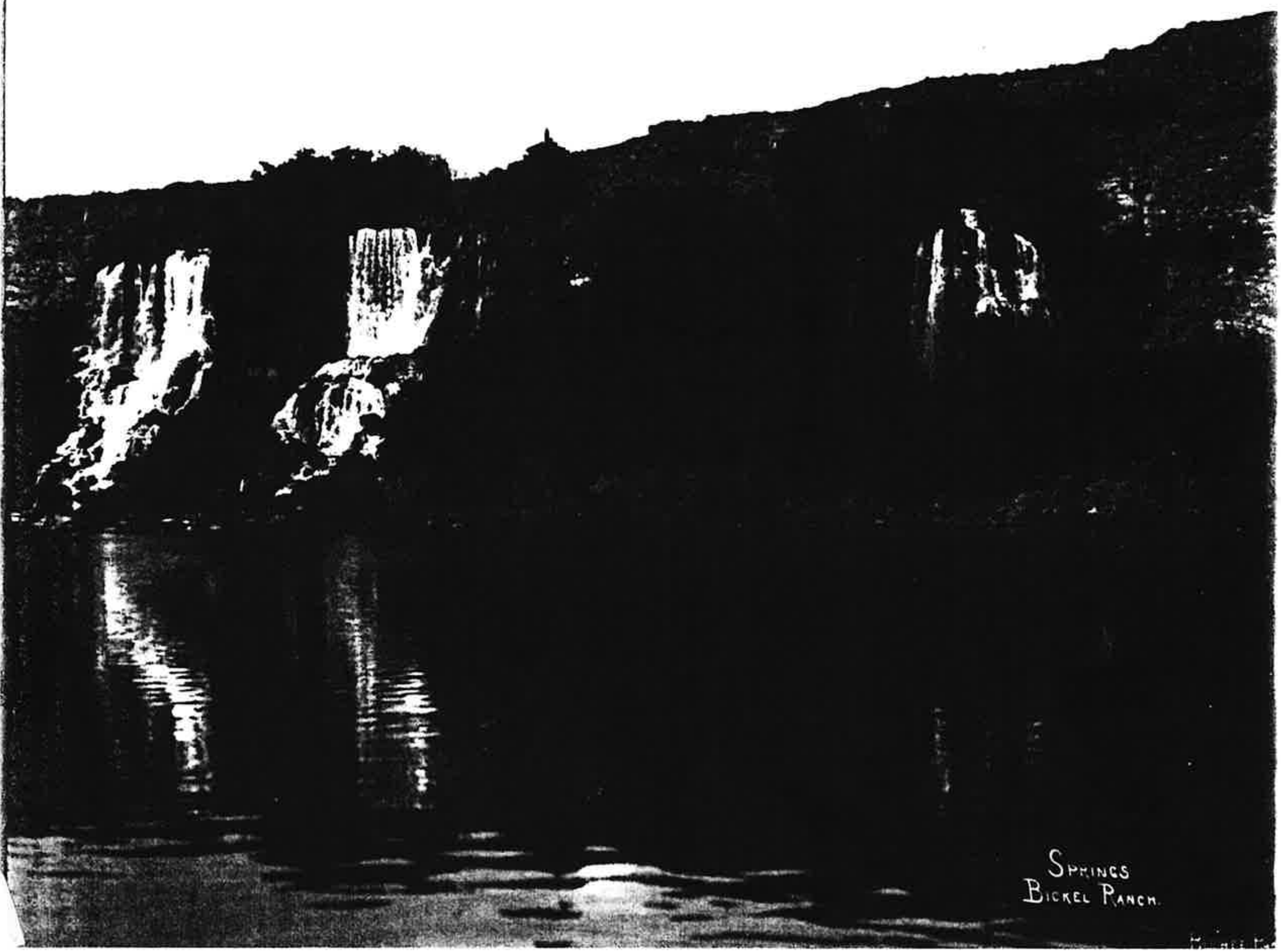
# Idaho's Statewide Ground Water Quality Monitoring Program -Status Report 1991-

**Idaho Department of Water Resources**
**January 1992**



Cecil D. Andrus,
*Governor*

R. Keith Higginson,
*Director*

# Idaho's Statewide Ground Water Quality Monitoring Program -Status Report 1991-

by

**Kenneth W. Neely**

and

**Janet K. Crockett**

January 1992

Idaho Department of Water Resources
1301 N. Orchard St.
Boise ID 83706
327-7900

# Table of Contents



**List of Figures and Tables**

# Executive Summary

This document describes the status and current results of Idaho's statewide ground water quality monitoring program through December 31, 1991.

Ground water samples were collected from 401 monitoring sites in 1991 for the statewide ground water quality monitoring program. Preliminary results indicate about 9 percent (37 sites) of the 401 ground water samples contained at least one constituent that exceeded a primary maximum contaminant level (MCL) for public drinking water as established or proposed by the Environmental Protection Agency (figure 1). (Because of limited sampling, the 9 percent calculation does not include those sites with values exceeding a proposed MCL for radon). The detections for this year's program include nitrates, radionuclides, trace elements and volatile organic compounds. All of the detections occurred in the central and southern part of the state.

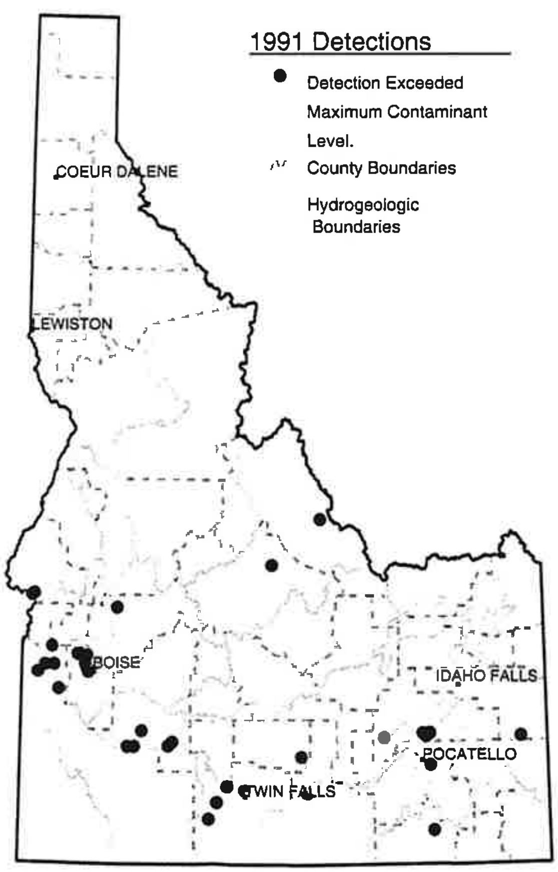



**Figure 1.** 1991 detections exceeding primary MCLs, excluding radon.

## The objectives of the statewide program are:

1. Characterize the ground water quality in the state's aquifers.
2. Identify trends and changes in ground water quality within individual aquifers.
3. Identify aquifers and/or geographic areas where water quality problems may exist or be emerging.

The Ground Water Monitoring Section of the Idaho Department of Water Resources (IDWR) administers the statewide ground water quality monitoring program. IDWR is responsible for designing the program, overseeing field and laboratory quality assurance, interpreting water quality data and publishing the results.

In 1990, 97 monitoring sites (wells and springs) were selected and sampled in a reconnaissance effort. In the spring of 1991, the Idaho State Legislature increased funding for the monitoring program from $187,300 to $539,300 as requested by the Ground Water Quality Council. IDWR, with assistance from the U.S. Geological Survey (USGS) and other technical experts throughout the state, developed a statewide ground water quality monitoring network that will eventually include at least 1,500 monitoring sites. Approximately 400 sites will be sampled every year on a rotation basis with most sites being sampled once every four years. Some sites will be sampled more frequently.

Ground water quality data from the 1990 and 1991 statewide ground water quality monitoring program will be stored at IDWR on a computer system known as the Environmental Data Management System (EDMS). EDMS will also house ground water quality data collected by other federal, state and private entities. Data to be stored on EDMS will be reviewed by Idaho's Ground Water Data Review committee and then released for public access.

## Proposed activities for 1992 and beyond include:

1. Approximately 400 monitoring sites will be sampled annually to determine the overall ground water quality in Idaho.
2. Selected sites in areas of emerging ground water quality concerns may be sampled more frequently to detect changes and/or trends.
3. Development and implementation will continue towards a fully operational EDMS.

# Preface

Ninety percent of Idaho citizens rely on ground water for their drinking and consumptive needs (U.S.Geological Survey, 1987). Other ground water uses, such as agriculture and industry, withdraw large quantities of water from Idaho's aquifers annually. Recent discoveries of chemical contaminants, such as nitrates, volatile organic compounds and pesticides in public and private wells have prompted many citizens and legislators to ask, "What is the quality of Idaho's ground waters?"

In response to this concern, the Ground Water Quality Protection Act was passed in 1989 and the Ground Water Quality Council was established in 1990. In 1991, funds were appropriated to institute the program and the Council drafted the Idaho Ground Water Quality Plan . The draft plan contains a three-part ground water quality monitoring program that includes statewide, regional and local monitoring (figure 2). Each part is designed to meet specific objectives in the overall effort to understand and protect the state's valuable ground water resources.

