A PROPOSED GROUND WATER QUALITY MONITORING NETWORK FOR IDAHO

By R. L. Whitehead and D. J. Parliman

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CONTENTS

ILLUSTRATIONS

TABLES

TABLES (Continued)

CONVERSION FACTORS

For the convenience of those who prefer to use International System (SI) units, rather than inch-pound units, conversion factors for terms used in this report are listed below. Chemical data for concentrations are given in mg/L (milligrams per liter) or µg/L (micrograms per liter), which are (within the range of values presented) numerically equal to parts per million or parts per billion, respectively.

Multiply Inch-Pound Unit	By	To Obtain SI Unit
	Length	
inch (in)	25.40	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre	4047	square meter (m^2)
	Volume	
acre-foot (acre-ft)	1233	cubic meter (m^3)
	Rate	
gallon per day (gal/d)	3.785	liter per day (L/d)
gallon per minute (gal/min)	0.06309	liter per second (L/s)

LIST OF ABBREVIATIONS

DOE--------U.S. Department of Energy
EPA--------U.S. Environmental Protection Agency
HPI--------Hydrologic priority index
HU---------Hydrologic unit
IDHW-------Idaho Department of Health and Welfare, Division of Environment
IDWR-------Idaho Department of Water Resources
INEL-------Idaho National Engineering Laboratory
RMA--------Responsible monitoring agency
STORET-----Storage and Retrieval System (EPA computer system)
USBR-------U.S. Bureau of Reclamation
USGS-------U.S. Geological Survey
WATSTORE--National Water Data Storage and Retrieval System (USGS automatic data-processing and retrieval system)

Data are given for laboratory analyses, field analyses, number of site visits, manpower, subsistence, and mileage, from which costs of implementing the statewide network and the alternative levels of monitoring can be estimated. Suggestions also are made for data storage and retrieval and for reporting changes in ground-water quality.

INTRODUCTION

Use of ground water for public and private supplies, industry, and irrigation is increasing in Idaho. Some aquifers are undesirably stressed by poor waste-disposal practices and by heavy withdrawals. There presently is no satisfactory means to evaluate the effects that these stresses have on the ground-water resources in the State. A ground-water-quality monitoring network that focuses on protection of water in major aquifers (water-bearing formations) would provide the means to make this evaluation.

The EPA, in compliance with section 208 of the Federal Water Pollution Control Act, 1972 (Public Law 92-500), requires States to establish water-quality-management plans. The IDHW is responsible for the "208 program" in Idaho and, in October 1976, requested the USGS to design a ground-water-quality monitoring network that would help the State meet its responsibility. In response to these needs, the USGS, in cooperation with the IDHW, undertook a 2-year study to evaluate the physical aspects of ground-water occurrence as they relate to potential sources of pollution of the water resources. Results of the study are described in this report, which culminates in design of a monitoring network for the State. The network offers a choice of several levels of monitoring coverage. Selection of which level to implement is left to the responsible State agency.

Purpose and Scope

The primary purposes of this report are to (1) describe and present the results of a 2-year study leading to the design of a proposed ground-water-quality monitoring network for Idaho, and (2) present the specifics of the proposed network, which include location of sampling sites, schedules and costs for sampling, and means for storing, retrieving, and reporting monitoring results.

The scope of study is comprehensive in that all major aquifers in the State are considered for water-quality monitoring. However, location of network sites is based mainly on monitoring of nonpoint sources of pollution. Monitoring of point sources of pollution would require detailed local investigations and specially constructed monitoring wells.

Site-Numbering System

The site-numbering system used by the USGS in Idaho for wells and springs indicates the location, within the official rectangular subdivisions of the public lands, with reference to the Boise base line and meridian. The first two segments of the number designate the township and range. The third segment gives the section number, followed by three letters and a numeral, which indicate the quarter section, the 40-acre tract, the 10-acre tract, and the serial number of the site within the tract, respectively. Quarter sections are lettered a, b, c, and d, in counterclockwise order from the northeast quarter of each section (fig. 1). Within the quarter sections, 40-acre and 10-acre tracts are lettered in the same manner. Well 2N-37E-14ccc1 is in the SW¼SW¼SW¼, sec. 14, T. 2 N., R. 37 E., and was the first well inventoried in that tract. Springs are designated by the suffix "S"--for example, 14ccc1S.

In addition, a unique identification number is assigned to each site. This number is based on the site's location with respect to latitude and longitude. For example, well 2N-37E-14ccc1 is at latitude 43°29'52" and longitude 112° 04'53". For each site that falls within this location, the sequential number is assigned and placed at the end. Therefore, its unique identification number is 432952112045301. Once this identification number is assigned to a site, it should not be changed, even if more accurate maps permit a different latitude-longitude assignment.

This site-location system provides a good base for correlative purposes. The addition of simple, descriptive sketches or road logs is necessary for each site to insure subsequent sampling.

Some spring sites in the USGS data base are assigned a number in downstream order in accordance with the surface-water-station numbering system used by the Geological Survey. Numbers are assigned in a downstream direction along the main stream, and stations on tributaries between main-stream stations are numbered in the order they enter the main stream. The complete 8-digit number, such as 13153400 (Malad Springs near Hagerman), includes a part number "13," indicating that Malad Springs is in the Snake River basin,

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ABSTRACT

A proposed ground-water-quality monitoring network for Idaho, which focuses on protection of the water in major aquifers, comprises 565 sites--557 are at existing wells and springs; 8 will require new wells to be drilled. Frequencies of sampling assigned are quarterly, semiannual, annual, and 5 years at the different sites. Selected chemical and physical properties in the ground water will be monitored by using both laboratory- and field-analysis methods.

Primary objectives of the network are to (1) enable water managers to keep abreast of the general quality of the State's ground water, and (2) serve as a warning system for undesirable changes in ground-water quality.

Data were compiled for hydrogeologic conditions, ground-water quality, cultural elements, and pollution sources. A "hydrologic unit priority index" was calculated from these data to rank 84 areas (hydrologic units) of the State for monitoring according to pollution potential. Emphasis for selection of monitoring sites is on the 15 highest ranked areas. Twenty-seven of the 84 areas are ranked low and are not now considered for monitoring in the proposed network. In anticipation of funding and manpower limitations, three alternative levels of monitoring are proposed: (1) Monitor the 15 highest ranked areas, 426 sites; (2) monitor the 10 highest ranked areas, 350 sites; and (3) monitor the 5 highest ranked areas, 233 sites. Regardless of the level of monitoring adopted, it is suggested that all sites should be monitored at least once every 5 years.

Ground-water-quality data were added to the Geological Survey's storage and retrieval system, WATSTORE (National Water Data Storage and Retrieval System), which presently (1979) contains water-quality data for more than 2,200 wells and springs in Idaho.

Potential for pollution is greatest in areas of privately owned agricultural land. Other areas of pollution potential are residential development, mining and its related processes, and hazardous waste disposal.

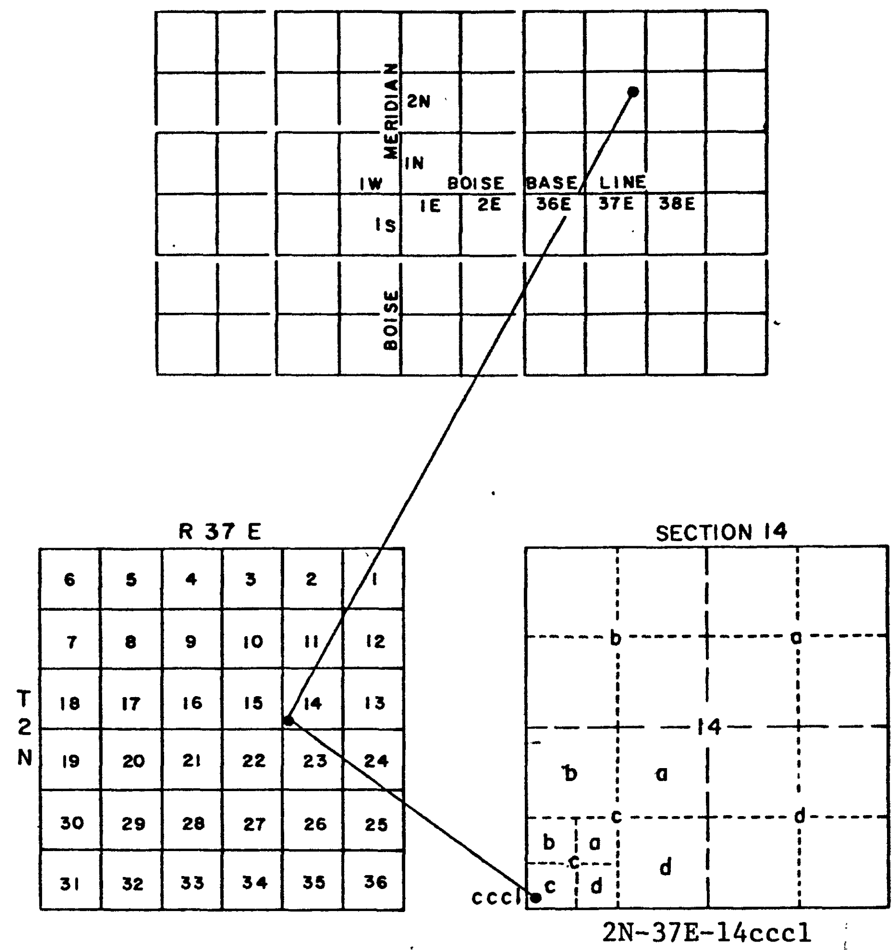

Figure 1. Diagram showing site-numbering system.

plus a 6-digit downstream order number "153400." Only two other part numbers are used for Idaho stations. They are numbers "12" and "10," which designate that the stations are in the Pend Oreille River and Bear River basins, respectively.

Acknowledgments

Information necessary for successful completion of this project was furnished by public and private agencies and landowners. The Idaho Department of Health and Welfare, Division of Environment, supplied data on sources and types of wastes and on water quality for public water systems in Idaho. The Idaho Department of Water Resources furnished drillers' logs, data for updating irrigated acreages in the State, and data on waste-disposal wells. Personnel at the Idaho National Engineering Laboratory provided data concerning waste-disposal and monitoring practices involved in their operations. To all the above, the authors are grateful.

FACTORS CONSIDERED IN NETWORK DESIGN

Considerable preliminary work was done before a network to monitor the State's ground-water quality could be designed. The work included determining the status of existing ground-water-quality information, defining aquifer systems and direction of ground-water movement, locating areas of potential pollution and defining types of associated wastes, ranking areas for monitoring, and considerations for monitoring assurance. The ranked areas consist of HU's (U.S. Geological Survey, 1974), which delineate river basins, or segments of river basins in the State (see fig. 2 and table 1). These units divide the State into relatively small areas which facilitate the network design. The preliminary work is described in the following sections of this report.

Status of Ground-Water-Quality Information in Idaho

Data for ground-water quality in many areas in Idaho are relatively sparse and monitoring networks are few. The closest program to statewide coverage is that of the IDHW, which requires that each public water-supply utility provide samples for water-quality analysis upon initial installation and periodically thereafter.

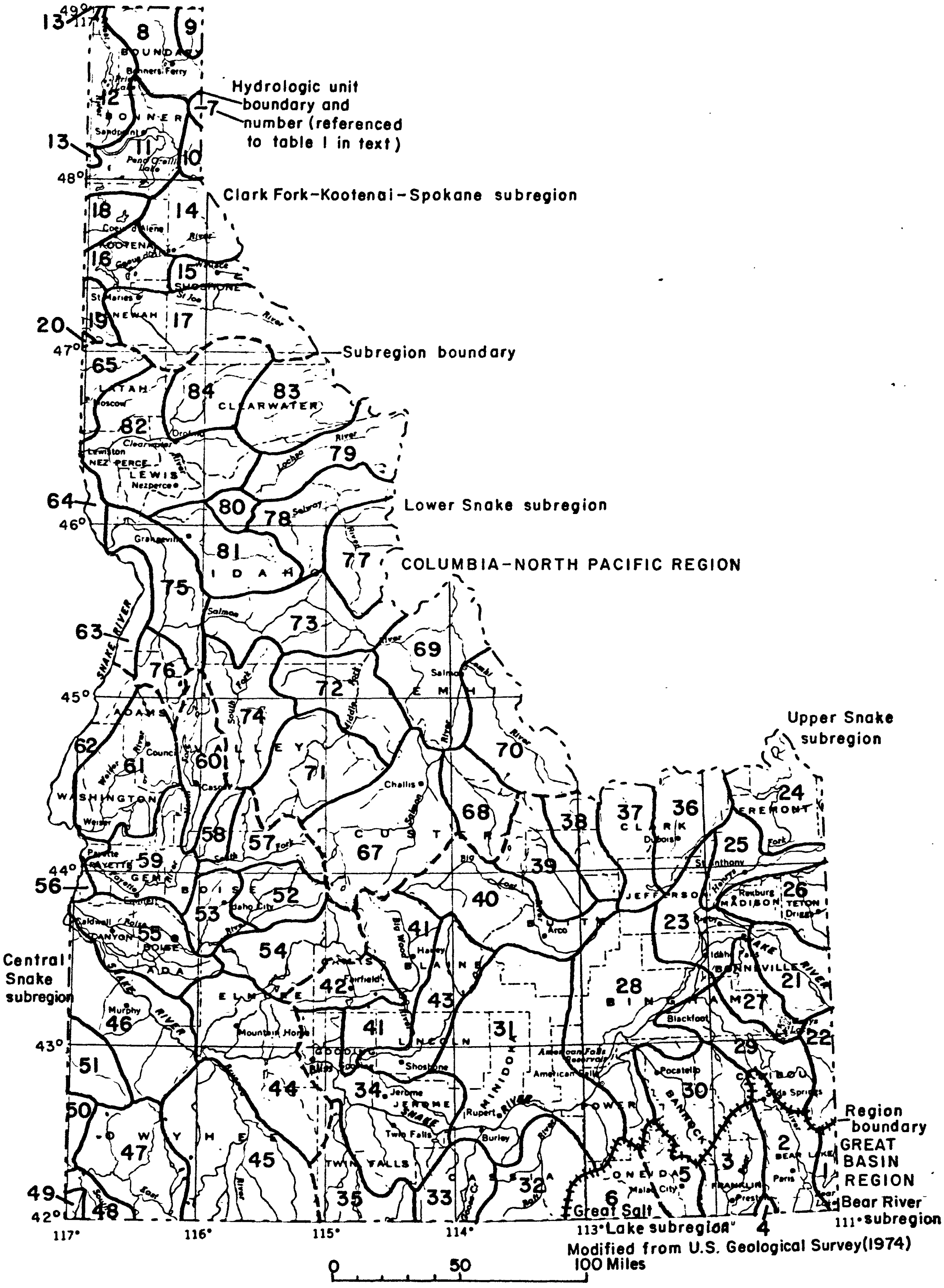

Figure 2. Hydrologic units in Idaho.
(Refer to table 1 for hydrologic unit code and name.)

Table 1.—Hydrologic units in Idaho

Region	Subregion	Number[1]	Code[2]	Name[3]
Great Basin Region	Bear River Subregion	1	16-01-01-02	Central Bear
Great Basin Region	Bear River Subregion	2	16-01-02-01	Bear Lake
Great Basin Region	Bear River Subregion	3	16-01-02-02	Middle Bear
Great Basin Region	Bear River Subregion	4	16-01-02-03	Little Bear—Logan
Great Basin Region	Bear River Subregion	5	16-01-02-04	Lower Bear—Malad
Great Basin Region	Great Salt Lake Subregion	6	16-02-03-09	Curlew Valley
Columbia-North Pacific Region	Clark Fork-Kootenai-Spokane Subregion	7	17-01-01-01	Upper Kootenai
Columbia-North Pacific Region	Clark Fork-Kootenai-Spokane Subregion	8	17-01-01-04	Lower Kootenai
Columbia-North Pacific Region	Clark Fork-Kootenai-Spokane Subregion	9	17-01-01-05	Moyie
Columbia-North Pacific Region	Clark Fork-Kootenai-Spokane Subregion	10	17-01-02-13	Lower Clark Fork
Columbia-North Pacific Region	Clark Fork-Kootenai-Spokane Subregion	11	17-01-02-14	Pend Oreille Lake
Columbia-North Pacific Region	Clark Fork-Kootenai-Spokane Subregion	12	17-01-02-15	Priest
Columbia-North Pacific Region	Clark Fork-Kootenai-Spokane Subregion	13	17-01-02-16	Pend Oreille
Columbia-North Pacific Region	Clark Fork-Kootenai-Spokane Subregion	14	17-01-03-01	Upper Coeur d'Alene
Columbia-North Pacific Region	Clark Fork-Kootenai-Spokane Subregion	15	17-01-03-02	South Fork Coeur d'Alene
Columbia-North Pacific Region	Clark Fork-Kootenai-Spokane Subregion	16	17-01-03-03	Coeur d'Alene Lake
Columbia-North Pacific Region	Clark Fork-Kootenai-Spokane Subregion	17	17-01-03-04	St. Joe
Columbia-North Pacific Region	Clark Fork-Kootenai-Spokane Subregion	18	17-01-03-05	Upper Spokane
Columbia-North Pacific Region	Clark Fork-Kootenai-Spokane Subregion	19	17-01-03-06	Hangman
Columbia-North Pacific Region	Clark Fork-Kootenai-Spokane Subregion	20	17-01-03-08	Little Spokane
Columbia-North Pacific Region	Upper Snake Subregion	21	17-04-01-04	Palisades
Columbia-North Pacific Region	Upper Snake Subregion	22	17-04-01-05	Salt
Columbia-North Pacific Region	Upper Snake Subregion	23	17-04-02-01	Idaho Falls
Columbia-North Pacific Region	Upper Snake Subregion	24	17-04-02-02	Upper Henrys
Columbia-North Pacific Region	Upper Snake Subregion	25	17-04-02-03	Lower Henrys
Columbia-North Pacific Region	Upper Snake Subregion	26	17-04-02-04	Teton
Columbia-North Pacific Region	Upper Snake Subregion	27	17-04-02-05	Willow
Columbia-North Pacific Region	Upper Snake Subregion	28	17-04-02-06	American Falls
Columbia-North Pacific Region	Upper Snake Subregion	29	17-04-02-07	Blackfoot
Columbia-North Pacific Region	Upper Snake Subregion	30	17-04-02-08	Portneuf
Columbia-North Pacific Region	Upper Snake Subregion	31	17-04-02-09	Lake Walcott
Columbia-North Pacific Region	Upper Snake Subregion	32	17-04-02-10	Raft
Columbia-North Pacific Region	Upper Snake Subregion	33	17-04-02-11	Goose
Columbia-North Pacific Region	Upper Snake Subregion	34	17-04-02-12	Lower Snake
Columbia-North Pacific Region	Upper Snake Subregion	35	07-04-02-13	Salmon Falls
Columbia-North Pacific Region	Upper Snake Subregion	36	17-04-02-14	Beaver—Camas
Columbia-North Pacific Region	Upper Snake Subregion	37	17-04-02-15	Medicine Lodge
Columbia-North Pacific Region	Upper Snake Subregion	38	17-04-02-16	Birch
Columbia-North Pacific Region	Upper Snake Subregion	39	17-04-02-17	Little Lost
Columbia-North Pacific Region	Upper Snake Subregion	40	17-04-02-18	Big Lost
Columbia-North Pacific Region	Upper Snake Subregion	41	17-04-02-19	Big Wood
Columbia-North Pacific Region	Upper Snake Subregion	42	17-04-02-20	Camas
Columbia-North Pacific Region	Upper Snake Subregion	43	17-04-02-21	Little Wood
Columbia-North Pacific Region	Central Snake Subregion	44	17-05-01-01	C. J. Strike
Columbia-North Pacific Region	Central Snake Subregion	45	17-05-01-02	Bruneau
Columbia-North Pacific Region	Central Snake Subregion	46	17-05-01-03	Upper Middle Snake
Columbia-North Pacific Region	Central Snake Subregion	47	17-05-01-04	Upper Owyhee
Columbia-North Pacific Region	Central Snake Subregion	48	17-05-01-05	South Fork Owyhee
Columbia-North Pacific Region	Central Snake Subregion	49	17-05-01-06	East Little Owyhee
Columbia-North Pacific Region	Central Snake Subregion	50	17-05-01-07	Middle Owyhee
Columbia-North Pacific Region	Central Snake Subregion	51	17-05-01-08	Jordan
Columbia-North Pacific Region	Central Snake Subregion	52	17-05-01-11	North Middle Fork Boise
Columbia-North Pacific Region	Central Snake Subregion	53	17-05-01-12	Mores—Upper Boise
Columbia-North Pacific Region	Central Snake Subregion	54	17-05-01-13	South Fork Boise
Columbia-North Pacific Region	Central Snake Subregion	55	17-05-01-14	Lower Boise
Columbia-North Pacific Region	Snake Subregion	56	17-05-01-15	Middle Snake
Columbia-North Pacific Region	Snake Subregion	57	17-05-01-20	South Fork Payette
Columbia-North Pacific Region	Snake Subregion	58	17-05-01-21	Middle Fork Payette
Columbia-North Pacific Region	Snake Subregion	59	17-05-01-22	Payette
Columbia-North Pacific Region	Snake Subregion	60	17-05-01-23	North Fork Payette
Columbia-North Pacific Region	Snake Subregion	61	17-05-01-24	Weiser
Columbia-North Pacific Region	Snake Subregion	62	17-05-02-01	Brownlee Reservoir
Columbia-North Pacific Region	Lower Snake Subregion	63	17-06-01-01	Hells Canyon
Columbia-North Pacific Region	Lower Snake Subregion	64	17-06-01-03	Upper Lower Snake
Columbia-North Pacific Region	Lower Snake Subregion	65	17-06-01-08	Palouse
Columbia-North Pacific Region	Lower Snake Subregion	66	17-06-01-09	Rock
Columbia-North Pacific Region	Lower Snake Subregion	67	17-06-02-01	Upper Salmon
Columbia-North Pacific Region	Lower Snake Subregion	68	17-06-02-02	Pahsimeroi
Columbia-North Pacific Region	Lower Snake Subregion	69	17-06-02-03	Upper Middle Salmon
Columbia-North Pacific Region	Lower Snake Subregion	70	17-06-02-04	Lemhi
Columbia-North Pacific Region	Lower Snake Subregion	71	17-06-02-05	Upper Middle Fork Salmon
Columbia-North Pacific Region	Lower Snake Subregion	72	17-06-02-06	Lower Middle Fork Salmon
Columbia-North Pacific Region	Lower Snake Subregion	73	17-06-02-07	Lower Middle Salmon
Columbia-North Pacific Region	Lower Snake Subregion	74	17-06-02-08	South Fork Salmon
Columbia-North Pacific Region	Lower Snake Subregion	75	17-06-02-09	Lower Salmon
Columbia-North Pacific Region	Lower Snake Subregion	76	17-06-02-10	Little Salmon
Columbia-North Pacific Region	Lower Snake Subregion	77	17-06-03-01	Upper Selway
Columbia-North Pacific Region	Lower Snake Subregion	78	17-06-03-02	Lower Selway
Columbia-North Pacific Region	Lower Snake Subregion	79	17-06-03-03	Lochsa
Columbia-North Pacific Region	Lower Snake Subregion	80	17-06-03-04	Middle Fork Clear-water
Columbia-North Pacific Region	Lower Snake Subregion	81	17-06-03-05	South Fork Clearwater
Columbia-North Pacific Region	Lower Snake Subregion	82	17-06-03-06	Clearwater
Columbia-North Pacific Region	Lower Snake Subregion	83	17-06-03-07	Upper North Fork Clearwater
Columbia-North Pacific Region	Lower Snake Subregion	84	17-06-03-08	Lower North Fork Clearwater

[1] Unofficial number, assigned for use in this study.
[2] Refer to U.S. Geological Survey (1974) for explanation.
[3] U.S. Geological Survey, Office of Water Data Coordination (written commun., 1977).

