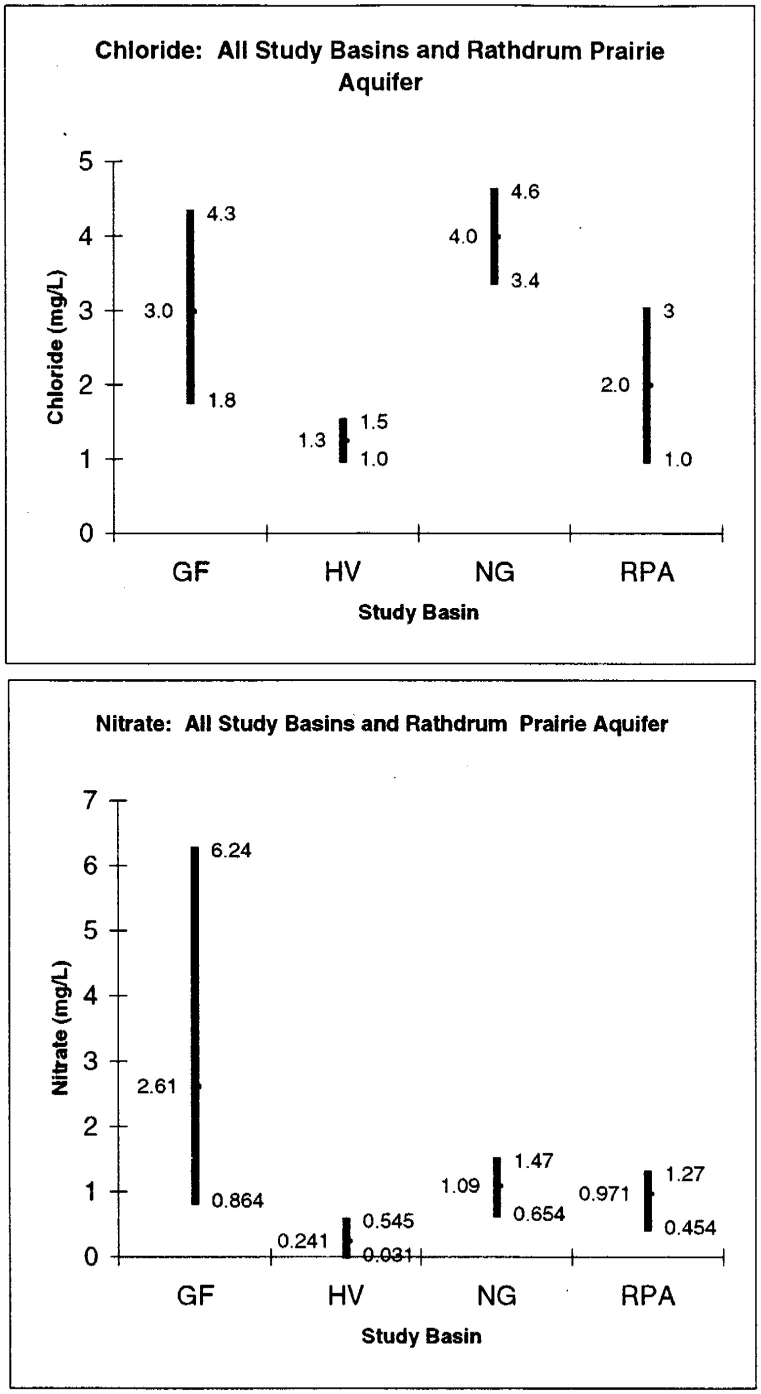


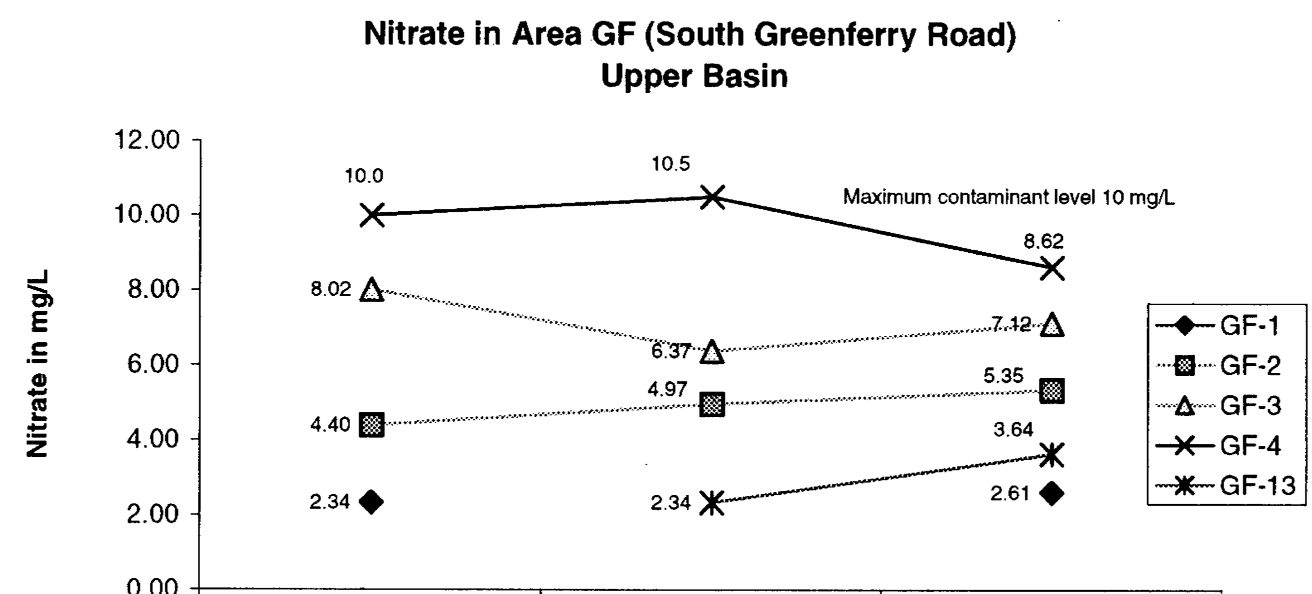
Figure 18. Chloride and nitrate, all basins and the Rathdrum Prairie aquifer. Bar represents the middle 50 percent of data (25th percentile to 75th percentile). The tick mark is the median. GF=the South Greensferry Road basin, HV=Hidden Valley, NG=Nettleton Gulch, RPA=Rathdrum Prairie aquifer.

(Lloyd and Heathcote, 1985, p.34). The measurement of alkalinity was used to establish the bicarbonate concentration in selected samples.

Nitrate concentrations reported for samples in this study are total nitrite plus nitrate reported as elemental nitrogen (nitrate-N), however, nitrite is negligible in most ground water, where it is oxidized to nitrate (Freeze and Cherry, 1979, p. 413). See Figure 18 for a comparison of nitrate concentrations in the three study basins and the Rathdrum Prairie aquifer. The background nitrate concentration of ground water recharging the Rathdrum Prairie aquifer at its southern end has been estimated at 0.5 to 0.8 mg/L (Painter, 1996a), a value similar to an estimate for North Idaho ground water, 0.5 mg/L (Parliaman and others, 1980).

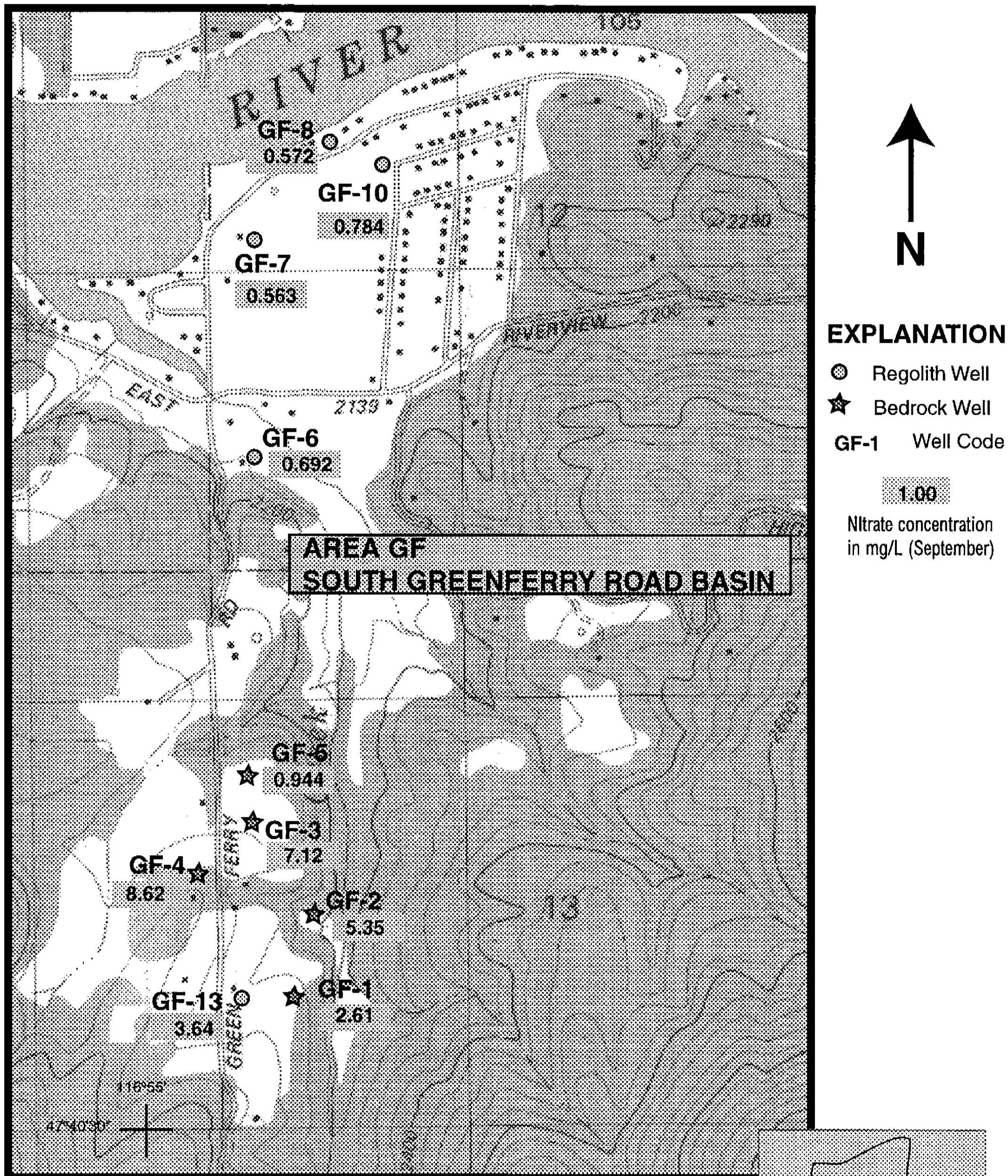
The nitrate concentrations for all study basins ranged from below the detection limit of 0.010 mg/L to 10.5 mg/L. Median nitrate was highest in area GF, 2.61 mg/L, ranging from below the detection limit to 10.5 mg/L. Nitrate concentrations were very low in samples from area HV wells, where the median was 0.242 mg/L, and the concentrations ranged from at or below the detection limit, 0.010 mg/L, to 1.50 mg/L. In area NG, median nitrate was 1.09 mg/L, and the range was from 0.019 to 3.90 mg/L.

The nitrate concentrations reported in some wells in areas GF and NG are generally much greater than in the Rathdrum Prairie aquifer. In the Rathdrum Prairie aquifer, the median nitrate concentration was 0.971 mg/L, and the range of nitrate was from 0.086 mg/L to a high of 5.12 mg/L in the South River Water Association well in South Post Falls. In area GF, nitrate concentrations at or slightly above 10.0 mg/L, the MCL established by the EPA for public drinking water, were found twice in well GF-4 (Fig. 19). Four nearby wells (see Figure 20) consistently produced samples with elevated nitrate concentrations ranging from 2.34 to 8.02 mg/L (Fig. 19). Samples from six wells (see Fig. 21) in area NG contained nitrate concentrations of greater than 1.00 mg/L, but no higher than 3.90 mg/L (Fig. 22).



Well code	July	August	September
GF-1	2.34		2.61
GF-2	4.4	4.97	5.35
GF-3	8.02	6.37	7.12
GF-4	10	10.5	8.62
GF-13		2.34	3.64

Figure 19. Nitrate concentrations in area GF (the South Greenferry Road basin). Displayed are wells where concentrations were above probable background levels. Blank: no data. See Figure 20 for well locations.



Base Map U.S. Geological Survey 7.5 Minute Series, Post Falls, Idaho

0 1/2 mile

1/2 kilometer

SCALE

Contour interval 40 feet

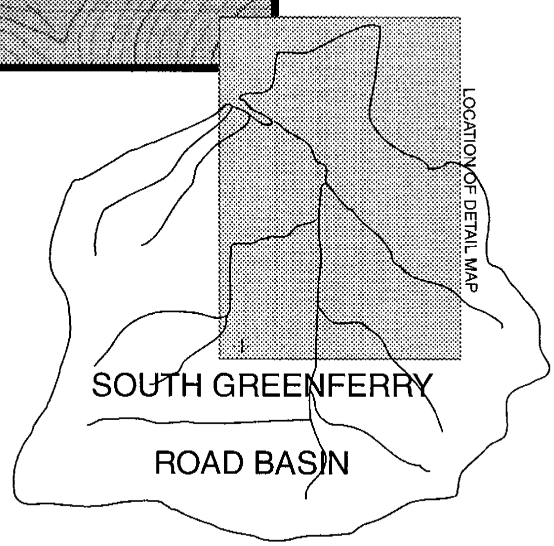


Figure 20. Nitrate concentrations in area GF (South Greenferry Road basin). Results from September samplingevent.

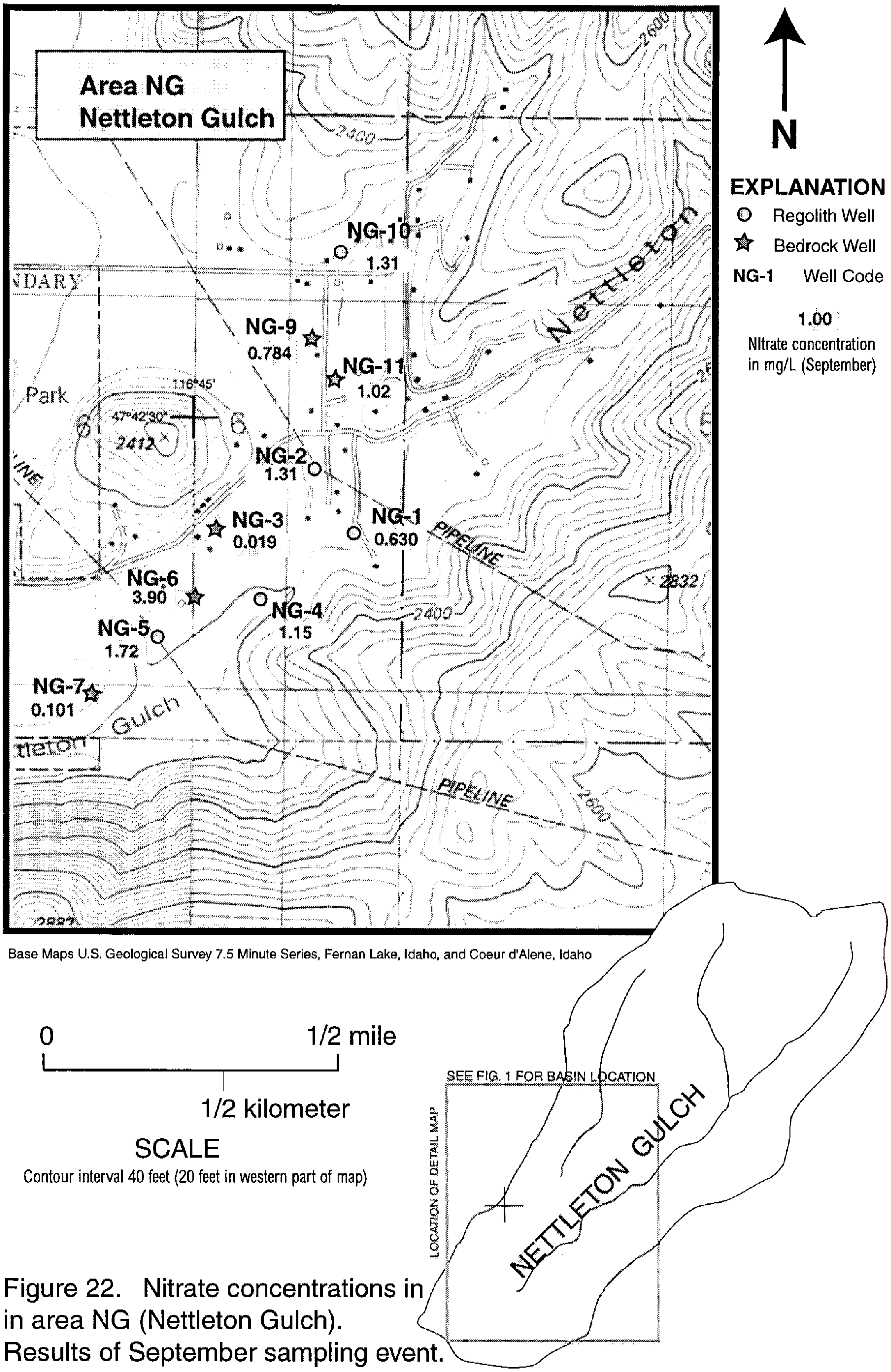
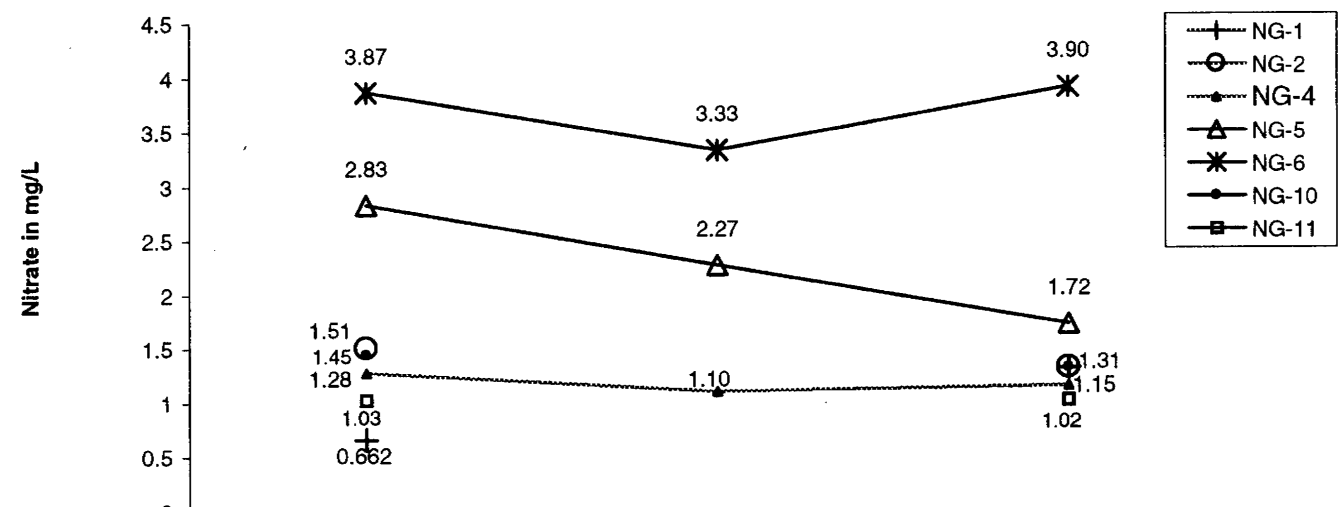


Figure 22. Nitrate concentrations in in area NG (Nettleton Gulch). Results of September sampling event.

Nitrate in Area NG (Nettleton Gulch)



Well code	July	August	September
NG-1	0.662		1.31
NG-2	1.51		1.31
NG-4	1.28	1.10	1.15
NG-5	2.83	2.27	1.72
NG-6	3.87	3.33	3.90
NG-10	1.45		1.31
NG-11	1.03		1.02

Figure 22. Nitrate concentrations in area NG (Nettleton Gulch). Data is displayed for wells where concentrations were above probable background levels. Blank: no data. See Figure 23 for well locations.

Iron concentrations in the study for all areas ranged from below the detection limit of 0.02 mg/L to 20.8 mg/L. The median iron concentration in area NG was 0.06 mg/L. Wells NG-1, NG-4, NG-6, and NG-7 consistently produced samples above the SMCL, 0.3 mg/L, established by the EPA for iron. The low median iron concentration in area NG reflected the presence of other wells where iron was at or below the detection limit. Wells HV-6 and GF-7 produced samples of high turbidity which were subsequently digested before analysis, as per standard method, yielding anomalously high iron concentrations. The iron concentration in GF-7 in July was 16.9 mg/L. In the September sample from GF-7, which was not turbid, the iron concentration detected was 0.05 mg/L. The iron concentration in HV 6 in July was 20.8 mg/L. Because the September sample from HV-6 was turbid, iron determination was not repeated. The residents who use these two wells reported that the turbidity is not a common occurrence. Median iron concentrations in areas GF area HV were 0.04 mg/L and 0.07 mg/L, respectively.

Iron concentration is not routinely measured in the PHD Rathdrum Prairie aquifer monitoring program. Review of the measurements available for the period 1976 to 1990 (Painter, 1991a), indicated that most values of iron concentrations were at or below the detection limit of 0.01 mg /L. Parliman and others (1980) reported median iron concentrations for a variety of aquifers in the Rathdrum Prairie area which ranged from below a detection limit of 0.02 mg/L to as high as 13.0 mg/L. The highest value was determined in a sample from a well completed in argillite.

Major ion analysis Plotting of the mineral content of study samples on a Piper diagram (Fig. 23) illustrates that all wells except one produced calcium-bicarbonate water. Well HV-9 produced water of the sodium-bicarbonate type (Hem, 1985). Stiff diagrams (Fig. 24a,b,c) of ion concentrations depict the results of the nine samples in which the total suite of major ions was determined. In each figure, three samples from a single study basin and a sample from the nearest monitored Rathdrum Prairie aquifer well are juxtaposed.

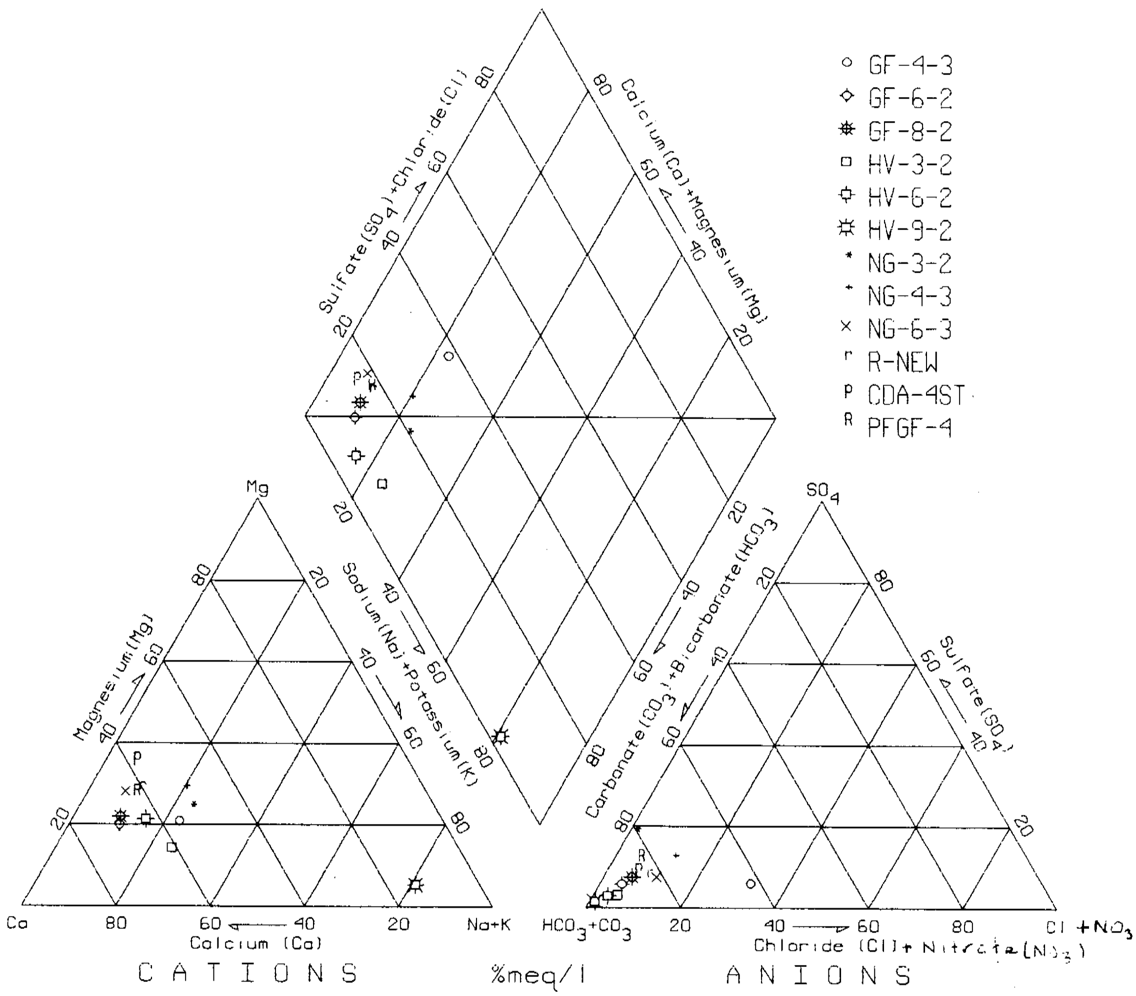


Figure 23. Piper Diagram. The piper diagram conveniently represents similarities and differences in water constituents. In nine complete ion analyses from the three study basins, all but one sample may be classified as calcium bicarbonate water type, the remaining sample is of sodium bicarbonate type.