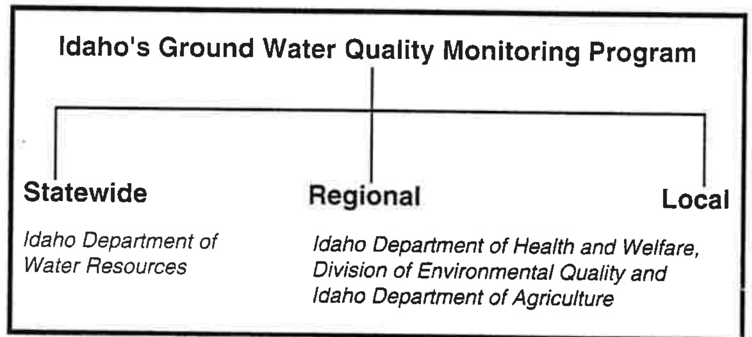



**Figure 2.** The three parts of Idaho's ground water quality monitoring program as outlined in the draft Idaho Ground Water Quality Plan.

The Ground Water Protection Act also recognizes that the Idaho Department of Water Resources (IDWR) is "the collector of baseline data for the state's water resources". In 1990, the Idaho Department of Water Resources began the process of collecting baseline data by sampling 97 wells and springs in a reconnaissance effort for the statewide ground water quality monitoring program. In 1991, the statewide ground water quality monitoring program was funded so that about 400 ground water monitoring sites could be sampled annually. This document reports on the development and implementation of the statewide ground water quality monitoring program and on the results from the 1990 and 1991 monitoring efforts.

# Objectives and Administration

## Program Objectives

The objectives of the statewide ground water quality monitoring program are:

1. Characterize the ground water quality in the state's aquifers.
2. Identify trends and changes in ground water quality within individual aquifers.
3. Identify aquifers and/or geographic areas where water quality problems may exist or be emerging.

Objective 1, characterizing ground water quality, will be accomplished by developing a network of at least 1,500 monitoring sites (wells and springs). It is anticipated that approximately 400 sites will be sampled annually. Currently, most of the program's financial resources are directed toward this objective.

Objective 2, identifying trends, will be accomplished by monitoring specific sites at frequent time intervals (annually, semi-annually, or quarterly) in areas where ground water quality may be changing.

Objective 3, identifying potential problem areas, will be accomplished through the identification and analysis of data which exceeds ground water quality standards.

## Program Administration

The Idaho Department of Water Resources, Ground Water Monitoring section, is responsible for developing and administering the statewide ground water quality monitoring program. Specific IDWR program responsibilities include designing the network, overseeing field and laboratory quality assurance, and interpreting water quality data. The staff is also responsible for publishing results and for maintaining this and other ground water quality data for Idaho in a computerized data base referred to as the Environmental Data Management System (EDMS).

As the principal cooperators in the statewide ground water quality monitoring program, the U.S. Geological Survey (USGS) provides technical expertise, matching funds, and field and laboratory support. Specifically, the USGS assists in designing the network, providing field teams for inspecting monitoring sites and collecting water samples, arranging for logistical and technical support such as shipping samples, and conducting some laboratory and field analyses.

# 1990 Reconnaissance

In 1990, the Idaho legislature appropriated funds for a statewide reconnaissance ground water quality monitoring effort. In April of that same year, IDWR sponsored a workshop attended by a broad base of experts. The workshop attendees provided recommendations on the network design, the constituents to be monitored and the number of sites for the monitoring program. The experts advised that a total network of 2,000 monitoring sites might be required to adequately define the ambient ground water quality in Idaho. They recommended sampling a minimum of 375 sites per year. Following the recommendations of the workshop experts, the Ground Water Quality Council passed a resolution requesting funding for a 1991 monitoring network consisting of at least 375 sites.

In the initial 1990 reconnaissance effort, water samples were collected throughout Idaho from 97 ground water quality monitoring sites (wells and springs). Figure 3 shows the location of the 1990 sites. The results of the 1990 reconnaissance effort are seen in Figure 4. In 1990, 6 percent of the monitoring sites revealed a contaminant that exceeded a maximum contaminant level (MCL) and 20 percent of the sites showed at least one chemical constituent where the concentration was "elevated" (greater than 50 percent of an MCL but less than the MCL, IDWR, 1991). The experience from this initial effort provided the foundation for planning the full-scale monitoring network the following year.

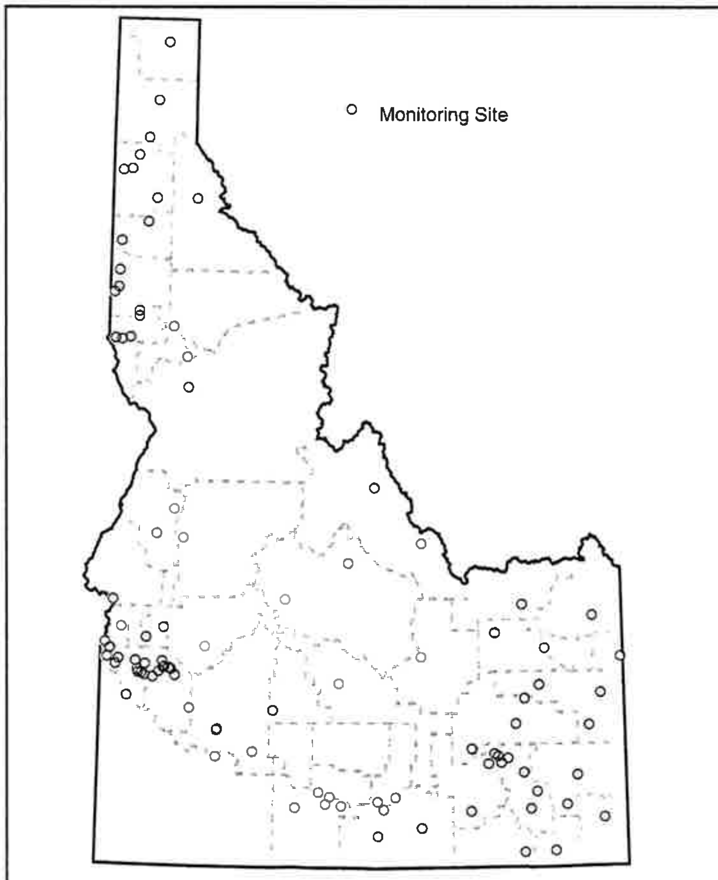



Figure 3. Sites sampled in 1990.