In the late 1960's, the USGS began annual quality monitoring of selected spring discharges from the Snake Plain aquifer in the Snake River Canyon between Twin Falls and Bliss (fig. 2). Twenty-seven sites are presently (1979) included in this annual sampling. The most intensive program of ground-water-quality monitoring in the State is being done by the USGS, in cooperation with the U.S. Atomic Energy Commission, as part of the research on effects of waste disposal at INEL. In addition, numerous one-time ground-water samples are analyzed as part of cooperative water-resources studies made by the USGS and IDWR in widespread parts of the State.

Other State and Federal agencies also analyze ground-water samples as part of their related water-resources studies. The IDHW, IDWR, EPA, USBR, and DOE have some water-quality data for Idaho in their files.

Short-term monitoring has been done by private consultants and other governmental agencies, but the data generally are restricted to local areas and are not readily available.

Existing ground-water-quality data are inadequate to meet the total needs of a statewide ground-water-quality monitoring network because information is lacking for the following: (1) Location of sampling sites; (2) hydrogeology of sampling sites; (3) quality control of data collection, preservation of samples, and methods of analysis; (4) trace elements, organics, and radiochemical determinations; and (5) seasonal changes in water quality. In addition, local and areal coverage afforded by existing data are insufficient to meet monitoring needs.

In spite of deficiencies, existing data serve as preliminary indicators and give a general picture of the quality of ground water in the State. Files of IDHW, IDWR, USBR, and USGS are chief sources for these data. Data for more than 2,200 sites are in WATSTORE (fig. 3).

Most of the Idaho data are for dissolved inorganic constituents; many are generally indicative of natural conditions. At places, concentrations of selected dissolved constituents in ground-water samples, based on data in WATSTORE, exceed the State's recommended limits for drinking water (Idaho Department of Health and Welfare, 1977). The chief characteristic exceeding its recommended limit of 500 mg/L is dissolved solids. Generalized areas where dissolved solids are excessive are shown in figure 3. Although the ground water in most of these areas is suitable for consumption, it is probably hard and may require treatment for some uses.

Chloride exceeded the recommended limit in a few tens of samples, and nitrite plus nitrate as N exceeded the limit in only a few samples. Samples exceeding the recommended limit may not be representative of an entire aquifer because of local conditions. In some places, better water may be obtained from different zones in the aquifer.

A summary of ground-water-quality data compiled from chemical analyses stored in WATSTORE is shown in table 2. The analyses are compiled from data collected since 1960. Selected dissolved-mineral concentrations and physical characteristics are listed by range (minimum and maximum values), mean, standard deviation, and standard error of the mean. The summaries of analyses in the table are categorized under cold- and hot-water headings because of the wide disparity in the range of many of the constituents in these two kinds of water. Cold water is categorized as that having a temperature of 18°C or less; hot water, as that above 18°C. The breakpoint temperature is arbitrarily chosen and is an attempt to include all cold water used for domestic and public supplies.

The unconsolidated-rock aquifers are comprised chiefly of alluvium, glacial outwash, and terrace gravel of Quaternary age (Qs, fig. 4). The consolidated-rock aquifers are comprised chiefly of volcanic rocks of Quaternary and Tertiary age (Qb, QTsv, and Tb, fig. 4). Primarily, the differentiation of major aquifers into volcanic and sedimentary rocks (fig. 4) corresponds to consolidated- and unconsolidated-rock aquifers, respectively, with only a few exceptions. Geothermal aquifers are limited largely to deep-seated consolidated rocks.

Most of the State's cold ground water is satisfactory for drinking, irrigating, and cooling.

Water samples were collected at selected sites, during this study, to obtain information where data were lacking or where comparison with existing data was desired. Generally close agreement was found between the old and new data, indicating that the water quality has changed little with time.

Data for short-term and seasonal changes in ground-water quality are lacking in the State. Collection of these data are essential to monitor some aquifers.

Table 2. Summary of water-quality data for major aquifers in Idaho

Data element and units	Cold water												Hot water					
	Unconsolidated rock aquifers						Consolidated rock aquifers						Geothermal aquifers					
	Number of analyses	Minimum value	Maximum value	Mean	Standard deviation	Standard error of mean	Number of analyses	Minimum value	Maximum value	Mean	Standard deviation	Standard error of mean	Number of analyses	Minimum value	Maximum value	Mean	Standard deviation	Standard error of mean
Specific conductance (µmho/cm)	386	56	3,000	588	344	17.6	206	40	4,390	628	501	34.9	502	43	28,000	947	2,190	97.7
pH (units)	230	6.1	8.9	7.4	.4	.02	83	5.9	9.2	7.6	.5	.05	479	5.9	10.0	8.1	.80	.04
Temperature (°C)	373	1.0	18.0	13.2	2.6	.14	130	8.0	18.0	13.7	2.2	.19	507	18.2	95.0	41.6	18.9	.84
Hardness (mg/L as $CaCO_3$)	205	5	1,700	226	186	13.0	85	3	1,620	180	238	25.9	471	1	3,000	135	291	13.4
Hardness, noncarbonate (mg/L as $CaCO_3$)	205	0	300	30	54	3.8	84	0	1,430	63	204	22.2	470	0	1,100	36	115	5.3
Calcium (mg/L)	205	1.7	150	52	32	2.2	85	1.0	401	44	56	6.1	470	.1	910	38	81	3.7
Magnesium (mg/L)	205	.1	320	23	32	2.3	85	.0	154	17	25	2.7	470	.0	260	9.6	24	1.1
Sodium (mg/L)	201	2.6	570	40	56	4.0	82	1.9	407	45	73	8.0	470	2.0	4,600	155	394	18.2
Potassium (mg/L)	200	.0	26	4	4.2	.30	82	.7	23	5	4.5	.50	466	.3	880	16	67	3.1
Bicarbonate (mg/L)	205	18	1,930	275	214	14.9	85	14	650	171	102	11.0	467	.0	2,500	206	262	12.1
Sulfate (mg/L)	209	.6	870	49	85	5.8	191	.2	994	57	99	7.2	470	.0	2,500	71	164	7.5
Chloride (mg/L)	387	.0	190	21	23	1.2	201	.0	1,080	47	114	8.0	478	.4	7,800	163	707	32.3
Fluoride (mg/L)	202	.0	5.0	.45	.55	.04	82	.0	13	.6	1.5	.16	471	.0	44	6.7	7.3	.34
Silica (mg/L)	203	7.7	130	34	18	1.3	84	1.0	110	39	16	1.8	454	4.5	190	67	32.6	1.5
Solids, residue at 180°C	18	98	684	367	172	40.6	31	92	3,350	685	839	151	51	123	9,180	624	1,290	181
Solids, sum of constituents	204	62	2,330	372	262	18.4	84	52	2,720	368	462	50.4	463	42	14,100	653	1,330	62.0
Nitrogen, $NO_2 + NO_3$ (mg/L as N)	169	.00	19	2.20	3.3	.26	144	.00	8.6	2.8	1.8	.15	375	.00	29	.59	1.9	.10
Phosphorus, total (mg/L as P)	176	.00	.99	.12	.17	.01	49	.00	1.2	.11	.19	.03	386	.00	.99	.04	.07	.01
Boron (µg/L)	36	0	4,100	310	750	125	18	0	1,700	148	393	92.7	228	0	11,000	522	1,390	91.8
Iron (µg/L)	148	0	18,000	352	1,650	136	34	0	1,600	173	381	65.4	76	0	2,200	139	345	39.6
Manganese (µg/L)	30	0	700	97	194	35.4	14	0	310	62	103	27.4	51	0	520	28	85	11.9

Aquifers in Idaho

Idaho's major aquifers consist of volcanic (chiefly consolidated) and sedimentary rocks (chiefly unconsolidated), or a combination of the two. The generalized extent of the aquifers and the HU's in which they occur are shown in figure 4. Their physical and hydrologic characteristics are described in table 3. Delineation of aquifer extent and designation of rock types are based on several published reports, including USGS Water-Supply Papers and IDWR Water Information Bulletins.

The generalized geology of the State is also shown in figure 4 because of its importance to the quality of ground water. A relation can be expected between the soluble minerals in rocks and the dissolved minerals in water. This relation may be simple or complex, depending on the influence of the aquifer rocks and mixing of recharge waters having different compositions. Refer to Hem (1970, p. 290-308) for a discussion of the water quality-lithology relations.

Ground-Water Movement

Pollutants introduced into an aquifer will move, primarily, with the water. Therefore, the direction of ground-water movement in an aquifer must be known to locate monitoring sites strategically.

Ground water moves downgradient at approximately right angles to potentiometric contours (fig. 5). For purposes of this study, where water-level data needed for construction of contours are lacking, movement is assumed to be from uplands toward valleys, as is common in most areas. Where water in an aquifer is confined or perched, a vertical component of movement may predominate. Also, the natural direction of movement commonly is altered in areas of pumping withdrawals and, locally at least, water is diverted toward the pumping wells. All these possible directions of movement are considered in the placement of monitoring wells.

Recharge

Because much natural ground water in Idaho is chemically suitable for most uses, the chemical quality of the water recharging the aquifers is a significant factor to consider in design of a monitoring network. Recharge water is supplied to aquifers naturally and artificially. The quantity and quality of this water varies, depending on its source.

Table 3. Summary of the physical and hydrologic characteristics of rock units

Period	Epoch	Rock unit	Aquifer code and rock name[1]	Physical characteristics and areal distribution	Water-bearing characteristics
Quaternary	Holocene and Pleistocene	Alluvium, glacial outwash, talus, terrace gravel, and lakebed and windblown deposits (Qs)	100VLFL, Cenozoic valley fill or basin fill 110ALVM, Quaternary alluvium 110SDMS, Quaternary sediments 111ALVM, Holocene alluvium 111TRRCY, Holocene terrace gravel, younger 112TRRCO, Pleistocene terrace gravel, older 112ALVM, Pleistocene alluvium 112OTSH, Pleistocene glacial outwash	Clay, silt, sand, gravel, and boulders; loose to well compacted; unbedded to well bedded. Alluvium floors the tributary valleys and flood plains of the main rivers and forms fans at mouths of some valleys. Lakebeds formed behind basalt dams near Rupert, American Falls, Roberts, Mud Lake, and other areas. Windblown deposits mantle much of the lowland areas; glacial debris, talus, and landslide material are coalesced with alluvium at many places; terrace gravel occurs locally along streams.	Sandy and gravelly alluvium an important aquifer; yields considerable water to wells. Lakebeds yield only small amounts of water because of low hydraulic conductivity. Windblown deposits mostly occur above the water table. Terrace gravel locally yields moderate to large supplies of water to wells, but in many areas, the gravel occurs above the water table.
Quaternary	Holocene and Pleistocene	Basalt of the Snake River Group (Qb)	110SKRV, Quaternary Snake River Group 112FLRV, Falls River Basalt	Olivine basalt, dense to vesicular, aphanitic to porphyritic; irregular to columnar jointing; thickness of flows variable; includes beds of basaltic cinders, rubbly basalt, and interflow sedimentary rocks. Crops out over much of the Snake River Plain; mantled in many places with alluvium, terrace gravel, and windblown deposits; locally intertongued with deposits of Pleistocene and Holocene age; overlies rocks of the Idaho Group, silicic-volcanic and sedimentary rocks, and basalt of the Columbia River Basalt Group.	Hydraulic conductivity highly variable; formational hydraulic conductivity high because of jointing and rubbly contacts between flows; rock hydraulic conductivity low. One of the more important aquifers in Idaho. Yields large amounts of water to wells where saturated; receives and transmits recharge readily.
Quaternary and Tertiary	Holocene to Paleocene(?)	Silicic-volcanic rocks (QTsv)	112LVCK, Lava Creek Tuff 120VLCC, Tertiary Volcanics 121IDVD, Idavada Volcanics 123CLLS, Challis Volcanics	Rhyolitic, latitic, and andesitic rocks; massive and dense; jointing ranges from platy to columnar; occurs as thick flows and blankets of welded tuff with associated fine- to coarse-grained ash and pumice beds (commonly reworked by running water) and as clay, silt, sand, and gravel; locally folded, tilted, and faulted. Includes the Challis Volcanics (extensive rocks ranging in composition from rhyolite to basalt, which crop out in the foothills and mountains along the north side of the Snake River Plain).	Joints and fault zones in flows and welded tuff and interstices in coarse-grained ash, sand, and gravel beds yield small to moderate, and rarely large, amounts of water to wells. Commonly contain warm water under confined conditions. An important aquifer in places. The Challis Volcanics generally have low hydraulic conductivity and are not an important aquifer.
Quaternary and Tertiary	Pleistocene to Miocene	Sedimentary rocks, undifferentiated (QTs)	112BRUN, Bruneau Formation 112GLFR, Glenns Ferry Formation 112IDHO, Idaho Group 112MCHD, Michaud Gravel 112PLSC, Pleistocene Series 121BNBR, Banbury Formation 121SLLK, Salt Lake Formation	Subaereal and lake deposits of clay, silt, sand, and some gravel (includes Idaho Group and Payette and Salt Lake Formations). Compacted to poorly consolidated; poorly to well stratified; beds somewhat lenticular and intertongued; contains beds of ash and intercalated basalt layers. Widespread in the southern part of the State.	Porosity and hydraulic conductivity highly variable; generally contain water under confined conditions; yields to wells range from a few gallons per minute from clayey beds to several hundred gallons per minute from sand and gravel. An important aquifer in places, especially in southwestern Idaho. Water is warm at some places.
Tertiary	Miocene	Columbia River Basalt Group (Tb)	122CBRV, Columbia River Basalt Group	Flood-type basalt, dense, rude columnar jointing at many places; folded and faulted; may include some rhyolitic and andesitic rock types; exposed near the Snake River in western and west-central Idaho.	Locally yields small to moderate amounts of water to wells from fractures, faults, and related sedimentary zones. Hydraulic conductivity is highly variable. An important aquifer having both confined and unconfined conditions.
Tertiary and Cretaceous		Granitic rocks, undifferentiated (TKi)	211IDAH, Idaho batholith	Intrusive granitic rocks and related rocks of comparable age. Chiefly includes granitic rocks of the Idaho batholith, which are exposed in the central part of the State.	Generslly yields only small amounts of water to wells where fractured. Not an important aquifer.
Pre-Cretaceous		Pre-Cretaceous rocks, undifferentiated (MzpC)	230TRSC, Triassic System 300CLSC, Paleozoic clastic rocks 340DVNN, Devonian System 400PCMB, Precambrian Erathem	Well-indurated sedimentary and metamorphic rocks that have been folded, faulted, and intruded by granitic rocks. Crop out in the mountainous areas. Include extrusive rocks of Permian and Triassic age in the western part of the State. May include some younger sedimentary rocks.	Hydraulic conductivity generally low, except where jointed. Not an important aquifer.

[1]Modified from Price and Baker (1974).

For purposes of this study, the source of most water to each HU is assumed to be precipitation that falls within the drainage basin of the HU (see table 4), unless data indicate otherwise. Significant additional recharge to aquifers may occur in some HU's as a result of one or more of the following: (1) Leakage from canals or ditches that import irrigation water from adjacent areas; (2) leakage from reservoirs; (3) deep percolation of applied irrigation water, either through the ground or through disposal wells; (4) underflow from aquifers in adjacent HU's; and (5) liquid wastes spread on the ground, stored in ponds, or dumped in wells.

Discharge

Natural discharge from aquifers occurs as evapotranspiration, discharge through springs, discharge to streams or other surface-water bodies, and underflow to adjacent aquifers.

Artificial discharge from aquifers occurs where ground water is withdrawn by pumping and where drainage ditches penetrate the water table. Much ground water is withdrawn for public supply, domestic, stock, industrial, agricultural, and mining purposes.

Sources and Types of Waste

Water enriched in pollutants may percolate to aquifers from any of the following sources: (1) Pesticides, fertilizers, and waste products applied to soils; (2) stockpiles of industrial, mining, or agricultural wastes; (3) landfills, sewerage ponds, septic-tank systems, and sewerage lines; (4) contaminants from urban and suburban areas, and from construction areas in which the land surface has been disturbed; (5) leakage or spillage of pollutants in loading and transfer areas; (6) excess irrigation water; and (7) waste-disposal wells. Major types of ground-water use and potential pollution sources in HU's are generalized in table 5.

Sources of ground-water pollution can be classified as line, point, or nonpoint (diffuse); but in many places, the source distinction is not clear. Line and point sources (direct sources of pollution) generally can be identified. However, in designing a network to monitor ground-water quality, some generalizations must be made. For example, waste-disposal wells and individual septic tanks are classified as point sources. Leakage along sewerage lines is

Table 4. Mean annual precipitation in hydrologic units

[Data based on maps prepared for the Pacific Northwest River Basins Commission (1970) and Pacific Southwest Interagency Committee, Water Resources Council (1971)]

HU	Precipitation (in)	HU	Precipitation (in)	HU	Precipitation (in)
1	20	29	19	57	37
2	20	30	17	58	35
3	18	31	9	59	22
4	37	32	17	60	33
5	20	33	16	61	29
6	17	34	10	62	23
7	47	35	12	63	25
8	36	36	18	64	15
9	24	37	17	65	31
10	44	38	21	66	22
11	35	39	25	67	29
12	39	40	22	68	26
13	40	41	22	69	24
14	51	42	18	70	21
15	49	43	15	71	31
16	32	44	10	72	31
17	44	45	11	73	29
18	28	46	12	74	36
19	27	47	15	75	22
20	34	48	11	76	32
21	22	49	10	77	45
22	28	50	15	78	48
23	9	51	16	79	50
24	26	52	42	80	31
25	16	53	25	81	28
26	17	54	31	82	28
27	16	55	12	83	54
28	10	56	12	84	46

Table 5. Major types of ground-water use and potential pollution source(s) in hydrologic units

Use:

A - Domestic, stock, and public supply
B - Irrigation
C - Industrial
U - Minor use

Pollution sources[1]:

D - Septic-tank systems, sewerage leakage, sewerage ponds, and landfills
E - Waste-disposal wells
F - Agricultural and livestock waste
G - Mining and related activities
H - Industrial processing
J - Runoff in urban areas
K - Known pollution minor

HU	Use	Source	HU	Use	Source	HU	Use	Source
1	A,B	D,F	29	A,B,C	D,F,G,H	57	A	D,G
2	A,B,C	D,F,H,J	30	A,B,C	D,E,F,G,H,J	58	A	D
3	A,B,C	D,F,H,J	31	A,B,C	D,E,F,H,J	59	A,B,C	D,F,H,J
4	U	K	32	A,B	D,F	60	A,B	D,F,J
5	A,B	D,F	33	A,B	D,F	61	A,B	D,F,J
6	A,B	D,F	34	A,B,C	D,E,F,G,H,J	62	A,B	D,F,J
7	U	K	35	A,B	D,E,F	63	U	K
8	A	D,F,J	36	A,B	D,F	64	A	D
9	A	D	37	A,B	D,E,F	65	A	D,F,J
10	U	D	38	A,C	D,E,H	66	A	K
11	A	D,H	39	A,B,C	D,F	67	A	D,F,G
12	A	D	40	A,B,C	D,E,F,G,H,J	68	A,B,C	D,F
13	U	K	41	A,B,C	D,E,F,H	69	A,B,C	D,F,G,H,J
14	A	D,G	42	A,B,C	D,E,F,H	70	A,B	D,F
15	A	D,G,H	43	A,B,C	D,E,F,H	71	A	K
16	A	D,G,J	44	A,B,C	D,F,H,J	72	U	K
17	A	D,G	45	A,B	D,F	73	A	D
18	A,B,C	D,F,H,J	46	A,B	D,E,F	74	A	D,G
19	A	D	47	A	K	75	A	D,F
20	U	D	48	U	K	76	A,B	D,F
21	A,B	D,F	49	U	K	77	U	K
22	A	D,F	50	U	K	78	U	K
23	A,B,C	D,E,F,G,H,J	51	A,C	D,H	79	U	K
24	A,B	D,F	52	A	D	80	A	D
25	A,B,C	D,E,F,H,J	53	A	D	81	A,B	D,F,J
26	A,B,C	D,E,F,H,J	54	A	D	82	A,B,C	D,F,H,J
27	A	D,F	55	A,B,C	D,F,H,J	83	U	K
28	A,B,C	D,E,F,G,H,J	56	A,B	D,F	84	A	D

[1]Data compiled chiefly from published reports of IDHW, IDWR, and USGS.

classified as a line source. But where point and line sources are closely spaced, the wastes may merge and become a nonpoint source before affecting an aquifer. Therefore, with few exceptions, most sources are considered as nonpoint for this study.

Average concentrations of selected properties in liquid wastes, chiefly from rural and agricultural sources, are given in table 6. Concentrations of selected properties in irrigation water and irrigation-waste water are presented in Carter, Robbins, and Bondurant (1973).

Exact values for volumes of wastes discharged to the aquifers are not available, except for closely controlled waste-disposal sites such as INEL. However, some average volumes are given in table 7.

Geologic formations with which ground water comes in contact also may contain soluble minerals that concentrate in water. Thus, anomalously high mineral concentrations in ground water do not necessarily indicate effects of human activities.

Priority Ranking of Hydrologic Units

Calculation of Hydrologic Priority Indexes

Knowledge of relations within the hydrogeology of an area, locations of pollution sources, and locations of water-supply systems is paramount in designing a ground-water-quality monitoring network. In addition, the network planner's judgment is important in selecting monitoring sites, deciding frequency of monitoring, and determining types of analyses to be made. To aid in making these judgments objectively, a priority-rating system is used in this study. The system is based chiefly on intensity of ground-water development. It was modified from one developed by Nowlin (1978) in planning a ground-water-monitoring program for Nevada.