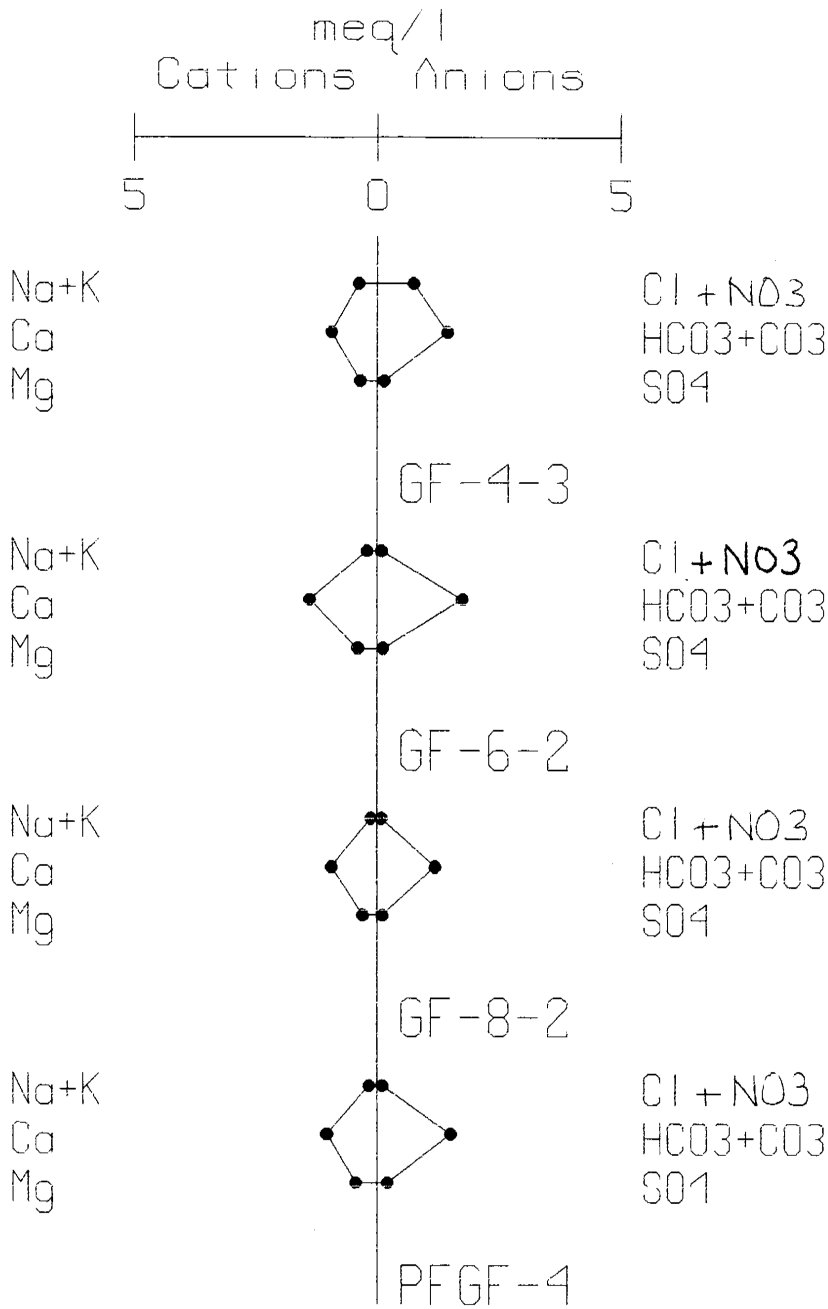
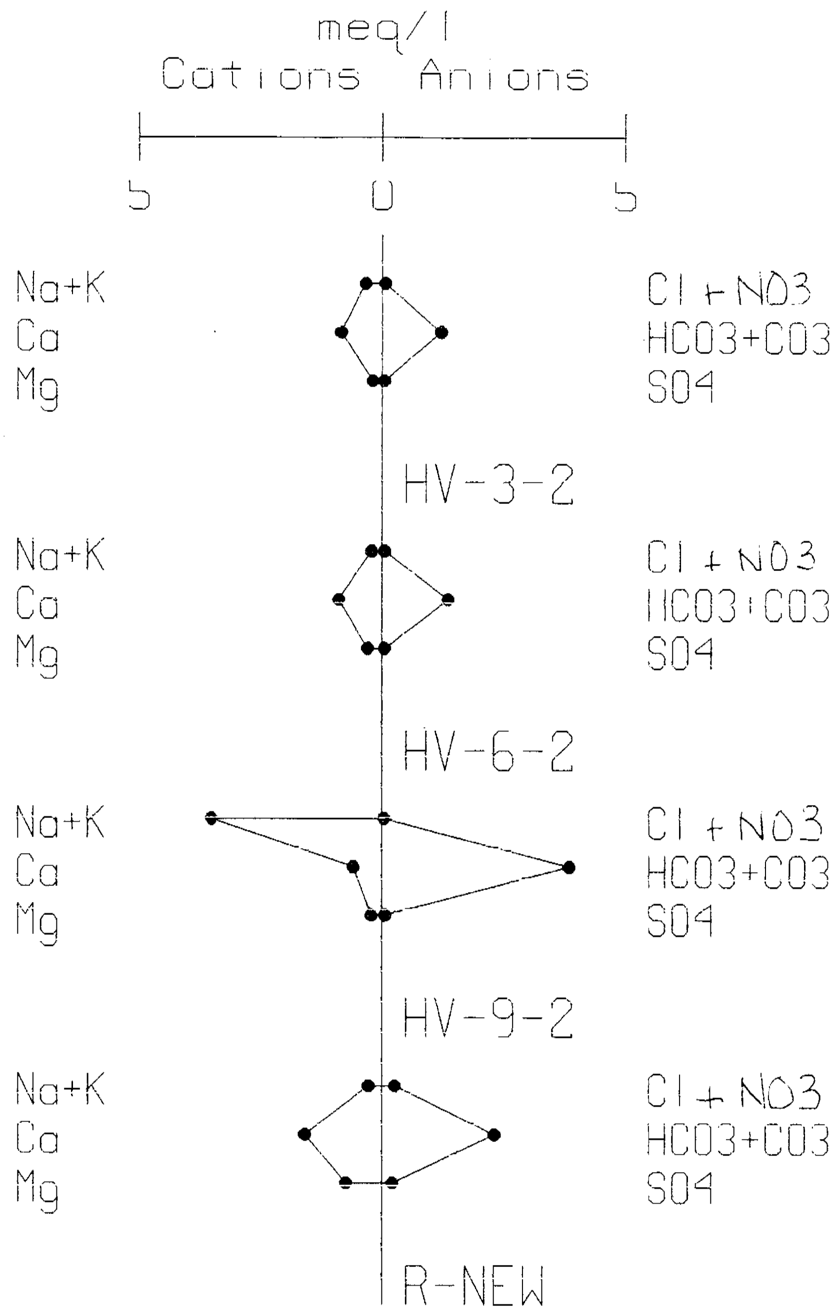


Figure 24a. Stiff diagrams. Three complete ion analyses in area GF, the South Greenferry Road basin and for comparison, the July sample of the Post Falls Greenferry Road well in the Rathdrum Prairie aquifer.



24b. Stiff diagrams. Three complete ion analyses in area HV, Hidden Valley, and for comparison, the July sample of the new Rathdrum well in the Rathdrum Prairie aquifer.

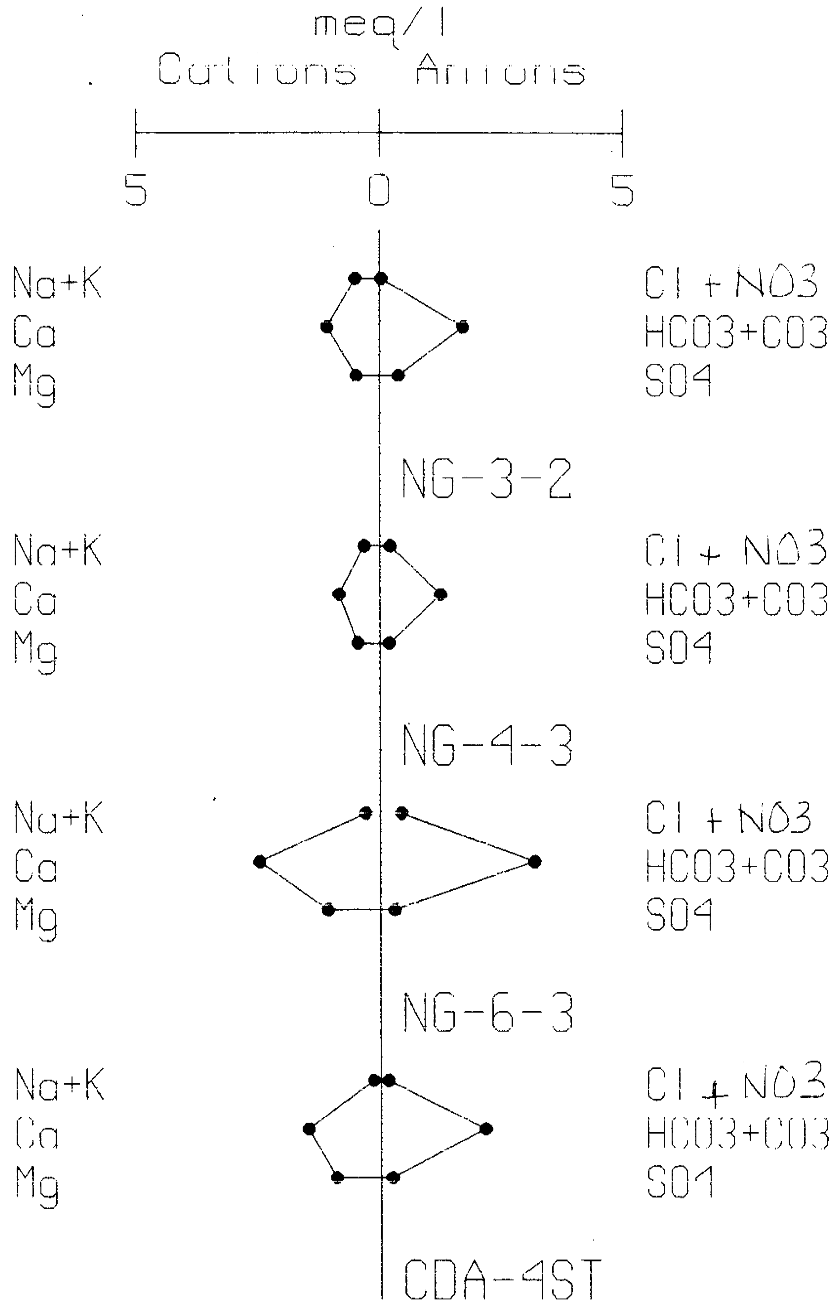


Figure 24c. Stiff diagrams. Three complete ion analyses in area NG, Nettleton Gulch, and for comparison, the July sample of the Coeur d'Alene Fourth Street well in the Rathdrum Prairie aquifer.

Discussion

Hydrogeologic Setting of the Hillside Areas

In the hydrogeologic regime of the hillside areas surrounding the Rathdrum Prairie, water is stored in regolith consisting of unconsolidated glacial flood and alluvial deposits, in saprolite, and in partially decomposed and fractured bedrock. Precipitation, irrigation water, and domestic effluent are the sources of recharge to the hillside aquifers. The flow paths of ground waters within the study basins are of minimal distance. The path of recharge is primarily by direct infiltration, however some deep bedrock wells may draw from fracture zones recharged at high elevations. Discharge from the hillside aquifers occurs by underflow to the Rathdrum Prairie aquifer. Surface flow out of the hillside basins percolates into the porous surface of the Rathdrum Prairie at basin outlets. Figure 25 is a conceptual model of the hydrogeologic setting of the hillside basins adjoining the Rathdrum Prairie.

The major ground water recharge period in Kootenai County follows spring snowmelt. In hydrographs of wells on the Rathdrum Prairie near the Spokane River (Young, 1983) based on measurements from 1971-1982, the highest water table elevations occurred in June or July. The lowest water table elevations occurred from January through March. This suggests that the July sampling event of the study captured data for the ground water at approximately its highest levels. The September sampling event occurred after a period of ground water decline. The static water levels declined between July and September in 12 of the 14 study wells where measurement was possible. The changes in static water levels between the sampling events are presented in Table 12. The change in static water levels ranged from +2.8 ft (+0.8 m) to -48.6 ft (-14.8 m). The greatest fluctuation in the static water level was measured in well NG-4, where a spring high water table exists. Another large fluctuation in the static water level was measured in well GF-8 where the static water level fell 35.5 ft (10.8 m) between July and September. Well GF-8 is on the bank of the

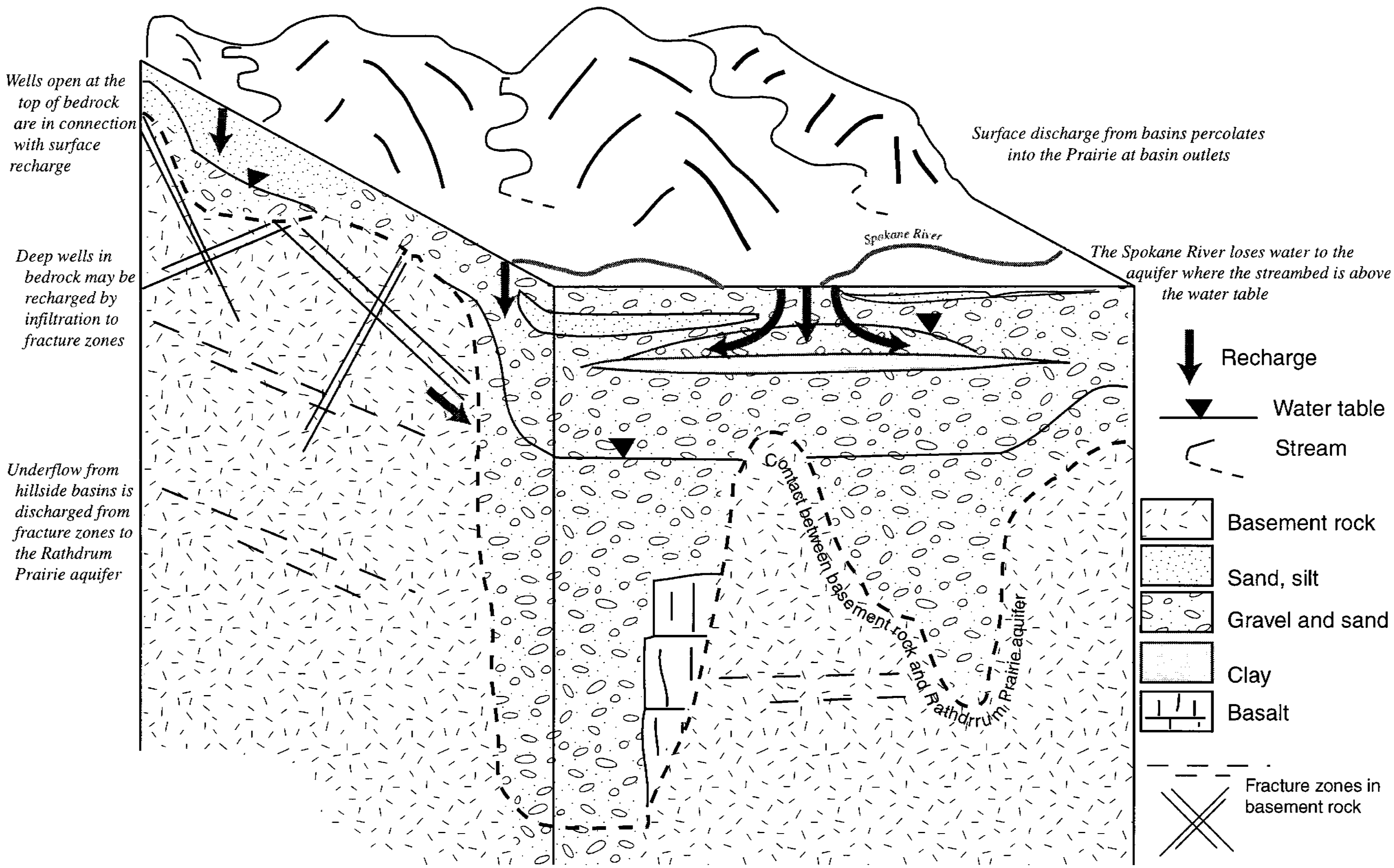


Figure 25. Hydrogeologic setting of the hillside basins. Basins are in hydraulic connection with the Rathdrum Prairie aquifer by suburface outflow and percolating surface water. In this conceptual model, the vertical scale is exaggerated for clarity.

Table 12. Measurements of static water levels in the study basins.
Blank: no data.

Area GF			
	Depth to water (ft)		Difference (ft)
Well Code	July	September	
GF-1	89.7	90.9	-1.2
GF-2	12.1	19.2	-7.1
GF-3	139.6		
GF-4	68.3	74.6	-6.3
GF-5	134.7	137.0	-2.3
GF-7	59.2	56.4	2.8
GF-8	60.7	96.2	-35.5
Area HV			
	Depth to water (ft)		Difference (ft)
Well Code	July	September	
HV-2		200.5	
HV-3	125.2	144.3	-19.1
HV-5	>100*		
HV-6	116.1	119.0	-2.9
HV-9		>300*	
HV-11	43.0	44.5	-1.5
Area NG			
	Depth to water (ft)		Difference (ft)
Well Code	July	September	
NG-1	107.4	113.4	-6.0
NG-3	139.8	144.1	-4.3
NG-4	83.0	131.6	-48.6
NG-6	145.0	144.0	1.0
NG-11	103.5	103.7	-0.2

*Wells were inaccessible beyond this point.

Spokane River. The comparison of static water levels in the wells in the study basins with the elevation of the water table in the Rathdrum Prairie aquifer indicated that the direction of ground water underflow in the study basins is toward the main aquifer.

Static water levels stand above the regolith-bedrock contact in areas GF and NG, suggesting storage of ground water in regolith. However, in area HV, measured water levels in the upper basin are in bedrock, indicating limited storage of ground water.

Table 13 is a list of estimates of hydraulic conductivity and porosity for various aquifer framework materials like those present in the study basins.

Table 13. Hydrogeologic properties of the aquifer framework materials.

Facies	Porosity [1]	Hydraulic conductivity
Clayey silt to gravely silt	35 to 70 percent	0.27 to 1.37 feet per day (ft/d) (9.53×10^{-5} to 4.83×10^{-4} centimeters per second (cm/s)) [2]
Silty sand and gravel	25 to 50 percent	60 to 200 ft/d (0.02 to 0.07 cm/s) [2]
Glacial outwash sediments	40 percent	360 to 1740 ft/d (0.127 to 0.614 cm/s) [2]
Weathered granite / saprolite	10 percent	4.4 ft/d (1.55×10^{-3} cm/s) [3]
Fractured crystalline rock (gneiss)	0 to 10 percent	0.864 to 86.4 ft/d (3×10^{-3} to 0.3 cm/s) [4]
Dense crystalline rock (gneiss)	0 to 5 percent	2.8×10^{-8} to 2.8×10^{-5} ft/d (10^{-11} to 10^{-8} cm/s) [5]
Fractured shale	0 to 10 percent	2.8×10^{-3} to 283 ft/d (10^{-6} to 10^{-1} cm/s) [5]
Shale	0 to 10 percent	2.83×10^{-7} to 2.82×10^{-4} (10^{-11} to 10^{-7} cm/s) [5]

1 Freeze and Cherry, 1979, p. 37
2. Sagstad, 1977
3. Todd, 1980
4. Bolke and Vaccaro, 1981
5. Freeze and Cherry, 1979, p. 29

The Spokane River flows at the base of area GF. The interaction of the Spokane River with the main aquifer at the base of the hillsides south of the Rathdrum Prairie is not well understood. Broom (1951) estimated an average loss of 78 cubic feet per second (cfs) from Post Falls to Greenacres, Washington, however the location of losing and gaining reaches of the river is not well established. The conductivity and temperature of ground water are properties that are influenced by surface water recharge; in ground water zones of lower conductivity and higher temperature river recharge may be occurring. In this study, low conductivity, relative to the study basin median of 174 µs/cm, was detected in ground water samples collected from the wells nearest to the Spokane River. The conductivity in the samples collected from these wells (GF-7, GF-8, GF-10) ranged from 103 to 142 µs/cm. The dilute nature of the samples from wells near the river may result from river recharge, however the conductivity was similar in samples from wells that are not in the vicinity of the Spokane River (GF-1, GF-13, HV-3, HV-9). The temperature in the well nearest to the Spokane River, 16.9°C (62.4 °F), was the highest measured in the study.

Effects of hydrogeology on ground water chemistry In recharge areas, there is a downward component to the direction of ground water flow (Freeze and Cherry, 1979, p.194), increasing the vulnerability of an aquifer to contamination. Ground water recharge areas are indicated by hydrogeochemical trends. In general, because ionic concentration increases along the flow path of ground water, water from recharge areas is relatively fresh and of lower conductivity (Freeze and Cherry, 1979, p.201). The conductivity in study samples indicates there are recharge areas in the flat uplands of areas GF and HV at the sites of wells GF-1 and HV-3. In area HV, most wells produced highly mineralized samples of high conductivity, suggesting long residence times. Well HV-9, at 500 ft (152.3 m) the deepest study well, produced the sole sodium bicarbonate water sample, while all other samples of the study were calcium bicarbonate water. The high sodium content (80 mg/L) of well HV-9 probably results from the isolation of its water-bearing interval from the influence of surface waters where sluggish ground water flow and long residence times can produce sodium rich water in the presence of sodium feldspar minerals (Freeze and Cherry, 1979, p. 273).

In area NG, conductivity was low in two wells (NG-1 and NG-4), as compared to the median conductivity (239 µs/cm), that are near the surface water flow of the basin. Water samples from area NG had the highest calcium, magnesium, sulfate, and iron concentrations in the study, which suggests a long residence time in contact with argillite containing iron sulfide minerals and basalt containing ferro-magnesian minerals.

In-depth examination of nitrate in the study basins

Significance of nitrate in drinking water Nitrate is the most common chemical contaminant identified in aquifers (Freeze and Cherry, 1979). Nitrate contamination is ubiquitous in aquifers throughout the world and the level of contamination by nitrate is increasing (Spalding and Exner, 1993). Nitrate is a product of septic system effluent and of both animal and chemical fertilizers. The movement of nitrate in groundwater is not retarded by reaction with other water constituents. Nitrate is not adsorbed by the aquifer framework (Hem, 1985). However, nitrate may be transformed to chemical species that are not detrimental to drinking water in low oxygen environments, for example, in waters at great depth (Freeze and Cherry, 1979).

The EPA has established a maximum contaminant level for nitrate in public drinking water supplies of 10 mg/L nitrate-N (U.S. Code of Federal Regulations, 1992A). This limit has been established to prevent a potentially fatal illness in infants, methemoglobinemia, or blue-baby syndrome. The etiologic agent of methemoglobinemia is nitrite, a product of nitrate in the immature digestive system. Nitrate can be converted to nitrite in the stomach. When nitrite binds with the oxygen-transporting hemoglobin in the blood, it forms methemoglobin. Until the age of about four months, infants lack an enzyme necessary to transform the methemoglobin back into hemoglobin, and may suffer from insufficient oxygen (Mueller and others, 1995).

There are further health concerns linked to nitrate by correlation studies that to date do not prove nitrate is a causative factor (Spalding and Exner, 1993). An increased risk of cancer through the role of nitrate as a precursor compound in the formation of nitrosamines, some of which are known carcinogenics, has been investigated. A recent epidemiological study (Ward and others, 1996) reported increased risk of a form of cancer, non-Hodgkins's lymphoma, from long-term consumption of drinking water with nitrate concentrations greater than or equal to 4 mg/L nitrate N. Conflicting results have been reported. When nitrate consumption was evaluated as a risk factor in stomach cancer in four separate studies, nitrate consumption had an inverse relationship, in general, with the occurrence of the disease (as reported in Ward and others, 1996). Nitrate and nitrite have been linked by correlation studies to mutagenic and teratogenic effects, cardiovascular disease, and deficits in infant development (Mitchell and Harding, 1996). The contribution of nitrate consumption to the occurrence of health disorders in humans continues to be the subject of much research.

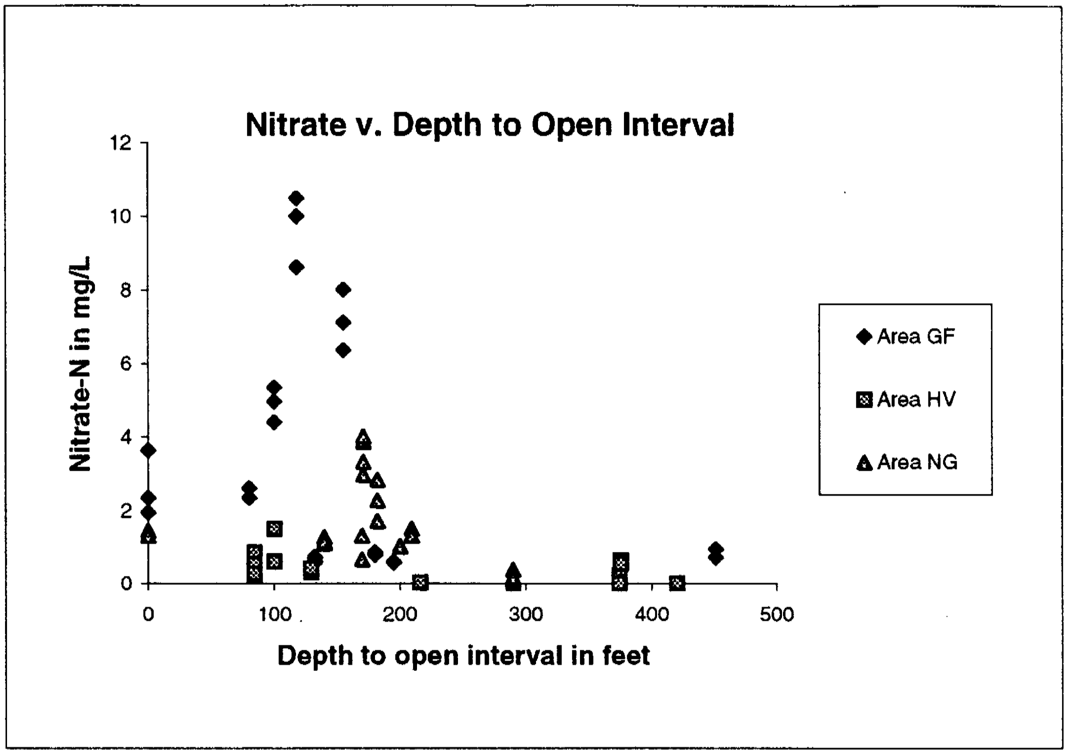
Background levels of nitrate Only very small amounts of nitrogen are found in rocks. Naturally occurring nitrogen in present in organic matter in soils (Hem, 1985).

The naturally occurring concentration (background level) of nitrate in the Rathdrum Prairie region is not known. Background levels of nitrate were estimated at 0.5 mg/L nitrate-N by Parliaman and others (1980). The range of nitrate concentrations in the southern portion of the Rathdrum Prairie aquifer near the source of lake recharge, from 0.5 to 0.8 mg/L was used by Painter (1996b) as a background level. Bolke and Vaccaro (1981) found nitrate levels generally 3 mg/L and greater in the peripheral areas of the Spokane aquifer.

Madison and Brunett (1985) used nitrate concentrations in more than 87,000 wells in the first nation-wide evaluation of the distribution of nitrate in ground water. Their background level for nitrate, 3 mg/L, could be too conservative from an environmental perspective, because half of the samples collected across the nation did not have detectable concentrations of nitrate (Spalding and Exner, 1993). The data sets of the National Water-Quality Assessment Program were used by Mueller and others (1995) to establish median nitrate concentrations by land use setting. The median nitrate ranged from 0.1 mg/L for forest land, to 1.8 mg/L for the urban setting, to 3.4 mg/L for ground water beneath agricultural regions. These figures reflect the greater capacity of forested land for uptake of nitrogen.

The results of this study suggest that the minimum naturally occurring concentration of nitrate in ground water in the hillside basins adjoining the Rathdrum Prairie aquifer is less than 0.010 mg/L, as detected in the deep wells of area HV, Hidden Valley.

Well construction and nitrate concentration The relationship between nitrate concentrations and two well construction variables, the depth of a well and the depth to the first open interval of a well, were examined by calculation of the Spearman rho correlation coefficient (r_s). A negative correlation ($r_s = -.51$) was found between nitrate concentration and well depth. A similar correlation was found between nitrate concentration and the depth to the first open interval ($r_s = -.47$). These correlations indicate that nitrate concentrations were lower in deeper wells, and about 25 percent of the variation in nitrate concentrations was attributable to well depth. Scatterplots (Fig. 26) illustrate that the highest nitrate concentrations are found in wells less than approximately 200 ft (61 m) deep.