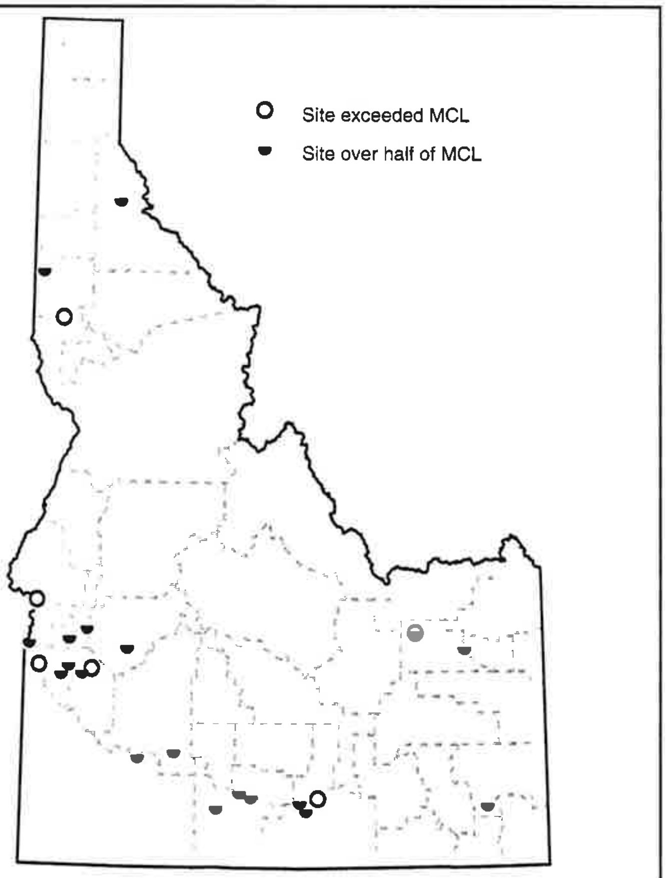



Figure 4. Detections in 1990

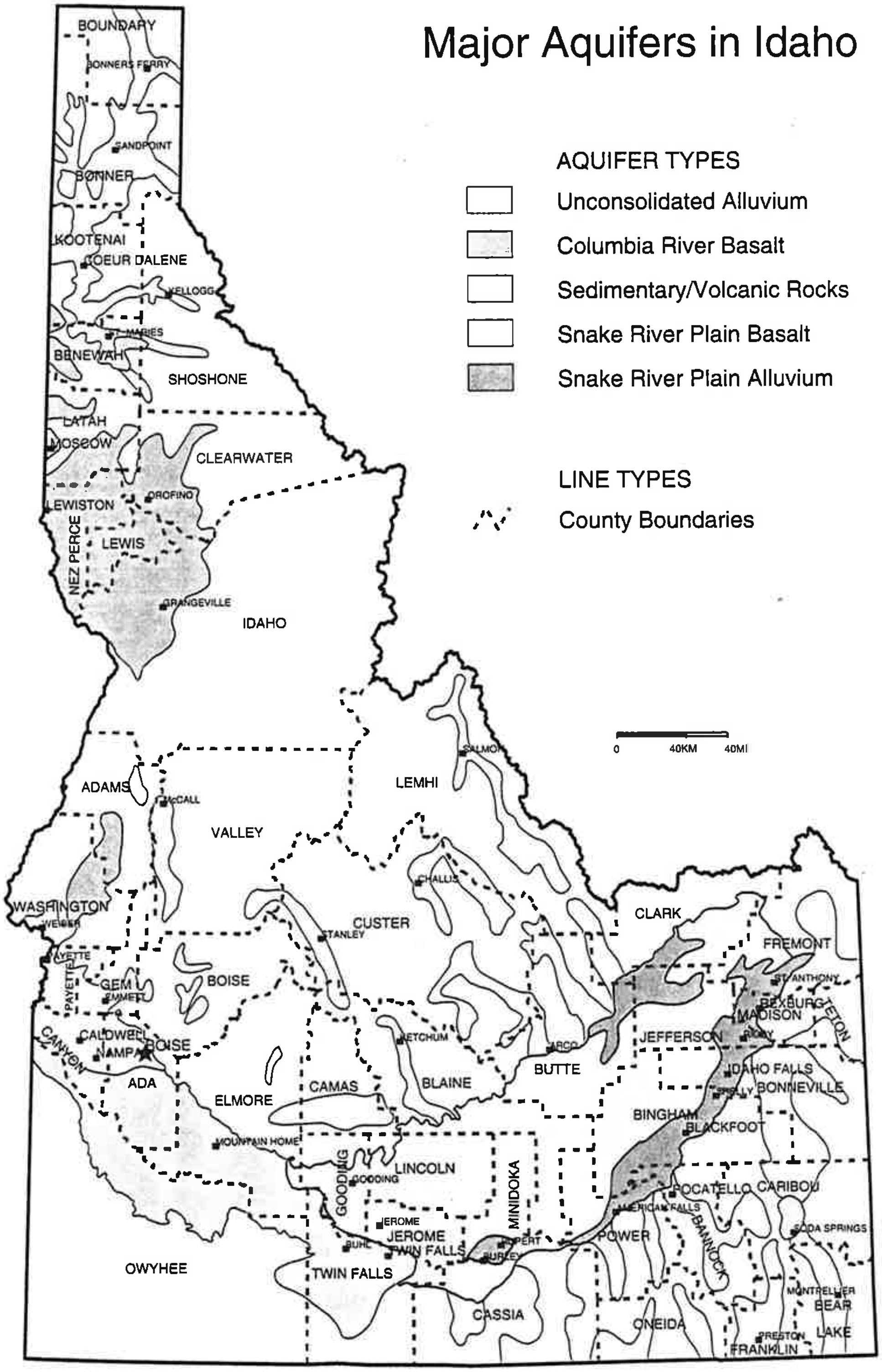



**Figure 5.** Aquifers in Idaho.

**Figure 7.** The monitoring sites were sampled for more than 100 different constituents. Constituents are listed on page 6 -7.

**FIELD PARAMETERS**

specific conductance
pH
temperature
alkalinity

**LABORATORY PARAMETERS**

**Common Ions**

calcium
magnesium
sodium
potassium
bicarbonate
carbonate
alkalinity
hardness
sulfate
chloride
fluoride
silica
dissolved solids

**Nutrients**

nitrogen (NO2+NO3)
nitrogen (ammonia)
phosphorus

**Trace Elements**

arsenic
cadmium
chromium
copper
cyanide
iron
lead
manganese
mercury
selenium
zinc

**Radioactivity/Radionuclides**

gross alpha
gross beta
radon

**Bacteria**

fecal coliform

**Pesticides**

aldicarb
alachlor
atrazine
2,4-D, compounds

**(Trihalomethanes) THM'S**

bromodichloromethane
bromoform
chloroform
dibromochloromethane

**Regulated Volatile Organic Compounds (VOCs)**

vinyl chloride

## Network Design

Types of aquifers in Idaho include: unconsolidated alluvium, basalt, and sedimentary and volcanic rock (Figure 5). Because aquifer types, water chemistries and ground water flow characteristics vary greatly throughout the state, twenty-two hydrogeologic subareas were determined (figure 6). Each subarea is relatively homogeneous with respect to hydrogeologic conditions.

The number of monitoring sites for each hydrogeologic subarea was determined using a statistical method that took into account the subarea's population, aquifer area and the known variability of the water quality of the aquifer. For example, subareas receiving the most sites were those areas with the greatest population, aquifer area and variation in water quality.

Figure 6 shows the predicted number of monitoring sites per hydrogeologic subarea per year. The specific monitoring sites for each subarea are selected randomly from the computerized USGS well and spring database and from IDWR's well log files. It is anticipated that the network will eventually include at least 1,500 monitoring sites.

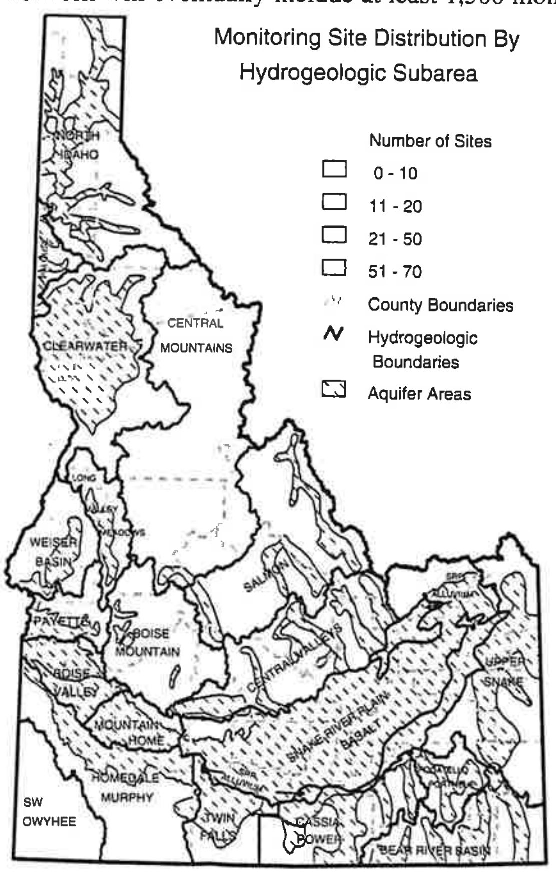



**Figure 6.** Hydrogeologic subareas and number of sites per subarea.

## Sampling and Analysis Protocols

Each monitoring site is to be sampled every three to four years. As a result, approximately 400 sites will be sampled annually. Under current contractual arrangements, the sampling will be conducted by USGS personnel during the summer and early fall months.

Samples from each ground water site are analyzed for more than 100 different chemical constituents and properties (figure 7). The constituents to be analyzed include those that occur naturally (such as calcium, magnesium, fluoride and some radionuclides) and those that occur as the result of man's activities (such as organic compounds, nitrate and some trace elements). Many of these constituents have established MCLs.

## Quality Assurance

IDWR is responsible for ensuring that the data is collected, handled and analyzed in a consistent and technically sound manner. This is accomplished in four ways. First, the quality assurance plan and standard operating procedures are reviewed and adjusted annually. Procedures are then discussed at annual pre-field season training seminars for field personnel. Second, designated quality assurance samples are collected at about 5 percent of the sites to check for contamination associated with the sampling and handling and to determine the laboratories' accuracy in analyzing the chemical constituents. Third, personnel from IDWR's Ground Water Monitoring Section meet and visit with the field teams to observe their safety and sampling techniques. Fourth, anomalous results and potential quality control problems are investigated by IDWR staff.

## Evaluating Water Quality Data

Ground water quality data from the statewide ground water quality monitoring program is evaluated using several methods. First, the overall quality of each water sample can be determined by comparing laboratory results with MCLs established by the Environmental Protection Agency (EPA). If chemical constituents exceed MCLs, natural or man-induced contamination has occurred.