In the Idaho system, the HU's of the State were ranked in order of priority according to assignment of an HPI for each HU. The HPI gauges the effects of man's activities on the quality of ground water in each HU. It is defined as the sum of the three components PL, PI, and UI, or HPI = PL+PI+UI. Logarithms are used in calculating the components because of the wide range in values for the individual elements (tables 8, 9, 10, and 11) composing the components. Assignment of values for these elements required first approximations and gross estimates because of the broad area

Table 6. Average concentrations of selected characteristics in liquid wastes from chiefly urban and rural sources[1]
(Concentrations in milligrams per liter)

Characteristic	Diary food plants	Dairy center	Secondary waste treatment	Rural domestic sewage
pH[1]	7.1	7.0	7.0	--
Sum of dissolved solids	2,400	5,000	500	200
Nitrite plus nitrate as N	76	250	20	30
Total phosphorus as P	50	200	10	10
Potassium	67	--	12	10
Sodium	322	--	40	50
Calcium	37	--	40	10
Magnesium	--	--	17	5
Chloride	276	--	100	100
Sulfate	--	--	--	20

[1] Data from Barnes (1975).
[2] pH, reported in units.

Table 7. Average volumes of waste water from selected sources (Modified from Feth, 1973)

Source	Gallons per day per capita
Domestic sewage, chiefly residential area	50
Same as above, but with heavy concentration of electrical appliances	75
Residential community with business and light industry	100
Ground-water contributions from irrigation	variable[1]

[1]Simons (1953) gives data for consumptive use of irrigation water for most of Idaho. Generally less than 30 percent may percolate to the ground water. Irrigation excess is the major source of ground-water recharge in some areas.

Table 8. Total area and area of privately owned agricultural land in hydrologic units
(Thousands of acres)

HU	Total area	IA, privately owned agricultural land[1]	HU	Total area	IA, privately owned agricultural land[1]	HU	Total area	IA, privately owned agricultural land[1]
1	147.8	37	29	688.6	150	57	527.4	3.8
2	627.8	210	30	847.4	370	58	214.4	4.5
3	613.1	300	31	2,344.3	600	59	798.1	160
4	30.7	[2].01	32	773.1	210	60	585.0	68
5	326.4	130	33	471.0	120	61	1,068.8	120
6	457.0	130	34	1,562.9	640	62	416.0	20
7	49.3	[2].01	35	590.7	88	63	215.0	10
8	531.8	65	36	636.2	120	64	130.6	27
9	120.3	1.3	37	617.6	130	65	332.2	160
10	133.1	3.2	38	449.9	5.1	66	14.7	3.8
11	739.8	75	39	618.9	47	67	1,568.0	19
12	481.3	[2]12	40	1,226.2	120	68	533.1	41
13	11.5	1.3	41	936.3	130	69	1,155.2	[2]30
14	586.9	1.9	42	434.6	140	70	816.6	59
15	188.2	[2]110	43	727.0	120	71	962.6	1.3
16	413.4	53	44	1,374.1	240	72	891.5	[3].3
17	1,181.4	47	45	1,597.4	32	73	1,086.1	[3]1.7
18	243.2	120	46	1,260.2	250	74	838.4	[3].6
19	151.7	95	47	987.5	30	75	798.1	90
20	16.0	7.7	48	163.2	1.3	76	373.8	18
21	535.7	63	49	57.6	1.3	77	627.8	[3].3
22	258.6	28	50	185.6	5.8	78	658.6	.01
23	737.3	430	51	389.8	19	79	739.2	[3].1
24	688.0	59	52	529.3	[3].3	80	137.0	[3]4.5
25	458.9	180	53	396.2	[3]3.2	81	748.8	110
26	547.8	350	54	837.1	1.3	82	1,476.5	630
27	417.3	90	55	873.0	550	83	828.8	[3].06
28	1,846.4	550	56	83.8	45	84	734.1	5.1

[1] Includes irrigated land (U.S. Bureau of Land Management, 1968, and Idaho Water Resources Board, 1970).
[2] Estimated; value less than shown.
[3] Developed area other than agricultural; estimate based on HU population.

Table 9. Population in hydrologic units, 1975
(An arbitrary value of 1 is assigned to unpopulated HU's)

HU	P, population	HU	P, population	HU	P, population
1	200	29	5,000	57	200
2	9,800	30	58,420	58	100
3	10,000	31	37,190	59	22,050
4	1	32	1,000	60	4,260
5	2,850	33	1,500	61	8,890
6	150	34	66,100	62	2,090
7	1	35	300	63	1
8	6,550	36	1,000	64	2,500
9	450	37	600	65	22,540
10	500	38	50	66	40
11	18,600	39	300	67	1,400
12	1,800	40	4,575	68	395
13	1	41	10,100	69	4,650
14	300	42	920	70	1,500
15	17,500	43	6,350	71	25
16	8,200	44	19,130	72	50
17	7,150	45	400	73	270
18	37,500	46	9,480	74	90
19	750	47	20	75	1,110
20	200	48	1	76	1,030
21	800	49	1	77	40
22	80	50	10	78	1
23	69,830	51	40	79	20
24	2,000	52	50	80	700
25	8,400	53	500	81	7,340
26	19,000	54	200	82	50,200
27	150	55	207,060	83	10
28	30,085	56	5,350	84	800

Table 10. Calculated water-yield potential and annual ground-water use in hydrologic units
(Thousands of acre-feet)

HU	C, water-yield potential[1]	Ground-water use	HU	C, water-yield potential[1]	Ground-water use	HU	C, water-yield potential[1]	Ground-water use
1	350	9.7	29	3,800	4.2	57	650	0.02
2	2,900	37	30	4,100	510	58	190	.01
3	3,700	56	31	13,000	1,000	59	3,400	6.3
4	33	.0001	32	5,000	190	60	1,900	.01
5	1,800	31	33	2,000	200	61	2,600	11
6	2,700	19	34	8,100	870	62	370	.70
7	25	.0001	35	2,200	9.7	63	110	.0001
8	1,200	.28	36	3,500	29	64	78	.46
9	320	.02	37	3,600	280	65	170	5.0
10	110	.0001	38	2,500	5.8	66	7	.03
11	2,000	.42	39	2,700	51	67	2,400	1.9
12	1,400	.02	40	4,800	100	68	2,200	11
13	24	.0001	41	2,900	21	69	860	1.9
14	620	.01	42	2,100	10	70	2,600	.45
15	250	.61	43	2,700	80	71	910	.01
16	580	1.1	44	11,000	84	72	600	.0001
17	830	.34	45	7,500	5.9	73	730	.01
18	1,400	39	46	7,800	56	74	1,100	.01
19	250	.04	47	4,300	.01	75	580	.24
20	63	.0001	48	920	.0001	76	390	.94
21	1,500	.26	49	240	.0001	77	310	.0001
22	630	.42	50	440	.0001	78	330	.0001
23	4,600	850	51	1,100	.01	79	69	.0001
24	2,700	.54	52	260	.01	80	68	.15
25	3,100	80	53	460	.04	81	740	7.6
26	2,500	290	54	800	.04	82	790	34
27	2,100	.01	55	6,900	210	83	460	.0001
28	11,000	1,000	56	840	7.6	84	370	.04

[1]Values shown are intended only for comparison of HU's and should not be used otherwise or assumed to replace previously determined values.

Table 11. Specified thickness and estimated specific yield for selected rock units

Rock unit[1]	Specified thickness[2] (ft)	Estimated specific yield[2] (percent)
Qs	50	20
Qb	100	5
QTsv	100	1
QTs	100	10
Tb	50	1
TKi	50	1
MzpЄ	50	[3]1

[1]Refer to table 3 for description of rock units.

[2]Modified from Pacific Northwest River Basins Commission (1970, p. 200), and Pacific Southwest Interagency Committee, Water Resources Council (1971, p. 48).

[3]Two percent was used for HU's 1-6.

covered and lack of quantitative data. Although suitable for use in this study, they do not preclude the need for more detailed quantitative evaluations. The elements IA, P, C, and U that compose the components are defined as follows:

1. IA, privately owned agricultural land--Most of the population and resulting development tend to concentrate in these areas. A land-status map (U.S. Bureau of Land Management, 1968) was updated to about 1976 and was used as the basis for determining landownership. Idaho land is 64 percent federally owned. Some small parcels of privately owned land (particularly in National Forest areas) are not shown because landownership can only be generalized on the map. IA, in thousands of acres, was obtained by planimetry from a map (Idaho Water Resource Board, 1970) updated to about 1976 conditions (table 8 and fig. 6).

2. P, population--The greatest pollution potential is likely where population is greatest (1975 census data were used); however, there are exceptions. Where no population was listed in an HU (table 9), an arbitrary value of 1 was assigned to facilitate priority calculations.

3. C, calculated water-yield potential (table 10)--This indicates, for comparative purposes only, the volume of ground water, in thousands of acre-feet, that may be stored in rock units (based on specified thicknesses and estimated specific yields).

   Areal distribution of rock units in each HU was planimetered from a 1:500,000-scale map (Ross and Forrester, 1947). The values for thickness and specific yield (table 11) were multiplied by the areas to determine volumes. Because some ground water occurs in most rock units, if only in small amounts suitable for use, the distribution of all rock units in each HU was planimetered.

4. U, ground-water use--Estimated annual ground-water use, in thousands of acre-feet, for each HU is based on data from files of the USGS and IDWR. Data are adjusted to 1975 conditions (table 10).

The three components (PL, PI, and UI) are defined in table 12.

Table 12. Hydrologic priority index components[1] used for priority rating

HU	PL[2]	PI[3]	UI[4]	HU	PL[2]	PI[3]	UI[4]	HU	PL[2]	PI[3]	UI[4]
1	2.30	0.73	1.56	29	3.70	1.52	2.96	57	2.30	1.72	4.51
2	3.99	1.67	1.89	30	4.77	2.20	.91	58	2.00	1.35	4.28
3	4.00	1.52	1.82	31	4.57	1.79	1.11	59	4.34	2.14	2.73
4	0	2.00	5.52	32	3.00	.68	1.42	60	3.63	1.80	5.28
5	3.45	1.34	1.76	33	3.18	1.10	1.00	61	3.95	1.87	2.37
6	2.18	.06	2.15	34	4.82	2.01	.97	62	3.32	2.02	2.72
7	0	2.00	5.40	35	2.48	.53	2.36	63	0	-1.00	6.04
8	3.82	2.00	3.63	36	3.00	.92	2.08	64	3.40	1.97	2.23
9	2.65	2.54	4.20	37	2.78	.66	1.11	65	4.35	2.15	1.53
10	2.70	2.19	6.04	38	1.70	.99	2.63	66	1.60	1.02	2.37
11	4.27	2.39	3.68	39	2.48	.81	1.72	67	3.15	1.87	3.10
12	3.26	2.18	4.85	40	3.66	1.58	1.68	68	2.60	.98	2.30
13	0	-.11	5.38	41	4.00	1.89	2.14	69	3.67	2.19	2.66
14	2.48	2.20	4.79	42	2.96	.82	2.32	70	3.18	1.41	3.76
15	4.24	2.20	2.61	43	3.80	1.72	1.53	71	1.40	1.28	4.96
16	3.91	2.19	2.72	44	4.28	1.90	2.12	72	1.70	2.22	6.78
17	3.85	2.18	3.39	45	2.60	1.10	3.10	73	2.43	2.20	4.86
18	4.57	2.49	1.56	46	3.98	1.58	2.14	74	1.95	2.18	5.04
19	2.88	.90	3.80	47	1.30	-.18	5.63	75	3.05	1.09	3.38
20	2.30	1.41	5.80	48	0	-.11	6.96	76	3.01	1.76	2.62
21	2.90	1.10	3.76	49	0	-.11	6.38	77	1.60	2.12	6.49
22	1.90	.46	3.18	50	1.00	.24	6.64	78	0	2.00	6.52
23	4.84	2.21	.73	51	1.60	.32	5.04	79	1.30	2.30	5.84
24	3.30	1.53	3.70	52	1.70	2.22	4.41	80	2.85	2.19	2.66
25	3.92	1.67	1.59	53	2.70	2.19	4.06	81	3.87	1.82	1.99
26	4.28	1.73	.94	54	2.30	2.19	4.30	82	4.70	1.90	1.37
27	2.18	.22	5.32	55	5.32	2.58	1.52	83	1.00	2.22	6.66
28	4.48	1.74	1.04	56	3.73	2.08	2.04	84	2.90	2.20	3.97

[1]HPI = PL+PI+UI.

[2]PL, the population component = log p.

[3]PI, the population density component = log $\frac{p}{IA}$.

[4]UI, the intensity of ground-water use component, = log $\frac{U}{C}$, all values are negative.

Ranking of Hydrologic Units

The HU having greatest HPI value has the highest priority for ground-water monitoring; descending priority follows the ranking shown in table 13. A reevaluation of HU's was made to consider future needs. Revised HPI values were calculated, using population forecasts for the year 2000 (Idaho Department of Water Resources and Boise State University, 1976) and estimates of ground-water use based on a direct percentage of the forecasted population increases. For the most part, resulting HPI values (table 14) changed only slightly.

HU's having the greater HPI values have rankings beginning with 1 and will receive early attention for monitoring. A final judgmental assessment was made because of other factors not considered in the priority rating, such as special hydrogeologic conditions or particular pollution sources. For the most part, the original rankings did not change significantly after this assessment.

The ranking of HU's resulting from the priority rating, based on the 1975 and 2000 data, is listed in tables 13 and 14, respectively.

A comparison of rankings using 1975 and 2000 data (table 15) shows that where changes occur, most are in the middle or lower priority HU's and generally not significant in the network design. Those HU's (41 and 81) that change from a lower (1975) to a higher (2000) ranking are assigned positions in the 15 higher ranked areas for the 1975 data base (fig. 7).

Design Requirements

After compiling sufficient background material, several primary elements involved in the proposed network must be considered to assure that monitoring can be accomplished. These elements include: (1) Site selection, (2) well construction, (3) site inspection, (4) sampling frequency, (5) characteristics to be monitored, (6) assurance of representative samples, and (7) quality assurance of water-sample analyses. The significance of each of these elements is briefly discussed in the following sections.

Site Selection

As stated previously, direction of ground-water movement is a controlling factor in the spread of pollutants. Therefore, selection of monitoring sites is based primarily on knowledge of the hydrogeology and location of pollution

Table 13. Priority and ranking of hydrologic units, 1975 data

Rank	HU	HPI	Rank	HU	HPI	Rank	HU	HPI
1	55	6.38	29	11	2.98	57	6	0.09
2	23	6.32	30	17	2.64	58	38	.06
3	30	6.06	31	62	2.62	59	19	-.02
4	34	5.86	32	80	2.38	60	14	-.11
5	18	5.50	33	37	2.33	61	73	-.23
6	31	5.25	34	29	2.26	62	52	-.49
7	82	5.23	35	32	2.26	63	57	-.49
8	28	5.18	36	8	2.19	64	22	-.82
9	26	5.07	37	76	2.15	65	74	-.91
10	65	4.97	38	67	1.92	66	58	-.93
11	44	4.06	39	36	1.84	67	10	-1.15
12	25	4.00	40	39	1.57	68	20	-2.09
13	43	3.99	41	1	1.47	69	79	-2.24
14	15	3.83	42	42	1.46	70	71	-2.28
15	2	3.77	43	68	1.28	71	77	-2.77
16	41	3.75	44	24	1.13	72	72	-2.86
17	59	3.75	45	84	1.13	73	27	-2.92
18	56	3.73	46	9	.99	74	51	-3.12
19	3	3.70	47	53	.83	75	7	-3.40
20	81	3.70	48	70	.83	76	83	-3.44
21	40	3.56	49	75	.76	77	4	-3.52
22	61	3.45	50	35	.65	78	47	-4.51
23	46	3.42	51	45	.60	79	78	-4.52
24	16	3.38	52	12	.59	80	50	-5.40
25	33	3.28	53	66	.25	81	13	-5.49
26	69	3.20	54	21	.24	82	49	-6.49
27	64	3.14	55	54	.19	83	63	-7.04
28	5	3.03	56	60	.15	84	48	-7.07

Table 14. Priority and ranking of hydrologic units, 2000 data[1]

Rank	HU	HPI	Rank	HU	HPI	Rank	HU	HPI
1	55	7.25	29	5	3.52	57	57	0.71
2	23	6.88	30	11	3.47	58	19	.67
3	30	6.88	31	17	3.36	59	6	.58
4	34	6.58	32	80	3.04	60	66	.56
5	18	6.23	33	8	3.00	61	73	.49
6	26	6.06	34	37	2.96	62	58	.35
7	31	5.80	35	32	2.95	63	22	.02
8	82	5.79	36	76	2.70	64	14	-.11
9	65	5.70	37	29	2.67	65	74	-.12
10	28	5.60	38	67	2.46	66	52	-.22
11	25	4.92	39	35	2.05	67	10	-.85
12	44	4.76	40	53	2.03	68	79	-1.26
13	41	4.56	41	68	2.00	69	71	-1.57
14	43	4.39	42	1	1.73	70	20	-1.75
15	81	4.33	43	24	1.71	71	27	-1.99
16	59	4.32	44	39	1.69	72	77	-2.03
17	61	4.28	45	70	1.67	73	72	-2.13
18	56	4.27	46	84	1.65	74	51	-2.80
19	2	4.24	47	9	1.47	75	83	-3.14
20	3	4.12	48	42	1.47	76	7	-3.40
21	16	4.10	49	75	1.41	77	5	-3.52
22	69	4.05	50	35	1.32	78	47	-3.72
23	46	4.02	51	45	1.29	79	78	-4.52
24	33	3.95	52	12	1.09	80	50	-5.24
25	40	3.87	53	21	.92	81	13	-5.49
26	15	3.85	54	60	.91	82	49	-6.49
27	64	3.68	55	54	.89	83	63	-7.04
28	62	3.63	56	38	.73	84	48	-7.07

[1]Estimates based on data from Idaho Department of Water Resources and Boise State University (1976).

Table 15. Comparison of ranking of hydrologic units, 1975 and 2000 data

Rank	1975	2000	Rank	1975	2000	Rank	1975	2000
1	55	55	29	11	5	57	6	57
2	23	23	30	17	11	58	38	19
3	30	30	31	62	17	59	19	6
4	34	34	32	80	80	60	14	66
5	18	18	33	37	8	61	73	73
6	31	26	34	29	37	62	52	58
7	82	31	35	32	32	63	57	22
8	28	82	36	8	76	64	22	14
9	26	65	37	76	29	65	74	74
10	65	28	38	67	67	66	58	52
11	44	25	39	36	36	67	10	10
12	25	44	40	39	53	68	20	79
13	43	41	41	1	68	69	79	71
14	15	43	42	42	1	70	71	20
15	2	81	43	68	24	71	77	27
16	41	59	44	24	39	72	72	77
17	59	61	45	84	70	73	27	72
18	56	56	46	9	84	74	51	51
19	3	2	47	53	9	75	7	83
20	81	3	48	70	42	76	83	7
21	40	16	49	75	75	77	4	4
22	61	69	50	35	35	78	47	47
23	46	46	51	45	45	79	78	78
24	16	33	52	12	12	80	50	50
25	33	40	53	66	21	81	13	13
26	69	15	54	21	60	82	49	49
27	64	64	55	54	54	83	63	63
28	5	62	56	60	38	84	48	48

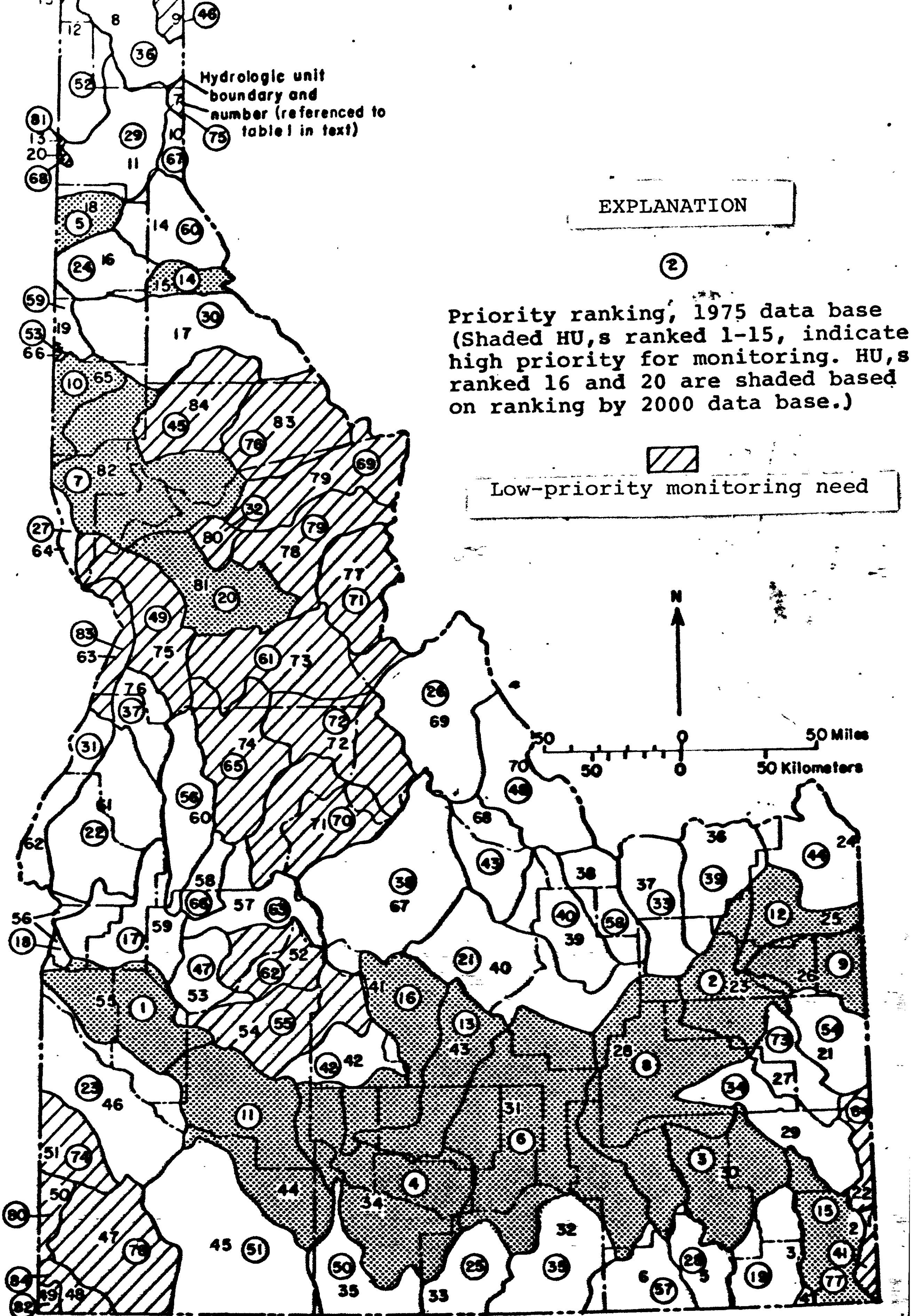

Figure 7. Priority ranking of hydrologic units for ground-water-quality monitoring.

sources. (The site selection is the result of the network planner's judgment after examining existing data for each area.) Because ground water may move both laterally and vertically, sites for sampling must be located not only down the hydraulic gradient (see fig. 5) from pollution sources, but also, in places, at various depths in the ground. In addition, some pollutant spread may be due to dispersive forces, so monitoring sites should also be located upgradient from pollution sources. These latter sites generally need to be located only short distances upgradient, for pollution tends to spread mostly in the direction of ground-water flow. The above factors were considered when locating monitoring sites for the proposed network.