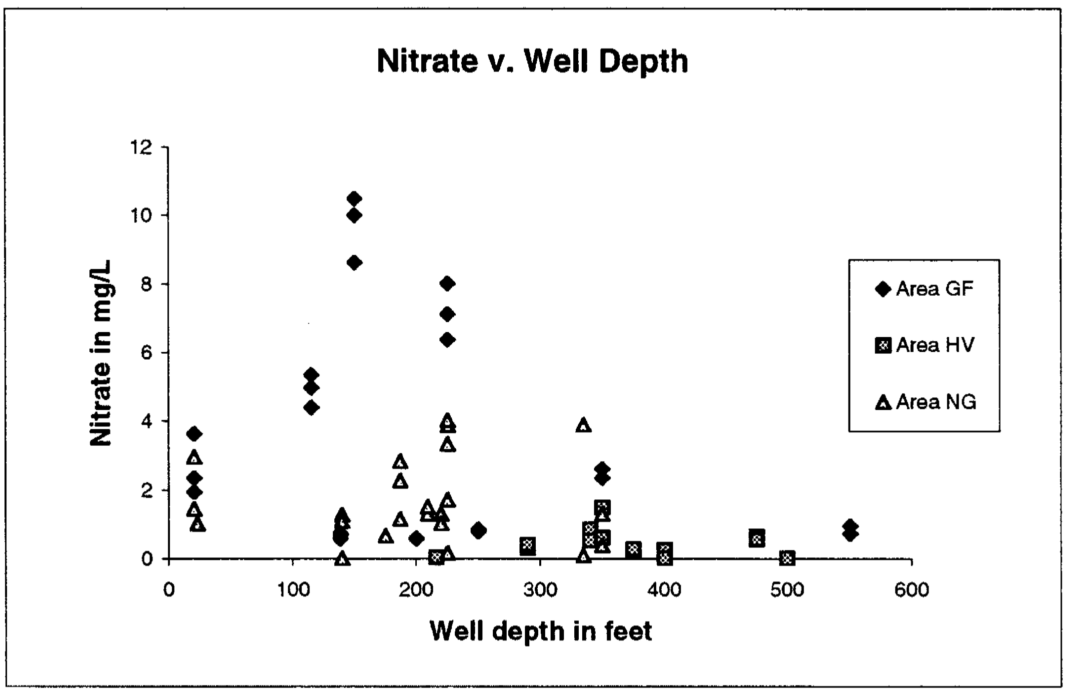
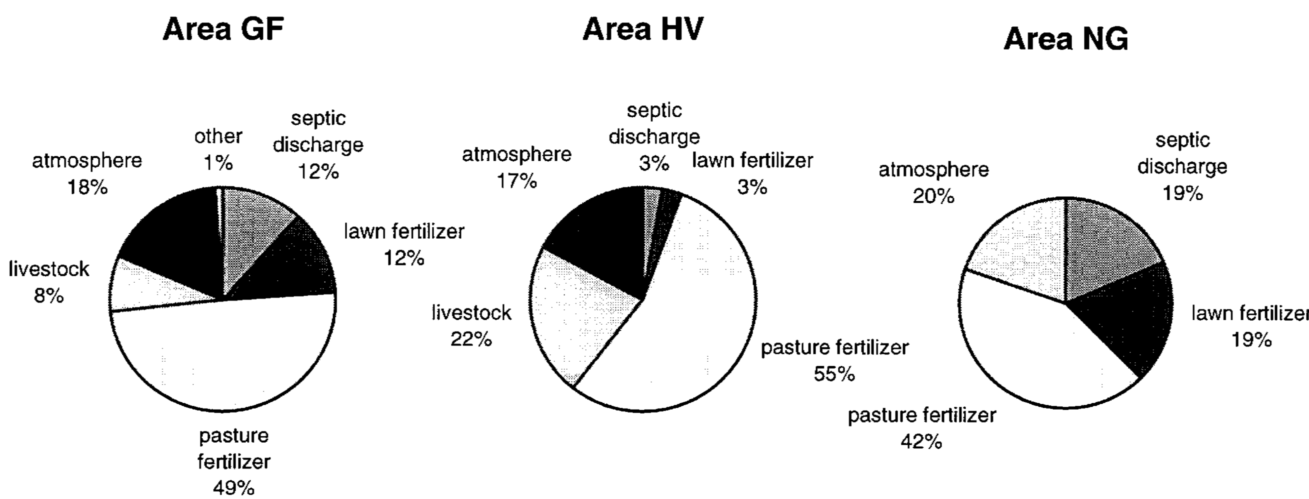


Figure 26. Nitrate concentrations and well depth. Scatter plots of nitrate concentration of well samples versus well depth and depth to the open interval.

Nitrogen inputs Estimates were made of the nitrogen loading of the study basins from septic system discharge, lawn fertilization, pasture fertilization, cattle waste, and atmospheric deposition in the study basins (Fig. 27). The number of households in each basin was limited to the number of septic systems counted from the PHD 1992 maps. The nitrogen load from septic discharge was calculated using the PHD estimate of average household wastewater discharge of 250 gallons (946 liters) per day per household, containing 32 mg/L nitrogen, the upper limit of the EPA (1980) estimate of wastewater nitrogen concentration. A lawn size was estimated at 5,000 square feet per household, with a fertilization rate of 5 lb nitrogen per 1,000 square feet per year, the rate recommended by the Cooperative Extension System (Parker-Clark and Mahler, 1996). The estimates of pasture acreage were based on field reconnaissance and acreage estimated from tax assessor maps. The nitrogen load from pasture fertilization was calculated using the rate, 140 lb of nitrogen per acre per year, recommended by the Cooperative Extension System for irrigated grass pastures (Mahler, 1996). The nitrogen load from beef cattle used was 113.1 pounds per animal per year (reported in McMahon and Woodside, 1997). The animal waste load calculated included only cattle, although there were some horses, sheep, and goats in small numbers in the study basins. The atmospheric deposition of nitrogen used in the estimate was 0.7 pounds per acre (0.8 kilograms per hectare) which was the measured rate of nitrogen deposition in Whitman County, Washington in 1996 (National Atmospheric Deposition Program, 1997).

The nitrogen load introduced by nitrification by plants was not estimated. A stand of clover or alfalfa can provide up to 200 lb of nitrogen per year (Mahler and others, 1997). These estimates represent the total loading in the study basins, not the amount of nitrogen entering the ground water.



	Number of households	Septic discharge	N load from septic discharge	Lawn fertilizer load	Estimate of pasture in acres	Pasture fertilization load	Livestock population, cattle only	Livestock load	Area (acres)	Atmospheric load	Other N load, descriptor	Other N load	Total load per year
Source of data	Count of septic systems mapped by PHD in 1992	250 gallons/day PHD estimate	At 32 mg/L, EPA (1980)	Assume 5,000 ft^2 lawn. 5 lbs N/1000 ft^2 (U of I)	Field reconnaissance and tax maps	140 lbs N/acre for irrigated pastures (U of I)	Field reconnaissance	113 lbs N per head of beef cattle per year (McMahon and Lloyd, 1995)	7.5' USGS maps, digitized	National Atmospheric Deposition Program, 1997		Resident report	
GF	41	3741250	999	1025	30	4200	6	678	2086	1485	corn, 1 acre	90	7452
HV	28	2555000	682	700	100	14000	50	5650	6120	4357			24690
NG	50	4562500	1218	1250	20	2800	0	0	1820	1296			5314

Figure 27. Estimated nitrogen loads in the study basins. Load estimates are in pounds per year. See text for a description of input parameters.

The nitrogen load to the basins by atmospheric deposition may be utilized by crops, denitrified in periodically saturated topsoils rich in organics (Walker and others, 1973), or may be lost to volatilization (National Research Council, 1978, p. 274). However, virtually all of the nitrogen from discharge of domestic wastewater to onsite septic systems is delivered eventually to the ground water (Walker and others, 1973; National Research Council, 1978, p. 264). Chemical and animal fertilizer uptake by plants varies by crop and soil characteristics. Nitrogen use efficiency averages 50 percent. Best management practices can increase nitrogen uptake to 70 percent and careless management can reduce uptake to 30 percent (Mahler and Mahler, 1997).

Fertilizer use in agricultural regions has been widely recognized as a source of nitrate contamination of ground water, yet the recognition of the potential for contamination from small farms like those in the hillsides of Kootenai County is relatively recent. The University of Idaho (Mahler and Mahler, 1997) summarizes the problem as follows. Massive federal education programs target the large farmer, however the owners of small farms, or ranchettes, have been neglected in pollution prevention programs. Small farms ranging in size from one to 20 acres are increasing in number throughout the northwest; large numbers of small farms are appearing near Coeur d'Alene and other cities in the Pacific Northwest. The contribution to ground water contamination of small scale farms can be significant. Small farms often support several horses and other livestock and owners attempt to feed animals from forage crops grown on site. Often small farm owners have off-farm sources of income and the costs of fertilizers and other farm chemicals do not limit their use.

The greatest nitrate concentrations in samples of the study were found in well GF-4 on a small farm. This farm contributes about 1150 lb of nitrogen (the owner's estimate) to the annual nitrogen load in the basin by chemical fertilizer and manure application to one acre of corn and seven acres of pasture. This load exceeds the approximately 1000 pounds per year of septic loading within the entire study basin. This does not include nitrogen loading from a small greenhouse on the farm. Highly permeable soils and decomposed bedrock underlie the farm. The low available water capacity of the soil here necessitates a high rate of irrigation, facilitating the leaching of nitrate to ground water.

The potential contribution of small businesses to groundwater pollution is a growing concern and these entities, not connected to large industrial companies that have been the focus of government pollution prevention efforts, may prove difficult to educate (Lowrie and Greenberg, 1997). In area GF and in South Post Falls where nitrate concentrations exceeded the MCL, greenhouses were in operation.

Nitrate concentrations in ground water from previous studies

Table 14 is a compilation of ground water nitrate concentrations reported in related studies. Most comparable to the current study are the reports by Graham (1994), Hall (1991), and Dion (1987) who studied hillside basins discharging to the Rathdrum Prairie-Spokane aquifer system. Graham (1994) reported nitrate concentrations (mean 0.454 to 0.715 mg/L) in the Chilco Channel, with a mean of 0.715 mg/L, and Sage-Lewellen watershed, with a median of 0.454 mg/L, which are similar to the concentrations in area HV, Hidden Valley , with a median nitrate concentration of 0.242 mg/L. Working in basins of greater development density, Hall (1991) and Dion (1987) reported higher nitrate concentrations. In wells at the outlet of the Forker and Northwood basins of Spokane County, Washington, Hall (1991) reported a mean nitrate concentration of 2.78 mg/L. The mean of the ground water samples from the Argonne Road basin was 6.5 mg/L (Dion, 1987). These values are more comparable to those of areas GF, South Greenferry Road, with a median 2.61 mg/L nitrate, and area NG, Nettleton Gulch, with a median of 1.09 mg/L.

Table 14. Ground water nitrate concentrations reported in related studies. All concentrations in mg/L as N. Blank: no data.

Study area	Author and year of study	Number of analyses	Median	Mean	Minimum	Maximum
Sage-Lewellen watershed, Kootenai County	Graham, 1994	14		0.454	<0.005	1.34
Chilco channel, Kootenai County, discharging to the Rathdrum Prairie aquifer	Graham, 1994	10		0.715	0.155	1.85
Wells at outlet to Forker and Northwood basins, hillsides adjoining the Spokane aquifer, Spokane County, Washington	1988 Spokane County monitoring program, in Hall, 1991	8		2.78	2.13	3.34
Argonne Road basin, discharging to the Spokane aquifer, Spokane County, Washington	Dion, 1987	6		6.5	1.5	17
Northern Spokane County, Washington	Boese, 1996	51		1.2	<0.01	9.86
Spokane-Rathdrum Prairie aquifer	Droste and Seitz, 1978	940				28
Kootenai County, granitic aquifers	Parliman, 1980	9	0.085		0.02	0.51
Kootenai County, glacial outwash aquifers	Parliman, 1980	7	0.32		0.01	25
Panhandle glacial deposits aquifer, includes Rathdrum Prairie aquifer	Yee and others, 1987	84	0.1	0.7	0.1	25
Rathdrum Prairie aquifer	Young and others, 1988	59	1.0	1.2	0.3	4.2
Rathdrum Prairie aquifer	PHD monitoring program, July, 1997	29	0.971		0.086	5.12

A spreadsheet model for nitrate loading

A simple spreadsheet has been developed that allows the estimation of nitrogen loading to an unconfined aquifer and is included with this report. Alternatively the spreadsheet is available through the Internet: e-mail to jbuchanan@ewu.edu. The user is required to input a variety of parameters which govern the concentration and loading of nitrogen to the vadose zone and to ground water in the aquifer. The spreadsheet calculates the ground water quality impact based on a simple conceptual model similar to that of Bauman and Schafer (date unknown) and Rodriguez-Estrada and Loaiciga (1995). This spreadsheet is not an empirical model based on data gathered during this study of hillside watersheds.

Input parameters include the number of lots (residences) on a given area of the land surface. The user can define the average occupancy of each residence (number of people), how much wastewater each person produces per day, and the nitrogen production per person per day. A retardation factor may also be input which reflects the uptake rate of nitrogen once it is released to the environment: zero percent retardation indicates no uptake while 100 percent retardation indicates all nitrogen is utilized and none is allowed to escape to ground water. The spreadsheet also allows for the consideration of the recharge volume to the aquifer by natural rainfall and by lawn irrigation, each specified in inches per year. Wastewater recharge volume to the aquifer is calculated by the spreadsheet based on input values discussed above. At this point the spreadsheet can calculate the nitrogen concentration in the vadose zone.

If the user wants to estimate the nitrogen concentration in the ground water in the saturated zone of the unconfined aquifer, then additional input parameters are required. The user must specify the mixing depth (the thickness of the portion of the saturated zone with which the recharge water will mix), the width of the property being considered across the direction of ground water flow, the slope of the water table surface beneath the property (the hydraulic gradient), and the permeability of the aquifer media. If background nitrate concentration in ground water in the area is known, the user may input this value. The spreadsheet then calculates the nitrogen concentration in the ground water due to the effect of mixing the effluent with the regional ground water flow. Once values for the input parameters are specified, the spreadsheet automatically calculates a variety of useful numbers. The residential density, volume of wastewater production, and nitrogen concentration in wastewater are determined first. The recharge volume due to rain and irrigation, and the nitrogen concentration in the recharge water (including septic effluent and allowing for retardation if specified) is also calculated. Lastly, the volume of ground water flow beneath the site and the total nitrogen concentration in the ground water (allowing for mixing of the recharge volume and considering background nitrogen concentration in the ground water) is determined. In sum, this spreadsheet is a useful tool that estimates the impact on an unconfined aquifer from nitrogen loading by septic discharge beneath a proposed development.

Prediction of nitrate concentrations with increasing development

The spreadsheet program described in the previous section was used to project nitrate concentrations in ground water with increasing development density within a basin. In these scenarios, data has been entered for area NG, Nettleton Gulch.

A readily developed area of 260 acres within Nettleton Gulch was used in these predictive examples. The household size was adjusted to reflect the PHD estimate of 250 gallons per day (gpd) of septic discharge per household in Kootenai County. Nitrogen production per person per day was calculated from the upper limit of the EPA estimate of nitrogen concentration of septic discharge, 32 mg/L (U.S. EPA, 1980). A retardation factor of zero was used. In well oxygenated soils, it is reasonable to assume that all nitrogen in septic discharge will be converted to nitrate (Freeze and Cherry, 1979, p. 413). The precipitation recharging ground water is estimated at eight inches per year, about one-third of the annual average rainfall, consistent with estimates of consumptive use by Droste and Seitz (1978). The amount of irrigation recharging ground water is not well constrained. Coeur d'Alene water use shows a differential of about 40,000 gallons per month between winter and summer months (personal communication, Coeur d'Alene City Water Department). Irrigation probably exceeds one inch per month; one inch per year ground water recharge from irrigation was employed in the predictions. The area of saturated flow out of the basin and the slope of the water table surface were calculated from field measurements and data from drillers' logs. The estimate of permeability (hydraulic conductivity), 123 foot per day (ft/d), used is consistent with the estimate by Painter (1991b) of basin ground water export of 0.59 cubic feet per second per square mile of basin area, and within the range of from 60 to 200 ft/d for a Rathdrum Prairie-perimeter locale of silty sand and gravel established empirically by Sagstad (1977). The background level of nitrate in recharge water used was 0.8 mg/L, from an estimate by Painter (1991a) for the Rathdrum Prairie aquifer. Nitrogen loading considered in the predictions was solely from septic discharge.

Tables 15, 16, 17, and 18 are examples of the output of the spreadsheet program. Figure 28 is plot of the increasing nitrogen concentrations resulting from decreasing lot size within a hypothetical development. As Figure 28 displays, the predicted nitrogen concentrations in ground water exported from the hypothetical developments increases to 7.22 mg/L in an approximately exponential trend with decreasing lot size in the development from five acres to one-fifth acre. For the five-acre lot size prediction, 52 lots are input. This closely parallels the current development status of area NG in the study, where 50 septic systems were mapped by the PHD in 1992. The actual median nitrogen concentration in the study samples from area NG was 1.09 mg/L; the predicted value for nitrogen concentration is 1.01 mg/L.

Table 15. Output of a nitrogen loading worksheet. Using a 260 acre estimate of readily developed land in area NG, Nettleton Gulch, and lot sizes of 5 acres, the concentration of nitrogen in ground water is calculated. This estimate approximates present day development. See text for an explanation of input parameters and assumptions.

NITROGEN LOADING CALCULATION WORKSHEET:

Area NG, Nettleton Gulch, 5 acre lots

Input the following parameters - be sure to use the indicated units!

What is the size of the proposed development?

Number of lots =	52
Number of acres =	260

What is the definition of a household?

Occupancy =	3.85 people
Wastewater produced =	65 gallons/person/day
N production =	8 grams/person/day

What percentage of nitrogen is taken up in the soil?

N retardation =	0 percent

Recharge parameters:

Estimate amount of precipitation going to groundwater?

Precipitation =	8 inches/year

Estimate amount of lawn irrigation going to groundwater?

Irrigation =	1 inches/year

Calculated wastewater volume for entire development:
(do not enter - this is calculated from above)

Wastewater =	4749745 gallons/year

Mixing effects and dilution with groundwater:

What is the thickness of the portion of the aquifer that recharge will mix with?

Mixing depth =	80 feet

What is the width of the development across the direction of groundwater flow?

Width of flow =	870 feet

What is the slope of the water table surface beneath the development?

Hydraulic gradient =	0.017 dimensionless

What is the permeability of the aquifer media?

Permeability =	123 feet/day

Impact of development to groundwater quality:

What is the N concentration in the aquifer?

Background N =	0.8 mg/L

Calculated or output values are in these columns:

The calculated density is:	0.20 lots/acre
Wastewater production =	250.25 gallons/day/house
	91341.25 gallons/year/house
	945.945 L/day/house
	345269.93 L/year/house
Household N loading =	30800 mg/day
N concentration per house =	32.56 mg/L
Total N production =	11.24 kg/year/house
N conc. for development =	1693.12 mg/L
N loading for development =	584.58 kg/year
N load all houses with no retardation =	584.58 kg/year
N load all houses with retardation =	584.58 kg/year
	11.24 kg/year/house
Recharge (rain + irrigation) =	23271.78 cubic feet per day
	8494200 cubic feet per year
	657995.64 liters per day
	240168408 liters per year
Total recharge volume to groundwater = (includes rain +irrigation +wastewater)	258122445 liters per year
N concentration in recharge water = (for entire development)	2.26 mg/L
Calculated groundwater Q = (beneath entire development)	145534 cubic feet per day
	4114875.2 liters/day
	53119764 cubic feet per year
	1.502E+09 liters/year

Total N concentration in groundwater = 1.01 mg/L
(as a result of the completed development)

Conversion factors:
3.78 liters per gallon
7.48 gallons per cubic foot
43560 square feet per acre

Table 16. Output of a nitrogen loading worksheet. Using a 260 acre estimate of readily developed land in area NG, Nettleton Gulch, and lot sizes of 1 acre, the concentration of nitrogen in ground water is calculated.
See text for an explanation of input parameters and assumptions.

NITROGEN LOADING CALCULATION WORKSHEET:

Area NG, Nettleton Gulch, 1 acre lots

Input the following parameters - be sure to use the indicated units!		Calculated or output values are in these columns:	
What is the size of the proposed development?			
Number of lots =	260	The calculated density is:	1.00 lots/acre
Number of acres =	260		
What is the definition of a household?			
Occupancy =	3.85 people	Wastewater production =	250.25 gallons/day/house
Wastewater produced =	65 gallons/person/day		91341.25 gallons/year/house
N production =	8 grams/person/day		945.945 L/day/house
			345269.93 L/year/house
		Household N loading =	30800 mg/day
		N concentration per house =	32.56 mg/L
		Total N production =	11.24 kg/year/house
		N conc. for development =	8465.61 mg/L
		N loading for development =	2922.92 kg/year
What percentage of nitrogen is taken up in the soil?			
N retardation =	0 percent	N load all houses with no retardation =	2922.92 kg/year
		N load all houses with retardation =	2922.92 kg/year
			11.24 kg/year/house
Recharge parameters:			
Estimate amount of precipitation going to groundwater?		Recharge (rain + irrigation) =	23271.78 cubic feet per day
Precipitation =	8 inches/year		8494200 cubic feet per year
Estimate amount of lawn irrigation going to groundwater?			657995.64 liters per day
Irrigation =	1 inches/year		240168408 liters per year
Calculated wastewater volume for entire development:			
(do not enter - this is calculated from above)		Total recharge volume to groundwater = (includes rain +irrigation +wastewater)	329938589 liters per year
Wastewater =	23748725 gallons/year		
		N concentration in recharge water = (for entire development)	8.86 mg/L
Mixing effects and dilution with groundwater:			
What is the thickness of the portion of the aquifer that recharge will mix with?		Calculated groundwater Q = (beneath entire development)	145534 cubic feet per day
Mixing depth =	80 feet		4114875.2 liters/day
What is the width of the development across the direction of groundwater flow?			53119764 cubic feet per year
Width of flow =	870 feet		1.502E+09 liters/year
What is the slope of the water table surface beneath the development?			
Hydraulic gradient =	0.017 dimensionless		
What is the permeability of the aquifer media?			
Permeability =	123 feet/day		
Impact of development to groundwater quality:			
What is the N concentration in the aquifer?			
Background N =	0.8 mg/L	**Total N concentration in groundwater = (as a result of the completed development)**	**2.25 mg/L**

Conversion factors:
3.78 liters per gallon
7.48 gallons per cubic foot
43560 square feet per acre

Table 17. Output of a nitrogen loading worksheet. Using a 260 acre estimate of readily developed land in area NG, Nettleton Gulch, and lot sizes of 1/2 acre, the concentration of nitrogen in ground water is calculated.
See text for an explanation of input parameters and assumptions.

NITROGEN LOADING CALCULATION WORKSHEET:

Area NG, Nettleton Gulch, 1/2 acre lots

Input the following parameters - be sure to use the indicated units!		**Calculated or output values are in these columns:**	
What is the size of the proposed development?			
Number of lots =	520	The calculated density is:	2.00 lots/acre
Number of acres =	260		
What is the definition of a household?			
Occupancy =	3.85 people	Wastewater production =	250.25 gallons/day/house
Wastewater produced =	65 gallons/person/day		91341.25 gallons/year/house
N production =	8 grams/person/day		945.945 L/day/house
			345269.93 L/year/house
		Household N loading =	30800 mg/day
		N concentration per house =	32.56 mg/L
		Total N production =	11.24 kg/year/house
		N conc. for development =	16931.22 mg/L
		N loading for development =	5845.84 kg/year
What percentage of nitrogen is taken up in the soil?			
N retardation =	0 percent	N load all houses with no retardation =	5845.84 kg/year
		N load all houses with retardation =	5845.84 kg/year
			11.24 kg/year/house
Recharge parameters:			
Estimate amount of precipitation going to groundwater?		Recharge (rain + irrigation) =	23271.78 cubic feet per day
Precipitation =	8 inches/year		8494200 cubic feet per year
Estimate amount of lawn irrigation going to groundwater?			657995.64 liters per day
Irrigation =	1 inches/year		240168408 liters per year
Calculated wastewater volume for entire development:		Total recharge volume to groundwater =	419708769 liters per year
(do not enter - this is calculated from above)		(includes rain +irrigation +wastewater)	
Wastewater =	47497450 gallons/year		
		N concentration in recharge water =	13.93 mg/L
		(for entire development)	
Mixing effects and dilution with groundwater:			
What is the thickness of the portion of the aquifer that recharge will mix with?		Calculated groundwater Q =	145534 cubic feet per day
Mixing depth =	80 feet	(beneath entire development)	4114875.2 liters/day
What is the width of the development across the direction of groundwater flow?			53119764 cubic feet per year
Width of flow =	870 feet		1.502E+09 liters/year
What is the slope of the water table surface beneath the development?			
Hydraulic gradient =	0.017 dimensionless		
What is the permeability of the aquifer media?			
Permeability =	123 feet/day		
Impact of development to groundwater quality:			
What is the N concentration in the aquifer?			
Background N =	0.8 mg/L	**Total N concentration in groundwater =**	**3.67 mg/L**
		(as a result of the completed development)	

Conversion factors:
3.78 liters per gallon
7.48 gallons per cubic foot
43560 square feet per acre

Table 18. Output of a nitrogen loading worksheet. Using a 260 acre estimate of readily developed land in area NG, Nettleton Gulch, and 5 lots per acre acre, the concentration of nitrogen in ground water is calculated.
See text for an explanation of input parameters and assumptions.

NITROGEN LOADING CALCULATION WORKSHEET:

Area NG, Nettleton Gulch, 5 lots per acre

Input the following parameters - be sure to use the indicated units!			Calculated or output values are in these columns:		
What is the size of the proposed development?					
Number of lots =	1300		The calculated density is:	5.00	lots/acre
Number of acres =	260				
What is the definition of a household?					
Occupancy =	3.85	people	Wastewater production =	250.25	gallons/day/house
Wastewater produced =	65	gallons/person/day		91341.25	gallons/year/house
N production =	8	grams/person/day		945.945	L/day/house
				345269.93	L/year/house
			Household N loading =	30800	mg/day
			N concentration per house =	32.56	mg/L
			Total N production =	11.24	kg/year/house
			N conc. for development =	42328.04	mg/L
			N loading for development =	14614.60	kg/year
What percentage of nitrogen is taken up in the soil?					
N retardation =	0	percent	N load all houses with no retardation =	14614.60	kg/year
			N load all houses with retardation =	14614.60	kg/year
				11.24	kg/year/house
Recharge parameters:					
Estimate amount of precipitation going to groundwater?			Recharge (rain + irrigation) =	23271.78	cubic feet per day
Precipitation =	8	inches/year		8494200	cubic feet per year
Estimate amount of lawn irrigation going to groundwater?				657995.64	liters per day
Irrigation =	1	inches/year		240168408	liters per year
Calculated wastewater volume for entire development: (do not enter - this is calculated from above)			Total recharge volume to groundwater = (includes rain +irrigation +wastewater)	689019311	liters per year
Wastewater =	118743625	gallons/year			
			N concentration in recharge water = (for entire development)	21.21	mg/L
Mixing effects and dilution with groundwater:					
What is the thickness of the portion of the aquifer that recharge will mix with?			Calculated groundwater Q = (beneath entire development)	145534	cubic feet per day
Mixing depth =	80	feet		4114875.2	liters/day
What is the width of the development across the direction of groundwater flow?				53119764	cubic feet per year
Width of flow =	870	feet		1.502E+09	liters/year
What is the slope of the water table surface beneath the development?					
Hydraulic gradient =	0.017	dimensionless			
What is the permeability of the aquifer media?					
Permeability =	123	feet/day			
Impact of development to groundwater quality:					
What is the N concentration in the aquifer?					
Background N =	0.8	mg/L	**Total N concentration in groundwater = (as a result of the completed development)**	**7.22**	**mg/L**

Conversion factors:
3.78 liters per gallon
7.48 gallons per cubic foot
43560 square feet per acre

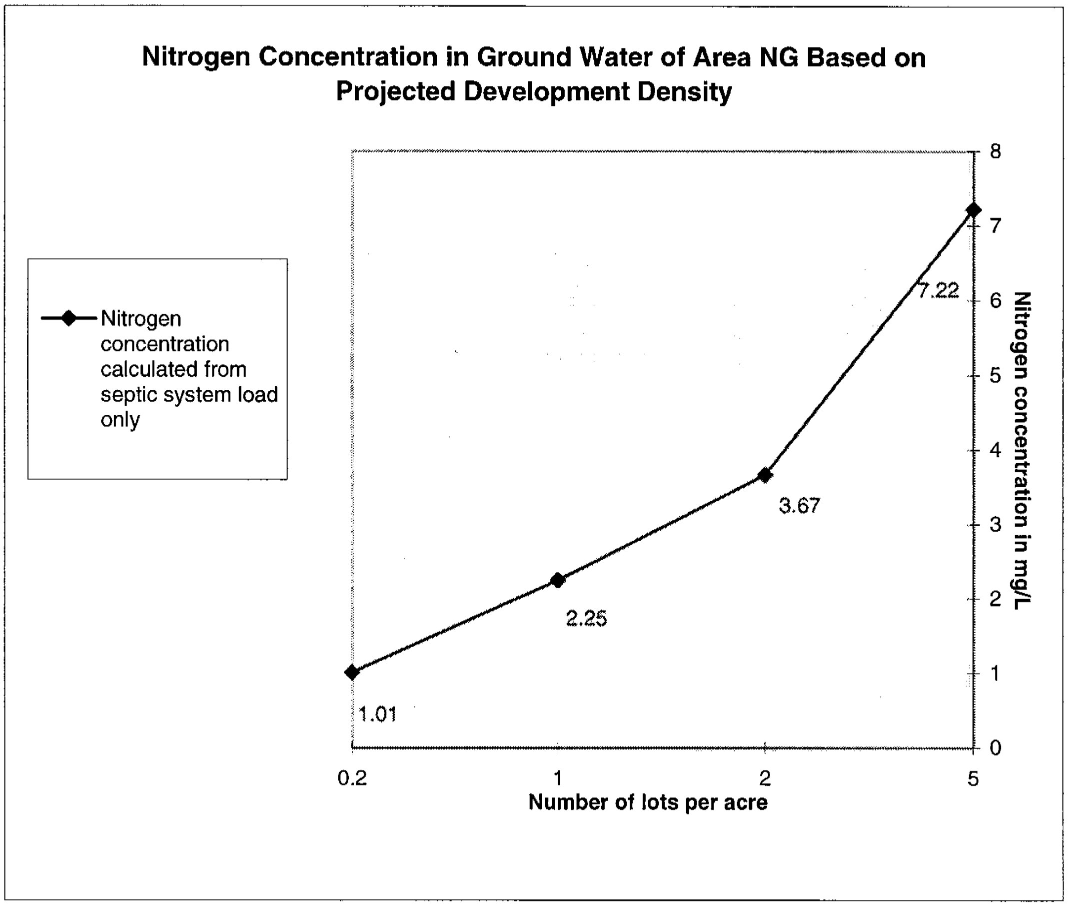


Figure 28. Projection of nitrogen concentrations in area NG, Nettleton Gulch. Increasing development of 260 acres within the basin is assumed. Concentrations of nitrogen are based on septic system loading. See text for explanation of input parameters and assumptions.