Frequently, a constituent's concentration will be detectable by the laboratory but will be less than the MCL. The constituent may be occurring naturally at the detected concentration. Since determining natural concentrations requires more data than is currently available, constituent concentrations in this report that exceed 50 percent of an MCL (but are less than the MCL) are considered *elevated*. However, nitrate

1,1-dichloroethene
1,1,1-trichlorethane
carbon tetrachloride
benzene
1,2-dichloroethane
trichloroethylene
1,4-dichlorobenzene

**Unregulated Volatile Organic Compounds (VOCs)**

bromobenzene
bromochloromethane
bromomethane
n-butylbenzene
sec-butylbenzene
tert-butylbenzene
chlorobenzene
chloroethane
chloromethane
2-chlorotoluene
4-chlorotoluene
1,2-dibromo-3-chloropropane (DBCP)
ethylene dibromide (EDB)
dibromomethane
1,2-dichlorobenzene
1,3-dichlorobenzene
dichlorodifluoromethane
1,1-dichloroethane
cis-1,2-dichloroethene
trans-1,2-dichloroethene
1,2-dichloropropane
1,3-dichloropropane
2,2-dichloropropane
1,1-dichloropropene
cis-1,3-dichloropropene
trans-1,3-dichloropropene
ethylbenzene
hexachlorobutadiene
isopropylbenzene
p-isopropyltoluene
methylene chloride
naphthalene
n-propylbenzene
styrene
1,1,1,2-tetrachloroethane
1,1,2,2,-tetrachloroethane
tetrachloroethene
toluene
1,2,3-trichlorobenzene
1,2,4-trichlorobenzene
1,1,2-trichloroethane
trichlorofluoromethane
1,2,3-trichloropropane
1,2,4-trimethylbenzene
1,3,5-trimethylbenzene
m-xylene + p-xylene
o-xylene

concentrations are considered *elevated* when the concentration exceeds 20 percent of the MCL. Elevated concentrations of constituents that are not naturally occurring and are directly related to man's activities are labeled *impacted.*

Another important approach to analyzing water quality data is using statistical methods. Descriptive statistics, such as the mean, median, variance and percentile ranges can be calculated to describe certain characteristics of a sample or the population from which the sample was obtained (Spruill, 1990). Other statistical tests can be used to analyze for trends and seasonal variability after data has been collected for an appropriate period of time.

Janet Crockett (IDWR) and Alvin Sablan (USGS) sample for radon at a home in the Boise Valley subarea.

## Notification

When contaminants are detected at concentrations approaching or exceeding the established maximum contaminant levels, the monitoring site owner is sent the results and any available health information. If the results are inconclusive, the well is re-sampled. Concurrently, the Division of Environmental Quality (DEQ) is notified so that any appropriate follow-up action may be taken. In cases where ground water quality may be affected by agricultural land uses, the Department of Agriculture is also notified.

After all annual sampling data are received and compiled, each site owner is mailed a copy of their water quality results and a summary letter that provides some basic interpretations. Site owners also receive names and phone numbers of water quality and health experts who can answer remaining questions they may have regarding their test results.

## Reporting

In January, 1991, IDWR published a status report for the 1990 reconnaissance program titled "Idaho's Statewide Ground Water Quality Monitoring Program-The First Six Months and Beyond" (IDWR,1991). Similarly, this document is a status report that describes the 1991 statewide ground water quality monitoring program, including analyses available through December 31, 1991.

It is anticipated that future fiscal year annual reports will be published beginning in September, 1993. This will allow for all the data to be included and for a more thorough analysis of the results. Preliminary results of the previous field season sampling will be published in newsletter form in January of each year.

IDWR also plans to publish comprehensive five year summaries, a technical document describing the statewide ground water quality monitoring program's development and design, and any additional reports that may be needed to describe the network's findings. The appropriate data from this program will also be used in the Idaho Department of Health and Welfare-Division of Environmental Quality's comprehensive annual ground water contamination report.

## Program Funding

The statewide ground water quality monitoring program for fiscal year 1992 cost $739,300. IDWR's program budget was $539,300 and the USGS contributed $200,000 in matching funds as the primary cooperator (figure 8). Figure 9 lists the state's major expenditures by category required to run this program.

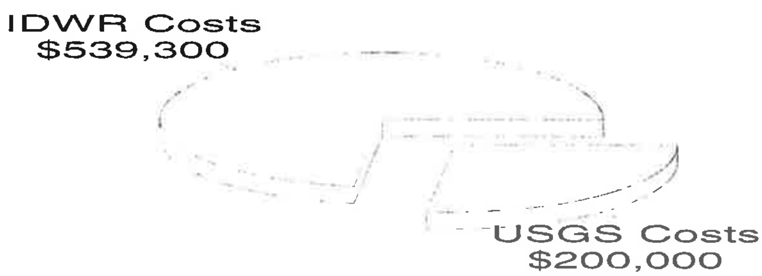



**Figure 8.** IDWR/USGS program costs

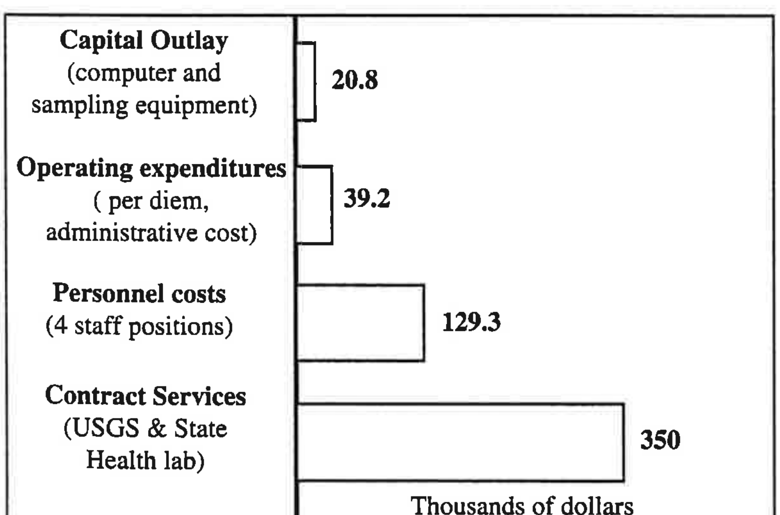



**Figure 9.** IDWR's program budget categories for FY 1992.

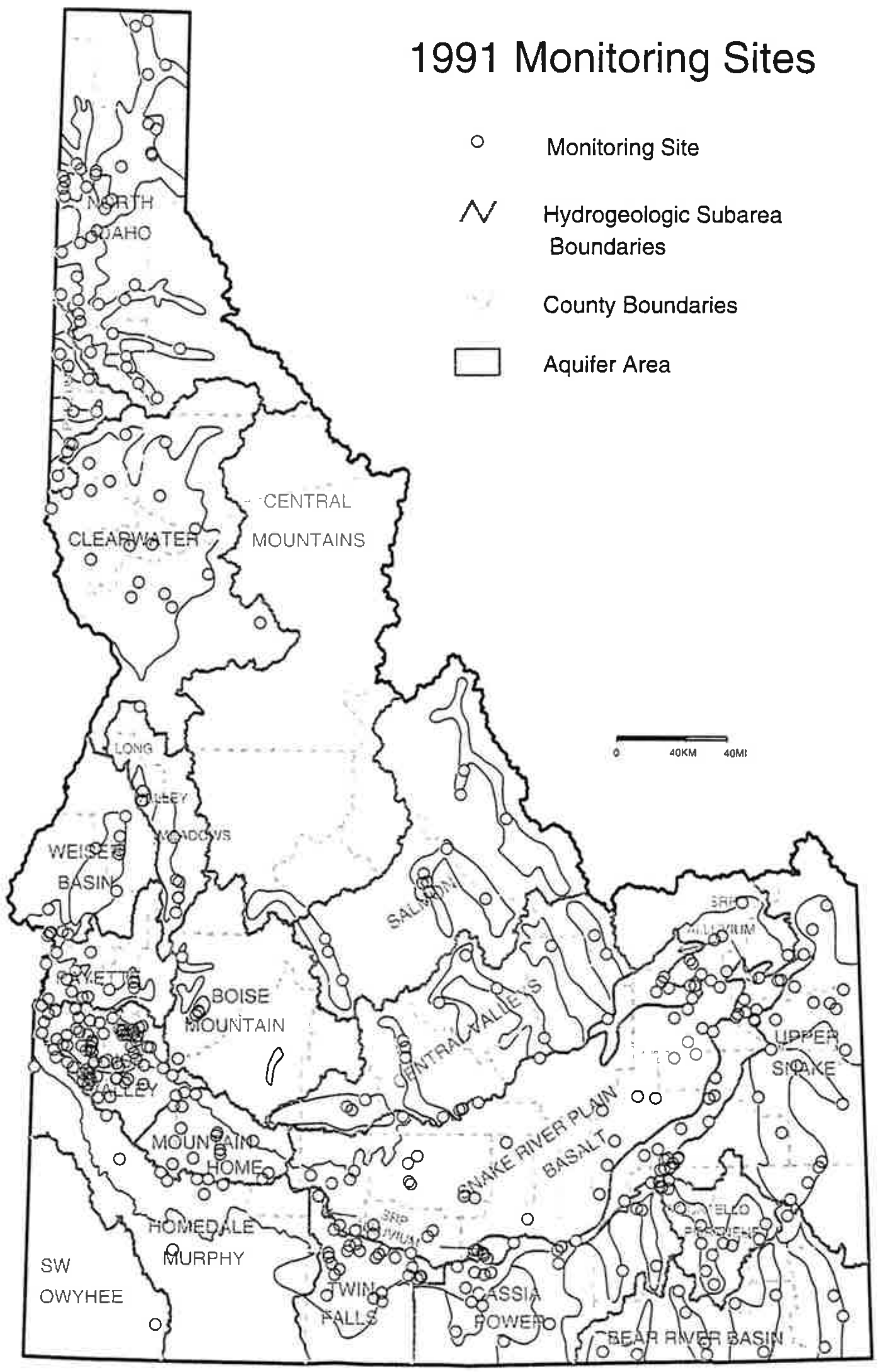



**Figure 10.** The 401 ground water quality monitoring sites sampled in 1991.

# 1991 Program and Results

## Sampling and Analysis

In 1991, ground water was collected from 401 monitoring sites (figure 10). Sampling took place between mid-July and mid-October by USGS and IDWR field teams.