Areas having the greatest pollution potential are shown in figure 8. The proposed network chiefly monitors nonpoint sources of pollution; therefore, existing wells can provide adequate coverage in most places.

Site Inspection

Onsite inspection of a candidate monitoring site is necessary to determine if the site will meet network needs. Items to be considered are:

1. Permission to sample periodically
2. Inspection of the surface seal around well
3. Potential pollution sources nearby
4. Presence and potential effects of water softeners, storage tanks, and disinfection equipment
5. Accessibility
6. Type of pump

Well Construction

Well construction can influence the chemical composition of water samples in several ways: (1) A well open to more than one water-bearing zone or aquifer may permit water with different compositions to mix, resulting in samples that are not representative of any particular zone or aquifer; (2) drilling mud may infiltrate formation rocks surrounding a well and contaminate the samples long after the well is completed; (3) corroded well casing, seals, or pumping equipment may contaminate samples; and (4) changes in pressure as water enters a well may cause precipitation and/or alteration of some dissolved minerals, thus affecting sample representation.

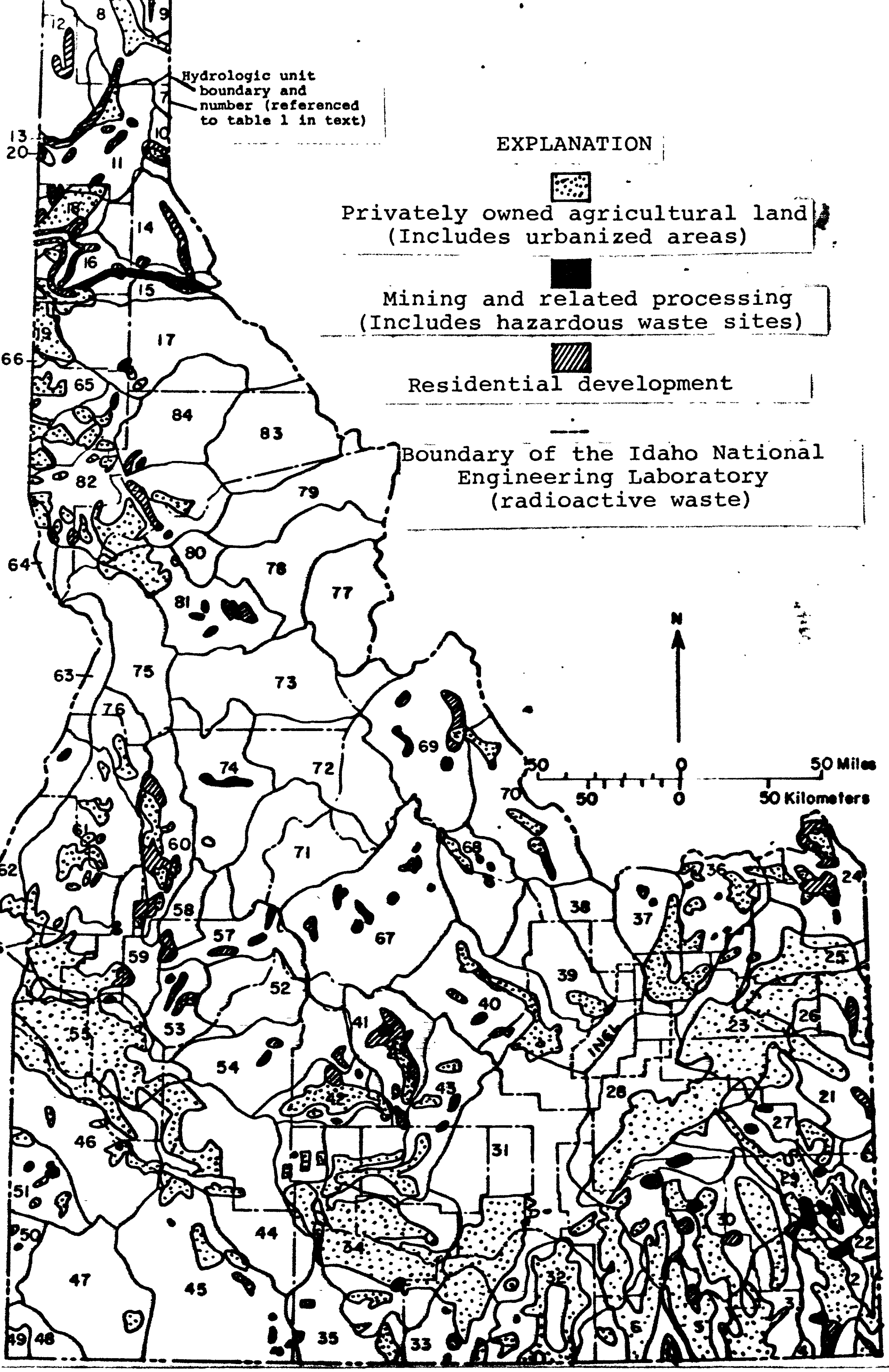

Figure 8. Areas of greatest pollution potential in the hydrologic units.

Drillers' logs can be used as guides for excluding wells that do not meet monitoring criteria. These criteria will vary for different hydrogeologic conditions throughout the State. An ideal driller's log includes the following information: (1) Description and thickness of lithologic units penetrated; (2) diameter of borehole; (3) diameter, depth, and type of casing; (4) manner of well completion, such as screen, open hole, perforated casing, or open end; (5) type of surface seal; (6) water-bearing zones; and (7) pump yield and water-level data. Drillers' logs were available for the wells at most of the proposed monitoring sites.

New monitoring wells should be drilled if existing wells are not available. Type of construction and development of wells for monitoring depend on the local environment and the water properties to be monitored. Everett and others (1976) discussed well-construction methods and costs of monitoring wells.

Wells completed in consolidated rocks or wells that require use of deep drilling methods are expensive. Wells completed in unconsolidated rocks at shallow depths (generally less than 150 ft) often may be hand driven or augered, requiring less costly drilling methods. Examples of the latter types of well construction are shown in figure 9.

Sampling Frequencies

Sampling frequencies were based on hydrogeologic conditions, kinds of potential pollution sources, ground-water use, and timing of need for data. Some sites will need sampling on a quarterly or semiannual basis for 1 or 2 years to establish whether or not ground-water quality changes seasonally; these data are lacking for much of the State.

Once seasonal trends are defined, many of the suggested initial sampling frequencies may be reduced to annual, or, in some cases, 5-year intervals, because ground-water quality is not expected to change rapidly in most areas. However, if sampling at the initial frequency indicates water-quality changes at a site, then the frequency may need to be increased to define the changes.

Selected Characteristics to be Monitored

Characteristics selected to be measured and monitored in water samples depend chiefly on the potential cause of natural or man-related pollution, the type of ground-water

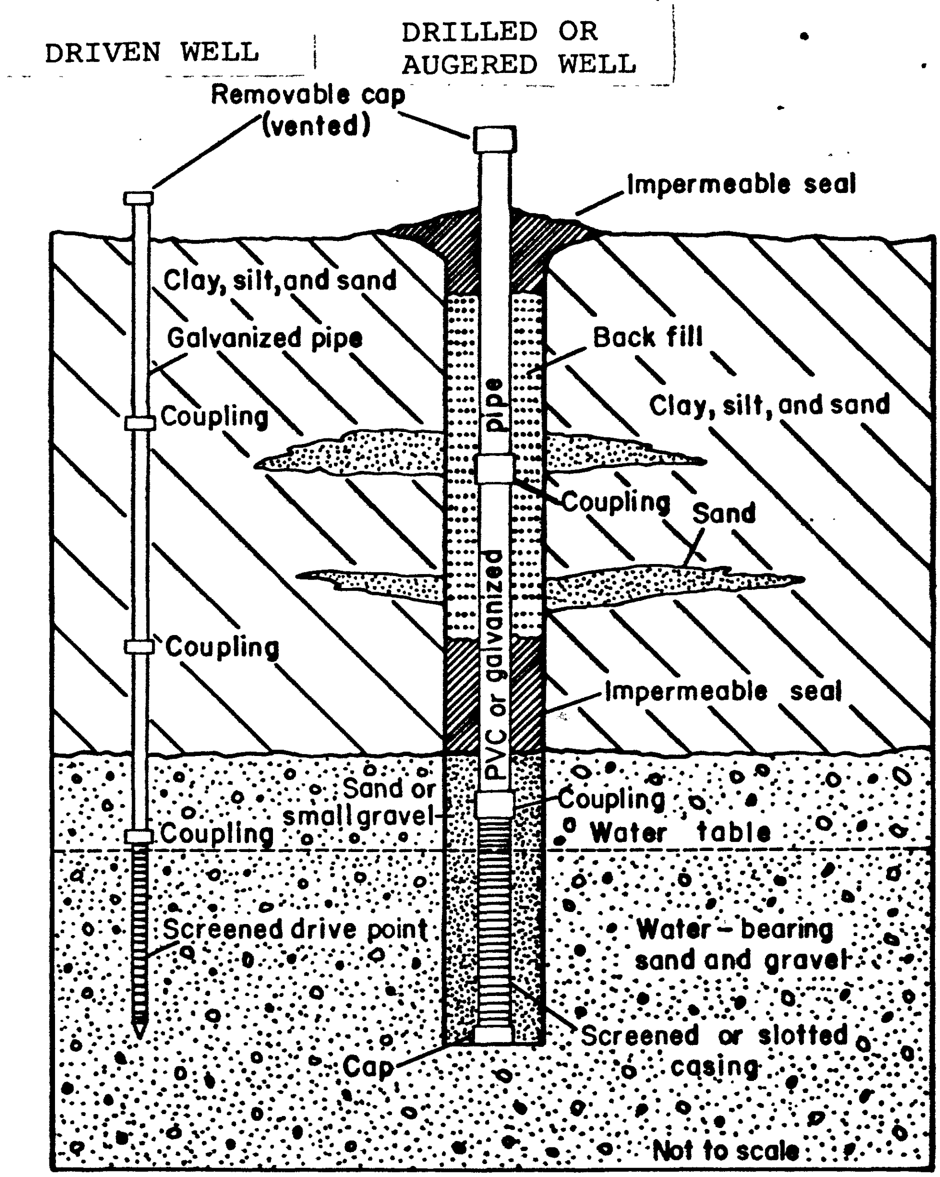

Figure 9. Examples of monitoring wells completed in unconsolidated rocks.

Table 16. Source or cause, approximate range in concentration, and significance of dissolved mineral constituents and characteristics of water (Modified from Todd, 1970)

Constituent or characteristic	Source or cause and approximate range of concentration in water	Significance
Silica (SiO_2)	Dissolved from practically all rocks and soils Ranges generally from 1.0 to 30 mg/L, although as much as 100 mg/L is common in areas having volcanic soil and rock.	Together with calcium and magnesium, silica forms a poor heat-conducting, hard, glassy scale in boilers and turbines. Silica inhibits deterioration of zeolite-type water softeners and corrosion of iron pipes by soft water.
Iron (Fe)	Dissolved from practically all rocks and soils. Found in some industrial wastes. Can be corroded from iron pipes, pumps, and other equipment. Generally less than 0.50 mg/L in fully aerated water. Water having a pH of less than 8.0 may contain more than 10 mg/L.	More than 0.1 mg/L often precipitates on exposure to air, causing turbidity, staining, and tastes and colors that are objectionable in food, beverage, textile processes, and ice manufacture, as well as causing problems in domestic use, such as staining plumbing fixtures and laundry. Idaho drinking-water standards recommend a maximum of 0.3 mg/L in finished supply.[1]
Manganese (Mn)	Dissolved from some rocks, soils, and lake bottom sediments. Sources associated with those of iron. Generally 0.20 mg/L or less. Ground water and acid mine water may contain more than 10 mg/L.	Some objectionable features as iron. Causes dark brown or black stains. Idaho drinking-water standards recommend a maximum concentration of of 0.05 mg/L.[1] Manganese removal associated with that of iron but more difficult and generally less complete.
Calcium (Ca), Magnesium (Mg)	Dissolved from practically all soils and rocks, but especially from limestone, dolomite, and gypsum. Generally ranges from 1 to 1,000 mg/L.	Causes most of the hardness and scale-forming properties of water; detergent consuming (see hardness). Water low in calcium and magnesium desired in electroplating, tanning, dyeing, and textile manufacturing. Small amounts desirable to prevent corrosion.
Sodium (Na), Potassium (K)	Dissolved from practically all rocks and soils. Found in industrial wastes and sewage. Sodium generally ranges from 1 to 1,000 mg/L; potassium generally less than about 10 mg/L.	More than 50 mg/L sodium and potassium in the presence of suspended matter causes foam in boilers which accelerates scale formation and corrosion.
Bicarbonate (HCO_3), Carbonate (CO_3)	Action of carbon dioxide in water on carbonate cementing material and rocks, such as limestone and dolomite. Bicarbonate commonly less than 500 mg/L; carbonate generally less than 10 mg/L.	Produces alkalinity. On heating in the presence of calcium and magnesium, can form scales in pipes and release corrosive carbon-dioxide gas. Aid in coagulation for removal of suspended matter from water.
Sulfate (SO_4)	Dissolved from rocks and soils containing gypsum, sulfides, and other sulfur compounds. May be derived from industrial wastes, both liquid and atmospheric. Generally ranges from 1 to 1,000 mg/L.	Sulfate in water containing calcium forms hard scale in steam boilers. In large amounts, sulfate in combination with other ions gives bitter taste to water. Some calcium sulfate is considered beneficial in brewing processes. Idaho drinking-water standards recommend that the sulfate content should not exceed 250 mg/L.[1]
Chloride (Cl)	Dissolved from rocks and soils. Present in sewage and industrial wastes. Commonly less than about 100mg/L in potable waters.	Some people can detect salty taste in concentrations exceeding 100 mg/L. In large quantities, increases the corrosiveness of water. Idaho drinking-water standards recommend a maximum concentration of 250 mg/L.[1] Present available treatment methods not generally economical for most uses.
Fluoride (F)	Dissolved in small to minute quantities from most rocks and soils. Added to many waters by fluoridation of public supplies. Commonly does not exceed 10 mg/L in ground water.	Fluoride concentrations between about 0.6 and 1.7 have beneficial effect on the structure and resistance to decay of children's teeth. Fluoride in excess of 6.0 mg/L causes pronounced mottling and disfiguration of teeth.[1]
Nitrate (NO_3)	Atmosphere, decaying organic matter, sewage, fertilizers, and nitrates in soils. Concentrations commonly less than 10 mg/L.	Small amounts of nitrate help reduce cracking of high-pressure boiler steel. It encourages growth of algae and other organisms which produce undesirable taste and odors. Idaho drinking-water standards recommend a maximum concentration of 10 mg/L as N[2]; concentrations in excess of this limit are suspected as cause of methemoglobinemia in infants.
Dissolved solids (residue on evaporation)	Chiefly mineral constituents dissolved from rocks and soils. Includes some water of crystallization. Ground water commonly contains less than 1,000 mg/L.	Idaho drinking-water standards recommend maximum of 500 mg/L[1]. Waters containing more than 1,000 mg/L of dissolved solids are unsuitable for many purposes.
Hardness as $CaCO_3$	In most waters, nearly all hardness is due to calcium and magnesium. Soft = 0-60; moderately hard = 61-120; hard = 121-180; very hard = more than 180.[2]	Consumes soap and synthetic detergents. Although less of a factor with synthetic detergents than with soap, it is still economical to soften hard waters.
Specific conductance	Mineral content of the water.	Guide to mineral content. It is a measure of the water to conduct a current of electricity, and varies with the concentration and degree of ionization of the different minerals in solution.
pH	Hydrogen-ion concentration.	A pH of 7.0 indicates neutrality of a solution. Values higher than 7.0 denote increased alkalinity; values lower than 7.0 indicate increased acidity. Corrosiveness of water generally increased with decreasing pH, but excessively alkaline waters may also attack metals.
Color	Decaying vegetation; peat, leaves, roots, and other organic substances; industrial wastes and sewage and certain minerals.	Water for domestic and some industrial uses should be free from perceptible color. Color in water is objectionable in food and beverage processing and many manufacturing processes.
Turbidity	Suspended and colloidal matter. Sources can be soil erosion, industrial wastes, and micro-organisms.	Turbid water aesthetically objectionable. Also objectionable in many industrial processes; generally removed by sedimentation, clarification, or filtration.
Alkyl benzene sulfonate (ABS)	Synthetic detergents in domestic and industrial wastes.	Causes tastes and odors and causes foam on streams and in treatment plants. Idaho drinking-water standards recommend a limit of 0.5 mg/L[1]. Treatment somewhat difficult and generally incomplete.
Fecal coliform bacteria	Derived from human and animal intestines.	Indicates contamination from human and/or animal wastes.

[1]Idaho Department of Health and Welfare (1977), and U.S. Environmental Protection Agency (1975b).
[2]Hem (1970).

use, and the need for data. These items were considered at each proposed monitoring site for selection of characteristics. Characteristic wastes are associated with the commonly known sources of pollution. Examples of some characteristic wastes from pollution sources (modified from U.S. Environmental Protection Agency, 1975a, p. 11-16) follow:

Source	Characteristic wastes
Industrial lagoons	Radioactive substances, trace elements, acids, solvents, other inorganic and organic substances
Cesspools, septic tanks	High dissolved solids, chlorides, sulfates, nitrogen, phosphates, detergents, bacteria
Tank farms (petroleum related)	Phenols, suspended solids, oil, grease, chromium, sulfide
Landfills and dumps	Soluble organics, iron, manganese, methane, carbon dioxide, phosphates, chloride, nitrate, trace elements
Stockpiles of chemical materials	Radioactive substances, trace elements, salts, organics, inorganics, high dissolved solids
Food processors	High biological oxygen demand, suspended solids, high sodium, high chloride
Agriculture	Fertilizers (chiefly nitrogen, phosphorus, and potassium), pesticides, bacteria, trace elements

Changes in water quality over a long period in an aquifer generally are associated with dissolved major constituents, including those carried into the aquifer by recharge and waste waters and those dissolved in the water during contact with subsurface materials (table 16). Therefore, selection of characteristics to be monitored is directed chiefly toward evaluating dissolved major constituents, certain trace elements, radiochemical data, and certain organics.

Proposed schedules of characteristics to be monitored are given in table 17. Schedules 1 and 2 will be performed onsite. Schedule 1 will be performed each visit and schedule 2 only as necessary, depending on the requirements at each site. The remaining schedules (3-9) will be combined with schedule 1 as required, depending on local conditions at each site.

Schedule 1, with or without some other partial analyses, should suffice for succeeding visits at many sites where samples were collected for laboratory analysis on the first visit. Only a field analysis should be needed at sites where a recent (1977 or 1978) laboratory analysis that includes most major ions is available. If field-determined values change unexpectedly in succeeding visits, another laboratory analysis may be necessary.

The characteristics in schedules 1 and 2 can be measured with minimum equipment. These are generally good indicators of change and are determinable without costly laboratory analyses. Field-determined data should give the earliest warning of changes in water quality.

Assurance of Representative Samples

Water samples should be representative of water in the aquifers from which they are obtained. However, certain conditions in some wells and pumping systems can adversely affect the representativeness of the samples. Corroded screens, well casings, pump parts, and pipelines can alter water quality. Further changes can occur if water sits in storage tanks or passes through treatment units, such as those used for softening, purification, and iron removal. Therefore, to minimize these effects, the condition of wells and pumping systems must be considered prior to their use for sampling. Where possible, old wells having rusted or corroded casings and dilapidated pumping equipment should not be used in the sampling network. Where wells equipped with pumps are used, the samples should be taken at or near the well head or from the line between the well head and the storage or treatment unit, not beyond the unit. If the water must pass through a storage tank, as in pressure systems, sufficient pumping time should elapse before the sample is collected to insure that fresh water is passing through the system.

Wells not equipped with pumps can be sampled by using portable pumps or special samplers. However, care should be taken to remove a sufficient volume of water from the well to insure that fresh water from the aquifer enters the well before the sample is collected.

Table 17. Proposed types of analyses

Schedule	Type of analysis	Determinations
1	Field, general	Specific conductance, pH, water temperature, air temperature, carbonate, bicarbonate, dissolved oxygen (as necessary)
2	Field, microbiological	Fecal and total coliform bacteria
3	Laboratory, major inorganics and nutrients	Calcium, sodium, potassium, magnesium, silica, nitrite plus nitrate (N), total phosphorus (P), dissolved solids, sulfate, chloride, and fluoride
4	Laboratory, trace elements	Arsenic, barium, boron, cadmium, hexavalent chromium, iron, lithium, mercury, lead, silver, selenium, and zinc. Not all parameters used at all sites
5	Laboratory, radiochemical	Tritium, strontium 90, gross alpha, and gross beta
6	Laboratory, pesticides	Endrin, lindane, methoxychlor, toxaphene, 2,4-D, 2,4,5-T, DDT, DDE, silvex, and dissolved organic carbon
7	Laboratory, selected ions[1]	Nitrate (N), sulfate, and chloride
8	Laboratory, individual ion	MBAS (methylene blue active substances)
9	Laboratory, individual ion	Phenols and dissolved organic carbon

[1]Field determinations could be made for these ions by use of special equipment.

Water samples should be collected by use of standard methods, most of which were described by Brown, Skougstad, and Fishman (1970); American Public Health Association, American Water Works Association, and Water Pollution Control Federation (1975); Wood (1976); and U.S. Geological Survey (1977).

Quality Assurance of Water-Sample Analyses

Analyses of samples should be complete enough to permit checks on accuracy. Some checks that can be used (Hem, 1970, p. 235) are:

1. Cation-anion balance. Sum of cations in milliequivalents per liter should equal the sum of anions in milliequivalents per liter, within a few percent.

2. Determined versus calculated dissolved-solids concentrations. Summation of individual concentrations of major constituents should equal the determined dissolved-solids concentration, within a few percent.

3. Conductivity-dissolved solids ratio. The dissolved-solids value in milligrams per liter is usually 0.55 to 0.75 times the specific conductance in micromhos per centimeter for water of ordinary composition.

4. The total of either cations or anions in milliequivalents per liter multiplied by 100 usually agrees approximately with the specific conductance in micromhos per centimeter.

Frequent calibration checks on pH and specific-conductance meters and on titrants are essential to help insure reliability of these field-measured properties. Samples collected for laboratory analyses require special preparation and preservation techniques. Laboratory analyses should be made only at laboratories approved by EPA.

THE NETWORK

The proposed ground-water-quality monitoring network is designed to (1) enable water managers to keep abreast of the general quality of the State's ground water, and (2) serve as a warning system for undesirable changes in the ground-water quality.