Conclusions

Water quality in the study basins

Area HV No evidence of contamination was present in ground water samples from area HV, Hidden Valley. Nitrate concentrations were not above probable background levels, and the median nitrate concentration of 0.242 mg/L was low. Chloride concentration in the sampled wells of area HV were also low, with a median of 1.3 mg/L, the lowest median concentration in the study basins.

The good ground water quality in area HV is the result of a combination of factors, including (a) low residential development density, (b) deep wells, and c) denitrification of nitrate facilitated by the high carbon content of the soil and low oxygen conditions in a seasonal high water table. The presence of extensive forested acreage may also attenuate nitrate loads. Complaints about discomfort by some residents new to the area may be related to not being accustomed to the high mineral content of the water, although it is possible that bacterial contamination exists in the water in these residences.

Water quantity in the basin is low. Water storage appears to be solely in fractured bedrock.

Area GF Ground water quality is compromised in the upper basin of area GF, the South Greenferry Road basin. Nitrate concentrations in four of the ten wells sampled were above probable background levels and reached 10.5 mg/L in one sample, exceeding the MCL of 10.0 mg/L. Nitrate contamination, with a median of 2.61 mg/L, may be a result of fertilizers applied on small farms and at a greenhouse. The chloride concentrations in all the study wells in area GF, median 3.0 mg/L, were above the median in area HV, 1.3 mg/L. Elevated chloride is suggestive of septic discharge contamination of ground water.

The high rate of irrigation practiced in area GF may contribute to the nitrate and chloride concentrations. Pumping of these relatively low yield wells may draw water down from shallow depths where fertilizer leachate and septic discharge reside. The low available water capacity of predominant soils in the basin necessitates heavy irrigation of cropland, lawns, and gardens, which also facilitates nitrate leaching.

Area NG The water quality of area NG, Nettleton Gulch, may be compromised. Median nitrate concentration was 1.09 mg/L, while in six wells nitrate exceeded the probable background in ground water in Kootenai County. However, the maximum nitrate concentration detected was 3.90 mg/L, well below the MCL of 10.0 mg/L. The primary source of contamination in area NG appears to be septic discharge, for in this study basin, septic discharge was the source of a greater proportion of the estimated nitrogen load than in the other two basins. Chloride concentrations in the sampled wells exhibit a median of 4.0 mg/L, the highest in the study basins, and the chloride concentrations in all the sampled wells were above the area HV median of 1.3 mg/L.

The predominant soils of area NG are highly permeable hydrologic class A where the available water capacity is low, contributing to the leaching potential of surface contaminants.

The bedrock lithology of area NG and the apparent low ground water velocity produce water that is highly mineralized. Ground water exceeds the SMCL of 0.3 mg/L for iron in five of the ten sampled wells. A report of bitter tasting water in this basin could be atttributed to the relatively high concentration of sulfate in the water of this basin.

Relationship of development density to ground water quality

Area NG, Nettleton Gulch, selected as the higher development density study area, presents evidence of ground water degradation related to septic discharge. The highest nitrate concentration in area NG wells was 3.90 mg/L, well above the probable background concentration but below any regulatory limit. Area NG presented the highest median chloride concentration, 4.0 mg/L, in the study. The lowest development density in the study basins was in area HV, Hidden Valley, where the concentration of ground water constituents related to septic discharge, nitrate and chloride, also were the lowest in the study. In area HV, no nitrate concentration was higher than 1.50 mg/L and the median concentration of nitrate was very low (0.242 mg/L). Median chloride concentration in Hidden Valley was 1.3 mg/L. In the study basin selected as intermediate in development density, area GF, the South Greenferry Road basin, the chloride concentrations in samples wells were also intermediate with a basin median of 3.0 mg/L. However the highest nitrate concentrations were detected in area GF, the maximum at 10.5 mg/L, slightly above the MCL of 10.0 mg/L. The ground water degradation in area GF was not proportional to development density in terms of the number of septic systems in the basin. The presence of high nitrate concentrations but relatively lower chloride concentrations in most wells reflected the probable degradation of ground water in area GF by chemical fertilizer. However evidence of septic discharge was present in well GF-2, where both nitrate and chloride were elevated.

Implications for management of the Rathdrum Prairie aquifer system

The Rathdrum Prairie aquifer system receives about two-thirds of its recharge from dilute water sources with very low levels of anthropogenic contaminants, specifically, Coeur d'Alene lake and other smaller lakes, the Spokane River, and direct precipitation over the aquifer (Painter, 1991a). Simple estimates of the nitrate concentration components in the aquifer system may be calculated using a total volume mixing calculation,

$$0.665\ C_{BG} + 0.335\ C_{HS} = C_{RPA}$$

where C_{BG} is the nitrate concentration in dilute sources of recharge, C_{HS} is the nitrate concentration in the remaining recharge (which may originate in the hillsides), and C_{RPA} is the current nitrate concentration in the Rathdrum Prairie aquifer. The current concentration of nitrate in the Rathdrum Prairie aquifer may be approximated by using the median nitrate concentration, 0.971 mg/L, from the July 1997 PHD aquifer monitoring samples. The nitrate concentration of the dilute recharge waters has been estimated at 0.5 to 0.8 mg/L (Painter, 1991a).

Using these estimates, calculation of the nitrate concentration in the remaining one-third of recharge water yields a range of 1.31 to 1.91 mg/L. This range approximates the study finding of median nitrate concentration in area NG, 1.09 mg/L. If the one-third of recharge water not derived from the dilute sources is degraded to the level of the worst case scenario of the spreadsheet calculations, its nitrate concentration would be 7.22 mg/L. Calculation using the simple mixing formula suggests that the subsequent impact on the Rathdrum Prairie aquifer would increase nitrate concentration in the main aquifer from the current level of approximately 0.971 mg/L to a range from 2.85 to 2.95 mg/L.

This simplification of the impact on the ground water of Kootenai County by hillside development without sewers does not reflect (a) the additional impact of animal waste or fertilizer application on ground water nitrate, or (b) the greater degradation that would occur in water pumped from Prairie-perimeter wells where aquifers are of lesser thickness and ground water flow is slow. In order to quantify the impact on these wells it will be necessary to obtain adequate estimates of the mixing ratio of underflow from hillside aquifers, inflow from the main aquifer, and river recharge where applicable. The simple volumetric mix of waters from different sources also does not allow for possible losses of nitrate by denitrification in ground water at depth.

The development of hillside areas will place more demand on the Rathdrum Prairie aquifer in exactly those areas where the risk of aquifer degradation is greatest. It is inevitable that water supplies for increasing populations in the hillside basins will come from wells at the base of these hills drawing from the Rathdrum Prairie aquifer since hillside aquifers do not appear to supply adequate yield. Residents of area GF are increasingly using water from the Greenferry Water District well, located between the hills and the Spokane River. There are more than 70 septic systems within 1000 ft (305 m) of this well. Dilution by river discharge coupled with semiconfined conditions may be providing some protection from surface contamination in the vicinity of the

Greenferry Water District well; however these conditions do not exist everywhere at the perimeter of the Prairie.

Septic discharge is a source of nitrate contamination that can be regulated by land use restrictions. Septic discharge and livestock wastes, but not chemical fertilizers, are sources of bacterial contamination. Many residents of the project areas expressed concern about bacterial contamination in their drinking water. There appears to be less awareness of the risks from nitrate contamination of ground water from these same sources. Residents of the study basins appeared well-informed of the need to maintain good quality drinking water and the importance of the Rathdrum Prairie aquifer.

The potential exists for ground water contamination from sources that are not readily regulated. The potential for small businesses to present ground water contamination risks is suggested by the fact that greenhouses exist at two sites of high nitrate concentrations in ground water in Kootenai County. Small scale agriculture can contribute substantial nitrogen loads to ground water. Nitrate contamination stems from high rates of irrigation coupled with excessive fertilizer application on small farms and large suburban lawns and gardens. Where elevated nitrate concentrations are linked to agricultural practices, ground water should be tested for contamination by other agricultural chemicals (pesticides and herbicides). The most vulnerable areas are those having highly permeable soils of low available water capacity.

The results of this study are consistent with previous conclusions that limiting lot size in unsewered development protects ground water, although fertilizer use can pose a serious threat to ground water quality perhaps equal to the risk of residential development without adequate wastewater treatment. Limiting lot size and requiring sewers in future development is essential to limiting nitrate contamination of ground water, since compliance with best management practices in fertilizer application is voluntary. Education may be the best way to prevent ground water contamination by fertilizers in suburbs, on small farms, and from small businesses.

References

Anderson, A.L., 1940, Geology and metalliferous deposits of Kootenai County, Idaho: Idaho Bureau of Mines and Geology Pamphlet n. 53, 47 p.

Baker, V.R., 1973, Paleohydrology and sedimentology of Lake Missoula flooding in eastern Washington: Geological Society of America Special Paper v. 144, 79 p.

Bauman, B.J., and Schafer, W.M., Estimating ground water impacts from on-site sewage treatment systems: Department of Plant and Soil Science, Montana State University, 8 p.

Bayer, K.C., 1983, Generalized structure, lithology, and physiographic provinces in the fold and thrust belts of the United States: U.S. Geological Survey.

Boese, R., 1996, Aquifer delineation and baseline ground water quality investigation of a portion of North Spokane County, Washington (M.S. thesis): Cheney, Washington, Eastern Washington University, 224 p.

Bolke, E.L, and Vaccaro, J.J., 1981, Digital-model simulation of the hydrologic flow system, with emphasis on groundwater, in the Spokane Valley, Washington and Idaho: U.S. Geological Survey Water-Resources Investigations, Open-file Report 80-1300, 43 p.

Bretz, J.H., 1923, The Channeled scabland of the Columbia Plateau: Journal of Geology, v. 31, p. 617-649.

Broom, H.C., 1951, Gaging stream records in the Spokane River basin, Washington, from Post Falls, Idaho, to Long Lake, Washington, including the Little Spokane River, water years 1948-1950: U.S. Geological Survey Open File Report, 29p.

Conover, W.J., 1980, Practical nonparametric statistics (2nd edition): New York, Wiley, 493 p.

Dion, N.P., 1987, Geohydrologic reconnaissance of a ground-water contamination problem in the Argonne Road area near Spokane, Washington: U.S. Geological Survey Water-Resources Investigation Report 86-4173, 37 p.

Drost, B.W., and Seitz, H.R., 1978, Spokane Valley-Rathdrum Prairie aquifer, Washington and Idaho: U.S. Geological Survey Open-File Report 77-829, 76 p.

Durfur, C.N., and Becker, Edith, 1964, Public water supplies of 100 largest cities in the U.S.: U.S. Geological Survey Water-Supply Paper 1812, 264 p.

Freeze, R.A., and Cherry, J.A., 1979, Groundwater: Englewood Cliffs, New Jersey, Prentice-Hall, Inc., 604 p.

Graham, W.A., 1994, Hydrogeologic characterization and reconnaissance water quality study of the Chilco Channel area, Kootenai County, Idaho (M.S. thesis):, Cheney, Washington, Eastern Washington University, 127 p.

Griggs, A.B., 1973, Geologic map of the Spokane quadrangle, Washington, Idaho, and Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Series map I-768, 1 sheet, scale 1:125,000.

Griggs, A.B., 1976, The Columbia River Basalt Group in the Spokane quadrangle, Washington, Idaho, and Montana, with a section on petrography by D.A. Swanson: U.S. Geological Survey Bulletin 1413, 39 p.

Hall, T.L., 1991, Effect of hillslope development on quantity and quality of recharge to the Spokane aquifer, Spokane, Washington (M.S. thesis): Cheney, Washington, Eastern Washington University, 133 p.

Hem, J.D., 1985, Study and interpretation of the chemical characteristics of natural water (3rd edition), U.S. Geological Survey Water-Supply Paper 2254, 263 p.

Idaho State Climate Services, 1997, Biological and Agricultural Engineering Department, University of Idaho, Moscow, Idaho 83844-0904.

Joseph, N.L., 1990, Geologic map of the Spokane 1:100,000 quadrangle, Washington-Idaho: Washington State Department of Natural Resources Open File Report 90-17, 27 p. 1 pl.

Kiver, E.P., Stradling, D.F., and Moody, U.L., 1989, Glacial and multiple flood history of the northern borderlands, Trip B, *in* Joseph, N.L. and others, ed., Geologic Guidebook for Washington and adjacent areas: Washington Division of Geology and Earth Resouces Information Circular 86, p.321-335.

Lloyd, J.W., and Heathcote, J.A., 1985, Natural inorganic hydrochemistry in relation to ground water: An introduction: Oxford, Clarendon Press, 296 p.

Lowrie, K.W., and Greenberg, Michael, 1997, Promoting ground water pollution prevention in small businesses: Journal of the American Water Resources Association, v. 33, no. 1, p. 193-204.

Madison, R.J., and Brunett, J.O., 1985, Overview of the occurrence of nitrate in ground water of the United States: U.S. Geological Survey Water Supply Paper 2275, 74 p.

Mahler, R.L, Tindall, T.A., and Mahler, K.A., 1997, Best management practices for nitrogen management: University of Idaho Water Quality Brochure No. 12, 3 p.

Mahler, R.L., 1996, Grass pastures: Northern Idaho Fertilizer Guide Current Information Series No. 853, University of Idaho College of Agriculture, 3 p.

Mahler, R.L, and Mahler, K.A., 1997, Nitrogen BMPs for small farms in the Pacific Northwest: University of Idaho Water Quality Brochure No. 20, 14 p.

McMahon, G., and Woodside, M.D., 1997, Nutrient mass balance for the Albemarle-Pamlico drainage basin, North Carolina and Virginia, 1990: Journal of the American Water Resources Association, v. 33, no. 3, p. 573-589.

Mitchell, T.J., and Harding, A.K., 1996, Who is drinking nitrate in their well water? a study conducted in rural northeastern Oregon: Environmental Health, October, 1996, p 14-19.

Mueller, D.K., Hamilton, P.A., Helsel, K.R., Hitt, K.J., and Ruddy, B.C., 1995, Nutrients in ground water and surface water of the United States—An analysis of data through 1992: U.S. Geological Survey Water Resources Investigations Report 95-4031, 74 p.

National Research Council, 1978, Nitrates: An environmental assessment: Washington, D.C., National Academy of Sciences, 723 p.

National Atmospheric Deposition Program, (NRSP-3)/National Trends Network, October 10, 1997: NADP/NTN Coordination Office, Illinois State Water Survey, 2204 Griffith Drive Champaign, IL 61820.

O'Connor, J.E., and Baker, V.R., 1992, Magnitudes and implications of peak discharge from glacial Lake Missoula: Geological Society of America Bulletin, v. 104, p. 267-279.

Painter, B., 1991a, Ground water quality status report no. 1: Ground water contamination and monitoring activities on the Rathdrum Prairie aquifer, Kootenai county: Idaho Department of Health and Welfare Division of Environmental Quality, 32 p.

Painter, B., 1991b, An estimate of recharge to the Rathdrum Prairie aquifer from all sources: Idaho Department of Health and Welfare Division of Environmental Quality, 5 p.

Painter, B., 1996a, Memorandum, May 29, 1996: Nitrate contamination in South Post Falls: Idaho Department of Health and Welfare Division of Environmental Quality, unpaginated.

Painter, B., 1996b, An estimate of nitrate export to the Rathdrum Prairie aquifer from hillside recharge areas and large community drainfields: Plan for future studies: Idaho Department of Health and Welfare Division of Environmental Quality, unpaginated.

Parker-Clark, V.J., and Mahler, R.L., 1996, Northern Idaho lawns: Northern Idaho Fertilizer Guide Current Information Series No. 911, University of Idaho College of Agriculture, 6 p.

Parliman, D.J., Seitz, H.R., and Jones, M.L., 1980, Ground water quality of North Idaho: U.S. Geological Survey Open-file Report 80-596, 34 p.

Pluhowski, E.J., and Thomas C.A., 1968, A water balance equation for the Rathdrum Prairie ground-water reservoir, near Spokane, Washington: U.S. Geological Survey Professional Paper 600-D, p. D75-D78.

Rhodes, B.P., Harms, T.A., and Hyndman, D.W., 1989, Geology of the southern Priest River Complex and the Newport fault, *in* Joseph, N.L. and others, ed., Geologic Guidebook for Washington and adjacent areas: Washington Division of Geology and Earth Resources Information Circular 86, p. 165-186.

Rhodes, B.P., and Hyndman, D.W., Regional metamorphism, structure, and tectonics of northeastern Washington and northern Idaho, *in* Ernst, W.G., ed., Metamorphism and crustal evolution of the western United States: Englewood Cliffs, New Jersey, Prentice-Hall, p. 271-296.

Rodriguez-Estrada, Hugo, and Loaiciga, H.A., 1995, Planning urban growth in ground water recharge areas: Central Valley, Costa, Rica: Ground Water Monitoring and Remediation, Summer 1995, p. 144-148.

Saad, D.A., 1997, Effects of land use and geohydrology on the quality of shallow ground water in two agricultural areas in the western Lake Michigan drainages, Wisconsin: U.S. Geological Survey Water-Resources Investigations Report 96-4292, 74 p.

Sagstad, S.R., 1977, Hydrogeologic analysis of the southern Rathdrum Prairie area (M.S. thesis): Moscow, Idaho, University of Idaho, 96 p.

Seitz, H.R., and Jones, M.L., 1981, Flow characteristics and water quality conditions in the Spokane River, Coeur d'Alene Lake to the Post Falls Dam, North Idaho: U.S. Geological Survey Open File Report 82-102, 56 p.

Soil Conservation Service, 1981, Soil Survey of Kootenai County Area, Idaho: U.S. Department of Agriculture, 255 p.

Spalding, R.F., and Exner, M.E., 1993, Occurrence of nitrate in groundwater—A review: Journal of Environmental Quality, v. 22, p. 392-402.

Todd, D.K., 1980, Ground Water Hydrology (2nd edition): New York, John Wiley and Sons, 535 p.

U.S. Army Corps of Engineers, 1951, Seismic survey of the Spokane River Valley: U.S. Army Corps of Engineers Waterways Experimental Station, Vicksburg, Massachusetts, 9 p.

U.S. Code of Federal Regulations, 1992A, Title 40, p141, Sec 11: National Primary Drinking Water Regulations, p. 596-597, 773-774, 288-292.

United States Environmental Protection Agency, 1980, Design manual for onsite wastewater treatment and disposal systems: Washington, Environmental Protection Agency Publication, 391 p.

Waitt, R.B., 1985, Case for periodic colossal jokulhlaups from Pleistocene glacial Lake Missoula: Geologic Society of America Bulletin no. 10, p.1271-1286.

Walker, W.G., Bouma, J., Keeney, D.R., and Olcott, P.G., 1973, Nitrogen transformations during subsurface disposal of septic tank effluent in sands: II. Ground water quality: Journal of Environmental Quality, v. 2, no. 4, p521-524.

Ward, M.H., Mark, S.D., Cantor, K.P., Weisenburger, D.D., Correa-Villasenor, A., and Zahm, S.H., 1996, Drinking water and the risk of non-Hodgkin's lymphoma: Epidemiology, v. 7, no. 5, p. 465-471.

Winter, Gerry, ed., December 22, 1993, Ground Water and Soils Quality Assurance Project Plan Development Manual: Idaho Department of Health and Welfare Division of Environmental Quality Programs.

Weis, P.L., 1968, Geologic map of the Greenacres quadrangle, Washington and Idaho: U.S. Geological Survey Quadrangle map GQ-734m 4 p., 1 pl., scale 1:62,500.

Yee, Johnson J.S., and Souza, W.R., 1987, Quality of ground water in Idaho: U.S. Geological Survey Water Supply Paper 2272.

Young, H.W., 1983, Hydrographs of water levels in observation wells in Idaho 1971-1982: U.S. Geological Survey Open File Report 83-225, 282 p.

Young, H.W., Jones, M.L., and Parliman, D.J., 1988, Selected water quality data for the Rathdrum Prairie aquifer, North Idaho, September, 1988: U.S. Geological Survey Open File Report 88-703, 1 p.

Appendix 1

Drillers' logs for the study wells

Wells are annotated in the upper right corner with study codes. For wells with two codes, the second code was used for field duplicate samples.

Note: No drillers' logs were located for the following wells:
GF-7, GF-13, GF-C, HV-5, HV-11, NG-9, NG-10

USE TYPEWRITER OR BALL POINT PEN

State of Idaho
Department of Water Resources

GF-1

WELL DRILLER'S REPORT N

C

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

1. WELL OWNER

Name Ruffie J. Cady

Address Rt1 Box 63 B Coeur d'Alene Idaho

Owner's Permit No. 95-77-N-58

2. NATURE OF WORK

☒ New well ☐ Deepened ☐ Replacement

☐ Abandoned (describe method of abandoning)

3. PROPOSED USE

☒ Domestic ☐ Irrigation ☐ Test ☐ Other (specify type)

☐ Municipal ☐ Industrial ☐ Stock ☐ Waste Disposal or Injection

4. METHOD DRILLED

☐ Cable ☒ Rotary ☐ Dug ☐ Other

5. WELL CONSTRUCTION

Diameter of hole 6 inches Total depth 350 feet

Casing schedule: ☒ Steel ☐ Concrete

Thickness		Diameter		From		To	
1/4	inches	6	inches	+1	feet	79	feet
	inches		inches		feet		feet
	inches		inches		feet		feet
	inches		inches		feet		feet
	inches		inches		feet		feet

Was casing drive shoe used? ☒ Yes ☐ No

Was a packer or seal used? ☐ Yes ☒ No

Perforated? ☐ Yes ☒ No

How perforated? ☐ Factory ☐ Knife ☐ Torch

Size of perforation ____ inches by ____ inches

Number		From		To	
100	perforations	80	feet	100	feet
100	perforations	240	feet	260	feet
	perforations		feet		feet

300 ft. of 4" P.V.C. Liner

Well screen installed? ☐ Yes ☒ No

Manufacturer's name ____

Type ____ Model No. ____

Diameter ____ Slot size ____ Set from ____ feet to ____ feet

Diameter ____ Slot size ____ Set from ____ feet to ____ feet

Gravel packed? ☐ Yes ☒ No Size of gravel ____

Placed from ____ feet to ____ feet

Surface seal depth 18' Material used in seal ☐ Cement grout

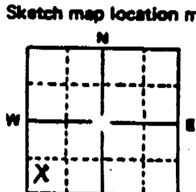
Bentonite ☐ Puddling clay ☒ Well cuttings

Sealing procedure used ☐ Slurry pit ☐ Temporary surface casing

☒ Overbore to seal depth

6. LOCATION OF WELL

Sketch map location must agree with written location. 95



Subdivision Name ____

Lot No. ____ Block No. ____

County Kootenai

SW ¼ SW ¼ 13 - 50 N - 5 W

7. WATER LEVEL

Static water level 92 feet below land surface

Flowing? ☐ Yes ☒ No G.P.M. flow ____

Temperature ____ °F. Quality ____

Artesian closed-in pressure ____ p.s.i.

Controlled by ☐ Valve ☐ Cap ☐ Plug

8. WELL TEST DATA

☐ Pump ☐ Bailer ☒ Other Air

Discharge G.P.M.	Draw Down	Hours Pumped
Aprox 4		

9. LITHOLOGIC LOG

Hole Diam.	Depth From	Depth To	Material	Water Yes	Water No
6	0	79	Sandy Loam		✓
	79	92	Granite		✓
	92	94	Dec. Granite	✓	
	94	138	Granite		✓
	138	140	Quartzite		✓
	140	178	Granite		✓
	178	182	Fractured Granite		✓
	182	184	Granite		✓
	184	192	Quartzite		✓
	192	193	Fractured Granite		✓
	193	197	Granite		✓
	197	200	Dec. Granite		✓
	200	206	Quartzite		✓
	206	240	Granite		✓
	240	241	Fractured Granite	✓	
	241	350	Granite		✓

RECEIVED
SEP 2 1977
Department of Water Resources
Northern District Office

10.

Work started 8-19-77 finished 8-23-77

11. DRILLERS CERTIFICATION

Firm Name Enterprise Drilling Co. Firm No. 30

Address Box 404 Post Falls, Idaho Date 8-23-77

Signed by (Firm Official) Floyd Curtis

and

(Operator) Floyd Curtis

USE TYPEWRITER OR BALL POINT PEN

GF-2

State of Idaho
Department of Water Administration

WELL DRILLER'S REPORT

RECEIVED APR 1 1975 Department of Water Resources Northern District Office

State law requires that this report be filed with the Director, Department of Water Administration within 30 days after the completion or abandonment of the well.

1. WELL OWNER

Name mike Geddes [redacted]

Address Box 671 Post Falls Idaho

Owner's Permit No. 95-74-N-66

2. NATURE OF WORK

☒ New well ☐ Deepened ☐ Replacement

☐ Abandoned (describe method of abandoning)

3. PROPOSED USE

☒ Domestic ☐ Irrigation ☐ Test ☐ Other (specify type)

☐ Municipal ☐ Industrial ☐ Stock ☐ Waste Disposal or Injection

4. METHOD DRILLED

☐ Cable ☒ Rotary ☐ Dug ☐ Other

5. WELL CONSTRUCTION

Diameter of hole 8 inches Total depth 115 feet

Casing schedule: ☒ Steel ☐ Concrete

Thickness	Diameter	From	To
.250 inches	6 inches	+1 feet	100 feet
inches	inches	feet	feet
inches	inches	feet	feet
inches	inches	feet	feet
inches	inches	feet	feet

Was a packer or seal used? ☐ Yes ☒ No

Perforated? ☐ Yes ☒ No

How perforated? ☐ Factory ☐ Knife ☒ Torch

Size of perforation ____ inches by ____ inches

Number	From	To
perforations	feet	feet
perforations	feet	feet
perforations	feet	feet

Well screen installed? ☐ Yes ☒ No

Manufacturer's name

Type ____ Model No. ____

Diameter ____ Slot size ____ Set from ____ feet to ____ feet

Diameter ____ Slot size ____ Set from ____ feet to ____ feet

Gravel packed? ☐ Yes ☒ No Size of gravel

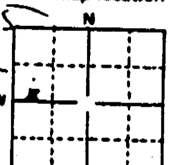
Placed from ____ feet to ____ feet

Surface seal depth 20 Material used in seal ☐ Cement grout ☒ Puddling clay ☐ Well cuttings

Sealing procedure used ☐ Slurry pit ☐ Temporary surface casing ☒ Overbore to seal depth

6. LOCATION OF WELL

Sketch map location must agree with written location.