Water samples were analyzed by the Idaho State Health laboratory in Boise, Idaho and by the USGS laboratory in Arvada, Colorado. Some water quality parameters were measured in the field; pesticide screening was done by laboratory technicians in the USGS Boise district field office. At the time of this publication, about 95 percent of 1991's laboratory analyses were complete and available to IDWR.

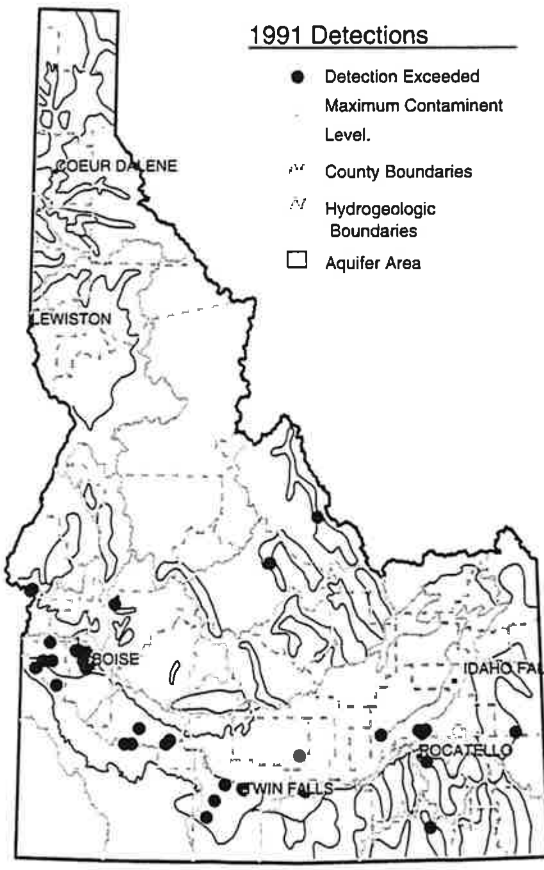



**Figure 11.** All detections > MCL, excluding radon.

## 1991's Findings

Preliminary results indicate that about 9 percent of the 1991 monitoring sites (37 of 401 water samples) had at least one chemical constituent with a concentration that exceeded an established or proposed primary maximum contaminant level. Because of limited sampling, the 9 percent calculation does not include those sites with values exceeding a proposed MCL for radon. Figure 11 shows the site locations with detections exceeding an MCL, excluding radon.

Constituents detected in this year's program include radionuclides, nitrate, volatile organic compounds and trace elements. The following sections summarize the 1991 findings for these detections and for pesticide analyses.

# Radioactivity/Radionuclides

Water samples were analyzed for gross alpha- and gross beta-particle activity and for radon-222. Concentrations for these radionuclides are recorded in picocuries per liter (pCi/l). Gross alpha and gross beta measurements were conducted on water samples from all 401 monitoring sites. Because of overnight shipping requirements, radon samples were only collected at 168 locations.

## Gross Alpha and Gross Beta

Gross alpha and gross beta measurements are screening tests that provide an indication of total alpha or beta radioactivity given off during the radioactive decay process (Wegner and Campbell, 1991). These tests do not distinguish specific and individual radionuclides.

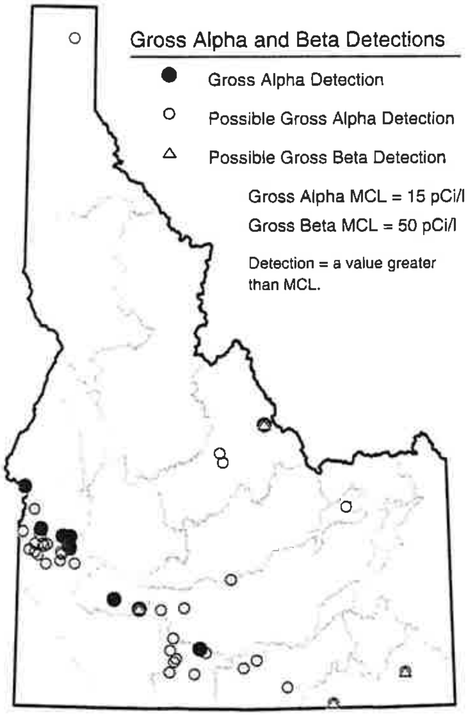



**Figure 12.** Gross alpha and beta detections.

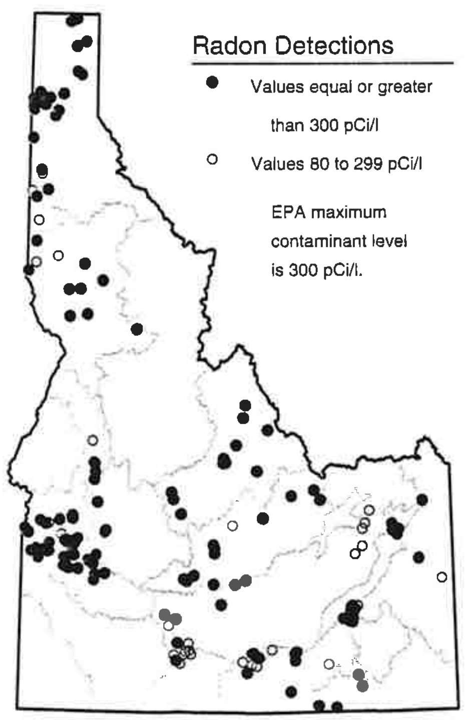



**Figure 13.** Radon detections

Each gross alpha and gross beta laboratory result contains an associated analytical uncertainty recorded as a plus or minus (±) value. For this report, the analytical uncertainty corresponds to a 95-percent probability interval. For example, the actual value for a gross alpha detection of 15.0 pCi/l, with an uncertainty of ± 5.0 pCi/l, has a 95-percent probability of being between 10.0 and 20.0 pCi/l. This inherent uncertainty makes it difficult to determine whether or not some gross alpha and gross beta detections actually exceed the MCLs.

Gross alpha concentrations, reported as americium-241, ranged from -1.2 ± 2.6 to 78.0 ± 23.1 pCi/l, with the mean value equal to 4.4 pCi/l. Gross beta concentrations, reported as cesium-137, ranged from 0.5 ± 0.7 to 56.8 ± 14.4 pCi/l, with the mean value equal to 6.4 pCi/l. (Although gross alpha and gross beta are reported as americium-241 and cesium-137, this does not mean that all of the radioactivity comes from these specific radionuclides).

Figure 12 shows the 10 gross alpha detections that exceed the MCL of 15.0 pCi/l and the 34 detections that may exceed the MCL. These detections were concentrated in southwestern Idaho, particularly in the Boise Valley, Mountain Home and Twin Falls subareas. Figure 12 also shows the four gross beta detections that may exceed the MCL of 50 pCi/l. These detections occurred in the Bear River, Mountain Home and Salmon subareas.

## Radon

Radon-222 is a naturally occurring radioactive gas that originates from the decay of Radium-226. Radon is found naturally in rocks, soil, water and air. Radon in ground water can be released into buildings by normal water use events such as showering and dish washing.

Airborne radon that is inhaled is suspected of causing lung cancer. The EPA estimates that ground water contributes only 5 percent of the total indoor airborne radon in the average house (USEPA, 1991).

Radon concentrations ranged from the laboratory detection limit (80 pCi/l) to 5,700 pCi/l, with the mean value being 629 pCi/l. Radon detections exceeded the EPA proposed MCL of 300 pCi/l at 121 of the 168 sampled locations (figure 13).

All of the subareas where radon samples were collected had detections exceeding the proposed MCL. The highest radon concentration (5,700 pCi/l) was in the Salmon subarea. The Palouse, Snake River Plain and Twin Falls subareas exhibited the lowest percentage of sites having concentrations greater than 300 pCi/l.

# Nitrate

Nitrate is an inorganic ion which makes up part of the nitrogen cycle (EPA, 1989). Nitrate is generated by decaying organic matter, sewage and fertilizers. In ground water, nitrate can encourage the growth of algae and other organisms which produce undesirable taste and odors.

Humans ingest nitrate through food and water. In infants, bacteria in their stomachs can change nitrate into nitrite. Excessive nitrite changes hemoglobin, the oxygen carrying element in the blood, to methoglobin, which cannot carry oxygen. The result is an oxygen deficiency called methemoglobinemia (blue baby syndrome) that can cause death in infants. Children and adults, however, are not affected by this condition. Boiling the water will not get rid of nitrate, and in fact, will concentrate it.

The MCL for nitrate in public drinking water is 10 milligrams per liter (mg/l). For the purposes of this report, concentrations greater than 2.0 mg/l indicate that ground water is *impacted* (elevated due to man's land use or other activities).

In 1991, concentrations for the 400 wells tested for nitrate ranged from the detection limit of 0.05 mg/l to 23.0 mg/l. Of those, 5 percent (20 sites) had nitrate concentrations greater than or equal to the MCL. An additional 27 percent (109 sites) had impacted levels of nitrate (Figure 14).