The network should supplement, not replace, ongoing local monitoring efforts and monitoring systems, which are required for new developments that could affect the State's aquifers. The proposed network includes 565 sites. These sites were chosen on the basis of results of background work described in the foregoing sections of this report. Specifics on the sites selected for monitoring are given in table 18 (back of text). Locations of the sites are shown in figure 10. Emphasis is on the 15 highest priority HU's. However, sampling sites are proposed for 57 of the State's 84 HU's. Most sites selected for inclusion in the network are existing wells or springs. Most sites are downgradient from potential pollution sources. Some are upgradient from potential pollution sources to provide comparative data. In some places, it will be desirable to monitor more than one aquifer or to monitor the same aquifer at different levels.

The proposed network should be flexible. As monitoring progresses, reevaluation of the network may reveal the need for changes in some site locations, characteristics measured, and frequency of sampling.

Twenty-seven of the State's lower ranked HU's do not presently require monitoring for ground-water quality because of their physical inaccessibility, small areas of privately owned land, or sparse population (fig. 7).

Eight new wells, included in the 565 candidate sites (table 18, back of text) are proposed to be drilled to aid monitoring wastes from INEL in Butte County and two hazardous waste-dumping areas in Owyhee County.

Three alternative levels of monitoring are offered for different levels of funding. These alternative levels are focused on the 15, 10, and 5 highest priority areas (fig. 7) for monitoring. All these sites are included in the statewide total of 565 sites.

In each of the three alternative levels of monitoring, suggestions are made to include the remainder of the 565 proposed sites, hereby referred to as supplemental sites, to keep the statewide ground-water-quality data base reasonably current. The supplemental sites could be sampled, at least for field analyses, at 5-year intervals.

Proposed New Wells

Drilling of eight new wells, six at INEL and two in Owyhee County, is tentatively proposed as part of the statewide network. The well locations and approximate depths are given in table 19.

Table 19. Suggested locations and depths for drilling or deepening wells for the network

HU	Site location	Approximate well depth, in feet below land surface	Aquifer to be monitored[1]	Potential pollution source	Remarks
				WELLS SUGGESTED FOR DRILLING	
28	2N-29E-25dbbl	1,400	110SKRV	INEL	Suggested for drilling as soon as possible. However, deepening of well 2N-29E-13aaal would replace the need for this site. Primary well.
28	1N-29E-3bdcl	1,450	11 SKRV	INEL	Suggested for drilling only if pollution is found in upgradient wells. Depth is maximum. Actual depth may be less, depending on level at which pollution is found upgradient. Secondary well.
28	1N-30E-5dccl	1,440	110SKRV	INEL	Suggested for drilling only if pollution is found in upgradient wells. Depth is maximum. Actual depth may be less, depending on level at which pollution is found upgradient. Secondary well.
31	1N-29E-6dcdl	1,480	110SKRV	INEL	Suggested for drilling only if pollution is found in upgradient wells. Depth is maximum. Actual depth may be less, depending on level at which pollution is found upgradient. Secondary well.
40	3N-30E-30ccb2	1,320	110SKRV	INEL	Suggested for drilling as soon as possible. However, deepening of well 3N-30E-30ccbl would replace the need for this site. Primary well.
40	2N-29E-19cccl	1,450	110SKRV	INEL	Suggested for drilling as soon as possible. However, deepening of well 2N-28E-35adal would replace the need for this site. Primary well.
45	8S-5E-33abbl	650	121IDVD	Hazardous waste	Suggested for drilling as soon as possible. Owyhee County.
46	4S-2E-18cdcl	400	112IDHO	Hazardous waste	Suggested for drilling as soon as possible. Depth is for monitoring shallow zones from which water is withdrawn for domestic and stock use. Owyhee County.
				EXISTING WELLS THAT COULD BE DEEPENED	
28	2N-29E-13aaal	1,330	110 SKRV	INEL	Current (1978) well is 752 ft deep. Primary well.
31	2N-28E-35adal	1,450	110 SKRV	INEL	Current (1978) well is 654 ft deep. Primary well.
40	3N-30E-30ccbl	1,320	110 SKRV	INEL	Current (1978) well is 610 ft deep. Primary well.

[1] Refer to table 3 for description of aquifer code.

Three of the new wells that would monitor INEL wastes would be needed only if it is not feasible to deepen three existing wells. The existing wells are now finished in the upper part of the Snake Plain aquifer at INEL. They would have to be completed in more than one water-bearing zone in this aquifer to serve the monitoring purpose that is intended. These wells are designated as primary wells in table 19 and should be implemented as soon as possible. The other three new wells at INEL, or secondary wells, should be drilled if water in the primary wells is found to be polluted. The secondary wells would be located down the hydraulic gradient in the Snake Plain aquifer from the primary wells.

The remaining two of the proposed new wells should be drilled downgradient of present hazardous-waste sites in Owyhee County.

This study suggests only the need for drilling new wells or deepening existing wells and does not assign responsibility for their drilling.

Alternative Levels of Monitoring

The monitoring network (table 18, back of text) represents essentially statewide coverage. Sampling frequencies range from quarterly to once every 5 years. However, to meet probable funding limitations for implementing the monitoring program, three alternative levels of monitoring (table 19) are given: (1) Monitor the 15 highest priority HU's (actually, 17 HU's are included due to differences in ranking between the 1975 and 2000 data bases, see table 15), a total of 426 sites; (2) monitor the 10 highest priority HU's, 350 sites; or (3) monitor the 5 highest priority HU's, 233 sites.

To further reduce costs involved in these alternatives, some of the proposed laboratory analyses could be eliminated and replaced by field analyses. In many places, field analyses, combined with existing laboratory data, would be adequate to indicate major changes that occur in water quality. Specific laboratory analyses could then be made to determine which constituents or properties are involved.

As part of the three alternative levels of sampling, different supplemental sites should be included annually to insure that minimal statewide coverage is obtained. This could be done by adding 23, 43, and 66 sites, respectively, each year to the alternative-level networks, as shown in table 19. Field analyses only would be made at the supplemental sites. By this means, all the 565 sites in the proposed statewide network would be sampled at least once in every 5 years.

Selected Data for Estimating Monitoring Costs

Means of estimating the cost of implementing the total network and its alternative levels of monitoring are shown in table 20. Actual costs are not given because they are subject to changes, depending on the RMA and inflationary increases. However, data are given from which reasonable cost estimates can be made.

Suggested trip itineraries (part B, table 20) are included to aid in estimating travel cost. All trips are assumed to originate at Boise, Ida.

Average item costs must be assigned by the RMA for laboratory analyses, field analyses, subsistence, manpower, mileage, and administration.

Estimates for costs and methods of drilling wells for ground-water monitoring are discussed by Everett and others (1976).

DATA STORAGE AND RETRIEVAL

A data-management and reporting system should be an integral part of any monitoring system. Often in the past, data have been collected and filed without a means for orderly retrieval and logical interpretation as to their significance.

Selection of the network data-management system depends on: (1) Volume of data to be generated; (2) use and distribution of the data; and (3) compatibility with other data systems. A thorough discussion of data-management costs, information to be managed, and reporting systems necessary for monitoring was given by Hampton (1976). Hampton's report gives specifications and guidelines for ground-water surveillance data systems. It also includes an inventory of existing data-management systems and gives recommendations for modifying the existing systems to better meet the needs of a ground-water-quality monitoring system. A summary of the information to be managed is given in table 21.

Table 20. Selected data for estimating monitoring costs

A. Site visits, field analyses, laboratory analyses, man days, subsistence, and mileage

	Proposed network and alternative monitoring levels						Supplementary sites					
Network	Number of sites	Field analyses and site visits	Laboratory analyses	Man days	Subsistence (days)	Travel (miles)	Number of sites	Field analyses and site visits per year	Laboratory analyses	Man days	Subsistence (days)	Travel (miles)
Statewide	565	830	307	350	300	35,000	0	0	0	0	0	0
Alternative 1	426	680	207	270	220	27,000	138	28	0	10	10	1,000
Alternative 2	350	574	162	200	160	22,000	214	43	0	14	14	1,400
Alternative 3	233	407	113	160	110	15,000	332	66	0	22	22	2,200

B. Suggested trip itineraries for estimating travel data[1]
(Based on headquarters at Boise, Idaho)

Trip	HU	Trip	HU	Trip	HU
A	1- 6	H	36-40	O	58
B	7-20	I	41-43	P	59
C	21-27	J	44-46	Q	60-62
D	28-29	K	53	R	64-65
E	30	L	55	S	67-70
F	31-32	M	56	T	76
G	33-35	N	57	U	81-82

[1] HU's that do not presently (1979) need monitoring are not included in the table.

Table 21. Summary of information to be managed by the responsible ground-water-quality monitoring agency (Modified from Hampton, 1976)

1. System-specific data
    - Water-quality characteristics
    - Units of measure
    - Property and constituent codes

2. Site-specific data
    - Site type
        - Sample-extraction method
        - Type data
        - Type site
        - Monitoring justification
    - Responsible monitoring agency
    - Site-identifier code
    - Geographic coordinates and associated measurement precision
    - Site location (township, range, section, etc.)
    - Site depth (hole depth and screen depth)
    - Site land-surface elevation
    - Site-specific information qualification
    - Quality criteria
        - Demographic and economic data
        - Land use
        - Water use
    - Political jurisdiction code
    - Geological data
        - Aquifer code (may be sample specific)
        - Geochemical information

3. Sample-specific data
    - Sample date
    - Pumping duration
    - Sample depth
    - Water-table depth (average range)

4. Measurement-specific data
    - Physical-chemical analyses

5. Information indexing
    - Water-quality-file abstracts
        - Characteristics monitored
        - Monitoring frequency
        - Period of record

A large amount of ground-water-quality data is now in WATSTORE. The proposed monitoring network is expected to generate much more. Therefore, the network's data-storage and retrieval system should be compatible with WATSTORE. Hampton (1976) recommended using STORET, the EPA computer system, to achieve compatibility between the existing data in WATSTORE and the data generated by the monitoring network.

An edit capability also is a necessary part of any monitoring system. The editing can be based on comparison of input data with trends, allowable data ranges, and established limits. Data failing any one of these checks should not be modified but flagged and reported as a possible indicator of potential pollution. In addition, the State ground-water-quality monitoring program administrator should have the capability of monitoring the RMA. This could be done by periodic computer-generated reports.

Ground-water data should be retrievable in groups by using any one or a combination of the following information elements:

1. Station number
2. Range of station numbers
3. Latitude and longitude
4. Polygon (specified by the latitude and longitude of its vertices)
5. Political jurisdiction
6. Sampling date
7. Range of sampling dates
8. Sampling depth
9. Range of sampling depths
10. Monitoring agency
11. Property and constituent values

A data storage and retrieval system should be capable of providing most of the information in table 22 for best use and quality control.

REPORTING OF CRITICAL CHANGES IN GROUND-WATER QUALITY

A ground-water-data management system should include the following components: (1) A method of maintaining the generated data; (2) a method of indexing the data; and (3) a method of maintaining and issuing citations where necessary. These components were discussed in detail by Hampton (1976). The monitoring network reporting system must have some capability to signal and report critical changes (water-quality properties exceeding predetermined limits) in the ground-water quality.

Table 22. Summary of required output information

Measured characteristics

Number of observations

Beginning and ending sampling dates

Raw data

Minimum and maximums

Arithmetic means

Standard deviations

Regression coefficients

Correlation coefficients

Percentiles

Confidence intervals

Logarithms

Station descriptive paragraphs

User requests for pictorial (graphic) displays may require the following type of plots:

Physical-chemical variations with time

Monitoring stations located geographically

Vertical bar charts

Circular diagrams

Radial vector diagrams

Pattern diagrams

Trilinear diagrams

Critical changes should result in special messages from the computer system. The RMA then should notify the IDHW and EPA of such changes by letter. Sites that show critical changes may require more intensive monitoring. In addition, onsite inspection should be made to determine whether a nearby source is responsible for the change.

An annual report containing data collected (chiefly computer generated) and significant happenings should be prepared by the RMA for the IDHW.

SUMMARY

A ground-water-quality monitoring network for Idaho has been designed to assist the State in complying with section 208 of the Federal Water Pollution Control Act, 1972. The network is designed to (1) enable water managers to keep abreast of the general quality of the State's ground water, and (2) serve as a warning system for undesirable changes in ground-water quality. The background work preliminary to network design consisted of data compilation on status of existing ground-water quality, definition of aquifer systems, direction of ground-water movement, location of potential pollution sources, and types of wastes. It culminated with prioritization of areas to insure proper focus of monitoring.

Ground-water-quality data from USGS files were compiled, checked, coded, and entered into the WATSTORE system to expand the data base for Idaho. Some ground-water-quality data for more than 2,200 sites are currently (1979) in the system. As part of this study, water samples were collected at selected sites where data were lacking or where comparison with existing data was desired. A statistical analysis was made to obtain the range, mean, and standard error of selected data in WATSTORE for the State's major aquifers.

A priority-rating system devised by Nowlin (1978) was modified for use in ranking areas of Idaho for monitoring. The rating system uses data for hydrologic, geologic, and cultural elements for a 1975 data base to rate areas for monitoring. To assess future monitoring needs, the rating system was applied to a year-2000 data base. As a result of the rating, 27 of the State's 84 HU's (U.S. Geological Survey, 1974) were not considered for monitoring at this time.

The statewide network is designed to use existing wells, for the most part. It includes 565 sites. Sampling frequencies range from quarterly to once in 5 years. The network is designed to monitor chiefly nonpoint sources of

pollution and is intended to supplement, not replace, ongoing local monitoring efforts. Sites in the network include eight wells suggested for drilling to aid in monitoring ground water in the INEL area and in two areas of hazardous waste dumping in Owyhee County.

Three alternative levels of monitoring are proposed to provide choices in operation of the network. Alternative 1 includes 426 sites in the 15 highest ranked HU's (actually includes 17 HU's because of changes between 1975 and 2000 data bases). Alternative 2 includes 350 sites in the 10 highest ranked HU's. Alternative 3 includes 233 sites in the 5 highest ranked HU's. In addition, a suggestion is made to incorporate supplementary sites in each alternative level of monitoring to insure that each of the 565 statewide proposed sites is sampled, at least for field analyses, once every 5 years.

Data are compiled (for manpower, water-quality analyses, and travel) from which costs for implementing the statewide network and the three alternative levels of monitoring, including the suggested supplementary sites, can be estimated.

Suggestions are made for data storage and retrieval and reporting. It is important that the storage and retrieval system used for the network be compatible with the WATSTORE computer system to make best use of the ground-water-quality data base.

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CANDIDATE MONITORING NETWORK DATA TABLE

Table 18. Candidate monitoring sites, sampling frequencies, types of analyses, and selected hydrogeologic characteristics

Headnotes

HU: For explanation of hydrologic unit, see text, table 1, and figure 2.

Location: For explanation of site-numbering system, see text.

USGS site identification: For explanation, see site-numbering system in text.

County: For explanation of county codes, see footnote 1 at end of table 15.

Frequency: A, quarterly; B, semiannual; C, annual; D, 5-year.

Type of analysis: 1, general field chemical analysis; 2, coliform bacteria (field analysis); 3, major inorganics and nutrients; 4, trace elements; 5, radiochemicals; 6, pesticides; 7, selected ions; 8, MBAS; 9, phenols. (See table 17 for more complete description.)

Aquifer code: For explanation of aquifer codes, refer to table 2.

Depth: Total depth of well, in feet below land surface.

First opening: Depth, in feet below land surface, to the first perforation or other opening where ground water may enter the well.

Approximate water level: Depth or range in depth, in feet below land surface, to the top of the water surface in the well.

Water use: D, drainage; H, domestic; I, irrigation; N, industrial; O, observation; P, public supply; S, stock; T, test; U, unused.

Specific conductance: Specific conductance measured in a water sample in micromhos per centimeter at 25°C; a, estimated value.

Major potential pollution sources: D, septic-tank systems, sewerage leakage, sewerage ponds, or landfills; E, waste-disposal wells; F, agriculture and livestock wastes; G, mining and related processing wastes; J, runoff from urban areas; K, known pollution minor; R, radioactive or hazardous waste.

Table 18. Candidate monitoring sites, sampling frequencies, types of analyses, and selected hydrogeologic characteristics

HU	Location	USGS site identification	County	Frequency	Type of analysis	Aquifer code	Depth	First opening	Approximate water level	Water use	Specific conductance	Major potential pollution sources
1	15S-46E-6ccal	420834111073701	7	D	1,7	112ALVM	38	33	8	I	940	F
2	8S-41E-2ddcl	424506111373101	29	C	1,7	112PLSC	100	21	60	H	769	K
2	8S-41E-35dcbl	--	29	C	1,7	340DVNN	110	56	33	H	--	G
2	8S-42E-9cbbl	424427111334701	29	C	1,3	112PLSC	245	225	150	H	1,030	G
2	8S-42E-15acl	--	29	C	1,7	230TRSC	180	--	1	H	--	G
2	8S-42E-28cdcl	424135111332501	29	C	1,7	112PLSC	90	65	54	H	992	G
2	8S-42E-29cccl	--	29	C	1,3	112PLSC	300	120	50	I	--	G
2	8S-42E-31adbl	424110111350801	29	C	1,3	112PLSC	255	110	40	N	1,010	G
2	9S-42E-6addl	424017111350901	29	C	1,3,4	112PLSC	105	85	23	H	1,170	D,G,J
2	9S-42E-18caal	423828111353601	29	C	1,3	112PLSC	108	61	45	H	802	D,J
2	13S-44E-4acbl	--	7	C	1,2,3,4,8	110ALVM	450	30	--	P	550	D,J
3	10S-40E-12aabl	--	29	C	1,2,3,4,8	112PLSC	--	--	--	P	--	D,F,J
3	14S-38E-15cdcl	421156112002701	41	C	1,2,3,4,8	121SLLK	200	--	20-40	P	--	F,J
3	15S-39E-16bbdl	--	41	C	1,7	110ALVM	17	17	4	H	--	F,J
4	--	--	--	--	--	--	--	--	--	--	--	--
5	14S-36E-34bb2	--	71	C	1,2,3,4,8	110ALVM	55	30	9	I	--	F,J
5	15S-35E-1daal	420855112182301	71	D	1,7	100VLFL	275	249	Flows	I	468	F
5	15S-36E-22abal	420638112140301	71	C	1,3	110ALVM	100	100	13	I	506	F
6	14S-33E-31abl	421000112383001	71	C	1,2,3,4,8	100VLFL	95	84	2	I	958	D,F
6	15S-32E-33dcdl	420402112431301	71	D	1,7	100VLFL	402	402	--	I	1,500	F
7	--	--	--	--	--	--	--	--	--	--	--	--
8	63N-1W-24cacl	484739116244101	21	C	1,3	110ALVM	45	41	23	H, S	43	K
8	62N-2E-29cdcl	484123116141101	21	C	1,7	110ALVM	60	--	27	H	412	F
8	62N-1E-34bdl	--	21	C	1,3	110ALVM	--	--	--	--	--	D,F
8	60N-1W-34adbl	483040116263001	21	C	1,7	110ALVM	60	50	40	H	43	K
9	--	--	--	--	--	--	--	--	--	--	--	--
10	55N-3E-19cbdl	480552116073801	17	D	1,7	110ALVM	57	52	--	H	--	K
10	55N-2E-3aaal	--	17	D	1,2,3,4,8	110ALVM	--	--	--	--	--	D,J
11	57N-2W-1bcbl	481909116312301	17	D	1,7	110ALVM	28	18	8	S	420	K
11	57N-2W-16accl	481718116343402	17	C	1,3	211IDAH	175	21	47	H	65	D
11	56N-2W-15ccbl	481151116335301	17	D	1,7	112OTSH	182	182	28	H	--	K
11	56N-5W-27aabl	481047116562901	17	D	1,7	112OTSH	232	226	203	H	312	D
11	56N-3W-30bacl	481041116452101	17	D	1,7	112OTSH	80	59	48	H	84	D
11	53N-4W-6ddb2	475754116523501	55	D	1,2,3	112OTSH	328	328	283-313	P	53	D
12	61N-4W-16bcal	483832116520301	17	D	1,3	112OTSH	40	40	24	H	58	D
12	60N-4W-31cbdl	483020116543701	17	D	1,3	112OTSH	47	43	44	H	41	D
12	57N-5W-14dccl	481656116562601	17	D	1,3	112OTSH	178	87	115	H	163	D,F
13	--	--	--	--	--	--	--	--	--	--	--	--
14	49N-2E-8caal	473631116135901	79	D	1,3,4	400PCMB	197	12	56	H	--	G
15	48N-2E-3abcl	473227116111601	79	C	1,3,4	400PCMB 110ALVM	200	35	14	P	171	D,G
15	48N-2E-5bdal	473221116135701	79	C	1,3,4	110ALVM	95	85	4	N	46	D,G
15	48N-3E-6adal	473220116065601	79	C	1,3,4	110ALVM	152	57	40	I	274	D,G,J
15	48N-3E-11dddl	473057116014401	79	D	1,3,4	110ALVM	40	25	29	I	199	D,G
15	48N-5E-36bbbl	472820115461101	79	D	1,3,4	112OTSH	--	--	--	I	104	G
16	49N-1W-22ddcl	473429116263001	55	C	1,3,4	110ALVM	130	116	23	H	102	D,G
16	49N-1E-34bcdl	473310116193701	79	D	1,3,4	110SDMS	83	30	10	P	166	G
16	48N-1W-18bbbl	473050116312201	55	D	1,3,4	110ALVM	125	80	26	H	208	G

Table 18. Candidate monitoring sites, sampling frequencies, types of analyses, and selected hydrogeologic characteristics (Continued)