95 N

Subdivision Name

Lot No. ____ Block No. ____

County Kootenai

SW ¼ NW ¼ Sec. 13 T. 50 N. R. 5 W.

7. WATER LEVEL

Static water level 10 feet below land surface

Flowing? ☐ Yes ☒ No G.P.M. flow 30

Temperature cold °F. Quality Good

Artesian closed-in pressure ____ p.s.i.

Controlled by ☐ Valve ☐ Cap ☐ Plug

8. WELL TEST DATA

☐ Pump ☐ Bailer ☒ Other Air

Discharge G.P.M.	Draw Down	Hours Pumped
30	—	4

9. LITHOLOGIC LOG

Hole Diam.	Depth From	Depth To	Material	Water Yes	Water No
8	0	98	Dec. Gran.		✓
8	98	100	Med. Gran.		✓
			Cased 6" - 100'		
6	100	104	H. Gran.		✓
6	104	111	Soft Blu Gran.	✓	
6	111	115	H. Gran.	✓	
			Water Has Brown		
			Clay Color		

10.

Work started 4-27-74 finished 4-28-74

11. DRILLERS CERTIFICATION

Firm Name Ayers Drilling & Well, Inc. Firm No. 169

Address Box 1001 CDA Ida. Date 5-10-74

Signed by (Firm Official) [signature]

and

(Operator) Richard Brown, Pres. [signature]

Form 238-7
9/82

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

WELL DRILLER'S REPORT

GF-3

USE TYPEWRITER OR BALLPOINT PEN

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

1. WELL OWNER

Name: Ronald A. or Diane R. Siverson

Address: S. 2410 Coeurs Ferry Rd.

Owner's Permit No. Cal. Id. 83814

2. NATURE OF WORK 95-86-N-38

☒ New well ☐ Deepened ☐ Replacement

☐ Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

3. PROPOSED USE

☒ Domestic ☐ Irrigation ☐ Test ☐ Municipal

☐ Industrial ☐ Stock ☐ Waste Disposal or Injection

☐ Other ______ (specify type)

4. METHOD DRILLED

☒ Rotary ☐ Air ☐ Hydraulic ☐ Reverse rotary

☐ Cable ☐ Dug ☐ Other ______

5. WELL CONSTRUCTION

Casing schedule: ☒ Steel ☐ Concrete ☐ Other ______

Thickness		Diameter		From		To	
.250	inches	6	inches	+ 2	feet	73	feet
.160	inches	4	inches	- 65	feet	225	feet
	inches		inches		feet		feet
	inches		inches		feet		feet

Was casing drive shoe used? ☒ Yes ☐ No

Was a packer or seal used? ☐ Yes ☒ No

Perforated? ☒ Yes ☐ No

How perforated? ☐ Factory ☒ Knife ☐ Torch

Size of perforation 1/4 inches by 3 inches

Number		From		To	
20	perforations	185	feet	205	feet
20	perforations	155	feet	175	feet
	perforations		feet		feet

Well screen installed? ☐ Yes ☒ No

Manufacturer's name ______

Type ______ Model No. ______

Diameter ___ Slot size ___ Set from ___ feet to ___ feet

Diameter ___ Slot size ___ Set from ___ feet to ___ feet

Gravel packed? ☐ Yes ☒ No ☐ Size of gravel ______

Placed from ______ feet to ______ feet

Surface seal depth 20 Material used in seal: ☐ Cement grout ☒ Bentonite ☐ Puddling clay ☒ Cuttings

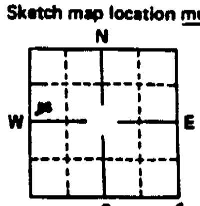
Sealing procedure used: ☐ Slurry pit ☐ Temp. surface casing ☒ Overbore to seal depth

Method of joining casing: ☐ Threaded ☒ Welded ☐ Solvent Weld ☐ Cemented between strata

Describe access port ______

6. LOCATION OF WELL

Sketch map location must agree with written location.



Subdivision Name ______

Lot No. ______ Block No. ______

County Kootenai

7. WATER LEVEL

Static water level 150 feet below land surface.

Flowing? ☐ Yes ☒ No G.P.M. flow ______

Artesian closed-in pressure ______ p.s.i.

Controlled by: ☐ Valve ☒ Cap ☐ Plug

Temperature cold °F. Quality Good

Describe artesian or temperature zones below.

8. WELL TEST DATA

☐ Pump ☐ Bailer ☒ Air ☐ Other ______

Discharge G.P.M.	Pumping Level	Hours Pumped
25	variable	1/2 hr

9. LITHOLOGIC LOG

Bore Diam.	Depth From	Depth To	Material	Water Yes	Water No
8	0	55	Fine Silt		
	55	73	Decomposed Granite		
	73	225	Granite (soft)	X	
			15 GPM at 190		
			10 GPM at 225		

RECEIVED
MAY 29 1986
Department of Water Resources
Northern District Office

10. Work started 4/24/86 finished 4/25/86

11. DRILLERS CERTIFICATION

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name Associated Well Drillers Inc Firm No. 245

Address Box 723 C.D.A. Date 4/25/86

Signed by (Firm Official) [signature]

and

(Operator) Robert F. [signature]

Form 238-7
1/78

STATE OF IDAHO
PARTMENT OF WATER RESOURCI

GF-4 /RITE INT P

WELL DRILLER'S REPORT

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

1. WELL OWNER

Name Neal Mashburn

Address Route 1 Box 55 CDA Idaho

Owner's Permit No. 95-80-N-88

2. NATURE OF WORK

☒ New well ☐ Deepened ☐ Replacement
☐ Abandoned (describe method of abandoning) ______

3. PROPOSED USE

☒ Domestic ☐ Irrigation ☐ Test ☐ Municipal
☐ Industrial ☐ Stock ☐ Waste Disposal or Injection
☐ Other ______ (specify type)

4. METHOD DRILLED

☒ Rotary ☐ Air ☐ Hydraulic ☐ Reverse rotary
☐ Cable ☐ Dug ☐ Other ______

5. WELL CONSTRUCTION

Casing schedule: ☒ Steel ☐ Concrete ☐ Other ______

Thickness	Diameter	From	To
.250 inches	6 inches +	1 feet	126 feet
inches	inches	feet	feet
inches	inches	feet	feet
inches	inches	feet	feet

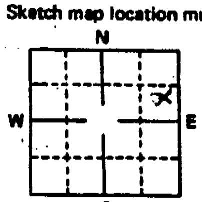
Was casing drive shoe used? ☒ Yes ☐ No
Was a packer or seal used? ☐ Yes ☒ No
Perforated? ☒ Yes ☐ No
How perforated? ☐ Factory ☐ Knife ☒ Torch
Size of perforation 1/4 inches by 4 inches

Number		From	To
15	perforations	118 feet	126 feet
	perforations	feet	feet
	perforations	feet	feet

Well screen installed? ☐ Yes ☒ No
Manufacturer's name ______
Type ______ Model No. ______
Diameter ___ Slot size ___ Set from ___ feet to ___ feet
Diameter ___ Slot size ___ Set from ___ feet to ___ feet
Gravel packed? ☐ Yes ☒ No ☐ Size of gravel ______
Placed from ______ feet to ______ feet
Surface seal depth 20 Material used in seal: ☐ Cement grout ☒ Puddling clay ☒ Well cuttings
Sealing procedure used: ☐ Slurry pit ☒ Temp. surface casing ☒ Overbore to seal depth
Method of joining casing: ☐ Threaded ☒ Welded ☐ Solvent Weld ☐ Cemented between strata
Describe access port ______

6. LOCATION OF WELL

Sketch map location must agree with written location.



Subdivision Name ______

Lot No. ______ Block No. ______

County Kootenai

SE ¼ NE ¼ Sec. 14 , T. 50N N/S R. ___ E/W

7. WATER LEVEL

Static water level 40 feet below land surface.
Flowing? ☐ Yes ☒ No G.P.M. flow ______
Artesian closed-in pressure ______ p.s.i.
Controlled by: ☐ Valve ☒ Cap ☐ Plug
Temperature cold °F. Quality Exc.

8. WELL TEST DATA

☐ Pump ☐ Bailer ☒ Air ☐ Other ______

Discharge G.P.M.	Pumping Level	Hours Pumped
50	—	1 hr.

9. LITHOLOGIC LOG

Hole Diam.	Depth From	Depth To	Material	Water Yes
8	0	1	Topsoil	
	1	22	Granite Sand	
	22	125	Decomposed Granite	X
6	125	150	Granite	X

RECEIVED
JUN 16 1980
Department of Water Resources

10.

Work started 4/7/80 finished 4/8/80

11. DRILLERS CERTIFICATION

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name Associated Well Drillers Inc Firm No. 245

Address Box 723 C.D.A. Idaho Date 4/8/80

Signed by (Firm Official) [signature]

and

(Operator) [signature]

Form 238-7
8/90

GF-5

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCE

USE TYPEWRITER OR BALLPOINT PEN

WELL DRILLER'S REPORT

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

1. WELL OWNER

Name Steve Burris

Address 2358 Greensferry RD. Post Falls, Idaho

Drilling Permit No. 95-91-N-118

Water Right Permit No. ______

2. NATURE OF WORK

☒ New well ☐ Deepened ☐ Replacement
☐ Well diameter increase
☐ Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

3. PROPOSED USE

☒ Domestic ☐ Irrigation ☐ Test ☐ Municipal
☐ Industrial ☐ Stock ☐ Waste Disposal or Injection
☐ Other ______ (specify type)

4. METHOD DRILLED

☒ Rotary ☒ Air ☐ Hydraulic ☐ Reverse rotary
☐ Cable ☐ Dug ☐ Other ______

5. WELL CONSTRUCTION

Casing schedule: ☒ Steel ☐ Concrete ☒ Other Plastic

Thickness		Diameter		From		To	
.250	inches	6"	inches	+ 1½	feet	146½	feet
	inches		inches		feet		feet
160 PSI	inches	4"	inches	141	feet	551	feet
	inches		inches		feet		feet

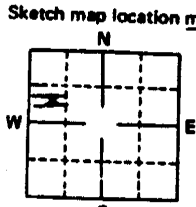
Was casing drive shoe used? ☒ Yes ☐ No
Was a packer or seal used? ☐ Yes ☒ No
Perforated? ☒ Yes ☐ No
How perforated? ☐ Factory ☐ Knife ☐ Torch ☐ Gun ☒ SAW
Size of perforation 3/16 inches by 4" inches

Number		From		To	
60	perforations	511	feet	545	feet
30	perforations	451	feet	471	feet
60	perforations	MISC. AREAS	feet		feet

Well screen installed? ☐ Yes ☒ No
Manufacturer's name ______
Type ______ Model No. ______
Diameter ____ Slot size ____ Set from ____ feet to ____ feet
Diameter ____ Slot size ____ Set from ____ feet to ____ feet
Gravel packed? ☐ Yes ☒ No ☐ Size of gravel ______
Placed from ______ feet to ______ feet
Surface seal depth 18+ Material used in seal: ☐ Cement grout ☒ Bentonite ☐ Puddling clay ☐
Sealing procedure used: ☐ Slurry pit ☒ Temp. surface casing ☒ Overbore to seal depth
Method of joining casing: ☐ Threaded ☒ Welded ☒ Solvent Weld ☐ Cemented between strata
Describe access port ______

6. LOCATION OF WELL

Sketch map location must agree with written location.



Subdivision Name ______

Lot No. ______ Block No. ______

County Kootenai S½ N½

SW ¼ NW ¼ Sec. 13, T. 50 N☒ S☐, R. 5 E☐ W☒

7. WATER LEVEL

Static water level Est 200' feet below land surface.
Flowing? ☐ Yes ☒ No G.P.M. flow ______
Artesian closed-in pressure ______ p.s.i.
Controlled by: ☐ Valve ☐ Cap ☐ Plug
Temperature ____ °F. Quality ______
Describe artesian or temperature zones below

8. WELL TEST DATA

☐ Pump ☐ Bailer ☒ Air ☐ Other ______

Discharge G.P.M.	Pumping Level	Hours Pumped
Est 16-20 GPM'S		

9. LITHOLOGIC LOG

Bore Diam.	Depth From	Depth To	Material	Water Yes	Water No
8"	0	2	TOP Soil		X
"	2	53	Sand		X
"	53	65	Boulders, Sand		X
"	65	89	Very Decomposed Granite		X
"	89	94	Granite		X
"	94	142	Decomposed Granite w/Hard spots		X
"	142	146½	Granite Hard		X
6"	146	200	Granite w/soft Areas		X
"	200	270	Granite Firm w/soft Areas	X	
"	270	551	Granite Hard	X	

15+ GPM'S AT 538'

RECEIVED
SEP 17 1991
NORTHERN REGION
IDWR

Department of Water Resources

10. Work started 8-3-91 finished 8-8-91

11. DRILLERS CERTIFICATION

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name AQUA Drilling Exploration Inc. Firm No. 163

Address P.O. Box 225 CDA, Idaho Date 8-9-91

Signed by (Firm Official) Scott M. Braun

and

(Operator) Scott M. Braun

Form 238-7

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

GF-6

USE TYPEWRITER OR BALLPOINT PEN

WELL DRILLER'S REPORT

GF-9

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

1. WELL OWNER

Dwight Fitzgerald
1870 Greensferry, Post Falls Id.

Permit No. 95-92-N-61

Water Right Permit No.

2. NATURE OF WORK

☒ New well ☐ Deepened ☐ Replacement
☐ Well diameter increase
☐ Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

3. PROPOSED USE

☒ Domestic ☐ Irrigation ☐ Test ☐ Municipal
☐ Industrial ☐ Stock ☐ Waste Disposal or Injection
☐ Other ________ (specify type)

4. METHOD DRILLED

☒ Rotary ☒ Air ☐ Hydraulic ☐ Reverse rotary
☐ Cable ☐ Dug ☐ Other

5. WELL CONSTRUCTION

Casing schedule: ☐ Steel ☐ Concrete ☐ Other

Thickness	Diameter	From	To
.250 inches	6 inches	+ 1 feet	132 feet
inches	inches	feet	feet
inches	inches	feet	feet
inches	inches	feet	feet

Was casing drive shoe used? ☒ Yes ☐ No
Was a packer or seal used? ☐ Yes ☒ No
Perforated? ☐ Yes ☒ No
How perforated? ☐ Factory ☐ Knife ☐ Torch ☐ Gun
Size of perforation ____ inches by ____ inches

Number	From	To
perforations	feet	feet
perforations	feet	feet
perforations	feet	feet

Well screen installed? ☐ Yes ☐ No
Manufacturer's name
Type ____ Model No.
Diameter ___ Slot size ___ Set from ___ feet to ___ feet
Diameter ___ Slot size ___ Set from ___ feet to ___ feet
Gravel packed? ☐ Yes ☒ No ☐ Size of gravel
Placed from ____ feet to ____ feet
Surface seal depth 18 Material used in seal: ☐ Cement grout ☒ Bentonite ☐ Puddling clay ☐
Sealing procedure used: ☐ Slurry pit ☐ Temp. surface casing ☒ Overbore to seal depth
Method of joining casing: ☐ Threaded ☐ Welded ☐ Solvent Weld ☐ Cemented between strata
Describe access port

6. LOCATION OF WELL

Sketch map location must agree with written location.

N / W — 12 — E / S (X marked in lower left)

Subdivision Name
Lot No. ____ Block No. ____

County Kootenai

N☒ E☐

7. WATER LEVEL

Static water level 98 feet below land surface.
Flowing? ☐ Yes ☐ No G.P.M. flow
Artesian closed-in pressure ____ p.s.i.
Controlled by: ☐ Valve ☐ Cap ☐ Plug
Temperature ____ °F. Quality
Describe artesian or temperature zones below

8. WELL TEST DATA

☐ Pump ☐ Bailer ☒ Air ☐ Other

Discharge G.P.M.	Pumping Level	Hours Pumped
20	138	1

9. LITHOLOGIC LOG

Bore Diam.	Depth From	Depth To	Material	Water Yes	Water No
8	0	20	Sand		
6	20	100	Sand		
	100	120	Sandy gravel & clay	x	
	120	138	Sandy gravel	x	

RECEIVED
MAY 18 1992
NORTHERN REGION IDWR

10. Work started 5-11-92 finished 5-12-92

11. DRILLERS CERTIFICATION

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name H2O Well Svc. Firm No. 448
Address Hayden Lake Id. Date 5-12-92
Signed by (Firm Official) [signature]
and
(Operator) [signature]

Form 238-7
9/82

STATE OF IDAHO
:PARTMENT OF WATER RESOURC.

GF-8 TER PEI

WELL DRILLER'S REPORT

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

1. WELL OWNER

Name Jack Knox

Address E. 2765 Driftwood Dr. Coeur D' Alene, ID

Owner's Permit No. 95-83-N-82

2. NATURE OF WORK

☒ New well ☐ Deepened ☐ Replacement
☐ Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

3. PROPOSED USE

☒ Domestic ☐ Irrigation ☐ Test ☐ Municipal
☐ Industrial ☐ Stock ☐ Waste Disposal or Injection
☐ Other ______ (specify type)

4. METHOD DRILLED

☐ Rotary ☐ Air ☐ Hydraulic ☐ Reverse rotary
☒ Cable ☐ Dug ☐ Other ______

5. WELL CONSTRUCTION

Casing schedule: ☒ Steel ☐ Concrete ☐ Other ______

Thickness	Diameter	From	To
.250 inches	6 inches	+ 1 feet	125 feet
inches	inches	feet	feet
inches	inches	feet	feet
inches	inches	feet	feet

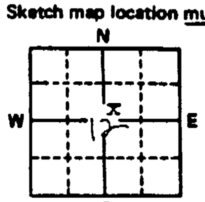
Was casing drive shoe used? ☒ Yes ☐ No
Was a packer or seal used? ☐ Yes ☒ No
Perforated? ☐ Yes ☒ No
How perforated? ☐ Factory ☐ Knife ☐ Torch
Size of perforation ______ inches by ______ inches

Number	From	To
perforations	feet	feet
perforations	feet	feet
perforations	feet	feet

Well screen installed? ☒ Yes ☐ No
Manufacturer's name Cook
Type stainless steel Model No. ______
Diameter 6 Slot size 20 Set from 125 feet to 200 feet
Diameter ____ Slot size ____ Set from ______ feet to ______ feet
Gravel packed? ☐ Yes ☒ No ☐ Size of gravel ______
Placed from ______ feet to ______ feet
Surface seal depth 20 Material used in seal: ☐ Cement grout
☐ Bentonite ☒ Puddling clay ☐ ______
Sealing procedure used: ☐ Slurry pit ☒ Temp. surface casing
☐ Overbore to seal depth
Method of joining casing: ☐ Threaded ☒ Welded ☐ Solvent Weld
☐ Cemented between strata
Describe access port well cap

6. LOCATION OF WELL

Sketch map location must agree with written location.



Subdivision Name [illegible]

JUN 21 1991

Lot No. ______ Block No. ______

County Kootenai 12 50N 5W

[illegible] ¼ [illegible] ¼ Sec. 12, T. 50 N N/S, R. 5 [illegible] E/W.

7. WATER LEVEL

Static water level 132 feet below land surface.
Flowing? ☐ Yes ☒ No G.P.M. flow ______
Artesian closed-in pressure ______ p.s.i.
Controlled by: ☐ Valve ☐ Cap ☐ Plug
Temperature ______ °F. Quality ______
Describe artesian or temperature zones below.

8. WELL TEST DATA

☐ Pump ☒ Bailer ☐ Air ☐ Other ______

Discharge G.P.M.	Pumping Level	Hours Pumped
15	200	4

9. LITHOLOGIC LOG

Bore Diam.	Depth From	Depth To	Material	Water Yes
	1	10	sand & gravel	
	10	45	sand & brn clay	
	45	70	blue clay & sand	
	70	100	sand & brn clay	
	100	200	sand & pea gravel with brn clay	

JUN 26 [illegible]

10.

Work started 9-27-83 finished 9-30-83

11. DRILLERS CERTIFICATION

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name Bronson Water Wells Firm No. 360

Address Box 1 Spirit Lake, ID. Date 10-2[illegible]-83

Signed by (Firm Official) [signature]

and

(Operator) ______

Form 238-7
9/82

STATE OF IDAHO
'ARTMENT OF WATER RESOURCE

GF-10 'ER (PEN

WELL DRILLER'S REPORT

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

N

1. WELL OWNER

Name GREEN FERRY WATER + SEWER DIST

Address P.O. Box 1105 POST FALLS ID. 83854

Owner's Permit No. 95-89-N-52

2. NATURE OF WORK

☒ New well ☐ Deepened ☐ Replacement
☐ Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

3. PROPOSED USE

☒ Domestic ☒ Irrigation ☐ Test ☒ Municipal
☐ Industrial ☐ Stock ☐ Waste Disposal or Injection
☐ Other ______ (specify type)

4. METHOD DRILLED

☐ Rotary ☐ Air ☐ Hydraulic ☐ Reverse rotary
☒ Cable ☐ Dug ☐ Other ______

5. WELL CONSTRUCTION

Casing schedule: ☒ Steel ☐ Concrete ☐ Other ______

Thickness	Diameter	From	To
.375 inches	12 inches	+ 2 feet	182 feet
.365 inches	10 inches	208 feet	235 feet
inches	inches	feet	feet
inches	inches	feet	feet

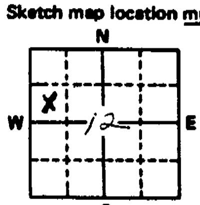
Was casing drive shoe used? ☒ Yes ☐ No
Was a packer or seal used? ☒ Yes ☐ No
Perforated? ☐ Yes ☒ No
How perforated? ☐ Factory ☐ Knife ☐ Torch
Size of perforation ______ inches by ______ inches

Number		From	To
	perforations	feet	feet
	perforations	feet	feet
	perforations	feet	feet

Well screen installed? ☒ Yes ☐ No
Manufacturer's name JOHNSON
Type STAINLESS STEEL Model No. P.S.
Diameter 12 Slot size 100 Set from 180 feet to 208 feet
Diameter 12 Slot size 100 Set from 208 feet to 245 feet
Gravel packed? ☐ Yes ☒ No ☐ Size of gravel ______
Placed from ______ feet to ______ feet
Surface seal depth 20 FT Material used in seal: ☒ Cement grout ☐ Bentonite ☐ Puddling clay ☐
Sealing procedure used: ☐ Slurry pit ☒ Temp. surface casing ☒ Overbore to seal depth
Method of joining casing: ☐ Threaded ☒ Welded ☐ Solvent Weld
☐ Cemented between strata
Describe access port 2" TUBE THRU SIDE OF CASING

6. LOCATION OF WELL

Sketch map location must agree with written location.



Subdivision Name ______

Lot No. ______ Block No. ______

County KOOTENAI

SW ¼ NW ¼ Sec. 12, T. 50 N/S, R. 5 E/W

7. WATER LEVEL

Static water level 124' 10" feet below land surface.
Flowing? ☐ Yes ☒ No G.P.M. flow ______
Artesian closed-in pressure ______ p.s.i.
Controlled by: ☐ Valve ☐ Cap ☐ Plug
Temperature 48 °F. Quality GOOD
Describe artesian or temperature zones below.

8. WELL TEST DATA

☒ Pump ☐ Bailer ☐ Air ☐ Other ______

Discharge G.P.M.	Pumping Level	Hours Pumped
400	125' 6"	1
500	125' 10"	1
600	125' 11"	2.8
800	126' 5"	1
1100	127' 3"	.3

9. LITHOLOGIC LOG

Bore Diam.	Depth From	Depth To	Material	Water Yes
16	0	20	GRAVEL + SAND 2" MINUS	
12	20	86	GRAVEL + SAND 2" MINUS	
12	86	124	SAND MED TO FINE	
12	124	163	SAND FINE + BRN CLAY	
12	163	165	GRAVEL + SAND 2" MINUS	X
12	165	171	SAND FINE + BRN CLAY	
12	171	199	GRAVEL + SAND 6" MINUS	X
12	199	208	GRAVEL + SAND 1" MINUS	X
12	208	211	FINE SAND + BRN CLAY	X
12	211	223	COURSE SAND	X
12	223	240	GRAVEL + SAND 1" MINUS	X
12	240	245	GRAVEL + SAND ½" MINUS	X
12	245	250	SAND MED TO FINE	X

12" HOLE BACKFILLED WITH GRAVEL FROM 245' TO 250' PRIOR TO SETTING SCREEN

10.

Work started OCT 17-89 finished DEC 8-8

11. DRILLERS CERTIFICATION

DL

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name HOLMAN DRILLING CORP Firm No. 108

Address E3410 9TH AVE SPOKANE WA 99202 Date DEC 26-8

Signed by (Firm Official) Arnold E. Holman PRES.

and

(Operator) [signature]

GF-A

USE TYPEWRITER OR BALL POINT PEN

State of Idaho
Department of Water Resources

WELL DRILLER'S REPORT

RECEIVED OCT 12 1976 — Department of Water Resources, Northern District Office

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

1. WELL OWNER

Name: Donald Johnson

Address: Rt 1 Box 132 CDA Ida

Owner's Permit No. 95-76-N-64

2. NATURE OF WORK

☒ New well ☐ Deepened ☐ Replacement

☐ Abandoned (describe method of abandoning)

3. PROPOSED USE

☒ Domestic ☐ Irrigation ☐ Test ☐ Other (specify type)

☐ Municipal ☐ Industrial ☐ Stock ☐ Waste Disposal or Injection

4. METHOD DRILLED

☐ Cable ☒ Rotary ☐ Dug ☐ Other

5. WELL CONSTRUCTION

Diameter of hole 6 inches Total depth 165 feet

Casing schedule: ☒ Steel ☐ Concrete

Thickness	Diameter	From	To
.250 inches	6 inches	+1 feet	142 feet
inches	inches	feet	feet
inches	inches	feet	feet
inches	inches	feet	feet
inches	inches	feet	feet

Was casing drive shoe used? ☒ Yes ☐ No

Was a packer or seal used? ☐ Yes ☒ No

Perforated? ☐ Yes ☒ No

How perforated? ☐ Factory ☐ Knife ☐ Torch

Size of perforation ____ inches by ____ inches

Number	From	To
perforations	feet	feet
perforations	feet	feet
perforations	feet	feet

Well screen installed? ☒ Yes ☐ No

Manufacturer's name Johnson 20

Type ____ Model No. ____

Diameter ____ Slot size 20 Set from 156 feet to 161 feet

Diameter ____ Slot size ____ Set from ____ feet to ____ feet

Gravel packed? ☐ Yes ☒ No Size of gravel ____

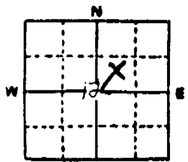
Placed from ____ feet to ____ feet

Surface seal depth 20 ft Material used in seal ☐ Cement grout ☒ Puddling clay ☐ Well cuttings

Sealing procedure used ☐ Slurry pit ☐ Temporary surface casing ☒ Overbore to seal depth

6. LOCATION OF WELL

Sketch map location must agree with written location. (95)



Subdivision Name ____

Lot No. ____ Block No. ____

County Kootenai

SE ¼ NE ¼ Sec. 12, T. 50 N/S, R. 5 E/W

7. WATER LEVEL

Static water level 127 feet below land surface

Flowing? ☐ Yes ☒ No G.P.M. flow ____

Temperature Cold °F. Quality Good

Artesian closed-in pressure ____ p.s.i.