Approximately 95 percent of all impacted nitrate detections (> 2.0 mg/l) are located along the western and eastern Snake River Plain (Figure 15). The highest nitrate concentration (23 mg/l) was found in the Snake River Plain Alluvium subarea. Three other samples in this subarea had nitrate concentrations that exceeded the MCL. The other 15 sites exceeding the drinking water standard were found in the Payette, Boise Valley, Mountain Home, Homedale/Murphy, Salmon River, Bear River and Twin Falls subareas.

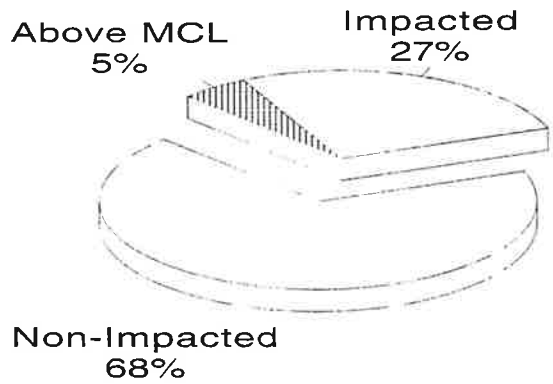



**Figure 14.** Impacted levels of nitrate samples.

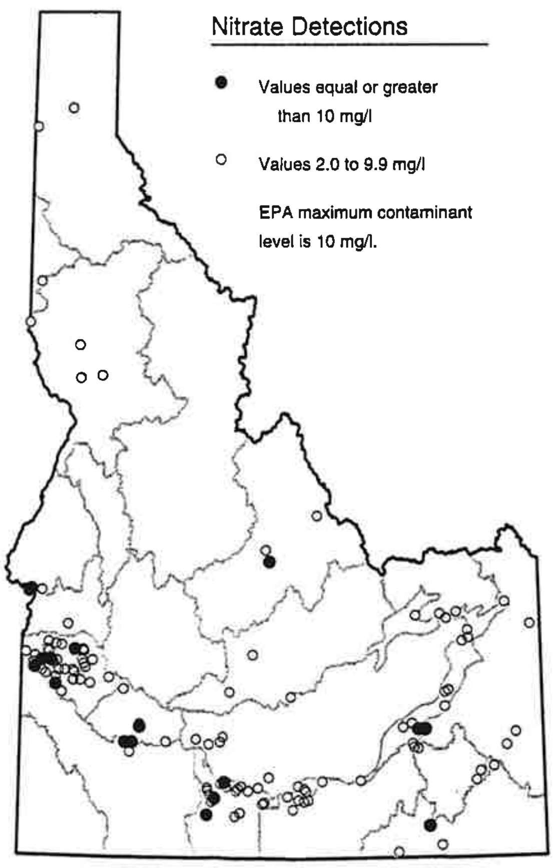



**Figure 15.** Nitrate detections

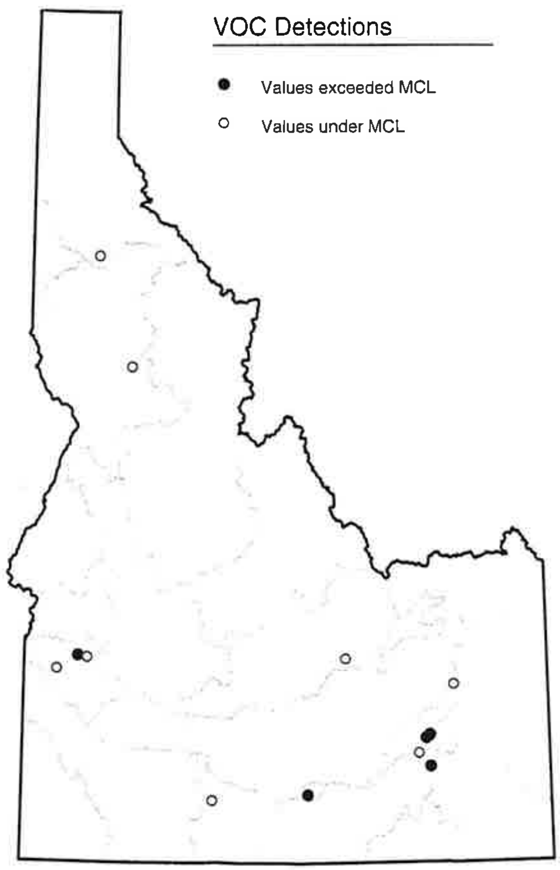



**Figure 16.** VOC detections

# Volatile Organic Compounds

Volatile Organic Compounds (VOCs) are synthetic chemicals commonly found in products such as gasoline, solvents, industrial materials and pesticides (USEPA. 1991). Many VOCs are carcinogenic (cancer causing) or otherwise harmful to human health. Removing these chemicals from ground water is difficult, expensive and sometimes impossible.

Water samples from 325 sites were analyzed for 59 VOCs. About 4 percent of the water samples (14 sites) had detectable VOCs. In all, eight different VOCs were detected (Table 1). Some locations had detections of a single compound; other locations had detections of up to three different VOCs. Figure 16 shows VOC detections occurred primarily in the Boise Valley, Snake River Plain and Pocatello/Portneuf subareas.

| Volatile Organic Compound (MCL in μg/l)* | Detections (μg/l) | Subarea |
|---|---|---|
| Benzene<br>(MCL=5.0) | 8.45 | Snake River Plain |
| Bromodichloromethane<br>(MCL=100) | 0.66<br>1.87 | Twin Falls<br>East-Central Valleys |
| Chloroform<br>(MCL=100) | 2.23<br>3.48 | Clearwater<br>North Idaho |
| 1,2-Dibromoethane(EDB)<br>(proposed MCL=0.05) | 6.77 to 20.2 | Snake River Plain |
| 1,2-Dichloropropane<br>(proposed MCL=5.0) | 2.34 to 8.91<br>0.23 to 19.1 | Snake River Plain<br>Boise Valley |
| Tetrachloroethylene<br>(Perk)<br>(proposed MCL=5.0) | 0.97 to 1.33<br>0.12<br>0.18 | Pocatello/Portneuf<br>Snake River Plain<br>Boise Vally |
| 1,1,1-Trichlorethane<br>(TCA) (MCL=200) | 0.56 | Pocatello/Portneuf |
| Trichloroethylene (TCE)<br>(MCL=5.0) | 15.5 | Pocatello/Portneuf |
| 1,2,3-Trichloropropane<br>(no MCL) | 1.43 to 1.62<br>0.12 to 6.77 | Snake River Plain<br>Boise Valley |

*μg/l=micrograms per liter

**Table 1:** A summary of volatile organic compounds detections.

# Trace Elements

Water samples were tested for the following trace element constituents: arsenic, cadmium, chromium, copper, cyanide, fluoride, iron, lead, manganese, mercury, selenium, and zinc. This report discusses constituents that had at least one detection that exceeded half of a primary or secondary MCL. Primary MCLs are established based on health issues and are enforced by the EPA for public drinking water supplies; secondary MCLs are established for aesthetic reasons, such as offensive taste, odor, color, corrosivity, foaming and staining (Taylor, 1990).

## Arsenic

Arsenic is a naturally occurring element found both in inorganic and the less toxic organic forms. It occurs in rock, volcanic gas and geothermal water. Elevated levels can be attributed to natural dissolution of rocks and soils, through the use of pesticides and by the intrusion of industrial waste (Life Systems, Inc, 1989). Most forms of arsenic are toxic to humans and may be carcinogenic. However, humans naturally ingest small amounts of arsenic, mainly through food consumption. The MCL for arsenic in public drinking water is 50 micrograms per liter (μg/l).

Arsenic analyses for 360 wells ranged from the detection limit of 1.0 μg/l to 96.0 μg/l. Of 360 arsenic analyses, just under 1 percent (3 sites) were greater than the MCL and an additional 3.5 percent (14 sites) were greater than half of the MCL. Of those 360 arsenic analyses, 65 percent (260 sites) were above the detection limit of 1 μg/l.

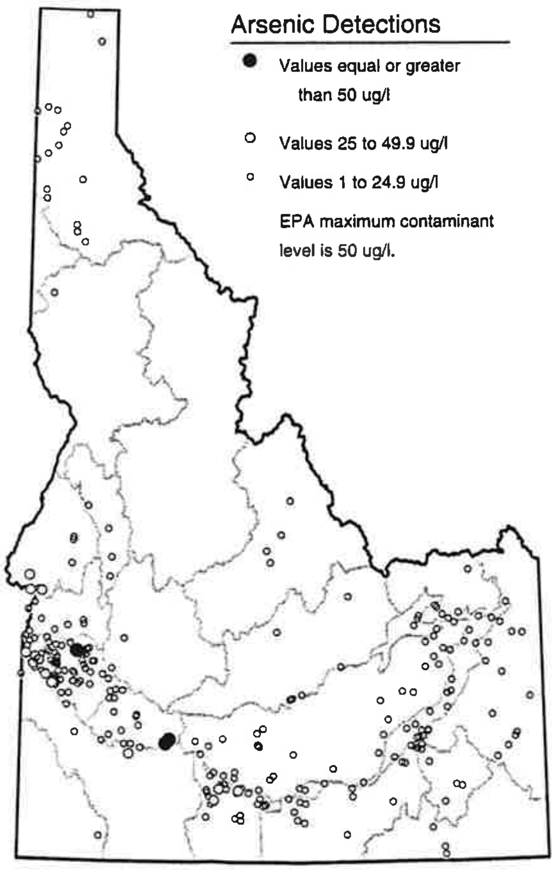



**Figure 17 .** Arsenic concentrations

Arsenic appears to be a natural background element in some of the ground waters of Idaho, but the background level of arsenic appears to vary from hydrogeologic subarea to subarea. Although data from this year's program is insufficient to make generalizations, an initial study of the data indicates that the Homedale/Murphy and Twin Falls hydrogeologic subareas appear to have higher background levels of arsenic than other areas in the state, where 75 and 62 percent respectively, of the arsenic values exceeded 10 μg/l. In contrast, the Palouse and Clearwater subareas had one very low detection in 25 sites sampled for arsenic.