HU	Location	USGS site identification	County	Frequency	Type of analysis	Aquifer code	Depth	First opening	Approximate water level	Water use	Specific conductance	Major potential pollution sources
17	46N-4W-7cdb1	472024116531701	9	C	1,3	110ALVM	100	67	28	H	262	D,F
17	46N-2W-16bbd1	472018116362801	9	C	1,2,3	122CBRV	80	79	42	H	290	D,F
17	46N-2W-36dda1	471712116312001	9	D	1,3	112CBRV	214	93	--	H	313	K
17	45N-5E-15aaa1	471502115480201	79	D	1,3	110ALVM	37	--	--	P	--	D,F
17	44N-1W-15dd1S	470925116274001	9	D	1,2,3	112CBRV	--	--	--	P	159	D
18	53N-4W-24bba1	475558116464701	55	C	1	112OTSH	480	--	462-474	H	262	D,F
18	53N-3W-9cdd1	475657116423601	55	C	1,2,7	112OTSH	357	--	335-349	P	297	D,J
18	53N-2W-19add1	475534116364801	55	C	1	112OTSH	401	126	79-86	H	274	K
18	52N-4W-14dcd1	475047116474401	55	C	1	112OTSH	365	240	212-217	H	199	F
18	52N-4W-27dcd1	474906116484801	55	C	1,3	112OTSH	306	265	255-275	P	297	D,H
18	52N-3W-7dca1	475146116445401	55	B	1; 1	112OTSH	270	106	83-98	N	164	K
18	51N-5W-21cbc1	474449116584401	55	C	1,7	112OTSH	191	183	155-162	H	--	D,F
18	51N-5W-25dab1	474416116535401	55	B	1,7; 1	112OTSH	290	125	215	K	269	D,F
18	51N-5W-31aca1	474325117002801	55	A	1,2,3,4; 1; 1; 1	112OTSH	189	167	127	I	264	D,F,J
18	51N-5W-33bba1	474344116583001	55	B	1,2,3,4,8; 1	112OTSH	174	--	153-160	U	--	D,F,J
18	51N-5W-35bdc1	474330116554501	55	B	1,2,7; 1	112OTSH	242	212	217-221	I	248	D,F,J
18	51N-4W-6ada1	474755116521901	55	B	1,7; 1	112OTSH	277	249	246-250	I	181	D,F
18	51N-4W-10bbd1	474704116435001	55	B	1,7; 1	112OTSH	361	336	296-302	I	--	D,F
18	51N-4W-15dab1	474558116484201	55	B	1,2,3,8; 1	112OTSH	343	323	298-305	N	144	D,F,J
18	51N-4W-18dbc1	474547116524801	55	C	1,7	112OTSH	323	298	257-261	I	--	F
18	51N-4W-22bca1	474517116492801	55	B	1,2,3,8; 1	112OTSH	357	337	299-305	I	301	D,F,J
18	51N-4W-24abb1	474526116462201	55	B	1,2,3,8; 1	112OTSH	217	210	185-189	H	97	D,J
18	51N-4W-27ddb1	--	55	B	1,7; 1	112OTSH	310	255	255	I	257	D,J
18	51N-4W-29dbb1	--	55	B	1,7; 1	112OTSH	268	237	227	I	262	D,F
18	51N-4W-32dac1	474314116511801	55	B	1,2,3,8; 1	112OTSH	343	313	265-271	I	--	D,F
18	51N-4W-35adb1	--	55	B	1,2,7; 1	112OTSH	228	203	203	H	327	D,J
18	51N-4W-35ccc1	--	55	B	1,2,3; 1	112OTSH	250	244	185	H	--	D,J
18	50N-5W-1aad1	474246116534101	55	B	1,2,3,8; 1	112OTSH	230	230	196-203	P	123	D,J
18	50N-4W-1cdc1	474207116464501	55	B	1,2,3,8; 1	112OTSH	226	196	190-205	P	--	D,J
18	50N-4W-3add1	474232116483101	55	B	1,2,3,8; 1	112OTSH	237	227	162-164	P	--	D,J
19	44N-5W-11ccc1	470949116560901	9	D	1,7	110ALVM	190	92	Flows	H	191	D
20	--	--	--	--	--	--	--	--	--	--	--	--
21	1N-44E-20aa1	--	19	D	1,7	110ALVM	69	69	15	P	--	D
22	--	--	--	--	--	--	--	--	--	--	--	--
23	5N-37E-32aca2	434323112073802	51	C	1,2,3	110SKRV	325	310	5	P	350	D,F
23	5N-38E-31bad1	--	51	B	1,2,3; 1	110SDMS	13	13	9	U	--	D,F
23	5N-38E-35ada1	434323111563801	51	B	1; 1	110SKRV	109	100	55	H	--	D,F
23	5N-39E-33ab1	--	51	B	1; 1	110ALVM	59	59	6	H	--	D,F
23	4N-36E-25bab1	--	51	D	1	110SKRV	312	31	259	H, S	--	F
23	4N-38E-8bcc1	--	51	B	1,2; 1,2	110SKRV	115	97	20	H	--	D,F,J
23	4N-38E-13abb1	--	51	B	1,2; 1,2	110ALVM	89	89	17	H	--	D,F,J
23	4N-39E-18abc1	434053111544501	51	C	1,2	110LAVM	65	55	9	H	--	D,F,J
23	4N-39E-18cac1	434027111545701	51	B	1,2,3; 1,2	110ALVM(?)	200	--	--	P	490	D,F,J
23	4N-39E-28bcd1	--	51	B	1; 1	110ALVM	125	125	40-75	H	--	D,F
23	4N-40E-32dbd1	433755111461101	51	B	1,2,3,7; 1,7	110ALVM	110	32	32	P	570	D,F,J

Table 18. Candidate monitoring sites, sampling frequencies, types of analyses, and selected hydrogeologic characteristics (Continued)

HU	Location	USGS site identification	County	Frequency	Type of analysis	Aquifer code	Depth	First opening	Approximate water level	Water use	Specific conductance	Major potential pollution sources
23	3N-36E-20cdb1	--	19	B	1,7; 1,7	110SKRV	452	14	390	I	501	E,F
23	3N-37E-2bcd1	--	19	B	1,7; 1,7	110SKRV	275	51	219	I	--	E,F
23	3N-38E-14bbd1	433541111572901	19	B	1,2,3; 1	110SKRV	230	--	52	P	--	D,E,F,H
23	3N-38E-22bab1	--	19	B	1; 1	110SKRV	180	69	90	H	--	E,F
23	2N-37E-14ccc1	432952112045301	19	B	1,2,3,4; 1,7	110SKRV	168	0	147	P	580	D,E,F,H
23	2N-37E-23abb1	--	19	B	1; 1	110SKRV	400	256	167	P	680	D,E,F,J
23	2N-37E-28aaa1	432856112060801	19	C	1,7	110SKRV	152	--	134	P	559	E,F
23	2N-38E-1dac1	433145111554001	19	C	1,2,3	110ALVM(?)	160	--	--	P	--	D,F
23	2N-38E-15bba1	433039111584701	19	B	1,7,8; 1,7	110SKRV 110ALVM	200	140	120	P	--	D,E,F
23	2N-38E-15daa1	--	19	B	1,2,3,4,8; 1,7	110SKRV 110ALVM	141	54	68	H	--	D,E,F
23	2N-38E-18cbc1	--	19	A	1,2,3,4,8; 1,7; 1,7; 1,7	110SKRV	394	314	140	P	550	D,E,J
23	2N-38E-19dbb1	--	19	B	1,7; 1,7	110SKRV 110ALVM	186	--	--	P	550	D,E,J
23	2N-38E-22ddb1	--	19	B	1,7; 1,7	110SKRV	116	80	90	H	--	D,E,J
23	2N-38E-26bdb1	432844111572301	19	C	1,2,7	110SKRV(?)	--	--	--	P	520	D,E,J
23	2N-38E-30bac1	--	19	B	1,2,3,4,8; 1,2,6,7	110SKRV	350	240	149	P	550	D,E,J
23	2N-38E-32cbc1	--	19	C	1,2,7,8	110SKRV 110ALVM	196	76	--	H	--	D,E,F
23	2N-38E-34dcc1	--	19	C	1,2,7,8	110SKRV	108	56	52	H	--	D,E,F
23	1N-37E-1bba1	--	19	B	1,2,7,8; 1,7	110SKRV	203	13	162	I	--	E,F
23	1N-37E-4cbc1	--	19	B	1,3,4,6,8; 1,8	110SKRV	130	23	102	H, S	--	E,F
23	1N-37E-10ddb1	--	19	C	1,7,8	110SKRV	180	126	--	N	--	E,F,H
23	1N-38E-6abb1	--	19	C	1,7,8	110SKRV	182	40	151	--	--	E,F
23	1N-38E-9bcb1	--	19	B	1,7; 1,7	110SKRV	183	79	80	P	--	E,F
24	13N-43E-15adc1	--	43	C	1,7	112LVCK	58	38	16	P	96	D,K
24	11N-42E-11dad1	--	43	D	1,7	112FLRV	80	18	37	P	130	D,K
24	9N-43E-30ccc2	--	43	C	1,3,4,8	112FLRV	73	13	12	I	443	D,F,J
25	8N-42E-3bab1	--	43	B	1,3,8; 1,7	110SKRV	100	--	Flows	N	--	D,F
25	8N-40E-36ddd1	--	43	C	1,2,3	111ALVM 110SKRV	209	127	144	P	260	D,F,J
25	7N-39E-19cdd1	--	65	C	1,3	111ALVM	135	135	96	H	--	D,F
25	7N-40E-2bbb1	--	43	C	1,2,3,8	110SKRV	244	40	111	P	--	D,F,J
25	7N-40E-5dbc1	--	43	C	1,7	111ALVM	39	36	6-12	O	155	D,E,F
25	7N-40E-24ddd1	--	43	C	1,7	110SKRV	95	62	60	H	--	D,F
25	6N-39E-20dcc1	--	65	C	1,3	111ALVM	51	39	51	H	--	F
25	6N-39E-20ddd1	--	65	C	1,3	111ALVM 110SKRV	353	270	32	O	--	F
26	6N-40E-4dbb1	435226111443801	65	B	1,2,3; 1,7	111ALVM	183	80	50	P	--	D,E,F

Table 18. Candidate monitoring sites, sampling frequencies, types of analyses, and selected hydrogeologic characteristics (Continued)

HU	Location	USGS site identification	County	Frequency	Type of analysis	Aquifer code	Depth	First opening	Approximate water level	Water use	Specific conductance	Major potential pollution sources
26	6N-40E-19aab1	--	65	B	1,7; 1	111ALVM 110SKRV	296	114	32	N	408	D,F,J
26	6N-40E-20bbb1	--	65	C	1,7	111ALVM	66	66	5	H	--	D,F,J
26	6N-39E-24dcc1	--	65	B	1,2,3,4,8; 1,7	111ALVM	75	75	14	P	440	D,F,J
26	6N-39E-26baa1	434528111493901	65	B	1,7; 1	111ALVM	80	80	18	H	--	D,F,J
26	6N-40E-30bda1	434919111472001	65	C	1,7	110SKRV	172	100	18	P	440	D,F,J
26	6N-40E-26bbb1	--	65	C	1,7	120VLCC(?)	320	222	285	H	--	K
26	5N-39E-24bcc1	434503111492501	65	B	1,3; 1	111ALVM	44	44	6	H	--	D,F
26	6N-45E-28cac1	434852111091201	81	C	1,2,3	120VLCC(?)	198	--	107	P	280	D,J
26	5N-45E-26daa1	434345111060001	81	C	1,2,3	110ALVM	225	85	6	P	--	D,J
26	5N-45E-31bcb1	434312111115701	81	C	1,7	110ALVM	13	10	4	H	--	F
26	4N-45E-30abc1	433852111112001	81	C	1,2,7	110ALVM	44	44	3	H	--	F
27	--	--	--	--	--	--	--	--	--	--	--	--
28	3N-34E-32bbc1	433307112300001	19	D	1,7	110ALVM	--	--	--	H	--	R
28	2N-29E-13aaa1	433023112561501	23	C	1,3,4,5	110SKRV	752	--	--	--	269	R
28	2N-29E-25dbb1	--	23	C	1,3,4,5	110SKRV	--	--	--	--	--	R
28	2N-33E-8aaa1	433136112360401	11	C	1,3,4,5	110SKRV	920	--	837	H, I	--	R
28	1N-29E-3bdc1	--	23	C	1,3,4,5	110SKRV	--	--	--	--	--	R
28	1N-30E-5dcc1	--	23	C	1,3,4,5	110SKRV	--	--	--	--	--	R
28	1N-30E-10bba1	432618112555501	11	C	1,3,4,5	110SKRV	564	--	530	--	--	R
28	1N-31E-3cad2	--	11	C	1,5,7	110SKRV	632	35	589	P	--	R
28	1N-31E-8cdd1	--	11	C	1,3,4,5	110SKRV	720	--	--	I	389	R
28	1N-33E-26dbc1	--	11	D	1,7	110SKRV	406	314	327	I	--	F
28	1N-35E-29cac1	--	11	D	1,3	110SKRV	413	--	312	--	575	F
28	1N-36E-33cdd2	--	11	D	1,7	110SKRV	203	--	171	S	--	F
28	1N-36E-24add1	--	11	B	1,3,4,8; 1	110SKRV	137	--	97	H, S	--	D,F
28	1N-36E-36acc1	--	11	C	1,7	110SKRV	200	--	68	H	--	D,F
28	1N-37E-32dbb1	--	11	B	1,7; 1	111ALVM 110SKRV	243	81	92	N	--	D,E,F,H,J
28	1N-37E-33bbb1	--	11	B	1,2,3,4; 1,7	110SKRV	371	288	71	P	500	D,E,F,H,J
28	1S-30E-22dbd1	431907112560201	11	C	1,3,4,5	110SKRV	--	--	--	S	376	R
28	1S-32E-19bbb1	--	11	C	1,7	110SKRV	234	6	130	H	--	F
28	1S-33E-28add1	--	11	C	1,7	110SKRV	299	4	222	I	--	F
28	1S-35E-31bda1	--	11	D	1,7	110SKRV	198	2	120	I	--	E,F
28	1S-36E-31bbd1	--	11	D	1,7	111ALVM 110SKRV	201	201	85	I	--	F
28	1S-36E-25adb1	--	11	C	1,3,6	111ALVM	57	57	9	N	510	D,E,F,H,J
28	2S-30E-30bbb1	431333113001701	11	D	1,7	110SKRV	739	704	686	S, O	303	R
28	2S-33E-25ccb1	--	11	C	1,7	110SKRV	136	5	57	I	--	F
28	2S-34E-34ddd1	--	11	C	1,7	111ALVM 110SKRV	192	120	20	H	--	D,E,F
28	2S-35E-30ddd1	--	11	B	1,7; 1	111ALVM	60	57	58	H	--	D,E,F
28	2S-35E-35daa1	--	11	B	1,3; 1,7	111ALVM 110SKRV	50	--	--	H	628	D,E,F
28	3S-31E-35cdc1	--	11	D	1,7	110SKRV	147	5	95	I	--	F
28	3S-33E-29aaa1	--	11	B	1,7; 1	110SKRV	129	6	125	H	--	F
28	3S-35E-2bbd1	--	11	C	1,2,3,4	111ALVM 110SKRV	623	385	--	P	550	D,E,J

Table 18. Candidate monitoring sites, sampling frequencies, types of analyses, and selected hydrogeologic characteristics (Continued)

HU	Location	USGS site identification	County	Frequency	Type of analysis	Aquifer code	Depth	First opening	Approximate water level	Water use	Specific conductance	Major potential pollution sources
28	3S-35E-3acbl	--	11	A	1,2,3,4,8; 1,2,7; 1,2,7; 1,2,7	111ALVM 110SKRV	182	86	49	P	--	D,E,J
28	3S-35E-9cddl	--	11	C	1,7	111ALVM	70	70	15	H	--	D,E,F,J
28	3S-35E-10bbal	--	11	B	1,2,7; 1	111ALVM 110SKRV	132	71	46	P	681	D,E,F,J
28	4S-32E-14dab2	--	11	B	1,3,4,6,8; 1,7	110SDMS	226	226	1	H	--	D,E,F
28	4S-33E-1adclS	--	11	A	1,7; 1,7; 1,7; 1,7	111ALVM 110SKRV	--	--	--	--	--	D,E,F
28	4S-33E-20dbdl	--	11	C	1,7	110SKRV(?)	56	--	36	--	--	D,F
28	4S-34E-35aabl	--	11	C	1,7	111ALVM	82	82	30	N	--	D
28	5S-30E-8cdcl	--	11	D	1,7	111ALVM	325	--	--	I	--	F
28	5S-31E-33adcl	--	11	B	1,3; 1,7	110SDMS 110SKRV	340	334	15	N	--	D,E,F,H,J
28	5S-34E-13bbbl	--	5	C	1,7	111ALVM	183	183	82	H, 8	--	D,E
28	6S-30E-33babl	--	77	A	1,7; 1; 1; 1	110SKRV	242	--	--	--	529	F
28	6S-31E-18aacl	--	11	B	1; 1	110SKRV	120	--	96(?)	H	705	D,E,F
28	6S-33E-15adcl	--	77	B	1,3,4,5; 1,7	110ALVM	203	99	60	P	--	F,G,H,R
28	7S-31E-22cbdl	--	77	B	1,7; 1	110SKRV	175	--	71	--	756	D,F
28	7S-31E-29dbbl	--	77	C	1,3,4	110SKRV 111ALVM	352	295	85	--	--	D,J
29	6S-42E-10cbal	--	29	D	1,7	300CLSC(?)	46	46	6	H	--	K
29	7S-43E-23bal	--	29	D	1,3,4	300CLSC	302	262	123	H	--	G
30	5S-34E-26dbdl	425712112263301	5	C	1,3	112PLSC	240	196	190	H	1,220	G
30	5S-34E-30badl	425740112313501	5	B	1,7; 1,7	112MCHD	151	151	41	H	459	D,F
30	6S-33E-2aaal	425606112332501	77	A	1,3,4,5; 1,7; 1,7 1,7	112MCHD	180	156	20	H	477	--
30	6S-33E-11dbdl	--	77	C	1,7	112MCHD	130	130	46	I	--	G,H
30	6S-33E-10dadl	--	77	C	1,7	112MCHD	214	209	32	P	--	D,F,H
30	6S-33E-12daal	--	77	A	1,3,4,5; 1,7; 1,7 1,7	112MCHD	113	81	65	P	--	G,H
30	6S-33E-12dddl	--	77	C	1,7	112MCHD	120	119	60	H	--	G,H
30	6S-33E-1bal	--	77	C	1,7	112MCHD	75	75	0	H	--	D,F,H
30	6S-33E-12dccl	--	77	A	1,3,4,5; 1,7; 1,7 1,7	112MCHD	213	175	50	I	--	D,F,H
30	6S-34E-3cccl	--	5	C	1,2,3,4,8	112MCHD	255	210	65	P	740	D,J
30	6S-34E-5cacl	425526112302601	5	B	1,2,3,4,5,8; 1,2,7	112MCHD	84	84	53	H	669	D,F,J
30	6S-34E-7acalS	425455112311900	77	A	1,2,3,4,5,8; 1,7; 1,7; 1,7	112MCHD	--	--	--	N	--	D,F,H
30	6S-34E-8dbl	--	5	B	1,3,4,5; 1,7	112ALVM	61	--	--	H	--	D,J
30	6S-34E-10ccdl	425422112282001	5	C	1,2,3,4,8	112MCHD	120	120	56	H	804	D,J
30	6S-34E-13cal	--	5	C	1,2,3,4	112ALVM	115	90	--	--	--	D,J
30	6S-34E-16cddl	425336112291201	5	C	1,2,3,4,8	112ALVM	68	68	32	N	910	D,J
30	6S-34E-22bbdl	425318112282201	5	B	1,2,7,8; 1,7	112MCHD	80	80	26	H	1,070	D,J
30	6S-34E-23baal	--	5	B	1,7,8; 1,7	112MCHD	--	--	--	--	730	D,J
30	6S-34E-26badl	--	5	C	1,2,3,4	112ALVM	349	339	38	P	700	D,J
30	6S-34E-33abcl	425138112290401	5	C	1,3,4	112ALVM	100	100	56	H	564	G,H
30	6S-38E-26bcdl	425209111584601	29	C	1,7	112ALVM	63	29	21	H	513	F
30	7S-34E-1bacl	425046112255201	5	C	1,2,3,4,8	112ALVM	63	63	18	I	697	D,J
30	7S-34E-1dadl	425018112254301	5	C	1,7	112PLSC	172	172	39	H	793	D,J

Table 18. Candidate monitoring sites, sampling frequencies, types of analyses, and selected hydrogeologic characteristics (Continued)

HU	Location	USGS site identification	County	Frequency	Type of analysis	Aquifer code	Depth	First opening	Approximate water level	Water use	Specific conductance	Major potential pollution sources
30	7S-35E-20abd1	424808112230401	5	C	1,7	112ALVM	102	100	48	H	690	F,G
30	7S-36E-28bad1	424719112150401	5	C	1,7	112ALVM	175	110	85	N	1,260	G,H,J
30	8S-39E-22bac1	424308111532401	29	C	1,2,3,4	112PLSC	185	103	85	P	903	D,J
30	9S-36E-12adc1	423916112110701	5	C	1,7	112ALVM	42	30	17	S	761	D,J
30	9S-37E-24ddd1	423705112050401	5	C	1,7	112PLSC	65	20	18	H	678	K
30	9S-40E-18cda1	423811111494101	29	C	1,7	112PLSC	190	150	93	I	1,354	K
30	10S-37E-6cda1	423446112105001	5	C	1,7	112ALVM	150	80	Flows	H	623	K
30	11S-37E-17abb1	422826112093101	5	C	1,7	121SLLK	85	--	35	H	843	F
30	11S-37E-27ddb1	422603112064501	5	C	1,2,3,4	110SDMS	177	97	--	P	--	D,J
31	2N-27E-33ac2	--	23	C	1,3,4,5	110SKRV	1,200	998	981-987	S	--	R
31	1N-27E-22acb1	432424113165401	23	C	1,3,4,5	110SKRV	1,056	994	984	S	297	R
31	1N-29E-6dcd1	--	23	C	1,3,4,5	110SKRV	--	--	--	--	--	R
31	1N-29E-30bbd1	422336113064201	23	C	1,3,4,5	110SKRV	704	679	649	O	314	R
31	1S-27E-14dcc1	431946113161401	23	C	1,7	110SKRV	1,041	1,011	990-992	--	--	R
31	1S-28E-2cd1	--	23	C	1,3,5	110SKRV	--	--	--	--	--	R
31	2S-28E-16abb1	--	13	C	1,7	110SKRV	777	--	746	S	--	R
31	4S-24E-6bbc1	430626113391001	67	D	1,7	110SKRV	445	420	412	O	--	R
31	5S-23E-17caa1	425907113444001	63	D	1,7	110SKRV	333	311	303-312	O	281	R
31	5S-25E-22dad1	425812113271201	67	D	1,7	110SKRV	581	525	493	O	--	F
31	6S-20E-15db1	425401114032801	63	C	1,7	110SKRV	461	136	270	--	323	F
31	6S-24E-33bbd1	--	67	D	1,3	110SKRV	350	--	226	I	349	F
31	7S-23E-5cda1	425022113474101	63	C	1,7	110SKRV	330	--	280	--	--	F
31	7S-26E-1ccc1	425048113212901	13	D	1,3	110SKRV	533	--	483	S	311	F
31	7S-28E-25ccc1	--	77	D	1,7	110SKRV	300	--	254	--	--	F
31	7S-30E-20acd1	--	77	B	1,7; 1	110SKRV	277	20	225	--	637	F
31	8S-22E-13ccb1	--	67	B	1,7; 1	110SKRV	335	334	306	--	--	E,F
31	8S-24E-10cdd1	--	67	B	1,7; 1	110SKRV	238	37	154	I	--	E,F
31	8S-25E-16dac1	424334113320201	67	B	1,3; 1	110SKRV	230	--	152	I	489	E,F
31	8S-26E-15bca1	424348113242401	13	D	1,7	110SKRV	189	16	168-181	--	594	F
31	8S-27E-16cdd1	424310113184301	13	D	1,7	110SKRV	162	--	142	H, S	465	F
31	9S-22E-33ada1	423604113522401	67	B	1,3,4,8; 1,7	110SKRV	252	90	226-240	O	984	D,E,F
31	9S-23E-15aaa1	--	67	C	1,7	110SKRV	100	40	70	H, S	784	D,E,F
31	9S-23E-25abb1	--	67	B	1,2,3,4,8; 1,7	111ALVM 110SKRV	137	86	23	I	--	D,E,F,H,J
31	9S-23E-32daa1	--	67	B	1,2,3,4,8; 1,7	111ALVM	105	20	6	I	--	D,E,F,H,J
31	9S-23E-35bbc1	--	67	B	1,7; 1	111ALVM 110SKRV	40	18	--	P	--	D,E,F,H,J
31	9S-24E-1dbc1	424006113355301	67	B	1,2,3,4; 1	110SKRV	88	--	--	H	493	D,E,F,J
31	9S-24E-20abd1	--	67	A	1,2,3,4; 1; 1,7; 1	111ALVM 110SKRV	538	120	67	P, I	500	D,E,F,H,J
31	9S-24E-29ab1	--	67	C	1,3	111ALVM 110SKRV	500	485	92	--	910	D,E,F,H,J
31	9S-24E-31ba1	--	67	B	1,7; 1	111ALVM	110	90	22	H	--	D,E,F,H,J
31	9S-25E-23dba1	423732113295801	31	C	1,7	110SKRV	174	172	120-130	O	--	K
31	9S-26E-13ccc1	--	31	C	1,3	110SKRV(?)	153	6	137	S, O	--	K
31	9S-27E-36add1	423550113140501	31	C	1,3	111ALVM	150	120	--	H	490	D,F
31	10S-22E-3ddc1	--	67	C	1,7	110SKRV	117	74	75	H	--	D,E,F
31	10S-22E-22ddd1	--	31	C	1,7	111ALVM	330	214	212	N	--	D,F,H,J