Controlled by ☐ Valve ☐ Cap ☐ Plug

8. WELL TEST DATA

☐ Pump ☐ Bailer ☒ Other Air

Discharge G.P.M.	Draw Down	Hours Pumped
15+		

9. LITHOLOGIC LOG

Hole Diam.	Depth From	Depth To	Material	Water Yes	Water No
8	0	40	Bldrs + Gravel		
8	40	86	Clean course Sand		
6	86	115	Brn Clay		
6	115	142	Soft Brn Broken		
6			6" Cased - 142'		
6	142	152	H. Brn Layers W Clay		
6	152	165	Dec. Grn Sand	✓	

10. Work started 9-30-76 finished 11-2-76

11. DRILLERS CERTIFICATION

Firm Name Aqua Drilling + Dev. Inc. Firm No. 16

Address Bx1499 CDA Ida Date 11-2-76

Signed by (Firm Official) Richard Bean [signature]

and

(Operator) Elmer Lewis [signature]

GF-B

Form 238-7
8/90

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

USE TYPEWRITER OR BALLPOINT PEN

WELL DRILLER'S REPORT

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

1. WELL OWNER

Name Phillip Margraff
Address S2517 Greenferry Rd
Drilling Permit No. 95-91-N-47
Water Right Permit No. [illegible]

2. NATURE OF WORK

☑ New well ☐ Deepened ☐ Replacement
☐ Well diameter increase
☐ Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

3. PROPOSED USE

☑ Domestic ☐ Irrigation ☐ Test ☐ Municipal
☐ Industrial ☐ Stock ☐ Waste Disposal or Injection
☐ Other ________ (specify type)

4. METHOD DRILLED

☑ Rotary ☑ Air ☐ Hydraulic ☐ Reverse rotary
☐ Cable ☐ Dug ☐ Other

5. WELL CONSTRUCTION

Casing schedule: ☑ Steel ☐ Concrete ☒ Other PVC 160

Thickness	Diameter	From	To
.250 inches	6 inches	+ 1½ feet	78½ feet
160 psi inches	4 inches	-18 feet	225 feet
inches	inches	feet	feet
inches	inches	feet	feet

Was casing drive shoe used? ☑ Yes ☐ No
Was a packer or seal used? ☑ Yes ☐ No
Perforated? ☐ Yes ☐ No
How perforated? ☐ Factory ☐ Knife ☐ Torch ☐ Gun
Size of perforation ____ inches by ____ inches

Number	From	To
perforations	feet	feet
perforations	feet	feet
perforations	feet	feet

Well screen installed? ☐ Yes ☑ No
Manufacturer's name
Type ________ Model No.
Diameter ____ Slot size ____ Set from ____ feet to ____ feet
Diameter ____ Slot size ____ Set from ____ feet to ____ feet
Gravel packed? ☐ Yes ☐ No ☐ Size of gravel
Placed from ________ feet to ________ feet
Surface seal depth 25 Material used in seal: ☐ Cement grout ☑ Bentonite ☐ Puddling clay ☐
Sealing procedure used: ☐ Slurry pit ☐ Temp. surface casing ☒ Overbore to seal depth
Method of joining casing: ☐ Threaded ☒ Welded ☐ Solvent Weld
☐ Cemented between strata
Describe access port

6. LOCATION OF WELL

Sketch map location must agree with written location.

(Section sketch N/S/E/W with X marked in NE quarter)

Subdivision Name
Lot No. ______ Block No. ______

County Kootenai

SE ¼ NE ¼ Sec. 14, T. 50 N ☒ S ☐ R. 5 E ☐ W ☒

7. WATER LEVEL

Static water level 65 ft feet below land surface.
Flowing? ☐ Yes ☒ No G.P.M. flow [struck through]
Artesian closed-in pressure ______ p.s.i.
Controlled by: ☐ Valve ☐ Cap ☐ Plug
Temperature ____ °F. Quality
Describe artesian or temperature zones below

8. WELL TEST DATA

☐ Pump ☐ Bailer ☑ Air ☐ Other

Discharge G.P.M.	Pumping Level	Hours Pumped
4		

9. LITHOLOGIC LOG

Bore Diam.	Depth From	Depth To	Material	Water Yes	Water No
8"	0	4"	Top Soil		
8"	4	25"	Sand - Clay		
6"	25	60	Sand - small Gravel		
6"	60	80	Sand		
6"	80	140	Tan Quartzite	X	
6"	140	180	Blue Green Quartzite		
6"	180	225	Tan Quartzite		

RECEIVED
MAY 31
[illegible]

10. Work started 5-9-91 finished 5-10-91

11. DRILLERS CERTIFICATION

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name H2O Well Service Firm No. 443
Address 582 W Hayden Date 5-13-91
Signed by (Firm Official) [signature]
and
(Operator) [signature]

USE TYPEWRITER OR BALL POINT PEN

State of Idaho
Department of Water Resources

RECE HV-1

WELL DRILLER'S REPORT

SEP 20 1976

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

Department of Water Resources
Northern District Office

1. WELL OWNER

Name Bruce Smith

Address Rt 3 Box 74 Rathdrum, Ida.

Owner's Permit No. 95-76-N-82

2. NATURE OF WORK

☑ New well ☐ Deepened ☐ Replacement

☐ Abandoned (describe method of abandoning)

RECEIVED OCT 1 1976 Department of Water Resources

3. PROPOSED USE

☑ Domestic ☐ Irrigation ☐ Test ☐ Other (specify type)

☐ Municipal ☐ Industrial ☐ Stock ☐ Waste Disposal or Injection

4. METHOD DRILLED

☐ Cable ☑ Rotary ☐ Dug ☐ Other

5. WELL CONSTRUCTION

Diameter of hole 6 inches Total depth 400 feet

Casing schedule: ☑ Steel ☐ Concrete

Thickness	Diameter	From	To
.250 inches	6 inches	+1 feet	374 feet
inches	inches	feet	feet
inches	inches	feet	feet
inches	inches	feet	feet
inches	inches	feet	feet

Was casing drive shoe used? ☑ Yes ☐ No

Was a packer or seal used? ☐ Yes ☑ No

Perforated? ☐ Yes ☑ No

How perforated? ☐ Factory ☐ Knife ☐ Torch

Size of perforation ____ inches by ____ inches

Number	From	To
perforations	feet	feet
perforations	feet	feet
perforations	feet	feet

Well screen installed? ☐ Yes ☑ No

Manufacturer's name ____

Type ____ Model No. ____

Diameter ____ Slot size ____ Set from ____ feet to ____ feet

Diameter ____ Slot size ____ Set from ____ feet to ____ feet

Gravel packed? ☐ Yes ☑ No Size of gravel ____

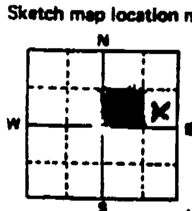
Placed from ____ feet to ____ feet

Surface seal depth 20' Material used in seal ☐ Cement grout ☑ Puddling clay ☑ Well cuttings

Sealing procedure used ☐ Slurry pit ☐ Temporary surface casing ☑ Overbore to seal depth

6. LOCATION OF WELL

Sketch map location must agree with written location. (95)



Subdivision Name ____

Lot No. ____ Block No. ____

County Kootenai

SW ¼ NE ¼ Sec. 3 T. 51 N/S, R. 5 E/W

7. WATER LEVEL

Static water level 350 feet below land surface

Flowing? ☐ Yes ☑ No G.P.M. flow ____

Temperature ____ °F. Quality ____

Artesian closed-in pressure ____ p.s.i.

Controlled by ☐ Valve ☐ Cap ☐ Plug

8. WELL TEST DATA

☐ Pump ☐ Bailer ☑ Other Air

Discharge G.P.M.	Draw Down	Hours Pumped
3	10'	1

9. LITHOLOGIC LOG

Hole Diam.	Depth From	Depth To	Material	Water Yes	Water No
8	0	70	Sand Gravel/clay		✓
6	70	374	Sand Gravel	✓	
6	374	400	Granite	✓	
			Water at 355' And 390'		

10. Work started Aug 23 finished Aug 30

11. DRILLERS CERTIFICATION

Firm Name Associated Well Firm No. 145

Address P.O. Box 723 Date Sept 11, 1976

Signed by (Firm Official) Bud Thornton

and

(Operator) Gary Smith

Form 238-7
9/82

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

HV-2 (WRITER OR TYPEN)

WELL DRILLER'S REPORT

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

1. WELL OWNER

Name Brian H. or Michelle & David B. or Doris Pruitt

Address 51245 North Idaho Rd.

Owner's Permit No. Rathdrum, ID. 83858

2. NATURE OF WORK 95-87-N-88

☒ New well ☐ Deepened ☐ Replacement

☐ Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

3. PROPOSED USE

☒ Domestic ☐ Irrigation ☐ Test ☐ Municipal
☐ Industrial ☐ Stock ☐ Waste Disposal or Injection
☐ Other (specify type)

4. METHOD DRILLED

☒ Rotary ☐ Air ☐ Hydraulic ☐ Reverse rotary
☐ Cable ☐ Dug ☐ Other

5. WELL CONSTRUCTION

Casing schedule: ☒ Steel ☐ Concrete ☐ Other

Thickness	Diameter	From	To
.250 inches	6 inches	+ 2 feet	178 feet
.160 inches	4 inches	-175 feet	475 feet
inches	inches	feet	feet
inches	inches	feet	feet

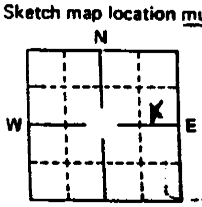
Was casing drive shoe used? ☒ Yes ☐ No
Was a packer or seal used? ☐ Yes ☒ No
Perforated? ☒ Yes ☐ No
How perforated? ☐ Factory ☐ Knife ☐ Torch
Size of perforation 1/4 inches by 3 inches

Number		From	To
30	perforations	435 feet	455 feet
30	perforations	375 feet	395 feet
	perforations	feet	feet

Well screen installed? ☐ Yes ☒ No
Manufacturer's name
Type Model No.
Diameter Slot size Set from feet to feet
Diameter Slot size Set from feet to feet
Gravel packed? ☐ Yes ☒ No ☐ Size of gravel
Placed from feet to feet
Surface seal depth 22 Material used in seal: ☐ Cement grout ☒ Bentonite ☐ Puddling clay ☒ cuttings
Sealing procedure used: ☐ Slurry pit ☒ Temp. surface casing ☒ Overbore to seal depth
Method of joining casing: ☐ Threaded ☒ Welded ☐ Solvent Weld ☐ Cemented between strata
Describe access port

6. LOCATION OF WELL

Sketch map location must agree with written location.



Subdivision Name

Lot No. Block No.

County Kootenai

7. WATER LEVEL

Static water level 200 feet below land surface.
Flowing? ☐ Yes ☒ No G.P.M. flow
Artesian closed-in pressure p.s.i.
Controlled by: ☐ Valve ☒ Cap ☐ Plug
Temperature cold °F. Quality Good
Describe artesian or temperature zones below.

8. WELL TEST DATA

☐ Pump ☐ Bailer ☒ Air ☐ Other

Discharge G.P.M.	Pumping Level	Hours Pumped
5	variable	1/2 hr

9. LITHOLOGIC LOG

Bore Diam.	Depth From	Depth To	Material	Water Yes	Water No
8	0	22	Gravel		x
	6	175	Sand and Gravel		x
6	175	178	Decomposed Granite		x
	178	475	Granite with many soft Areas	x	
			Water at 302'		

AUG 04 1987
Department of Water Resources

RECEIVED
JUL 24 1987
Department of Water Resources
Northern District Office

10. Work started 6/16/87 finished 6/19/87

11. DRILLERS CERTIFICATION

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name Associated Well Drillers Inc Firm No. 245

Address Box 723 C.D.A Date 6/19/87

Signed by (Firm Official) [signature]

and

(Operator) [signature]

NG-B

238-7

IDAHO DEPARTMENT OF WATER RESOURCES
WELL DRILLER'S REPORT
Use Typewriter or Ballpoint Pen

Office Use Only
Inspected by____________
Twp____ Rge____ Sec____
____1/4____1/4____1/4
Lat: : : Long: : :

1. DRILLING PERMIT NO. 95-96-N-180-000
Other IDWR No. ____________

2. OWNER
Name CLEMONS, KEITH — Well Number: 515
Address 3301 NETTLETON GULCH
City CDA State ID Zip 83814

3. LOCATION OF WELL by legal description
sketch map location must agree with written location

Twp. 50 ☒ North or ☐ South
Rge. 03 ☐ East or ☒ West
Sec. 06 ____1/4 NE 1/4 SE 1/4
Gov't Lot ______ County KOOTENAI
Lat: : : Long: : :
Address of Well Site 3301 NETTLETON
City CDA
(Give at least name of road + Distance to Road or Landmark)
Lt. ______ Blk. ______ Sub. Name ____________

4. USE:
☒ Domestic ☐ Municipal ☐ Monitor ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other ______

5. TYPE OF WORK check all that apply (Replacement, etc.)
☒ New Well ☐ Modify ☐ Abandonment ☐ Other ______

6. DRILL METHOD
☒ Air Rotary ☐ Cable ☐ Mud Rotary ☐ Other ______

7. SEALING PROCEDURES

SEAL/FILTER PACK Material	From	To	AMOUNT Sacks or Pounds	METHOD
BENTONITE	0	18	6 Sacks	Dry

Was drive shoe used? ☒ Y ☐ N Shoe Depth(s) 155
Was drive shoe seal tested? ☐ Y ☐ N How? ______

8. CASING/LINER:

Diameter	From	To	Gauge	Material	Casing	Liner	Welded	Threaded
6	+2	155	.250	STEEL	☒	☐	☒	☐
4	-120	600	.160	PVC	☐	☒	☐	☐

Length of Headpipe ______ Length of Tailpipe ______

9. PERFORATIONS/SCREENS
☒ Perforations Method SKILLSAW
☐ Screens Screen Type ______

From	To	Slot Size	Number	Diameter	Material	Casing	Liner
-560	-100	1/8X6	120	4	PVC	☐	☒

10. STATIC WATER LEVEL OR ARTESIAN PRESSURE:
550 ~~ft. below~~ ground Artesian pressure ______ lb.
Depth flow encountered ______ ft. Describe access port or control devices: ______

11. WELL TESTS:
☐ Pump ☐ Bailer ☒ Air ☐ Flowing Artesian

Yield gal./min.	Drawdown	Pumping Level	Time
1 GPM			

Water Temp. ______ Bottom Hole Temp ______
Water Quality test or comments: ______
______ Depth first Water encountered ______

12. LITHOLOGIC LOG: (Describe repairs or abandonment)

Bore Diam.	From	To	Remarks: Lithology, Water Quality, Temperature	Water Y	Water N
8	0	3	Topsoil	☐	☒
8	3	18	Gravels Sand	☐	☒
6	18	70	Gravels Sand	☐	☒
6	70	125	Cemented Gravels Some Sand	☐	☒
6	125	135	Gravels Sand clay Brown	☐	☒
6	135	155	Gravels Gray Clay Moist	☐	☒
6	155	180	Shale Gray Soft To Medium	☐	☒
6	180	283	Shale Gray Medium	☐	☒
6	283	289	Shale Green Medium	☐	☒
6	289	357	Shale Gray Medium	☐	☒
6	357	430	Shale Gray Medium Trace H20 428	☒	☐
6	430	520	Shale Greenish Gray Medium	☒	☐
6	520	600	Shale Gray Green Some White Mediu	☐	☒

Completed Depth 600' (Measurable)
Date: Started 12/10/96 Completed 12/12/96

13. DRILLER'S CERTIFICATION
I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name H20 WellService, Inc. Firm No. 448
Firm Official [signature] Date 12-16-96
and
Supervisor or Operator [signature] Date 12-16-96
(Sign Once if Firm Official and Operator)

NESE 6 50N 3W

orm 238-7
/82

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

USE TYP **HV-3**
BALLPOINT PEN

WELL DRILLER'S REPORT

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

N 85

1. WELL OWNER

Name Wm. L. Giles, Jr. or Kathryn F. Giles
Address Po Box 221 Bonners Falls, Id. 83854
Owner's Permit No. 95-85-N-74

2. NATURE OF WORK

☒ New well ☐ Deepened ☐ Replacement
☐ Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

3. PROPOSED USE

☒ Domestic ☐ Irrigation ☐ Test ☐ Municipal
☐ Industrial ☐ Stock ☐ Waste Disposal or Injection
☐ Other ______ (specify type)

4. METHOD DRILLED

☒ Rotary ☐ Air ☐ Hydraulic ☐ Reverse rotary
☐ Cable ☐ Dug ☐ Other

5. WELL CONSTRUCTION

Casing schedule: ☒ Steel ☐ Concrete ☐ Other

Thickness	Diameter	From	To
.250 inches	6 inches	+ 2 feet	84 feet
inches	inches	feet	feet
inches	inches	feet	feet
inches	inches	feet	feet

Was casing drive shoe used? ☒ Yes ☐ No
Was a packer or seal used? ☐ Yes ☒ No
Perforated? ☐ Yes ☒ No
How perforated? ☐ Factory ☐ Knife ☐ Torch
Size of perforation ______ inches by ______ inches

Number	From	To
perforations	feet	feet
perforations	feet	feet
perforations	feet	feet

Well screen installed? ☐ Yes ☒ No
Manufacturer's name
Type ______ Model No.
Diameter ___ Slot size ___ Set from ___ feet to ___ feet
Diameter ___ Slot size ___ Set from ___ feet to ___ feet
Gravel packed? ☐ Yes ☒ No ☐ Size of gravel
Placed from ______ feet to ______ feet
Surface seal depth 25 Material used in seal: ☐ Cement grout ☒ Bentonite ☐ Puddling clay ☒ Cuttings
Sealing procedure used: ☐ Slurry pit ☐ Temp. surface casing ☒ Overbore to seal depth
Method of joining casing: ☐ Threaded ☒ Welded ☐ Solvent Weld ☐ Cemented between strata
Describe access port

6. LOCATION OF WELL

Sketch map location must agree with written location.

(Sketch map: N / S / E / W grid, marked 34, x)

Subdivision Name
Lot No. ______ Block No.
County Kootenai
SE ¼ SE ¼ Sec. 34, T. 52 N/S, R. 5 E/W

7. WATER LEVEL

Static water level 70 feet below land surface.
Flowing? ☐ Yes ☒ No G.P.M. flow
Artesian closed-in pressure ______ p.s.i.
Controlled by: ☐ Valve ☒ Cap ☐ Plug
Temperature cold °F. Quality Excellent
Describe artesian or temperature zones below.

8. WELL TEST DATA

☐ Pump ☐ Bailer ☒ Air ☐ Other

Discharge G.P.M.	Pumping Level	Hours Pumped
8	Within	½ hr

9. LITHOLOGIC LOG

Bore Diam.	Depth From	Depth To	Material	Water Yes	Water No
8	0	2	Topsoil		X
	2	6	Gravel with Clay		X
	6	76	Decomposed Granite		X
	76	84	Granite		X
6	84	340	Granite	X	
			2 GPM AT 170		
			6 GPM AT 328		

RECEIVED APR 3 1986 Department of Water Resources

RECEIVED MAR 25 1986 Department of Water Resources Northern District Office

10.

Work started 12/21/85 finished 12/31/85

11. DRILLERS CERTIFICATION

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name Associated Well Drillers Inc. Firm No. 245
Address Box 723 C.O.A. Date 12/31/85
Signed by (Firm Official) [signature]
and
(Operator) Robert F. Dieguez

Form 238-7
9/82

STATE OF IDAHO
PARTMENT OF WATER RESOURCE

USI[illegible] ER OR
[illegible] EN HV-4

WELL DRILLER'S REPORT

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

N

1. WELL OWNER

Name Randy P. Staeb
Lynn C. Staeb

Address N. 5318 Elm
Spokane, WA 99205

Owner's Permit No. 95-86-N-82

2. NATURE OF WORK

☒ New well ☐ Deepened ☐ Replacement
☐ Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

3. PROPOSED USE

☒ Domestic ☐ Irrigation ☐ Test ☐ Municipal
☐ Industrial ☐ Stock ☐ Waste Disposal or Injection
☐ Other ______ (specify type)

4. METHOD DRILLED

☒ Rotary ☒ Air ☐ Hydraulic ☐ Reverse rotary
☐ Cable ☐ Dug ☐ Other ______

5. WELL CONSTRUCTION

Casing schedule: ☒ Steel ☐ Concrete ☐ Other ______

Thickness	Diameter	From	To
.250 inches	6 inches	+ 1 feet	120 feet
inches	inches	feet	feet
inches	inches	feet	feet
inches	inches	feet	feet

Was casing drive shoe used? ☒ Yes ☐ No
Was a packer or seal used? ☐ Yes ☒ No
Perforated? ☐ Yes ☒ No
How perforated? ☐ Factory ☐ Knife ☐ Torch
Size of perforation ______ inches by ______ inches

Number	From	To
perforations	feet	feet
perforations	feet	feet
perforations	feet	feet

Well screen installed? ☐ Yes ☒ No
Manufacturer's name ______
Type ______ Model No. ______
Diameter ____ Slot size ____ Set from ______ feet to ______ feet
Diameter ____ Slot size ____ Set from ______ feet to ______ feet
Gravel packed? ☐ Yes ☒ No ☐ Size of gravel ______
Placed from ______ feet to ______ feet
Surface seal depth 18 Material used in seal: ☐ Cement grout ☒ Bentonite ☐ Puddling clay ☐ ______
Sealing procedure used: ☐ Slurry pit ☐ Temp. surface casing ☒ Overbore to seal depth
Method of joining casing: ☐ Threaded ☒ Welded ☐ Solvent Weld ☐ Cemented between strata
Describe access port ______

6. LOCATION OF WELL

Sketch map location must agree with written location.

(Section sketch: N / S / E / W, section 3, X in NE quarter)

Subdivision Name ______

Lot No. ______ Block No. ______

County KOOTENAI

NW ¼ NE ¼ Sec. 3, T. 51N N/S, R. 5W E/W.

7. WATER LEVEL

Static water level 130 feet below land surface.
Flowing? ☐ Yes ☒ No G.P.M. flow ______
Artesian closed-in pressure ______ p.s.i.
Controlled by: ☐ Valve ☐ Cap ☐ Plug
Temperature ____ °F. Quality ______
Describe artesian or temperature zones below.

8. WELL TEST DATA

☐ Pump ☐ Bailer ☒ Air ☐ Other ______

Discharge G.P.M.	Pumping Level	Hours Pumped
8.5 GPM - ESTIMATED AIRLIFT		

9. LITHOLOGIC LOG

Bore Diam.	Depth From	Depth To	Material	Water Yes	Water No
8"	0	18	Sand		X
6"	18	127	Sand		X
6"	127	235	Granite, hard, salt & pepper		X
6"	235	280	Granite, soft, fractured, green w/water	X	
6"	280	290'	Granite, hard, salt & pepper		X

280' of 4" PVC Liner Installed

6" Drive shoe utilized

RECEIVED
DEC 5 1986
Department of Water Resources

RECEIVED
[illegible] 1988
Department of Water Resources
Northern District Office

10. Work started 10/16/86 finished 10/21/86

11. DRILLERS CERTIFICATION

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name PONDEROSA DRILLING Firm No. 228
Address E. 6010 Broadway
Spokane, WA 99212 Date 10/21/86

Signed by (Firm Official) W. Scott Barratt

and

(Operator) Louie E. Hanner

MICROFILMED

USE ADDITIONAL SHEETS IF NECESSARY

HV-6

Form 238-7
6/93

POSTED

IDAHO DEPARTMENT OF WATER RESOURCES
WELL DRILLER'S REPORT

Use Typewriter or Ball Point Pen

1. DRILLING PERMIT NO. 95 - 94 - N 32 -
Other IDWR No.

2. OWNER:
Name LESLIE & JOAN KIRSCH
Address N 100 PLEASANTVIEW RD
City POST FALLS State ID Zip 83854

3. LOCATION OF WELL by legal description:
Sketch map location must agree with written location.

T. 51 North [X] or South [ ]
R. 05 East [ ] or West [X]
Sec. 10, ___ 1/4 SE 1/4 NW 1/4
Gov't Lot ___ County KOOTENAI

Address of Well Site HWY 53
(Give at least Direction + Distance to Road or Landmark)
Lot No. ___ Block No. ___ Subd. Name ___

4. PROPOSED USE:
[X] Domestic [ ] Municipal [ ] Monitor [ ] Irrigation
[ ] Thermal [ ] Injection [ ] Other ___

5. TYPE OF WORK
[X] New Well [ ] Modify or Repair [ ] Replacement [ ] Abandonment

6. DRILL METHOD
[ ] Mud Rotary [X] Air Rotary [ ] Cable [ ] Other ___

7. SEALING PROCEDURES

SEAL/FILTER PACK Material	From	To	AMOUNT Sacks or Pounds	METHOD
BENTONITE	0	40	100gals	POURED

Was drive shoe seal tested? Y[ ] N[ ] How? ___

8. CASING/LINER:

Diameter	From	To	Gauge	Casing	Liner	Steel	Plastic	Welded	Threaded
6"	+2	216	.250			[X]	[ ]	[ ]	[ ]
						[ ]	[ ]	[ ]	[ ]
						[ ]	[ ]	[ ]	[ ]
						[ ]	[ ]	[ ]	[ ]

Final location of shoe(s) 216'
Top Packer or Headpipe ___ Bottom Tailpipe ___

9. PERFORATIONS/SCREENS
[ ] Perforations Method ___
[ ] Screens Type ___ Material ___

From	To	Slot Size	Number	Diameter	Tele/Pipe Size	Casing	Liner
						[ ]	[ ]
						[ ]	[ ]
						[ ]	[ ]
						[ ]	[ ]

SENW 10 51N 5W

10. WELL TESTS:
[ ] Pump [ ] Bailer [X] Air [ ] Flowing Artesian

Yield gal./min.	Drawdown	Pumping Depth	Time
50+			

Temperature of water ___ Was a water analysis done? Yes [ ] No [ ]
By whom? ___
Water Quality (odor, etc.) ___
Bottom Hole Temperature ___

11. STATIC WATER LEVEL:
140' ft. below surface Depth artesian flow found ___
Artesian pressure ___ lb. Describe access port ___
Describe Controlling Devices: ___

12. LITHOLOGIC LOG: (Describe repairs or abandonment)

Bore Dia.	From	To	Remarks: Lithology, Water Quality & Temperature	GPM	SWL
8	0	70	SAND & GRAVEL		
8	70	120	CEMENTED GRAVEL & SAND		140
8	120	137	SAND & GRAVEL W/CLAY SEEMS		
8	137	190	sand & gravel w/CLAY SEEMS W/WATER BROWN		
8	190	216	SAND & GRAVEL COURSE W/WATER	50+	

RECEIVED FEB 2 ? 1994 NORTHERN REGION IDWR

Date: Started 02/11/94 Completed 02/14/94

13. DRILLER'S CERTIFICATION
I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name H2O WELL SERVICE INC Firm No. #448
Firm Official [signature] Date 2-17-94
and
Supervisor or Operator [signature] Date 2-15-94

USE TYPEWRITER
BALL POINT PEN

State of Idaho
Department of Water Administration

WELL DRILLER'S REPORT

HV-7
HV-8

RECEIVED
APR 1 1975
Department of Water Resources
Northern District Office

State law requires that this report be filed with the Director, Department of Water Administration within 30 days after the completion or abandonment of the well.

1. WELL OWNER

Name Yvonne N. Brazill (dec)

Address Rt. 1 Box 17 Rathdrum, Idaho

Owner's Permit No. 95-73-N-81

2. NATURE OF WORK

☑ New well ☐ Deepened ☐ Replacement

☐ Abandoned (describe method of abandoning)

3. PROPOSED USE

☑ Domestic ☐ Irrigation ☐ Test

☐ Municipal ☐ Industrial ☐ Stock

4. METHOD DRILLED

☐ Cable ☑ Rotary ☐ Dug ☐ Other

5. WELL CONSTRUCTION

Diameter of hole 6 inches Total depth 375 feet

Casing schedule: ☑ Steel ☐ Concrete

Thickness	Diameter	From	To
.250 inches	6 inches	+1 feet	95 feet
inches	inches	feet	feet
inches	inches	feet	feet
inches	inches	feet	feet
inches	inches	feet	feet

Was a packer or seal used? ☐ Yes ☑ No

Perforated? ☑ Yes ☐ No

How perforated? ☐ Factory ☐ Knife ☑ Torch

Size of perforation 3/16 inches by 10 inches

[redacted] To

30 perforations [redacted] feet

perforations feet feet

perforations feet feet

Well screen installed? ☐ Yes ☑ No

Manufacturer's name

Type Model No.