All of the arsenic concentrations that exceeded half the MCL were located in the western Snake River Plain (figure 17). Of the three concentrations exceeding the MCL, one was located in the Boise Valley subarea and two were in the Mountain Home subarea. Other sites with elevated arsenic levels were found in the Weiser, Payette, Homedale-Murphy and Twin Falls subareas and in the Boise Valley subarea (especially along the eastern boundary of Canyon County).

Fluoride is the common form of fluorine, a naturally occurring element

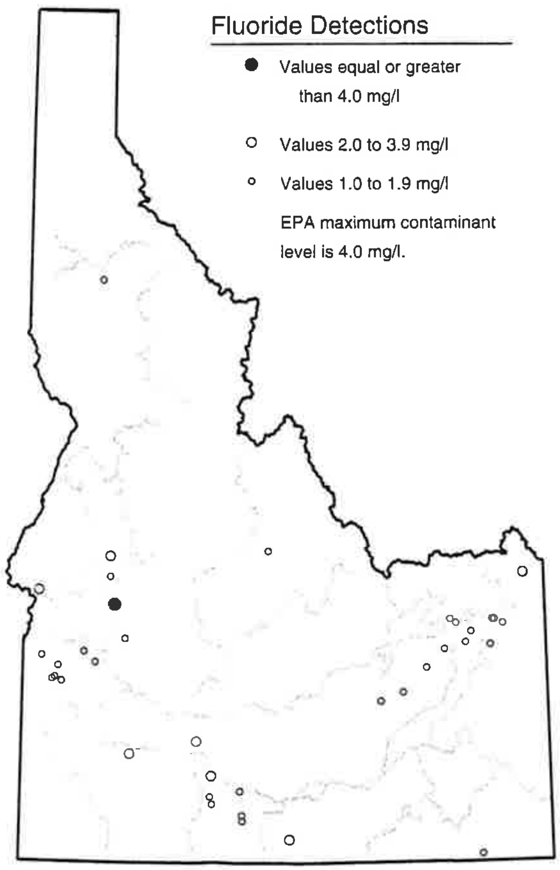



**Figure 18.** Fluoride detections

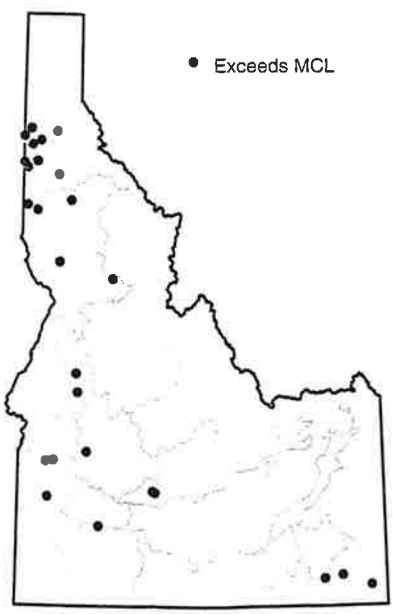



**Figure 19.** Iron detections > MCL

## Fluoride

found mostly in the earth's crust. According to the EPA, levels of naturally occurring fluoride in ground waters range from .02 to 1.5 mg/l. Elevated levels of fluoride can be attributed to natural dissolution of rocks and soils, through the use of fertilizers, particularly super phosphates, and by the intrusion of industrial waste (Clement Associates, Inc, 1991). Although fluoride is beneficial to dental and skeletal health at lower levels, it can be harmful at higher levels. Fluoride concentrations as low as 2.0 mg/l have produced teeth mottling in children and, in rare cases, levels as low as 5 mg/l have resulted in crippling skeletal fluorosis in adults. The primary MCL for fluoride in water is 4.0 mg/l; the secondary MCL is 2.0 mg/l.

Fluoride analyses for 360 wells ranged in concentration from the detection limit of .1 mg/l to 5.6 mg/l. Only one of the 360 was above the primary MCL, an additional 7 were above the secondary MCL, and 37 were above 1.0 mg/l (half the secondary MCL). The eight fluoride detections greater than the secondary MCL occurred in eight different hydrogeologic subareas throughout the southern half of the state (figure 18). These concentrations did not appear to be associated with geothermal waters.

Because 96 percent of the analyses (345 sites) had fluoride values above the detection limit of .1 mg/l, this year's data would suggest that fluoride is a natural background element in the ground waters throughout the state.

## Iron and Manganese

Iron and manganese are among the most abundant of the earth's elements. They occur naturally in ground water in low to high concentrations depending on the water chemistry. Both elements are essential to animal and plant life. Since high concentrations of these elements can produce undesirable color and taste as well as causing problems in plumbing, the EPA has established secondary MCLs of 300 µg/l and 50 µg/l for iron and manganese, respectively (Hem, 1989).

Dissolved iron concentrations ranged from the detection limit of 3.0 µg/l to 16,000 µg/l. Of 360 analyses for iron, 7 percent (26 sites) were above the secondary MCL (figure 19). Dissolved manganese concentrations ranged from the detection limit of 1.0 µg/l to 1,300 µg/l. Of 360 analyses for manganese, 16 percent (56 sites) exceeded the secondary MCL (figure 20).

The three highest dissolved iron concentrations occurred in the North Idaho subarea. The highest percentage of wells that showed iron over the secondary MCL was in the Palouse subarea (Table 2). The highest dissolved manganese concentration occurred in the Upper Snake subarea. The highest percentage of wells with manganese concentrathe secondary MCL was in the Palouse subarea (Table 2). The highest dissolved manganese concentration occurred in the Upper Snake subarea. The highest percentage of wells with manganese concentrations over the secondary MCL was in the Long Valley-Meadows subarea, followed by the North Idaho, Palouse and Homedale/Murphy subareas (Table 2).

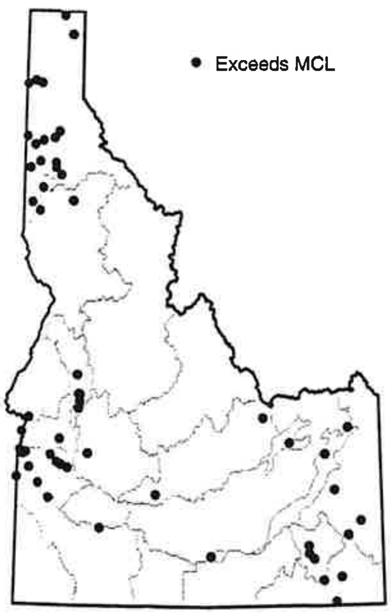



**Figure 20.** Manganese detections > MCL

| Subarea | # of sites | % Fe > MCL | % Mn >MCL |
|---|---|---|---|
| North Idaho | 39 | 18% | 36% |
| Palouse | 9 | 33% | 33% |
| Clearwater | 18 | 22% | 11% |
| Long Valley-Meadows | 9 | 22% | 67% |
| Weiser | 9 | 0% | 11% |
| Payette | 16 | 0% | 19% |
| Boise Valley | 67 | 3% | 12% |
| Homedale-Murphy | 10 | 20% | 30% |
| East Central Valleys | 15 | 13% | 13% |
| Snake River Plain | 87 | 0% | 5% |
| Pocatello-Portneuf | 15 | 0% | 20% |
| Upper Snake | 19 | 0% | 16% |
| Bear River | 13 | 23% | 23% |

**Table 2.** Iron and Manganese detections in Idaho. Mountain Home, Salmon, Twin Falls and Cassia/Power subareas had no detections for iron or magnesium. Boise Mountains, Central Mountains and SW Owyhee had less than nine samples resulting in insufficient data.

## Other Trace Elements

Other trace elements discussed in this report are cadmium, mercury, zinc and selenium. The three former are heavy metals; selenium is a non-metal. Cadmium, mercury and zinc may be elevated in ground water due to mineral deposits or intrusions from buried or industrial waste, although the use of mercury has been drastically reduced since the 1960's (Hem, 1989). Cadmium tends to accumulate in plants and is known to cause bone deterioration. Mercury, a relatively rare element, compounds in the food chain and is known to be highly toxic to animals and humans. Zinc is an essential element for plants and animals. There are no known health risks from zinc (Hem, 1989).