Table 18. Candidate monitoring sites, sampling frequencies, types of analyses, and selected hydrogeologic characteristics (Continued)

HU	Location	USGS site identification	County	Frequency	Type of analysis	Aquifer code	Depth	First opening	Approximate water level	Water use	Specific conductance	Major potential pollution sources
31	10S-22E-25dbd1	--	31	A	1,2,3,4,8; 1,7; 1,7; 1,7	111ALVM	67	65	25	H	--	D,F,H,J
31	10S-23E-1ccc1	--	67	C	1,7	111ALVM	104	104	14	H	--	D,E,F,H,J
31	10S-23E-15bdd1	--	67	B	1,3; 1,7	111ALVM 110SKRV	460	315	205	P	--	D,E,F,H,J
31	10S-24E-26bdb1	423144113372901	31	C	1,7	110SKRV	31	2	12	H, S	--	D,F
31	10S-25E-29dab1	--	31	C	1,7	110SKRV	100	11	53	I	--	F
31	11S-21E-11add2	--	31	C	1,7	110SKRV	481	19	455	I	--	F
31	11S-22E-1ab3	--	31	B	1,7; 1	111ALVM	65	65	44	H	--	F
31	11S-23E-2ddd1	--	31	C	1,7	111ALVM	72	53	11	I	--	D,F
31	11S-25E-32ccc2	422458113340201	31	C	1,7	121IDVD	500	--	19-30	I	--	F
31	12S-25E-18bba1	422310113350801	31	C	1,7	111ALVM	104	--	31-40	S	--	K
31	10S-26E-5dd1	--	31	C	1,7	110SKRV	450	20	370	P	--	K
31	10S-31E-7aa1	--	77	C	1,3,5	110ALVM	--	--	--	--	640	D,F,J
32	13S-25E-32cb1	--	31	D	1,3	110ALVM	79	7S	0	H	--	D,F
32	13S-26E-1ccc1	421852113222601	31	D	1,3,4	110ALVM	69	24	22	I	--	D,F
32	14S-27E-33cdd1	420917113181501	31	D	1,3	110ALVM	200	45	37	I	--	F
32	15S-24E-27da1	--	31	D	1,3	111ALVM(?)	350	50	43	I	--	D,F
33	12S-22E-21bcc1	--	31	D	1,3	121IDVD	660	451	392	I	--	F
33	13S-22E-33bcd1	--	31	C	1,2,3,8	110ALVM	270	--	15-25	I	--	D,E,F,J
34	5S-11E-7acd1	430013115112501	39	C	1,7	112GLFR	1,300	--	Flows	P	370	D,F
34	5S-12E-31dc1	--	47	D	1,3	110SKRV	596	408	--	P	--	K
34	6S-13E-6dca1	425533114571801	47	C	1,2,3,4	110SKRV	515	445	--	H	--	D,J
34	7S-14E-32abb1	--	47	B	1,7; 1	110SKRV	90	--	60	H, S	--	E,F
34	7S-15E-27ccc1	--	47	B	1,7; 1	110SKRV	165	4	135	H, S	--	D,E,F,J
34	7S-15E-32caa1	--	47	B	1,2,7,8; 1	110SKRV	148	0	112	H, S	--	D,E,F,J
34	7S-15E-33bbc1	--	47	B	1,2,3,4,8; 1,7	110SKRV	365	160	160	P	370	D,E,F,J
34	7S-16E-13acc1	--	53	C	1,3	110SKRV	324	--	284	H, S	--	E,F
34	8S-14E-2aaa1	--	47	B	1,7; 1	110SKRV	98	13	69	I	--	D,E,F
34	8S-15E-8abb1	--	47	B	1,2,6,7,8; 1	110SKRV	96	6	75	S	--	D,E,F
34	8S-16E-14dc1	--	53	B	1,2,7,8; 1	110SKRV	325	10	--	--	--	D,E,F,H,J
34	8S-16E-24ab1	--	53	B	1,2,3,4,6,8; 1,7	110SKRV	366	6	256	N	--	D,E,H,J
34	8S-16E-26bb1	--	53	C	1,2,7,8	110SKRV	168	--	162	H, S	--	D,E,F,J
34	8S-17E-7ddd1	--	53	C	1,7	110SKRV	339	2	--	H	--	D,E,F,J
34	8S-17E-18bcd1	--	53	A	1,2,3; 1; 1,7; 1	110SKRV	397	10	305	P	400	D,E,F,J
34	8S-17E-19bac1	424357114304901	53	B	1,2,3,4,8; 1,7	110SKRV	380	30	274-305	P	400	D,E,F,J
34	8S-17E-31bbb1	--	53	B	1,7,8; 1	110SKRV	262	0	227	H, S	--	E,F
34	8S-18E-16dbb1	--	53	C	1,7	110SKRV	305	8	239	I	--	F
34	8S-21E-22dba1	--	53	C	1,7	110SKRV	351	14	308	I	--	F
34	9S-15E-3aa1	--	47	B	1,7; 1	110SKRV	134	9	110	--	--	D,E,F
34	9S-16E-9aaa1	--	53	B	1,7; 1	110SKRV	422	200	143	I	--	D,E,F
34	9S-19E-35bcb1	423606114123201	53	A	1,2,3; 1; 1,7; 1	110SKRV	380	380	195	P	700	D,E,F,J
34	9S-20E-32dbb1	423539114074301	53	B	1,2,3,4; 1,7	110SKRV	314	--	255	P	780	D,E,F,J
34	9S-21E-31bc1	--	53	C	1,7	110SKRV	250	21	211	H, 8	--	E,F
34	10S-19E-11aab1	--	53	C	1,7,8	110SKRV	305	5	270	H, S	--	E,F
34	10S-20E-29dda1	--	53	C	1,7	110SKRV	395	--	--	H, S	--	E,F
34	9S-14E-24ccc1	--	83	B	1,2,7,8; 1	112GLFR	108	4	18	H	1,090	D,E,F,J
34	9S-14E-36dbd1	--	83	C	1,3,4	121IDVD	904	686	96	P	540	D,E,F,H,J

Tabla 18. Candidate monitoring sites, sampling frequencies, types of analyses, and selected hydrogeologic characteristics (Continued)

HU	Location	USGS site identification	County	Frequency	Type of analysis	Aquifer code	Depth	First opening	Approximate water level	Water use	Specific conductance	Major potential pollution sources
34	9S-15E-31bba1	--	83	B	1,2,3,4,8; 1	112GLFR	207	5	52	H	--	D,E,F,H,J
34	10S-14E-1ccc1	--	83	B	1,7; 1	112GLFR	125	5	53	H	--	D,E,F
34	10S-15E-7abb2	--	83	C	1,7	121IDVD	1,991	500	65	P	620	D,E,F
34	10S-16E-8abb1	--	83	B	1,2,3,4,8; 1	112GLFR	60	16	24	H	--	D,E,F,J
34	10S-16E-8cca1	--	83	C	1,3	121BNBR	953	700	37	P	--	D,E,F,J
34	10S-17E-8ad1	--	83	B	1,2,3,4,8; 1	112GLFR	105	14	35	H	--	D,E,F,J
34	10S-17E-10bcc1	--	83	B	1,2,3,4; 1	121BNBR 121IDVD	875	47	10	P	--	D,E,F,J
34	10S-17E-10cac1	--	83	B	1,2,3,4,6,8; 1	112GLFR	131	8	15	P	--	D,E,F,J
34	10S-17E-14cd1	--	83	B	1,7; 1	121BNBR	1,154	575	53	I	--	D,E,F,J
34	10S-17E-15dd1	--	83	B	1,2,3,4; 1	112GLFR	83	10	33	H	--	D,E,F,J
34	10S-17E-17ca1	--	83	B	1,7; 1	112GLFR	50	16	48	I	--	D,E,F,J
34	10S-17E-21ca1	--	83	B	1,3,8; 1	112GLFR	110	19	58	H, I	--	D,E,F,J
34	10S-17E-22cc1	--	83	B	1,7; 1	112GLFR	108	10	17	H	--	D,E,F,J
34	10S-17E-24aa1	--	83	B	1,3,8; 1	112GLFR	182	--	105	H	--	D,E,F
34	10S-17E-26ccb1	--	83	B	1,7; 1	112GLFR	100	25	8	H	--	D,E,F
34	10S-17E-31bcb1	--	83	B	1,7; 1	112GLFR	185	5	110	H	--	F
34	10S-17E-33bba1	423107114282401	83	B	1,2,3,4; 1	121BNBR	630	--	165	P	670	D,E,F
34	10S-18E-20baa1	--	83	B	1,2,7,8; 1	121BNBR	275	29	182	H	--	F
34	10S-18E-20ddd1	423207114215301	83	B	1,2,3,4,8; 1,7	121BNBR	1,200	300	165-175	P	820	D,F,J
34	10S-18E-25bac1	423151114180401	83	B	1,2,3,4; 1,7	121BNBR	371	--	331	P	970	D,F,J
34	10S-18E-28bbd1	--	83	B	1,7; 1	121BNBR	375	100	176	P	820	F
34	10S-19E-29abb1	--	83	C	1,7	121BNBR	365	48	313	H	--	F
34	10S-13E-25ddc1	--	83	C	1,3	121BNBR	186	--	68	P	--	D,E,F
34	11S-16E-33aaa1	--	83	C	1,7	121BNBR	669	--	520	H, S	--	F
34	11S-17E-23add1	422717114251301	83	C	1,7	121BNBR	515	10	192	I	--	F
34	11S-18E-25daa1	423119114170801	83	C	1,7	121GLFR	260	70	45	I	--	F
34	11S-19E-36dcc1	--	83	C	1,7	121BNBR	757	218	30	I	--	K
34	12S-15E-23ddd1	--	83	B	1,7; 1	121BNBR	630	40	300	I	--	F
34	12S-16E-28db1	--	83	C	1,3	121BNBR	580	--	410	P	450	D,F,J
34	11s-19E-12bd2	--	83	C	1,7	121GLFR	250	10	130	I	--	F
35	12S-13E-26bcc1	422113114542101	83	D	1,2,3	121BNBR	400	--	166	H, S	--	F
36	8N-36E-27db1	--	51	D	1,3	110SKRV	--	--	--	--	285	K
36	7N-36E-22ac1	--	51	C	1,3	110SKRV	--	--	--	--	--	D,E,F
36	12N-39E-5bbc1	--	33	D	1,2,3	110ALVM	30	27	4	H	--	D,F
36	12N-39E-5ccc1	--	33	D	1,2,3,4	110ALVM	212	180	Flows	I	--	D,F
36	10N-36E-21cba1	--	33	C	1,2,3,4	110SKRV	447	--	360	P	250	D,F,J
37	8N-33E-15ab1	--	51	D	1,3	110SKRV	220	121	72	I	--	F
37	7N-33E-13dbb1	--	51	D	1,3	110SDMS	35	3	12	H, S	--	F
37	6N-34E-17dc1	--	51	C	1,2,3,4,8	110SKRV	280	--	156	P	--	D,E,F
37	6N-34E-22abb1	--	51	C	1,2,3,4	110SKRV	267	80	210	P	--	D,E,F
38	8N-31E-14aaa1	--	33	D	1,2	110ALVM 123CLLS	540	--	535	H, S	--	K
39	6N-29E-21ddc1	--	23	D	1,2,3	110ALVM	--	--	51	H, S	--	F
39	5N-29E-4dcb1	--	23	C	1,2,3,4	110SKRV	280	--	250	P	--	D,F
40	7N-24E-28bbd1	--	37	C	1,2,3,4,8	110ALVM	114	50	16	P	--	D,F,J
40	5N-26E-28bdd1	--	23	C	1,2,3,4,8	110ALVM	174	125	15	P	490	D,F,J
40	4N-26E-3dcc1	--	23	D	1,3	110ALVM	140	30	26	I	--	F
40	4N-26E-36aaa1	--	23	B	1,2,3,4; 1,2,7	110ALVM	190	--	--	P	--	D,F,J

Table 18. Candidata monitoring sites, sampling frequancias, types of analyses, and selectad hydrogeologic characteristics (Continued)

HU	Location	USGS SITE identification	County	Frequency	Type of analysis	Aquifer code	Depth	First opening	Approximate water level	Water use	Specific conductance	Major potential pollution sources
40	3N-27E-9aadl	--	23	D	1,3,4	110ALVM	72	50	52	S	--	D,F,J
40	2N-27E-2ddcl	433121113115701	23	B	1,3,4,5; 1,7	110SKRV	812	782	764	O	447	R
40	3N-30E-30ccbl	433315112560501	23	B	1,3,4,5	110SKRV	--	--	--	--	--	R
40	2N-28E-35adal	432732113044001	23	C	1,3,4,5	110SKRV	654	619	604	O	310	R
40	2N-29E-18ccdl	432940113030201	23	B	1,3,4,5; 1,7	110SKRV	635	587	587	O	522	R
40	2N-29E-19cccl	--	23	B	1,3,4,5; 1,7	110SKRV	--	--	--	--	--	R
41	4N-17E-11ddbl	--	13	C	1,3,4	110ALVM	42	42	9	H	--	D,G,J
41	4N-17E-1adcl	--	13	C	1,7	110ALVM	103	45	26	H	--	K
41	4N-17E-13aabl	--	13	B	1,2,3,4; 1,7	110ALVM	187	34	21	P	--	D,G,J
41	4N-18E-7adcl	--	13	B	1,2,3,4; 1,7	110ALVM	175	54	50	P	--	D,J
41	4N-18E-18cbcl	--	13	C	1,7	110ALVM	66	66	--	H	--	D,F,G,J
41	4N-18E-19cccl	--	13	B	1,2,7,8; 1,7	110ALVM	52	28	9	P	--	D,F,G
41	2N-18E-4cbbl	--	13	C	1,7	110ALVM	37	37	13	H	--	D,J
41	2N-18E-9abdl	--	13	B	1,2,3,4,8; 1,2,7	110ALVM	90	90	14	P	--	D,J
41	2N-18E-14accl	--	13	B	1,7; 1	110ALVM	64	64	41	P	--	D,F
41	2N-18E-25cddl	--	13	B	1,3,4; 1,7	110ALVM	60	--	40	H	--	D,F,J
41	1N-18E-1baal	--	13	B	1,7; 1	110ALVM	100	48	39	I	--	D,F,J
41	1N-18E-25aabl	--	13	B	1,3,4,8; 1,7	110ALVM	113	113	69	--	--	D,F
41	1S-18E-13aabl	--	13	B	1,7; 1	110ALVM	65	65	45	H, I	--	D,F
41	5S-15E-17ddal	--	47	B	1,7; 1	110SKRV	169	--	130	H, S	--	D,F
41	5S-16E-1bcbl	--	63	C	1,3,4	110SKRV	235	210	198	H, S	--	F
41	6S-13E-35bbalS	425153114531200	47	B	1,2,3,4,5,6,8; 1,7,8	110SKRV	--	--	Flows	--	577	D,E,F
41	6S-14E-11bcal	--	47	B	1,2,3,4,8; 1,7	110SKRV	430	--	418	P	--	D,F,J
42	1S-12E-31aaal	431751111504001	25	D	1,3	110SDMS	81	58	19	H	107	K
42	1S-13E-27ccbl	431807114543101	25	D	1,3,4	110SDMS	190	110	12	H	413	F
42	1S-14E-9aadl	432115114474201	25	C	1,2,3,4	110SDMS	256	160	Flows	H	173	D,F,J
42	1S-14E-9aad2	432114114474301	25	C	1,7	110SDMS	35	1	6	H	--	D,F,J
42	1S-15E-19bcbl	431926114433501	25	D	1,7	110SDMS	11	1	--	H	381	F
43	1S-19E-2cbcl	--	13	B	1,7,8; 1	110ALVM	23	--	6	I	--	D,F
43	1S-19E-22aaal	431944114103501	13	B	1,7; 1	110ALVM	--	--	Flows	--	250	D,F
43	1S-20E-27dcal	--	13	C	1,3,4	110SKRV	140	20	113	H	--	D,F
43	1S-21E-34bal	--	13	C	1,3,4,8	110ALVM	102	101	26	H	--	D,E,F,H,J
43	4S-19E-26aadl	430306114092801	63	C	1,2,3,4,8	110SKRV	537	--	360	P	--	D,E,F,H,J
43	4S-19E-33baal	--	63	B	1,2,3,4,8; 1	110SKRV	348	107	300	H, S	--	D,E,F
43	5S-15E-31cbbl	--	47	B	1,7; 1	110SKRV	175	23	150	H	--	D,E,F,J
43	5S-15E-32cdal	425630114420901	47	B	1,2,7,8; 1,7	111ALVM 110SKRV	283	252	164	P	--	D,E,F,J
43	5S-18E-32cccl	--	63	C	1,7	110SKRV	255	208	225	H, S	--	E,F
43	6S-15E-6cbbl	--	47	B	1,2,7,8; 1,7	110SKRV	420	--	170	P	--	D,E,F,J
43	6S-17E-2abbl	425611114240401	63	B	1,2,3,4,8; 1,7	110SKRV	355	55	178	P	415	D,E,J
43	6S-18E-12cddl	--	63	C	1,3,4,8	110SKRV	279	0	270	H, 8	--	D,E,J
43	6S-18E-22aaal	--	63	C	1,7	110SKRV	232	4	180	I	--	E,F
44	3S-6E-11cbcl	431030115425001	39	C	1,7	111ALVM	28	8	15	I	257	D,F
44	3S-6E-11dcdl	431015115420601	39	C	1,2,3,4	112BRUN	140	30	13-20	I	1,431	D,F
44	3S-6E-13aadl	431001115403901	39	C	1,2,3,4	112BRUN	525	10	65	I	--	D,F
44	3S-6E-14cddl	430926115422601	39	B	1,7; 1	112BRUN	253	65	125-133	--	--	D,J
44	3S-6E-24bbbl	--	39	C	1,2,3,8	112BRUN	185	--	156	I	--	D,J
44	3S-6E-25aaal	--	39	B	1,3,4; 1,7	112BRUN	990	69	395	P	170	D,J

Table 18. Candidate monitoring sites, sampling frequencies, types of analyses, and selected hydrogeologic characteristics (Continued)

HU	Location	USGS site identification	County	Frequency	Type of analysis	Aquifer code	Depth	First opening	Approximate water level	Water use	Specific conductance	Major potential pollution sources
44	3S-6E-26addl	--	39	B	1,3; 1,7	112BRUN	940	107	381	P	210	D,J
44	3S-6E-27dddl	--	39	B	1,7; 1	112BRUN	815	50	410	H	--	D,J
44	3S-6E-34dddl	430648115430301	39	B	1,2,7,8; 1	112BRUN	350	18	150	H	551	D,F,J
44	3S-6E-36bcl	--	39	B	1,7; 1	112BRUN	465	25	332	H	--	D,F,J
44	3S-6E-36abl	--	39	B	1,2,3,4,8; 1	111ALVM	27	27	8	H, I	--	D,F,J
44	3S-7E-19bbbl	430915115403301	39	C	1,7,8	112BRUN	261	19	102-108	S	--	D,F,J
44	3S-7E-31adal	430717115392501	39	B	1,7; 1	112BRUN	130	5	95	U	--	D,F,J
44	4S-5E-21cadl	430340115520101	39	C	1,2,3,4,8	112BRUN	588	299	316	P	147	D,J
44	4S-5E-33cdcl	430145115520401	39	C	1,7	112BRUN	422	--	326	P	--	D,J
44	4S-6E-2daal	430615115415301	39	B	1,2,3,4,8; 1	112BRUN	420	27	324-327	H	178	D,F,J
44	4S-6E-11cdcl	430502115424001	39	B	1,7; 1	112BRUN	291	20	194-152	H	--	F
44	5S-8E-35dbl	--	39	C	1,2,3,4	112GLFR(?)	78	48	35	P	--	D,F,J
44	5S-10E-12adal	425914115114001	39	C	1,2,3	112GLFR(?)	--	--	--	P	--	D,J
44	5S-10E-30ddcl	--	39	C	1,2,3,4	112GLFR(?)	90	90	--	P	--	D,F,J
45	6S-4E-14abal	--	73	D	1,3,4	112BRUN	140	100	55	H	--	F
45	6S-5E-24bcal	425323115484301	73	D	1,3,4	112IDHO	1,095	76	Flows	H, S	509	D,F
45	7S-4E-1accl	425039115552201	73	D	1,7	112IDVD	1,800	--	--	--	278	F
45	7S-5E-19cccl	424737115544801	73	D	1,7	111IDVD	760	--	--	--	309	F
45	7S-5E-33	--	73	D	1,2,3,4,6	--	--	--	--	--	--	R
45	8S-5E-33abbl	--	73	C	1,2,3,4,6	--	650	--	600	--	--	R
46	3N-5W-10bbb4	--	73	D	1,3,8	112IDHO	550	--	--	P	--	D,F,J
46	2N-4W-3bbbl	--	73	D	1,3,8	112IDHO	976	--	--	P	--	D,F,J
46	3S-1E-35dacl	430704116174901	73	C	1,3,4,6	112IDHO	300	60	--	H	440	R
46	4S-2E-18cdcl	--	73	C	1,3,4,6	112IDHO	400	--	335	--	--	R
46	5S-3E-15cdl	--	73	D	1,2,3,4,8	111ALVM	21	--	8	--	--	D,F,J
46	5S-3E-21aaal	--	73	D	1,3	111ALVM	70	--	50	H	--	D,F,J
47	--	--	--	--	--	--	--	--	--	--	--	--
48	--	--	--	--	--	--	--	--	--	--	--	--
49	--	--	--	--	--	--	--	--	--	--	--	--
50	--	--	--	--	--	--	--	--	--	--	--	--
51	--	--	--	--	--	--	--	--	--	--	--	--
52	--	--	--	--	--	--	--	--	--	--	--	--
53	6N-5E-26ccdl	434926115501401	15	D	1,2,3,4	110ALVM	52	--	7	H	212	D,G
54	--	--	--	--	--	--	--	--	--	--	--	--
55	5N-5W-9ccbl	434653116565101	27	C	1,2,3,4,8	112IDHO	265	265	8	P	360	D,F,J
55	5N-4W-34daal	--	27	C	1,2,3,4	112IDHO	148	111	--	P	180	D,F,J
55	5N-1W-16cabl	434349116224101	1	D	1,3	112IDHO	628	492	185-190	H	360	K
55	4N-5W-23cbbl	434006116543701	27	C	1,2,3,4	110ALVM	--	--	--	P	1,711	D,F,J
55	4N-3W-19dabl	--	27	B	1,2,3,4,6,8; 1,7	110ALVM	381	19	24	N	--	F,H,J
55	4N-3W-21aaal	--	27	B	1,7; 1	111ALVM	80	73	Flows	H	--	D,J
55	4N-3W-21cdl	--	27	C	1,3,4,8,9	110ALVM	316	280	Flows	P	--	D,J
55	4N-3W-22aaal	--	27	B	1,2,3,4,8; 1,7	110ALVM	180	--	Flows	P	200	D,J
55	4N-3W-22cca2	--	27	C	1,3,4,8,9	110ALVM	399	243	1-2	P, N	--	D,J
55	4N-3W-27bcbl	--	27	C	1,7,8,9	110ALVM	130	102	--	P, I	--	D,F,J
55	4N-2W-6cddl	434228116372701	27	C	1,2,3,4,8	112IDHO	420	404	Flows	P	180	D,F,J
55	4N-1W-18aabl	434131116294601	1	C	1,2,3	112IDHO	450	428	Flows	H, S	638	D,F,J
55	4N-1E-8dcbl	434144116213301	1	C	1,2,3,4,8	110ALVM	67	67	6-8	I	361	D,F,J
55	3N-2W-9ddcl	433620116343201	27	B	1,3,4,8; 1,7	111TRRCY	380	--	3-7	D, I	585	F,H