Diameter Slot size Set from feet to feet

Diameter Slot size Set from feet to feet

Gravel packed? ☐ Yes ☑ No Size of gravel

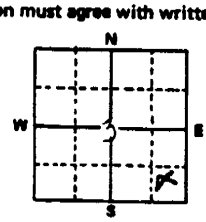
Placed from feet to feet

Surface seal? ☐ Yes ☑ No To what depth 20 feet

Material used in seal ☐ Cement grout ☑ Puddling clay

6. LOCATION OF WELL

Sketch map location must agree with written location.



95

County Kootenai

SE ¼ SE ¼ Sec. 3, T. 51 N; R. 5 W

7. WATER LEVEL

Static water level 140 feet below land surface

Flowing? ☐ Yes ☑ No G.P.M. flow

Temperature Cold °F. Quality Good

Artesian closed-in pressure p.s.i.

Controlled by ☐ Valve ☐ Cap ☐ Plug

8. WELL TEST DATA

☐ Pump ☐ Bailer ☑ Other Air

Discharge G.P.M.	Draw Down	Hours Pumped
8	—	3

9. LITHOLOGIC LOG

Hole Diam.	Depth From	Depth To	Material	Water Yes	Water No
8	0	94	Sand		X
6	94	110	Med Hard Granite		X
6	110	375	Granite w/seams	X	

10.

Work started 10-26-73 finished 10-27-73

11. DRILLER'S CERTIFICATION

This well was drilled under my supervision and this report is true to the best of my knowledge.

Associated Well Drillers, Inc. 245

Driller's or Firm's Name Number

PO Box 723 Coeur d'Alene, Idaho 83814

Address

Signed By [signature] Date 10-29-73

orm 238-7
/82

STATE OF IDAHO
[illegible]ARTMENT OF WATER RESOURCES

USE TYPE HV-9 R
BALLP[illegible]

WELL DRILLER'S REPORT

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

N

1. WELL OWNER

Name William L. or Sandra L. Reeser
West 3875 Hidden Valley Road AND

Address Robert R. or Linda J. Fus
West 2485 Hidden Valley Road

Owner's Permit No. ~~Rathdrum, Idaho 83858~~

2. NATURE OF WORK

95-84-N-8

☑ New well ☐ Deepened ☐ Replacement
☐ Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

3. PROPOSED USE

☑ Domestic ☐ Irrigation ☐ Test ☐ Municipal
☐ Industrial ☐ Stock ☐ Waste Disposal or Injection
☐ Other ______ (specify type)

4. METHOD DRILLED

☑ Rotary ☐ Air ☐ Hydraulic ☐ Reverse rotary
☐ Cable ☐ Dug ☐ Other

5. WELL CONSTRUCTION

Casing schedule: ☑ Steel ☐ Concrete ☐ Other

Thickness	Diameter	From	To
.250 inches	6 inches	+ 2 feet	322 feet
PVC inches	4 inches	-320 feet	500 feet
inches	inches	feet	feet
inches	inches	feet	feet

Was casing drive shoe used? ☑ Yes ☐ No
Was a packer or seal used? ☐ Yes ☑ No
Perforated? ☑ Yes ☐ No
How perforated? ☐ Factory ☐ Knife DRILLED ☐ Torch
Size of perforation 1/4 inches by 1/4 inches

Number	From	To
50 perforations	460 feet	480 feet
50 perforations	420 feet	440 feet
perforations	feet	feet

Well screen installed? ☐ Yes ☑ No
Manufacturer's name
Type ______ Model No.
Diameter ___ Slot size ___ Set from ___ feet to ___ feet
Diameter ___ Slot size ___ Set from ___ feet to ___ feet
Gravel packed? ☐ Yes ☑ No ☐ Size of gravel
Placed from ___ feet to ___ feet
Surface seal depth 30 Material used in seal: ☐ Cement grout ☑ Bentonite ☐ Puddling clay ☑ Cuttings
Sealing procedure used: ☐ Slurry pit ☑ Temp. surface casing ☑ Overbore to seal depth
Method of joining casing: ☐ Threaded ☑ Welded ☐ Solvent Weld ☐ Cemented between strata
Describe access port

6. LOCATION OF WELL

Sketch map location must agree with written location.

N / W / E / S — 3

Subdivision Name
Government
Lot No. 2 Block No.

County Kootenai

___ ¼ ___ ¼ Sec. 3, T. 51 N/S, R. 5 E/W

7. WATER LEVEL

Static water level ✓ ______ feet below land surface.
Flowing? ☐ Yes ☑ No G.P.M. flow
Artesian closed-in pressure ______ p.s.i.
Controlled by: ☐ Valve ☐ Cap ☐ Plug
Temperature Cold °F. Quality Good
Describe artesian or temperature zones below.

8. WELL TEST DATA

☐ Pump ☐ Bailer ☑ Air ☐ Other

Discharge G.P.M.	Pumping Level	Hours Pumped
9	Various	1½ Hrs.

9. LITHOLOGIC LOG

Bore Diam.	Depth From	Depth To	Material	Water Yes	Water No
8	0	2	Topsoil		X
	2	140	Gravel		X
	140	210	Silt		X
	210	315	Course Sand		X
	315	322	Decomposed Granite		X
6	322	500	Medium Granite	X	
			Water at 470'		

RECEIVED
OCT 29 1984
Department of Water Resources

RECEIVED
OCT [illegible]
Department of Water Resources
Northern District Office

10.

Work started 7-10-84 finished 7-13-84

11. DRILLERS CERTIFICATION

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name Associated Well Drillers, Inc. Firm No. 245
Address Box 723 Coeur d'Alene [illegible] Date 7-13-84
Signed by (Firm Official) [signature]
and
(Operator) [signature]

Form 238-7
7/82

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

USE TYPEWRITER OR BALLPOINT PEN HV-10

WELL DRILLER'S REPORT

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

RECEIVED
OCT 20 1988
Department of Water Resources

1. WELL OWNER

Name JIM CROWE

Address HIDDEN VALLEY, RATH. 83858

Owner's Permit No. 95-88-N-90

2. NATURE OF WORK

☒ New well ☐ Deepened ☐ Replacement
☐ Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

3. PROPOSED USE

☒ Domestic ☐ Irrigation ☐ Test ☐ Municipal
☐ Industrial ☐ Stock ☐ Waste Disposal or Injection
☐ Other ______ (specify type)

4. METHOD DRILLED

☒ Rotary ☒ Air ☐ Hydraulic ☐ Reverse rotary
☐ Cable ☐ Dug ☐ Other

5. WELL CONSTRUCTION

Casing schedule: ☐ Steel ☐ Concrete ☐ Other

Thickness		Diameter		From		To	
.250	inches	6	inches	+ 18"	feet	100	feet
	inches		inches		feet		feet
	inches		inches		feet		feet
	inches		inches		feet		feet

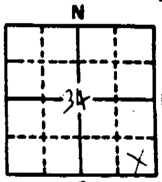
Was casing drive shoe used? ☒ Yes ☐ No
Was a packer or seal used? ☐ Yes ☒ No
Perforated? ☐ Yes ☒ No
How perforated? ☐ Factory ☐ Knife ☐ Torch
Size of perforation ____ inches by ____ inches

Number		From		To	
	perforations		feet		feet
	perforations		feet		feet
	perforations		feet		feet

Well screen installed? ☐ Yes ☒ No
Manufacturer's name
Type ______ Model No.
Diameter ____ Slot size ____ Set from ____ feet to ____ feet
Diameter ____ Slot size ____ Set from ____ feet to ____ feet
Gravel packed? ☐ Yes ☐ No ☐ Size of gravel
Placed from ____ feet to ____ feet
Surface seal depth 18 Material used in seal: ☐ Cement grout ☒ Bentonite ☐ Puddling clay ☐
Sealing procedure used: ☐ Slurry pit ☐ Temp. surface casing ☒ Overbore to seal depth
Method of joining casing: ☐ Threaded ☒ Welded ☐ Solvent Weld ☐ Cemented between strata
Describe access port

6. LOCATION OF WELL

Sketch map location must agree with written location.



Subdivision Name

Lot No. ____ Block No. ____

County Kootenai

SE ¼ SE ¼ Sec. 34, T. 52 N/S, R. 5 E/W.

7. WATER LEVEL

Static water level ____ feet below land surface.
Flowing? ☐ Yes ☒ No G.P.M. flow
Artesian closed-in pressure ____ p.s.i.
Controlled by: ☐ Valve ☐ Cap ☐ Plug
Temperature ____ °F. Quality Good
Describe artesian or temperature zones below.

8. WELL TEST DATA

☐ Pump ☐ Bailer ☒ Air ☐ Other

Discharge G.P.M.	Pumping Level	Hours Pumped
5+ GPM		

9. LITHOLOGIC LOG

Bore Diam.	Depth From	Depth To	Material	Water Yes	Water No
8	0	3	Top Soil		X
	3	100	Sand + Gravel		X
	100	350	Granite	X	

RECEIVED
NOV 11 1988
Department of Water Resources
Northern District Office

10.

Work started 9-21-88 finished 9-22-88

11. DRILLERS CERTIFICATION

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name UNITED DRILLING INC. Firm No. 414

Address P. O. BOX 2499 CD'A Id. 83814 Date

Signed by (Firm Official) [signature] Pres

and

(Operator) Tim Volking

Form 238-7
9/82

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

USE BY NG-1 DR

WELL DRILLER'S REPORT

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

RECEIVED AUG 25 1988 Department of Water Resources

1. WELL OWNER

Name DAVID PELZ

Address .1620 N.W. BLVD, CD'A Id 83814

Owner's Permit No. 95 88 N 76

2. NATURE OF WORK

☒ New well ☐ Deepened ☐ Replacement
☐ Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

3. PROPOSED USE

☒ Domestic ☐ Irrigation ☐ Test ☐ Municipal
☐ Industrial ☐ Stock ☐ Waste Disposal or Injection
☐ Other ______ (specify type)

4. METHOD DRILLED

☐ Rotary ☐ Air ☐ Hydraulic ☐ Reverse rotary
☒ Cable ☐ Dug ☐ Other

5. WELL CONSTRUCTION

Casing schedule: ☒ Steel ☐ Concrete ☐ Other

Thickness	Diameter	From	To
250 inches	6 inches +	1 feet	170 feet
inches	inches	feet	feet
inches	inches	feet	feet
inches	inches	feet	feet

Was casing drive shoe used? ☒ Yes ☐ No
Was a packer or seal used? ☒ Yes ☐ No
Perforated? ☐ Yes ☒ No
How perforated? ☐ Factory ☐ Knife ☐ Torch
Size of perforation ______ inches by ______ inches

Number	From	To
perforations	feet	feet
perforations	feet	feet
perforations	feet	feet

Well screen installed? ☐ Yes ☒ No
Manufacturer's name
Type ______ Model No.
Diameter ____ Slot size ____ Set from ______ feet to ______ feet
Diameter ____ Slot size ____ Set from ______ feet to ______ feet
Gravel packed? ☐ Yes ☐ No ☐ Size of gravel
Placed from ______ feet to ______ feet
Surface seal depth 20 Material used in seal: ☐ Cement grout ☒ Bentonite ☒ Puddling clay ☐
Sealing procedure used: ☐ Slurry pit ☐ Temp. surface casing ☒ Overbore to seal depth
Method of joining casing: ☐ Threaded ☒ Welded ☐ Solvent Weld
☐ Cemented between strata
Describe access port

6. LOCATION OF WELL

Sketch map location must agree with written location.

N / W / E / S — 6, X

Subdivision Name

Lot No. ______ Block No. ______

County Kootenai

N/E ¼ SE ¼ Sec. 6, T. 50 N, R. 3 W.

7. WATER LEVEL

Static water level 150 feet below land surface.
Flowing? ☐ Yes ☒ No G.P.M. flow
Artesian closed-in pressure ______ p.s.i.
Controlled by: ☐ Valve ☐ Cap ☐ Plug
Temperature ____ °F. Quality good
Describe artesian or temperature zones below.

8. WELL TEST DATA

☐ Pump ☒ Bailer ☐ Air ☐ Other

Discharge G.P.M.	Pumping Level	Hours Pumped
10-15 GPM	175	1 HR

9. LITHOLOGIC LOG

Bore Diam.	Depth From	Depth To	Material	Water Yes	Water No
8	1	20	Gravel		x
	~~20~~	~~170~~	~~Gravel Clay~~		x
	170	175	Cemented Gravel	x	

10.

Work started 8-12-88 finished 8-17-88

11. DRILLERS CERTIFICATION

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name ~~ASSOCIATED~~ DRILLING INC. Firm No. 414

Address P. O. BOX 819 Cd'A Id. 83814 Date

Signed by (Firm Official) [signature]

and

(Operator) [signature]

Form 238-7
3/82

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

US NG-2 FOR

WELL DRILLER'S REPORT

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

1. WELL OWNER

Name Richard C. Nordstrom

Address Granville Id. 83839

Owner's Permit No. 95-84-N-15

2. NATURE OF WORK

☒ New well ☐ Deepened ☐ Replacement

☐ Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

3. PROPOSED USE

☒ Domestic ☐ Irrigation ☐ Test ☐ Municipal
☐ Industrial ☐ Stock ☐ Waste Disposal or Injection
☐ Other ______ (specify type)

4. METHOD DRILLED

☒ Rotary ☐ Air ☐ Hydraulic ☐ Reverse rotary
☐ Cable ☐ Dug ☐ Other ______

5. WELL CONSTRUCTION

Casing schedule: ☒ Steel ☐ Concrete ☐ Other ______

Thickness	Diameter	From	To
.250 inches	6 inches	+ 2 feet	209 feet
inches	inches	feet	feet
inches	inches	feet	feet
inches	inches	feet	feet

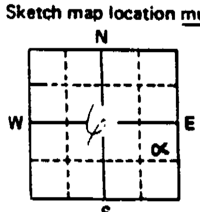
Was casing drive shoe used? ☒ Yes ☐ No
Was a packer or seal used? ☐ Yes ☒ No
Perforated? ☐ Yes ☒ No
How perforated? ☐ Factory ☐ Knife ☐ Torch
Size of perforation ______ inches by ______ inches

Number	From	To
perforations	feet	feet
perforations	feet	feet
perforations	feet	feet

Well screen installed? ☐ Yes ☒ No
Manufacturer's name ______
Type ______ Model No. ______
Diameter ___ Slot size ___ Set from ___ feet to ___ feet
Diameter ___ Slot size ___ Set from ___ feet to ___ feet
Gravel packed? ☐ Yes ☒ No ☐ Size of gravel ______
Placed from ______ feet to ______ feet
Surface seal depth 25 Material used in seal: ☐ Cement grout ☒ Bentonite ☐ Puddling clay ☒ Cuttings
Sealing procedure used: ☐ Slurry pit ☐ Temp. surface casing ☒ Overbore to seal depth
Method of joining casing: ☐ Threaded ☒ Welded ☐ Solvent Weld ☐ Cemented between strata
Describe access port ______

6. LOCATION OF WELL

Sketch map location must agree with written location.



Subdivision Name ______

Lot No. ______ Block No. ______

County Kootenai

NE SE ...

7. WATER LEVEL

Static water level 145 feet below land surface.
Flowing? ☐ Yes ☒ No G.P.M. flow ______
Artesian closed-in pressure ______ p.s.i.
Controlled by: ☐ Valve ☒ Cap ☐ Plug
Temperature Cold °F. Quality Excellent
Describe artesian or temperature zones below.

8. WELL TEST DATA

☐ Pump ☐ Bailer ☒ Air ☐ Other ______

Discharge G.P.M.	Pumping Level	Hours Pumped
60	Variable	½ hr

9. LITHOLOGIC LOG

Bore Diam.	Depth From	Depth To	Material	Water Yes	Water No
8	0	16	Sand		X
	16	25	Gravel		X
6	25	140	Gravel		X
	140	190	Sand		X
	190	205	Coarse Gravel	X	

RECEIVED
OCT 29 1984
Department of Water Resources

RECEIVED
OCT 25 1984
Department of Water Resources
Northern District Office

10.

Work started 10/12/84 finished 10/15/84

11. DRILLERS CERTIFICATION

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name Associated Well Drillers Inc Firm No. 245

Address Box 723 C.D.A. Date 10/16/84

Signed by (Firm Official) [signature]

and

(Operator) [signature]

NG-3

Form 238-7
6/93

POSTED

IDAHO DEPARTMENT OF WATER RESOURCES
WELL DRILLER'S REPORT

Use Typewriter or Ball Point Pen

1. DRILLING PERMIT NO. 95 94-N-245-
Other IDWR No.

2. OWNER:
Name Terry Martin
Address E2630 Kettleton Gulch Rd
City Coeur d'Alene State Id Zip 83814

3. LOCATION OF WELL by legal description:
Sketch map location must agree with written location.

T. 50 North [X] or South [ ]
R. 3 East [ ] or West [X]
Sec. 6, ___ 1/4 NW 1/4 SE 1/4
Gov't Lot ___ County Kootenai

Address of Well Site Same as Above
(Give at least Direction + Distance to Road or Landmark)

Lot No. ___ Block No. ___ Subd. Name ___

4. PROPOSED USE:
[X] Domestic [ ] Municipal [ ] Monitor [ ] Irrigation
[ ] Thermal [ ] Injection [ ] Other

5. TYPE OF WORK
[X] New Well [ ] Modify or Repair [ ] Replacement [ ] Abandonment

6. DRILL METHOD
[ ] Mud Rotary [X] Air Rotary [ ] Cable [ ] Other

7. SEALING PROCEDURES

SEAL/FILTER PACK Material	From	To	AMOUNT Sacks or Pounds	METHOD
Casing Seal	0	21	8	

Was drive shoe seal tested? Y[X] N How? Air pressure

8. CASING/LINER:

Diameter	From	To	Guage	Casing	Liner	Steel	Plastic	Welded	Threaded
6	+1	138	250	St.		[X]	[ ]	[X]	[ ]
4	+10	350	160	PVC	X	[ ]	[X]	[ ]	[ ]
						[ ]	[ ]	[ ]	[ ]
						[ ]	[ ]	[ ]	[ ]

Final location of shoes 138'
Top Packer or Headpipe ___ Bottom Tailpipe ___

9. PERFORATIONS/SCREENS
[X] Perforations Method Sawcut
[ ] Screens Type ___ Material PVC.

From	To	Slot Size	Number	Diameter	Tele/Pipe Size	Casing	Liner
290	310	1/8	40	4"		[ ]	X
330	350	1/8	40	4"		[ ]	X
						[ ]	[ ]
						[ ]	[ ]

NWSE 6 50N 3W

10. WELL TESTS:
[ ] Pump [ ] Bailer [X] Air [ ] Flowing Artesian

Yield gal./min.	Drawdown	Pumping Depth	Time
12			

Temperature of water Cold Was a water analysis done? Yes [ ] No [ ]
By whom?
Water Quality (odor, etc.) Good, No smell
Bottom Hole Temperature

11. STATIC WATER LEVEL:
180 ft. below surface Depth artesian flow found
Artesian pressure ___ lb. Describe access port Bolted Cap
Describe Controlling Devices:

12. LITHOLOGIC LOG: (Describe repairs or abandonment)

Bore Dia.	From	To	Remarks: Lithology, Water Quality & Temperature	GPM	SWL
8	0	138			
6	138	350			
	0	85	Clay & Cemented Fine Gravel	0	
	85	260	Green Shale	1	
	260	350	Blue Shale	11	

RECEIVED
DEC 13 1994
IDWR

Date: Started 10-17-94 Completed 10-19-94

13. DRILLER'S CERTIFICATION
I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name AQUA DRILLING & EXPLORATION INC. Firm No. 163

Firm Official Scott [illegible] Date
and
Supervisor or Operator Wayne Miller Date 10-20-94
(Sign once if Firm Official & Operator)

Form 238-7
8/90

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

USE TYPEWRITER OR PEN

NG-4

WELL DRILLER'S REPORT

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

1. WELL OWNER

Name MIKE GUINDON

Address NETTLETON GULCH RD

Drilling Permit No. 95-92-N-22

Water Right Permit No. ______

2. NATURE OF WORK

☒ New well ☐ Deepened ☐ Replacement

☐ Well diameter increase

☐ Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

3. PROPOSED USE

☒ Domestic ☐ Irrigation ☐ Test ☐ Municipal

☐ Industrial ☐ Stock ☐ Waste Disposal or Injection

☐ Other ______ (specify type)

4. METHOD DRILLED

☒ Rotary ☒ Air ☐ Hydraulic ☐ Reverse rotary

☐ Cable ☐ Dug ☐ Other ______

5. WELL CONSTRUCTION

Casing schedule: ☒ Steel ☐ Concrete ☐ Other ______

Thickness		Diameter		From		To	
.250	inches	6	inches	+1	feet	140	feet
	inches		inches		feet		feet
	inches		inches		feet		feet
	inches		inches		feet		feet

Was casing drive shoe used? ☒ Yes ☐ No

Was a packer or seal used? ☐ Yes ☒ No

Perforated? ☐ Yes ☒ No

How perforated? ☐ Factory ☐ Knife ☐ Torch ☐ Gun

Size of perforation ______ inches by ______ inches

Number		From		To	
	perforations		feet		feet
	perforations		feet		feet
	perforations		feet		feet

Well screen installed? ☐ Yes ☒ No

Manufacturer's name ______

Type ______ Model No. ______

Diameter ___ Slot size ___ Set from ___ feet to ___ feet

Diameter ___ Slot size ___ Set from ___ feet to ___ feet

Gravel packed? ☐ Yes ☒ No ☐ Size of gravel ______

Placed from ______ feet to ______ feet

Surface seal depth 25 Material used in seal: ☐ Cement grout ☒ Bentonite ☐ Puddling clay ☐ ______

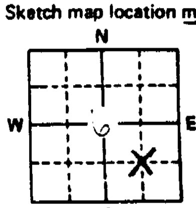
Sealing procedure used: ☐ Slurry pit ☐ Temp. surface casing ☒ Overbore to seal depth

Method of joining casing: ☐ Threaded ☒ Welded ☐ Solvent Weld ☐ Cemented between strata

Describe access port ______

6. LOCATION OF WELL

Sketch map location must agree with written location.



Subdivision Name ______

Lot No. ______ Block No. ______

PARCEL # 8500

County KOOTENAI

SE ¼ ______ ¼ Sec. 6, T. 50N N☐ S☐, R. 3W E☐ W☐

7. WATER LEVEL

Static water level 120 feet below land surface.

Flowing? ☐ Yes ☒ No G.P.M. flow ______

Artesian closed-in pressure ______ p.s.i.

Controlled by: ☐ Valve ☐ Cap ☐ Plug

Temperature ______ °F. Quality GOOD

Describe artesian or temperature zones below.

8. WELL TEST DATA

☐ Pump ☐ Bailer ☒ Air ☐ Other ______

Discharge G.P.M.	Pumping Level	Hours Pumped
15-20 ESTIMATED	140	2 HRS

9. LITHOLOGIC LOG

Bore Diam.	Depth From	Depth To	Material	Water Yes	Water No
8	0	22	SAND		X
	22	26	CLAY BROWN		X
6	26	42	CLAY & SAND MIX		X
	42	120	SAND & GRAVEL		X
	120	140	SAND & GRAVEL & CLAY	X	

RECEIVED
APR 8 1992
NORTHERN REGION
DWR

10.

Work started 3/4/92 finished 3/5/92

11. DRILLERS CERTIFICATION

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name UNITED DRILLING INC Firm No. 414

Address P.O. BOX 2499 CDA, ID 83816 Date 3/5/92

Signed by (Firm Official) [signature]

and

(Operator) Tim Olkins

n 238-7

STATE OF IDAHO
DE RTMENT OF WATER RESOURCES

USE TYPE BALLP(**NG-5**

WELL DRILLER'S REPORT

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

RECEIVED AUG 14 1990 NORTHERN REGION IDWR

WELL OWNER

Name JEFF ANDREWS

Address P.O. BOX 275   2500 Nelt Gul Rd
COEUR D'ALENE, ID 83814   765-4020

Owner's Permit No. 95-90-N-86

NATURE OF WORK

☒ New well ☐ Deepened ☐ Replacement
☐ Well diameter increase
☐ Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

PROPOSED USE

☒ Domestic ☐ Irrigation ☐ Test ☐ Municipal
☐ Industrial ☐ Stock ☐ Waste Disposal or Injection
☐ Other ________ (specify type)

METHOD DRILLED

☐ Rotary ☐ Air ☐ Hydraulic ☐ Reverse rotary
☒ Cable ☐ Dug ☐ Other ________

WELL CONSTRUCTION

Casing schedule: ☒ Steel ☐ Concrete ☐ Other ________

Thickness	Diameter	From	To
.250 inches	6 inches	+1 feet	182 feet
inches	inches	feet	feet
inches	inches	feet	feet
inches	inches	feet	feet

Was casing drive shoe used? ☒ Yes ☐ No
Was a packer or seal used? ☐ Yes ☒ No
Perforated? ☐ Yes ☒ No
How perforated? ☐ Factory ☐ Knife ☐ Torch ☐ Gun
Size of perforation ____ inches by ____ inches

Number		From	To
	perforations	feet	feet
	perforations	feet	feet
	perforations	feet	feet

Well screen installed? ☒ Yes ☐ No
Manufacturer's name JOHNSON
Type ________ Model No. ________
Diameter 6 Slot size .040 Set from 182 feet to 187 feet
Diameter ____ Slot size ____ Set from ____ feet to ____ feet
Gravel packed? ☐ Yes ☐ No ☐ Size of gravel ________
Placed from ____ feet to ____ feet
Surface seal depth 20 Material used in seal: ☐ Cement grout ☒ Bentonite ☒ Puddling clay ☐
Sealing procedure used: ☐ Slurry pit ☐ Temp. surface casing ☒ Overbore to seal depth
Method of joining casing: ☐ Threaded ☒ Welded ☐ Solvent Weld ☐ Cemented between strata
Describe access port ________

7. WATER LEVEL

Static water level 155 feet below land surface
Flowing? ☐ Yes ☒ No G.P.M. flow ________
Artesian closed-in pressure ____ p.s.i.
Controlled by: ☐ Valve ☐ Cap ☐ Plug
Temperature ____ °F. Quality GOOD
Describe artesian or temperature zones below.

8. WELL TEST DATA

☐ Pump ☒ Bailer ☐ Air ☐ Other ________

Discharge G.P.M.	Pumping Level	Hours Pumped
8 ESTIMATED	175	3 HR

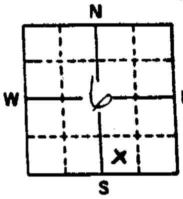
9. LITHOLOGIC LOG

Bore Diam.	Depth From	Depth To	Material	Water Yes	Water No
8	1	20	SURFACE SEAL		X
	1	3	TOPSOIL		X
	3	75	SILTY SAND		X
	76	132	SAND GRAVEL - CLAY		X
	137	158	SAND CLAY		X
	158	185	SAND WATER	X	

10. Work started 8/6/90 finished 8/13/90

6. LOCATION OF WELL

Sketch map location must agree with written location.



Subdivision Name ________
Lot No. ____ Block No. ____

County KOOTENAI
SW ¼ SE ¼ Sec. 26, T. 50N N☐ S☐ R. 3W E☐ W☐

11. DRILLERS CERTIFICATION

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name UNITED DRILLING INC. Firm No. 414
Address P.O. BOX 2499 Date 8/14/90
CDA ID 83814
Signed by (Firm Official) [signature]
and
(Operator) Richard Webb

Form 238-7
9/82

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

WELL DRILLER'S REPORT

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

NG-6

NG-8
USE TYPEWRITER OR BALLPOINT PEN
JUL 10 1991
NORTHERN REGION

1. WELL OWNER

Name TOM BIONDO

Address 2510 NETTLETON RD./CDA, IDAHO 83814

Owner's Permit No. 95-91-N-66

2. NATURE OF WORK

☒ New well ☐ Deepened ☐ Replacement

☐ Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

3. PROPOSED USE

☒ Domestic ☐ Irrigation ☐ Test ☐ Municipal

☐ Industrial ☐ Stock ☐ Waste Disposal or Injection

☐ Other ______ (specify type)

4. METHOD DRILLED

☒ Rotary ☐ Air ☐ Hydraulic ☐ Reverse rotary

☐ Cable ☐ Dug ☐ Other

5. WELL CONSTRUCTION

Casing schedule: ☒ Steel ☐ Concrete ☐ Other

Thickness	Diameter	From	To
.250 inches	6" inches	+1' feet	171' feet
inches	inches	feet	feet
inches	inches	feet	feet
inches	inches	feet	feet

Was casing drive shoe used? ☒ Yes ☐ No

Was a packer or seal used? ☐ Yes ☒ No

Perforated? ☐ Yes ☒ No

How perforated? ☐ Factory ☐ Knife ☐ Torch

Size of perforation ____ inches by ____ inches

Number		From	To
	perforations	feet	feet
	perforations	feet	feet
	perforations	feet	feet

Well screen installed? ☐ Yes ☒ No

Manufacturer's name

Type ______ Model No.

Diameter ____ Slot size ____ Set from ____ feet to ____ feet

Diameter ____ Slot size ____ Set from ____ feet to ____ feet

Gravel packed? ☐ Yes ☒ No ☐ Size of gravel

Placed from ____ feet to ____ feet

Surface seal depth 20' Material used in seal: ☐ Cement grout ☒ Bentonite ☐ Puddling clay ☐

Sealing procedure used: ☐ Slurry pit ☐ Temp. surface casing ☐ Overbore to seal depth

Method of joining casing: ☐ Threaded ☒ Welded ☐ Solvent Weld ☐ Cemented between strata

Describe access port

6. LOCATION OF WELL

Sketch map location must agree with written location.

N / W / E / S — X marked in sketch grid

Subdivision Name

Lot No. ____ Block No. ____

County KOOTENAI

7. WATER LEVEL

Static water level 120' feet below land surface.

Flowing? ☐ Yes ☒ No G.P.M. flow

Artesian closed-in pressure ____ p.s.i.

Controlled by: ☐ Valve ☐ Cap ☐ Plug

Temperature 55 °F. Quality EXCELLENT

Describe artesian or temperature zones below.

8. WELL TEST DATA

☐ Pump ☐ Bailer ☒ Air ☐ Other

Discharge G.P.M.	Pumping Level	Hours Pumped
30 GPM	AT 225'	1 HOUR

9. LITHOLOGIC LOG

Bore Diam.	Depth From	Depth To	Material	Water Yes	Water No
10"	0	20	SAND, MED.		
6"	20	45	SAND, MED		
6"	45	165	SAND & GRAVEL,COURSE -- W/CLAY @ 150'-159'		
6"	165	170	SHALE,VERY FRACTURED,-- GREY SHALE,MED.,SLIGHTLY FRAC.,GREY.	XX	
			6" DRIVE SHOE INSTALLED		
			1 HOUR DEVELOPMENT		
			EXCELLENT RECOVERY		

10.

Work started 6/13/91 finished 6/14/91

11. DRILLERS CERTIFICATION

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name VERMILLION WELL DRILLING, INC. Firm No. 467

Address OTIS ORCHARDS,WA. Date 6/28/91

Signed by (Firm Official) Keith D. Vermillion

and

(Operator) Same

Form 238-7
5/89

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

USE TYPEWRITER OR BALLPEN

NG-7

WELL DRILLER'S REPORT

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

1. WELL OWNER

Name: BRUCE STARR

Address: 515 Hanley cda

Owner's Permit No. 95-91-N-23

2. NATURE OF WORK

- [X] New well
- [ ] Deepened
- [ ] Replacement
- [ ] Well diameter increase
- [ ] Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

3. PROPOSED USE

- [X] Domestic
- [ ] Irrigation
- [ ] Test
- [ ] Municipal
- [ ] Industrial
- [ ] Stock
- [ ] Waste Disposal or Injection
- [ ] Other ______ (specify type)

4. METHOD DRILLED

- [X] Rotary
- [ ] Air
- [ ] Hydraulic
- [ ] Reverse rotary
- [ ] Cable
- [ ] Dug
- [ ] Other

5. WELL CONSTRUCTION

Casing schedule: [X] Steel [ ] Concrete [ ] Other PVC

Thickness	Diameter	From	To
.250 inches	6 inches	+ 1 feet	337 feet
.160 inches	4 inches	- 295 feet	- 335 feet
inches	inches	feet	feet
inches	inches	feet	feet

Was casing drive shoe used? [X] Yes [ ] No

Was a packer or seal used? [ ] Yes [X] No

Perforated? [X] Yes [ ] No

How perforated? [ ] Factory [ ] Knife [ ] Torch [ ] Gun (Lowered)

Size of perforation 1/4 inches by 6 inches

Number	From	To
120 perforations	335 feet	290 feet
perforations	feet	feet
perforations	feet	feet

Well screen installed? [ ] Yes [X] No

Manufacturer's name ______

Type ______ Model No. ______

Diameter ___ Slot size ___ Set from ___ feet to ___ feet

Diameter ___ Slot size ___ Set from ___ feet to ___ feet

Gravel packed? [ ] Yes [ ] No [ ] Size of gravel ______

Placed from ___ feet to ___ feet

Surface seal depth 20 Material used in seal: [ ] Cement grout [X] Bentonite [ ] Puddling clay [ ]

Sealing procedure used: [ ] Slurry pit [X] Temp. surface casing [ ] Overbore to seal depth

Method of joining casing: [ ] Threaded [X] Welded [ ] Solvent Weld [ ] Cemented between strata

Describe access port ______

6. LOCATION OF WELL

Sketch map location must agree with written location.

(Sketch map: section grid with N, S, E, W; X marked in the SE quarter, SW part)

Subdivision Name ______

Lot No. ___ Block No. ___

County ______

SW ¼ SE ¼ Sec. 6, T. 50 N, R. 3 W

7. WATER LEVEL

Static water level 135 feet below land surface.

Flowing? [ ] Yes [X] No G.P.M. flow ______

Artesian closed-in pressure ______ p.s.i.

Controlled by: [ ] Valve [ ] Cap [ ] Plug

Temperature ___ °F. Quality ______

Describe artesian or temperature zones below.

8. WELL TEST DATA

- [ ] Pump
- [ ] Bailer
- [X] Air
- [ ] Other

Discharge G.P.M.	Pumping Level	Hours Pumped
20 GPM	By Air	

9. LITHOLOGIC LOG

Bore Diam.	Depth From	Depth To	Material	Water Yes	Water No
10"	0	35	Brown Sandy top Soil		X
8"	35	47	Brown Gravel Sand Sand		X
8"	47	170	Sand Brown Clay Little water at 130 ft	X	
6"	170	240	Sand and Silt & Brown Clay	X	
	240	335	Soft Blue Shale (water)	X	

The Well has 120 foot of 4" PVC 40' of it is Perforated

RECEIVED
APR 12 1991
Department of Water Resources

RECEIVED
APR 05 1991
NORTHERN REGION
I.W.R.

10.

Work started 3-30-91 finished 4-2-91

11. DRILLERS CERTIFICATION

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name H2O Well Service Firm No. 448

Address Hayden Idaho Date 4-3-91

Signed by (Firm Official) [signature]

and

(Operator) John Wheeler

Form 238-7
9/82

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

NG-11

WELL DRILLER'S REPORT

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

1. WELL OWNER

Name Milton H. Fritze
Address 3150 Shaw Loop Road
Coeur d'Alene. ID 83814

Owner's Permit No. 95-85-N-46

2. NATURE OF WORK

☒ New well ☐ Deepened ☐ Replacement
☐ Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

3. PROPOSED USE

☒ Domestic ☐ Irrigation ☐ Test ☐ Municipal
☐ Industrial ☐ Stock ☐ Waste Disposal or Injection
☐ Other ______ (specify type)

4. METHOD DRILLED

☒ Rotary ☒ Air ☐ Hydraulic ☐ Reverse rotary
☐ Cable ☐ Dug ☐ Other ______

5. WELL CONSTRUCTION

Casing schedule: ☒ Steel ☐ Concrete ☐ Other ______

Thickness		Diameter		From		To	
.250	inches	6	inches	+ 1	feet	103	feet
	inches		inches		feet		feet
	inches		inches		feet		feet
	inches		inches		feet		feet

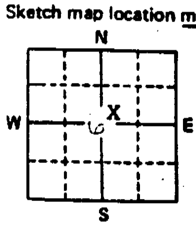
Was casing drive shoe used? ☒ Yes ☐ No
Was a packer or seal used? ☐ Yes ☒ No
Perforated? ☐ Yes ☒ No
How perforated? ☐ Factory ☐ Knife ☐ Torch
Size of perforation ______ inches by ______ inches

Number		From		To	
	perforations		feet		feet
	perforations		feet		feet
	perforations		feet		feet

Well screen installed? ☐ Yes ☒ No
Manufacturer's name ______
Type ______ Model No. ______
Diameter ___ Slot size ___ Set from ___ feet to ___ feet
Diameter ___ Slot size ___ Set from ___ feet to ___ feet
Gravel packed? ☐ Yes ☒ No ☐ Size of gravel ______
Placed from ______ feet to ______ feet
Surface seal depth 18 Material used in seal: ☐ Cement grout ☒ Bentonite ☐ Puddling clay ☐
Sealing procedure used: ☐ Slurry pit ☐ Temp. surface casing ☒ Overbore to seal depth
Method of joining casing: ☐ Threaded ☒ Welded ☐ Solvent Weld
☐ Cemented between strata
Describe access port ______

6. LOCATION OF WELL

Sketch map location must agree with written location.



Subdivision Name
Thomas Gardens
the $S\frac{1}{2}$
Lot No. 1 & 2 Block No. B

County KOOTENAI

7. WATER LEVEL

Static water level 108 feet below land surface.
Flowing? ☐ Yes ☒ No G.P.M. flow ______
Artesian closed-in pressure ______ p.s.i.
Controlled by: ☐ Valve ☐ Cap ☐ Plug
Temperature ______ °F. Quality ______
Describe artesian or temperature zones below.

8. WELL TEST DATA

☐ Pump ☐ Bailer ☒ Air ☐ Other ______

Discharge G.P.M.	Pumping Level	Hours Pumped
7 GPM - ESTIMATED AIRLIFT		

9. LITHOLOGIC LOG

Bore Diam.	Depth From	Depth To	Material	Water Yes	Water No
10	0	10	Sand, fine		X
10	10	18	Sand, course		X
6	18	52	Sand, course; gravel; boulders		X
6	52	70	Clay, brown		X
6	70	75	Gravel, fine		X
6	75	100	Clay, brown		X
6	100	104	Gravel, fine	X	X
6	104	130	Shale, blue-green		X
6	130	190	Shale, blue-green	X	
6	190	220	Shale, blue-green		X
			200' PVC Liner Installed		
			6" Drive shoe installed		

RECEIVED SEP 12 1985 Department of Water Resources

RECEIVED SEP 12 1985 Department of Water Resources Northern District Office

MICROFILMED

10. Work started 8/28/85 finished 8/29/85

11. DRILLERS CERTIFICATION

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name PONDEROSA DRILLING Firm No. 228
Address E. 6010 Broadway
Spokane, WA 99212 Date 8/29/85

Signed by (Firm Official) W. Scott Barratt
and
(Operator) [signature]

NG-A

Form 238-7
9/82

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES

USE TYPEWRITER OR BALLPOINT PEN

WELL DRILLER'S REPORT

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

1. WELL OWNER

Name AL Harrison

Address 1208 N. 2nd. CDA.

Owner's Permit No. 95-86-N-69

2. NATURE OF WORK

☒ New well ☐ Deepened ☐ Replacement
☐ Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

3. PROPOSED USE

☒ Domestic ☐ Irrigation ☐ Test ☐ Municipal
☐ Industrial ☐ Stock ☐ Waste Disposal or Injection
☐ Other ______ (specify type)

4. METHOD DRILLED

☒ Rotary ☒ Air ☐ Hydraulic ☐ Reverse rotary
☐ Cable ☐ Dug ☐ Other ______

5. WELL CONSTRUCTION

Casing schedule: ☐ Steel ☐ Concrete ☐ Other ______

Thickness		Diameter		From		To	
.250	inches	6	inches	+ 1½	feet	60	feet
	inches		inches		feet		feet
160	inches	4"	inches PVC	40	feet	540	feet
	inches		inches		feet		feet

Was casing drive shoe used? ☒ Yes ☐ No
Was a packer or seal used? ☐ Yes ☒ No
Perforated? ☐ Yes ☒ No
How perforated? ☐ Factory ☐ Knife ☐ Torch
Size of perforation ______ inches by ______ inches

Number		From		To	
	perforations		feet		feet
	perforations		feet		feet
	perforations		feet		feet

Well screen installed? ☐ Yes ☒ No
Manufacturer's name ______
Type ______ Model No. ______
Diameter ___ Slot size ___ Set from ___ feet to ___ feet
Diameter ___ Slot size ___ Set from ___ feet to ___ feet
Gravel packed? ☐ Yes ☐ No ☐ Size of gravel ______
Placed from ______ feet to ______ feet
Surface seal depth 60 Material used in seal: ☐ Cement grout ☒ Bentonite ☐ Puddling clay ☒ cuttings
Sealing procedure used: ☐ Slurry pit ☐ Temp. surface casing ☒ Overbore to seal depth
Method of joining casing: ☐ Threaded ☒ Welded ☐ Solvent Weld ☐ Cemented between strata
Describe access port None

6. LOCATION OF WELL

Sketch map location must agree with written location.

(Sketch map: N, W, E, S — X marked in NE portion)

Subdivision Name ______
Lot No. ______ Block No. ______

County Kootenai

SE ¼ NE ¼ Sec. 6, T. 50 N/S, R. 3 E/W.

7. WATER LEVEL

Static water level 250' feet below land surface.
Flowing? ☐ Yes ☒ No G.P.M. flow ______
Artesian closed-in pressure ______ p.s.i.
Controlled by: ☐ Valve ☐ Cap ☐ Plug
Temperature [illegible] °F. Quality [illegible]
Describe artesian or temperature zones below.

8. WELL TEST DATA

☐ Pump ☐ Bailer ☒ Air ☐ Other ______

Discharge G.P.M.	Pumping Level	Hours Pumped
Estimated 50 plus	540	2 HRS.

9. LITHOLOGIC LOG

Bore Diam.	Depth From	Depth To	Material	Water Yes	Water No
8	0	60	overburden - clay		X
6	60	250	Soft Basalt.	X	
6	250	300	Slate.		X
6	300	540	Very soft Basalt	X	
			Bulk of the water At 525		

RECEIVED OCT 23 1986 Department of Water Resources Northern District Office

RECEIVED OCT 23 1986 Department of Water Resources

10. Work started 6-6-86 finished 6-7-86

11. DRILLERS CERTIFICATION

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name United Drilling Firm No. 414

Address P.O. Box 2497 CDA Date 6-25-86

Signed by (Firm Official) [signature]

and

(Operator) Tim Volking

USE ADDITIONAL SHEETS IF NECESSARY — FORWARD THE WHITE COPY TO THE DEPARTMENT

Form 238-7
9/82

NG-C

STATE OF IDAHO
DEPARTMENT OF WATER RESOURCES
WELL DRILLER'S REPORT

USE TYPEWRITER OR BALLPOINT PEN

State law requires that this report be filed with the Director, Department of Water Resources within 30 days after the completion or abandonment of the well.

RECEIVED MAY 1984

1. WELL OWNER
Department of Water Resources

Name Allan Sater

Address 3640 Government Way Box 20
Coeur d'Alene Id. 83814

Owner's Permit No. 95-84-N-69

2. NATURE OF WORK

☒ New well ☐ Deepened ☐ Replacement
☐ Abandoned (describe abandonment procedures such as materials, plug depths, etc. in lithologic log)

3. PROPOSED USE

☒ Domestic ☐ Irrigation ☐ Test ☐ Municipal
☐ Industrial ☐ Stock ☐ Waste Disposal or Injection
☐ Other ______ (specify type)

4. METHOD DRILLED

☒ Rotary ☐ Air ☐ Hydraulic ☐ Reverse rotary
☐ Cable ☐ Dug ☐ Other

5. WELL CONSTRUCTION

Casing schedule: ☒ Steel ☐ Concrete ☐ Other 4" PVC

Thickness	Diameter	From	To
.250 inches	6 inches +	1 feet	59 feet
PVC 160 inches	4 inches	-55 feet	175 feet
inches	inches	feet	feet
inches	inches	feet	feet

Was casing drive shoe used? ☒ Yes ☐ No
Was a packer or seal used? ☐ Yes ☒ No
Perforated? ☒ Yes ☐ No
How perforated? ☐ Factory ☒ Knife ☐ Torch
Size of perforation 1/16 inches by 3 inches

Number		From	To
20	perforations	135 feet	155 feet
20	perforations	95 feet	115 feet
	perforations	feet	feet

Well screen installed? ☐ Yes ☒ No
Manufacturer's name
Type ______ Model No.
Diameter ___ Slot size ___ Set from ___ feet to ___ feet
Diameter ___ Slot size ___ Set from ___ feet to ___ feet
Gravel packed? ☐ Yes ☒ No ☐ Size of gravel
Placed from ______ feet to ______ feet
Surface seal depth 25 Material used in seal: ☐ Cement grout ☒ Bentonite ☐ Puddling clay ☐ cuttings
Sealing procedure used: ☐ Slurry pit ☐ Temp. surface casing ☒ Overbore to seal depth
Method of joining casing: ☐ Threaded ☒ Welded ☐ Solvent Weld ☐ Cemented between strata
Describe access port

6. LOCATION OF WELL

Sketch map location must agree with written location.

(Section grid, N/S/E/W, marked X in NE corner, section 6)

Subdivision Name
Lot No. ______ Block No. ______

County Kootenai

NE ¼ NE ¼ Sec. 6, T. 50 (N)/S, R. 3 E/(W).

7. WATER LEVEL

Static water level 25 feet below land surface.
Flowing? ☐ Yes ☒ No G.P.M. flow
Artesian closed-in pressure ______ p.s.i.
Controlled by: ☐ Valve ☒ Cap ☐ Plug
Temperature Cold °F. Quality Excellent
Describe artesian or temperature zones below.

8. WELL TEST DATA

☐ Pump ☐ Bailer ☒ Air ☐ Other

Discharge G.P.M.	Pumping Level	Hours Pumped
7.5	variable	½ hr

9. LITHOLOGIC LOG

Bore Diam.	Depth From	Depth To	Material	Water Yes	Water No
8	0	4	TopSoil		X
	4	9	Shale Gravel		X
	4	51	Brown Shale		X
	51	59	Grey Shale		X
6	59	175	Grey Shale	X	
			1.5 GPM at 118		
			3.0 GPM at 150		
			3.0 GPM at 175		

RECEIVED MAY 10 1984 Department of Water Resources Northern District Office

10. Work started 1/31/84 finished 1/31/84

11. DRILLERS CERTIFICATION

I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name Associated Well Drillers Inc Firm No. 245

Address Bx 723 C.DA Date 1/31/84

Signed by (Firm Official) [signature] agent

and

(Operator) [signature]

USE ADDITIONAL SHEETS IF NECESSARY — FORWARD THE WHITE COPY TO THE ...

NG-B

238-7

IDAHO DEPARTMENT OF WATER RESOURCES
WELL DRILLER'S REPORT
Use Typewriter or Ballpoint Pen

Office Use Only
Inspected by ______
Twp ____ Rge ____ Sec ____
____ 1/4 ____ 1/4 ____ 1/4
Lat: : : Long: : :

1. DRILLING PERMIT NO. 95-96-N-180-000
Other IDWR No. ______

2. OWNER
Name CLEMONS, KEITH   **Well Number:** 515
Address 3301 NETTLETON GULCH
City CDA   State ID   Zip 83814

3. LOCATION OF WELL by legal description
sketch map location must agree with written location

Twp. 50 ☒ North or ☐ South
Rge. 03 ☐ East or ☒ West
Sec. 06 ____ 1/4 NE 1/4 SE 1/4
Gov't Lot ______ County KOOTENAI
Lat: : : Long: : :
Address of Well Site 3301 NETTLETON
City CDA
(Give at least name of road + Distance to Road or Landmark)
Lt. ______ Blk. ______ Sub. Name ______

4. USE:
☒ Domestic ☐ Municipal ☐ Monitor ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other ______

5. TYPE OF WORK check all that apply (Replacement, etc.)
☒ New Well ☐ Modify ☐ Abandonment ☐ Other ______

6. DRILL METHOD
☒ Air Rotary ☐ Cable ☐ Mud Rotary ☐ Other ______

7. SEALING PROCEDURES

SEAL/FILTER PACK			AMOUNT	METHOD
Material	From	To	Sacks or Pounds	
BENTONITE	0	18	6 Sacks	Dry

Was drive shoe used? ☒ Y ☐ N Shoe Depth(s) 155
Was drive shoe seal tested? ☐ Y ☐ N How? ______

8. CASING/LINER:

Diameter	From	To	Gauge	Material	Casing	Liner	Welded	Threaded
6	+2	155	.250	STEEL	☒	☐	☒	☐
4	-120	600	.160	PVC	☐	☒	☐	☐

Length of Headpipe ______ Length of Tailpipe ______

9. PERFORATIONS/SCREENS
☒ Perforations Method SKILLSAW
☐ Screens Screen Type ______

From	To	Slot Size	Number	Diameter	Material	Casing	Liner
560	100	1/8X6	120	4	PVC	☐	☒

10. STATIC WATER LEVEL OR ARTESIAN PRESSURE:
550 ft. below ground Artesian pressure ______ lb.
Depth flow encountered ______ ft. Describe access port or control devices: ______

NESE 6 50N 3W

11. WELL TESTS:
☐ Pump ☐ Bailer ☒ Air ☐ Flowing Artesian

Yield gal./min.	Drawdown	Pumping Level	Time
1 GPM			

Water Temp. ______ Bottom Hole Temp ______
Water Quality test or comments: ______
______ Depth first Water encountered ______

12. LITHOLOGIC LOG:(Describe repairs or abandonment)

Bore Diam	From	To	Remarks: Lithology, Water Quality, Temperature	Water Y	Water N
8	0	3	Topsoil	☐	☒
8	3	18	Gravels Sand	☐	☒
6	18	70	Gravels Sand	☐	☒
6	70	125	Cemented Gravels Some Sand	☐	☒
6	125	135	Gravels Sand clay Brown	☐	☒
6	135	155	Gravels Gray Clay Moist	☐	☒
6	155	180	Shale Gray Soft To Medium	☐	☒
6	180	283	Shale Gray Medium	☐	☒
6	283	289	Shale Green Medium	☐	☒
6	289	357	Shale Gray Medium	☐	☒
6	357	430	Shale Gray Medium Trace H20 428	☒	☐
6	430	520	Shale Greenish Gray Medium	☒	☐
6	520	600	Shale Gray Green Some White Mediu	☐	☒

Completed Depth 600' (Measurable)
Date: Started 12/10/96 Completed 12/12/96

13. DRILLER'S CERTIFICATION
I/We certify that all minimum well construction standards were complied with at the time the rig was removed.

Firm Name H20 WellService, Inc. Firm No. 448
Firm Official [signature] Date 12-16-96
and
Supervisor or Operator: [signature] Date 12-16-96
(Sign Once if Firm Offical and Operator)

Appendix 2

Standard operating procedures (Ground Water and Soils Quality Assurance Project Plan (QAPP) Development Manual, Idaho Department of Health and Welfare Division of Environmental Quality Community Programs, December 22, 1993):

- Measuring the depth to ground water
- Collecting a ground water sample
- Using the conductivity meter
- Using the pH meter

Description of field instruments:

- Orion conductivity meter
- Corning pH meter

Appendix 3

Rathdrum Prairie Aquifer
Water Quality Data
Panhandle Health District July 1997

Panhandle [illegible] th District 1 — Aquifer Sampling Results — Location: K[illegible] [illegible] County — Date collected 7/29/97 — Coordinator: J. Lawlor Martindale

NO	WELLNAME	PHD #	Ca	So$_4$	ORTHP	Fl	Na	K	Mg	NO_2 NO_3 as N	Cl	TEMP C°	COND µ mhos/cm	pH	Purgable Halocarbons VOC'S
			INORGANICS (ppm)												
1	SILVER W.A.*	126	37	<10	<0.01	<12	2.9	2	9.5	0.454	1.5	10	190	7.57	No VOC's Detected
3	FARRAGUT	118	29	15	<0.01	<12	3.1	2.2	13.8	0.166	2	13	205	7.38	
5	ATHOL	119	29	15	<01	<12	3	1.7	11.8	0.227	1	20	225	7.12	
8	SPIRIT LAKE #3	120	10	<10	0.01	<12	2.2	0.8	0.6	0.133	1	11	30	7.55	
23	PINE ST. WELL (FORMALLY RATHDRUM DOG POUND)	121	45	<10	0.01	<12	2.9	1.8	8.7	1.23	3.5	11	250	7.29	
25	L.A. ALUMINUM*	125	26	<10	<01	<12	3.2	1.6	10.2	1.08	2	11	190	7.36	No VOC's Detected
27	DALTON #1	111	19	<10	0.02	<12	2.6	1.3	6	0.282	2	10	110	7.73	
28	CDA 4TH STREET	99	30	11	<0.01	<12	2.6	1.6	11.2	0.971	3	13	185	7.49	
29	CDA LOCUST*	100	32	11	<0.01	<12	2.7	1.7	9.6	0.954	3	15	185	7.21	No VOC's Detected
30	CDA - LINDEN STREET	101	34	10	<0.01	<12	2.7	1.5	6.6	0.868	3	14	170	7.36	
31	CDA ATLAS	102	38	14	<0.01	<12	3.4	2.2	12.9	1.48	11	13	235	7.35	
32	CDA - HANLEY*	127	40	12	0.05	<12	4	2.4	19	1.25	4	12	260	7.49	5.4 Trichloroethylene Detected No other VOC's Detected
34	ROSSPT- HWY 41	123	21	<10	<.01	<12	2.5	1.8	6.9	0.975	2.5	17	150	7.41	
35	P.F. GREENSFERRY #4	103	21	<10	0.01	<12	2.8	2	5.5	0.801	1.5	15	130	6.1**	
36	ROSSPOINT-SYRINGA	115	21	11	<.01	<12	2.6	1.8	9.7	0.881	1	16	155	7.44	
37	P.F.- IDAHO RD. #3	104	21	12	<0.01	<12	2.5	1.7	12.4	1.13	2	16	170	6.8**	
38	P.F.- S. OF TENNIS #2*	107	22	16	0.01	<12	2.5	1.5	8.1	0.647	1	15	155	7.53	
39	P.F.- N. OF TENNIS #1	106	26	15	<0.01	<12	2.8	2.1	12.5	1.85	2	14	185	7.56	No VOC's Detected
40	P.F. MAJESTIC*	128	6	<10	0.01	<12	1.7	1	1.6	0.145	0.5	12	42**	5.9**	No VOC's Detected
43	MT. VIEWTERRACE	113	35	16	<0.01	<12	3	2.2	14.5	2.22	2.5	17	220	7.19	
44	PACIFIC SUPPLY COOP *	114	30	16	0.01	<12	3	2.1	13.8	1.27	2	11	200	7.29	
129	POST FALLS - MULLAN # 6*	129	22	<10	<0.01	<12	2.9	1.6	5.8	1.14	1.5	15	140	7.55	
134	EAST GREENACRES	112	38	18	0.01	<12	3.2	2.2	18.5	1.77	1.5	12	245	7.48	RECEIVED
190	HAYDEN PINES	109	17	<10	<0.01	<12	2.3	0.9	3	0.086	1	11	90	7.7	OCT - 9 1997
194	USFS NURSERY	117	46	10	<0.01	<12	3.5	2.8	9.4	0.551	5	14	215	7.48	IDHW-DEQ
213	S. RIVER WATER ASSN	108	30	14	0.01	<12	5.1	1.8	4	5.12	5	14	185	7.2	Coeur d'Alene Field Office
249	GRANGE WELL (FORMALLY RATHDRUM-NEWWELL*)	122	32	<10	<.01	<12	5.4	2	9.1	2.11	4	11	180	7.44	No VOC's Detected
253	P.F. POLELINE #5	105	24	14	<0.01	<12	2.9	1.8	10.7	1.37	2.5	14	170	7.62	
262	TURREL*	116	10	<10	<0.01	<12	2.4	1.4	2.6	0.109	0.5	15	65	7.25	No VOC's Detected

c:\[illegible]\sampling\7-29-97.wpd\10\97\sd

*Purgable Halocarbons being sampled

**Meter may not have been working properly