Table 18. Candidate monitoring sites, sampling frequencies, types of analyses, and selected hydrogeologic characteristics (Continued)

HU	Location	USGS site identification	County	Frequency	Type of analysis	Aquifer code	Depth	First opening	Approximate water level	Water use	Specific conductance	Major potential pollution sources
55	3N-2W-13cbb1	433552116314901	27	B	1,7; 1	110SKRV 111TRRCY	105	94	54-65	H	834	D,J
55	3N-2W-15dcd1	433532116332901	27	B	1,7; 1	110SKRV 111TRRCY	131	114	17-18	D, I	701	D,J
55	3N-2W-19aad1	433517116364501	27	C	1,7	111TRRCY	230	--	11-15	D, I	717	F
55	3N-2W-21bab1	433526116351001	27	A	1,3,4,8,9; 1; 1,7; 1	111TRRCY	133	47	13-15	D, I	821	D,F,J
55	3N-2W-22cca1	433443116340701	27	B	1,7,8,9; 1	111TRRCY	83	60	13-16	I	930	D,J
55	3N-2W-23dba1	433459116322201	27	C	1,7	111ALVM	77	77	9-16	H	720	D,F,J
55	3N-2W-25bbb1	433422116315201	27	C	1,7	111ALVM	300	--	9-15	H	541	D,F
55	3N-1W-2ddd1	433712116244701	1	A	1,2,3,4,6,8; 1; 1,7; 1	111TRRCY	80	8	8-10	D, I	856	D,F,J
55	3N-1W-14cbb1	433546116255601	1	B	1,7; 1	111TRRCY	100	96	0-13	H, S	647	D,F
55	3N-1W-24abb1	433524116240301	1	C	1,7	112IDHO	212	202	20-22	P	721	D,F
55	3N-1W-25dad1	433351116233601	1	C	1,7	112IDHO	330	327	85-95	H, S	936	D,F
55	3N-1E-2aba1	433759116175401	1	A	1,2,3,4,6,8; 1; 1,7; 1	111TRRCY	110	110	4-12	H	634	D,F,J
55	3N-1E-3adc1	433736116190501	1	B	1,7; 1	112IDHO	880	347	10-20	P	182	D,F
55	3N-1E-3bba1	433802116194801	1	B	1,7; 1	111TRRCY	117	90	10-20	H	663	D,F
55	3N-1E-5aba1	433755116213101	1	C	1,7	111TRRCY	84	13	5-15	U	646	D,F
55	3N-1E-6ddd1	433716116223001	1	C	1	111TRRCY	83	83	2-5	H	769	D,F
55	3N-1E-7dba1	433643116231801	1	C	1,7	111TRRCY	63	10	8-12	D	882	D,F,J
55	3N-1E-9baa1	433708116204001	1	C	1,2	111TRRCY	72	72	7-12	H	598	D,F
55	3N-1E-10baa1	433705116192601	1	C	1,2	111TRRCY	20	--	5-14	H	495	D,F
55	3N-1E-11ddd1	433619116173801	1	C	1	112TRRCO	139	--	4	I	596	D,F,J
55	3N-1E-12ada1	433650116162801	1	C	1,7	111TRRCY	20	20	3-8	I	621	D,F,J
55	3N-1E-13ccc1	433526116173001	1	A	1,2,7,8; 1; 1,7; 1	112TRRCO	76	69	24-38	H	816	D,F,J
55	3N-1E-14cbc1	433439116184701	1	B	1; 1	112TRRCO	80	80	13-30	H	762	D,F,J
55	3N-1E-15asc1	433608116190001	1	B	1,2,7; 1	112TRRCO	129	124	32-30	H	800	D,F,J
55	3N-1E-16ddb1	433536116201401	1	A	1; 1; 1; 1	111TRRCY	83	83	16-30	H, I	125	D,F
55	3N-1E-17dda1	433537116211401	1	B	1,7; 1	112TRRCO	184	179	6-14	H	1,080	D,F
55	3N-1E-18daa1	433548116222901	1	B	1; 1	111TRRCY	81	76	17-25	H	780	D,F
55	3N-1E-19cdd1	433437116230301	1	B	1,7; 1	112TRRCO	207	--	42-50	I	967	D,F
55	3N-1E-22ccc1	433441116195901	1	A	1; 1; 1; 1	112TRRCO	86	81	21-32	H	804	D,F
55	3N-1E-23dab1	433456116174501	1	A	1; 1; 1; 1	112TRRCO	47	47	6-15	H	676	D,F
55	3N-1E-25bbd1	433424116172401	1	A	1,2,3,4; 1; 1,7; 1 1	112IDHO	127	127	34-54	H	1,210	D,F
55	3N-1E-26bad1	433425116181301	1	B	1; 1	112IDHO	195	182	25-30	H	540	D,F
55	3N-1E-27cdd1	433342116193201	1	B	1; 1	112TRRCO	119	119	30-42	H, 8	496	D,F
55	3N-1E-32dda1	433256116211401	1	A	1; 1; 1; 1	112TRRCO	127	--	41-46	H	553	D,F
55	3N-1E-33aaa1	--	1	B	1,7; 1	112TRRCO	92	92	48	H	--	D,F
55	3N-1E-36ada2	433322116162801	1	C	1,3,8	112TRRCO	310	225	115-120	U	216	D,F
55	3N-2E-3cca1	433719116123201	1	B	1,2,3,8; 1,7	111TRRCY	40	24	22-25	I	309	D,F,J
55	3N-2E-5abb1	433800116142601	1	B	1; 1	112ALVM	27	27	6-9	I	218	D,F,J
55	3N-2E-6aad1	433749116151801	1	B	1,2,7; 1	111TRRCY	79	--	23-33	H	520	D,F,J
55	3N-2E-7aba1	433706116152901	1	B	1,7,8; 1,8	111TRRCY	48	48	13-20	H	394	D,F,J
55	3N-2E-8adc1	433646116141001	1	B	1,8; 1	111TRRCY	90	50	18-30	H	595	D,F,J
55	3N-2E-11aaa1	433703116102401	1	C	1,2,3,4	112IDHO	163	143	112	H	285	D,F,J

Table 18. Candidate monitoring sites, sampling frequencies, types of analyses, and selected hydrogeologic characteristics (Continued)

HU	Location	USGS site identification	County	Frequency	Type of analysis	Aquifer code	Depth	First opening	Approximate water level	Water use	Specific conductance	Major potential pollution sources
55	3N-2E-15bdb1	433558116122101	1	B	1,2,3,8; 1,7	111TRRCY	55	41	9-18	H	434	D,F,J
55	3N-2E-16dbb1	433546116131801	1	B	1,2,7,8; 1	111TRRCY	40	40	28-32	I	491	D,F,J
55	3N-2E-17caa1	433548116143401	1	B	1,7,8; 1	111TRRCY	60	48	9-17	H	636	D,F,J
55	3N-2E-18bdc1	433552116155801	1	B	1,2,3,8; 1	112TRRCO	87	57	40-45	H	1,010	D,F,J
55	3N-2E-20bbb1	433523116150101	1	B	1,7,8; 1	111TRRCY	65	—	—	H	574	D,F,J
55	3N-2E-21aba1	433518116125801	1	C	1,3,4	112IDHO	990	410	25	P	162	D,F,J
55	3N-2E-22ddd1	433437116113501	1	C	1,7	112IDHO	532	353	30	P	195	D,F,J
55	3N-2E-23ada1	433506116102801	1	B	1,2,7,8; 1	111ALVM	32	32	5-8	H	135	D,F,J
55	3N-2E-24aca1	433507116092801	1	C	1,7	112GLFR	495	263	29-57	P	132	D,F,J
55	3N-2E-25bbb1	433428116101701	1	C	1	110ALVM	65	42	4-14	D, I	173	D,F,J
55	3N-2E-30bcb1	433413116090401	1	A	1,2,7; 1; 1; 1	111ALVM	—	—	—	—	242	D,F,J
55	8N-2E-30cbc1	433358116162301	1	A	1,7; 1; 1; 1	112TRRCO	157	157	60-62	H	435	D,F,J
55	3N-2E-36abc1	433328116094201	1	C	1,3,4	112IDHO	642	342	198	P	205	K
55	2N-1W-11abd1	433148116250701	1	C	1,3; 1	112TRRCO	120	85	78-86	I	1,030	F
55	2N-1W-23dda1	432925116245301	1	B	1,3,4; 1	112TRRCO	410	410	100	P	270	D,F,J
55	2N-1E-3cdd1	433157116192801	1	A	1,2,3,4,8; 1; 1; 1	112TRRCO	225	200	138	I	822	D,F,J
55	2N-1E-9cad1	433121116204101	1	A	1,7,8; 1; 1; 1	112IDHO	296	391	118	H	670	D,F
55	2N-1E-15aba1	433101116191301	1	B	1,7; 1	112TRRCO	243	240	128-132	H	—	D,F
55	2N-1E-15cbc1	433030116195901	1	B	1,7; 1	112TRRCO	—	—	—	—	812	D,F
55	2N-2E-3aaa1	433243116113901	1	C	1,3,4,8	112IDHO	530	470	223-233	I	—	D
55	2N-2E-4cba1	433220116133901	1	C	1,7,8	112IDHO	412	300	198-200	I	418	D,F
55	2N-2E-5cca1	433206116145201	1	C	1,3,4,8	112IDHO	333	210	160-165	—	—	D,F
55	2N-2E-34ccd1	432733116123501	1	C	1,7	112IDHO	504	484	440-455	H	381	F
55	2N-3E-6bcc1	433224116090801	1	C	1,7	110SKRV	520	420	330	P	227	D
						112IDHO						
55	2N-3E-7cdd2	433110116084002	1	C	1,7	110SKRV	400	400	350	H	254	D
						112IDHO						
55	1N-2W-3cbb1	432707116341201	27	C	1,7	112IDHO	375	275	155	I	258	F
55	1N-1W-7bcc2	432618116304401	1	C	1,7	110SKRV	455	275	275	H	—	F
55	1N-1E-1adc1	432707116164001	1	C	1,7	112TRRCO	480	280	262	I	347	F
55	1N-1E-7acc1	432616116302701	1	B	1,7; 1	110SKRV	—	—	—	—	656	F
56	10N-5W-14ccc1	—	87	D	1,3	110SDMS	43	43	8	I	—	F
56	9N-5W-26bdd1	—	75	D	1,3	112IDHO	187	126	80	P	—	F
56	7N-5W-25bcb1	435511116533201	75	D	1,3	112IDHO	160	160	—	H	—	F
56	6N-5W-20aaa1	435059116571301	27	D	1,3	110ALVM	—	—	—	—	270	F
57	9N-7E-35abc1	440439115354101	15	C	1,3	110ALVM	120	52	4	H	193	D
58	9N-4E-15bdd1	440652115580901	15	D	1,2,3,8	110ALVM	108	83	40	H	186	D
59	9N-5W-34ad1	—	75	B	1,2,3,4,8; 1	110ALVM(?)	—	—	—	P	—	D,F
59	8N-5W-26bcb1	—	75	B	1,2,3,4,8; 1	110ALVM	68	—	—	P	—	D,F,J
59	7N-4W-4dcb1	—	75	B	1,2,3,4,8; 1	110ALVM	64	63	8	P	—	D,F,J
59	7N-1E-3acc2	—	45	D	1,3	110ALVM	97	97	10	H	—	D,F
59	7N-1E-22bcb1	—	45	C	1,7	110ALVM	101	96	Flows	H	—	D,F
59	7N-2E-34aaa1	—	15	C	1,3	112IDHO	—	—	—	—	—	D
59	6N-2W-1bdd1	435313116312301	45	B	1,2,3,4,8; 1	110ALVM	95	79	—	H	617	D,F
59	6N-2W-14dc1	—	45	B	1,2,7; 1	110ALVM	26	26	—	P	—	D,F,J
59	6N-1W-3cbb1	435310116265801	45	D	1,2,3	110ALVM	33	—	—	—	321	D,F
59	6N-1W-5cdd1	435248116290001	45	B	1,2,3,8; 1,7	110ALVM	189	142	9	P	274	D,J
60	18N-3E-16dcd1	445328116052601	85	C	1,2,3	110GLCL	65	65	30	P	92	D

Table 18. Candidate monitoring sites, sampling frequencies, types of analyses, and selected hydrogeologic characteristics (Continued)

HU	Location	USGS site identification	County	Frequency	Type of analysis	Aquifer code	Depth	First opening	Approximate water level	Water use	Specific conductance	Major potential pollution sources
60	16N-3E-10cd1	—	85	D	1,3	110ALVM	—	—	—	P	—	D
60	14N-3E-36ba1	—	85	B	1,2,3,4,8; 1	110ALVM	—	—	—	—	—	D,J
60	13N-4E-16bsd1	—	85	C	1,7	110ALVM	84	67	20-27	H	—	K
60	12N-4E-19ad1	—	85	C	1,7	110ALVM	—	—	—	—	—	D
61	17N-1W-15aac1	444854116262301	3	D	1,3	122CBRV	131	84	—	H	145	D,F
61	16N-1W-14abb1	444345116251701	3	C	1,2,3,4	122CBRV	730	—	210	P	136	D
61	16N-1W-22baa1	444256116263401	3	D	1,7	122CBRV	390	28	71	I	187	D,F,J
61	14N-3W-3ddc1	443421116404100	87	C	1,3	122CBRV	929	906	Flows	P	279	D,F
61	14N-3W-11ccb1	443335116402701	87	C	1,2,3,4	110SDMS	105	83	7	H	168	F
61	13N-3W-5bcb1	442941116435601	87	D	1,2,3,4	110SDMS	101	34	21	H	494	F
61	12N-4W-19cac1	442130116520201	87	D	1,3	110SDMS	100	72	39	H	350	F
61	11N-5W-29bcd1	441540116581001	87	B	1,2,3,4; 1,7	110SDMS	226	123	—	P	728	D,F,J
61	11N-5W-33acb1	—	87	C	1,7	110SDMS	150	21	12	—	—	F
61	10N-4W-6add1	—	87	C	1,7	110SDMS	460	—	Flows	S	—	K
62	11N-6W-14bcb1	—	87	D	1,3	110SDMS	72	45	35	I	—	F
62	11N-6W-25cac1	441527117002501	87	C	1,2,3,8	110SDMS	39	27	10	H	648	D,F,J
62	11N-6W-17bdd1	441722117050001	87	C	1,3	110SDMS	—	—	—	S	534	F
63	—	—	—	—	—	—	—	—	—	—	—	—
64	35N-6W-12cca1	—	69	D	1,2,3,4	122CBRV	600	—	128	P	—	D,J
65	39N-5W-5cb1	—	57	C	1,2,7	111ALVM	—	—	—	P	—	D
65	39N-5W-7bad1	464428117004401	57	B	1,3,4; 1,7	110ALVM 122CBRV	1,458	—	212	P	—	D,J
65	39N-5W-7cdc1	464353117005601	57	B	1,3; 1,7	122CBRV	1,336	975	256	P	—	K
65	39N-5W-7ddd3	464407117000401	57	B	1,2,3,4,8; 1,7	110ALVM 122CBRV	235	40	100	P	—	D,J
65	39N-5W-8abd1	464228116590801	57	C	1,7	110ALVM	373	141	240	U	—	D,J
65	39N-5W-9bcc1	464424116583701	57	B	1,2,3; 1,7	110ALVM	25	25	9	U	—	D,J
65	39N-5W-16aca1	465334116575501	57	B	1,2,3,4; 1,7	110ALVM 211IDAH	63	60	6	H	770	D,F
65	39N-5W-19aba1	464255117002401	57	B	1,7; 1,7	110ALVM 122CBRV	60	37	10	H	—	D,F
66	—	—	—	—	—	—	—	—	—	—	—	—
67	14N-19E-32aa1	—	37	C	1,2,3,4	110ALVM	140	7	75	P	—	D
67	13N-19E-10bad1	—	37	D	1,3	110ALVM	50	50	36	H	—	D
67	10N-13E-9aaa1	—	37	C	1,2,7	110ALVM	75	32	5	P	—	D
67	10N-13E-3ccd1	—	37	C	1,2,3,4,8	110ALVM	36	35	8	H	—	D
67	9N-14E-29cd1	—	37	D	1,3	110ALVM	41	41	6	H	—	G
68	15N-21E-21abc1	—	59	D	1,3,4	110ALVM	130	115	Flows	H	—	D,G
68	14N-21E-3aba1	443445113572301	37	C	1,7	110ALVM	20	—	3	H	562	F
68	13N-22E-11aac1	442832113484701	37	C	1,7	110ALVM	49	—	24	H	516	K
69	23N-22E-31ddc1	—	59	C	1,7	110ALVM	58	23	2	H	—	D
69	22N-22E-31dab1	—	59	C	1,2,3,4,8	110ALVM	29	28	6	H	—	D,J
69	21N-22E-6ddd1	—	59	C	1,2,3,4,8	110ALVM	32	32	8	H	—	D,J
69	21N-22E-31daa1	450711113533401	59	C	1,3	110ALVM	33	33	6	H	945	D
70	21N-22E-15bac1	450915113504501	59	C	1,2,7,8	110ALVM	37	26	6	H	636	D,F
70	16N-26E-28dc1	444055113212000	59	D	1,2,7	110ALVM	60	60	16	H	408	D
70	19N-24E-8cdd1	445904113382601	59	C	1,7	110ALVM	59	33	11-20	S	—	D
71	—	—	—	—	—	—	—	—	—	—	—	—
72	—	—	—	—	—	—	—	—	—	—	—	—

Table 18. Candidate monitoring sites, sampling frequencies, types of analyses, and selected hydrogeologic charecteristics (Continued)

HU	Location	USGS site identification	County	Frequency	Type of analysis	Aquifer code	Depth	First opening	Approximate water level	Water use	Specific conductance	Major potential pollution sources
73	—	—	—	—	—	—	—	—	—	—	—	—
74	—	—	—	—	—	—	—	—	—	—	—	—
75	—	—	—	—	—	—	—	—	—	—	—	—
76	19N-1E-24bdd1	--	3	C	1,2,7	110ALVM	43	20	7	I	—	D,F
76	19N-1E-24bc1	—	3	C	1,2,3,4	122CBRV	610	157	--	P	—	D,F
77	—	—	—	—	—	—	—	—	—	—	—	—
78	—	—	—	—	—	—	—	—	—	—	—	—
79	—	—	—	—	—	—	—	—	—	—	—	—
80	—	—	—	—	—	—	—	—	—	—	—	—
81	30N-3E-18cc1	—	49	C	1,2,3,4	122CBRV	715	140	76	P	—	DF
81	30N-3E-30ad1	—	49	C	1,7	122CBRV	628	—	110	P	—	D,F
81	31N-1E-8ac1	—	49	C	1,2,3,4	122CBRV	908	25	372	P	—	D,F
82	36N-6W-36aca1	462521117014001	69	C	1,2,3,4	122CBRV	735	--	38	P	—	D,J
82	36N-5W-31dcd1	462448117003201	69	C	1,2,3	122CBRV	600	—	107	P	—	D,J
82	36N-5W-32bcc1	462517117000201	69	C	1,2,3	122CBRV	275	—	20	P	—	D,J
82	35N-5W-20bbb1	--	69	C	1,2,3	110SKRV(?) 122CBRV	—	--	—	—	—	D,F,J
82	35N-5W-23ada1	462054116550601	69	C	1,2,3	122CBRV	201	19	92	—	—	D,F,J
83	—	—	—	—	—	—	—	—	—	—	—	—
84	—	—	—	—	—	—	—	—	—	—	—	—

[1]Ada	1	Cassia	31	Lewis	61
Adams	3	Clark	33	Lincoln	63
Bannock	5	Clearwater	35	Madison	65
Bear Lake	7	Custer	37	Minidoka	67
Benewah	9	Elmore	39	Nez Perce	69
Bingham	11	Franklin	41	Oneida	71
Blaine	13	Fremont	43	Owyhee	73
Boise	15	Gem	45	Payette	75
Bonner	17	Gooding	47	Power	77
Bonneville	19	Idaho	49	Shoshone	79
Boundary	21	Jefferson	51	Teton	81
Butte	23	Jerome	53	Twin Falls	83
Camas	25	Kootenai	55	Valley	85
Canyon	27	Latah	57	Washington	87
Caribou	29	Lemhi	59		