Selenium is generally found in soils as salts and in elemental form. It can be elevated due to agricultural practices that concentrate salts at the surface. Although in trace amounts selenium is beneficial to grazing animals (Hem, 1989), at higher levels it is a known toxin resulting in symptoms similar to arsenic poisoning (Parliman, 1983).

Primary MCLs exist for cadmium, mercury and selenium. A secondary MCL was established for zinc due to the objectionable taste of water with high concentrations of zinc. Table 3 summarizes the concentrations and occurrences of these elements.

| Element | Detection Limit | Number of Detections | MCL | Number > half MCL | Number > MCL | Subareas of Occurence (#) |
|---|---|---|---|---|---|---|
| Cadmium | 1.0 µg/l | 3 | 10 µg/l | 0 | 1 | Snake River Plain Basalt |
| Mercury | 0.1 µg/l | 13 | 2 µg/l | 1 | 0 | Boise Mountain |
| Zinc | 3.0 µg/l | 326 | 5,000 µg/l | 0 | 1 | North Idaho |
| Selenium | 1.0 µg/l | 95 | 10 µg/l | 6 | 2 | Salmon River >MCL (1)<br>Upper Snake > MCL (1)<br>Boise Valley (1)<br>Homedale/Murphy (3)<br>Snake River Plain Alluvium (1)<br>Cassia/Power (1) |

**Table 3.** Trace element detections

## Pesticides

Ground water samples were checked for alachlor, aldicarb, atrazine and 2,4-D pesticide compounds using immunoassay technology. Immunoassays are screening tests that can determine the presence or absence of certain families of pesticide compounds with similar chemical structures (Vanderlaan, et all, 1988). Immunoassay screens were chosen because they are currently considered to be an inexpensive alternative to conventional laboratory analyses.

In 1991, there were 63 possible detections of atrazine, aldicarb, and alachlor using immunoassays. Most of these possible detections had concentrations that were below any established or proposed MCLs. However, several water samples had concentrations that warranted confirmation sampling. To date, sites of two atrazine and three aldicarb detections have been resampled and retested using additional immunoassays in some cases and conventional laboratory technology in other cases. All five confirmation samples tested negative for pesticides.

Clearly, testing for pesticides is a difficult, but important part of the statewide ground water quality monitoring program. In 1992, IDWR will reassess the available technology for detecting pesticides in ground water.

# EDMS

The Ground Water Quality Protection Act of 1989 provides for the development of a comprehensive computer system to store and manage water resource information. The Environmental Data Management System (EDMS) was designed to provide easy access to Idaho's ground water quality data.

EDMS is to be developed in three phases. Phase I is the planning and design phase. Phase II is the development of a prototype to be tested with actual data. Phase III is the application phase, where data will be reviewed and entered to EDMS for public access.

EDMS is currently in Phase II. At this stage, the following has been accomplished or is under development.

* Computer workstations have been acquired with sufficient memory and disk storage space to accommodate estimated software and initial data requirements. The workstations utilize the Unix operating system, which allows multiple users to access the system simultaneously.

* The software engineers, Egret Technologies, are developing the software needed to address the requirements of the state of Idaho.

* Well construction, location and sample quality data modules have been completed by the consultant and successfully loaded onto the Unix workstations.

* Data has been acquired from the USGS and a subset of that data has been loaded for testing purposes. Data acquisition efforts are also being concentrated on Idaho National Engineering Laboratory (INEL) data and on Farm Bureau data through the INEL Oversight Program and the Division of Environmental Quality.

* Modem access to EDMS is now available. INEL Oversight users in the Idaho Falls field office, the Idaho State University Geology Department, the Boise office of the Division of Environmental Quality and the Idaho Department of Agriculture now have accounts and are accessing the test data in EDMS.

* A training program, tutorial screens and user documentation are currently under development.

* Software testing is ongoing. Initial results indicate that the software is functional, but that a more finished user interface is needed. This interface will provide easier access for the average user and reduce the need for extensive user training.

* A descriptive brochure introducing EDMS has been published with two additional to follow. The next two brochures will: 1) provide guidance to the data submitting organization and 2) provide guidance to the EDMS user.

To manage the large volumes of data anticipated, EDMS uses Ingres, a powerful relational database management system. Ingres, along with modules completed by Egret Technologies, comprise a core system which provides the structures for data entry, update and reporting. For those users who have access to GIS systems, this core system also provides the capability to prepare data for use in GIS software systems, such as ARC/INFO, thereby increasing the application potential of the data for a greater number of users.

Access to the core system is through database query languages. However, to ease the process of retrieving and reporting data for system users, an information module is being developed by IDWR staff. It is in this module that users will be able to retrieve the data they need through simple menu selections. The information module will also include a bibliographic reference to water quality publications from around the state.

Access to EDMS is now available with test data to users with personal computers, workstations or mainframes with access to a modem. In Phase III, when more data is available, members of the general public may contact the Information Specialist for assistance.

Plans are being made to acquire, convert and load existing data as well as accommodate ongoing monitoring programs. In addition to the INEL Oversight and Farm Bureau data mentioned above, data acquisition for early Phase III will include the statewide ground water quality monitoring program, the USGS well inventory and the artesian well inventory.

The Ground Water Data Review committee, established in the Ground Water Quality Plan, has been meeting regularly in preparation for Phase III. The committee has outlined the data review process and defined data confidence levels, laying the groundwork to assist outside organizations in preparing and submitting data to EDMS. The work of the Ground Water Data Review committee is not to censor data, but to make all data available to the public and to assure that data is correctly identified as meeting certain criteria for precision, accuracy and confidence levels.

# 1992 and Beyond

The statewide ground water quality monitoring program will continue to focus on accomplishing the first objective of determining the overall water quality in Idaho's aquifers in 1992. The second set of about 400 sites are to be sampled in 1992. With some overlap for trend analysis, this will expand the monitoring network to approximately 900 sites. This expansion will continue each year until the network adequately covers the state's aquifers. It is anticipated that the total network will consist of at least 1,500 monitoring sites.

In 1992, IDWR will also begin selecting monitoring sites that will be used to accomplish the program's second objective: identifying trends in ground water quality. It is anticipated that as the first objective is accomplished (determining the overall water quality for the aquifers), a subset of network sites will be used for trend analyses.

By the summer of 1992, all water quality data from the 1990 and 1991 statewide ground water quality monitoring programs is to be available on the Environmental Data Management System. This and other water quality data will then be readily available to the citizens of Idaho.

# Glossary

**Alluvium-**Sediments laid down by physical processes in river channels, floodplains, and fans at the foot of mountain slopes.

**Aquifer-**Any body of porous saturated material, such as rock, sand, gravel, etc., capable of transmitting ground water and yielding economically significant quantities of water to wells and springs.

**Basalt-**A fine-grained, igneous extrusive volcanic rock, commonly dark in color and composed mainly of minerals rich in magnesium and iron.

**Common Ions-**Commonly-occurring charged atom or group of atoms. Examples are calcium, magnesium, potassium and silica.

**Contaminant-**Any chemical, ion, radionuclide, synthetic organic compound, microorganism, waste or other substance which does not occur naturally in ground water or which naturally occurs at a lower concentration.

**Contamination-**The direct or indirect introduction into ground water of any contaminant caused in whole or in part by human activities.

**Drinking Water Standards-**Drinking water standards serve as a basis for appraising water quality and are established by the EPA. The standards consist of a *maximum contaminant level* (MCL) allowed for each constituent listed under the standards. *Primary* MCLs are established based on health issues and are enforced by the EPA for public drinking water supplies. *Secondary* MCLs are established for aesthetic reasons such as water taste, color or odor.

**Elevated -**For this report, constituents other than nitrate that exceed 50 percent of an MCL, but less than the MCL. Nitrate levels above 20 percent of MCL are considered elevated.

**Gross Alpha-**Radioactivity given off as alpha particles during the radioactive decay process. Gross alpha is measured in picocuries per liter (pCi/l).

**Gross Beta-**Radioactivity given off as beta particles during the radioactive decay process. Gross beta is measured in picocuries per liter (pCi/l).

**Ground Water-**Any water of the state which occurs beneath the surface of the earth in a saturated geological formation of rock or soil.

**Immunoassay Scan-**An enzyme-based field screening technique for detecting pesticides in water and soil.

**Impacted-**A constituent with an elevated concentration, not naturally occurring and directly related to man's activities.

**Maximum Contaminant Level (MCL)-See** Drinking Water Standards.

**Micrograms per liter (µg/l)-**Unit of measurement equivalent to parts per billion.

**Milligrams per liter (mg/l)-**Unit of measurement equivalent to parts per million.

**Monitoring Site-**A specific point or location where air, water or soil samples are collected for analysis. In this study, monitoring sites are wells and springs.

**Nitrate-**A naturally occurring inorganic ion comprised of the chemical radical NO3. Nitrate can be generated by animal wastes, fertilizer, etc.

**Pesticide-** 1) any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, and 2) any substance or mixture of substances intended for use as a plant growth regulator, defoliant or desiccant. Insecticides, herbicides, fungicides, rodenticides, fumigants, disinfectants and plant growth regulators are all identified as pesticides.

**Picocurie (pCi)-**A unit of radioactivity. One picocurie equals 2.22 disintegrations per minute.

**Radon-**A naturally occurring radioactive gas that originates from decay of radium-226. Radon is measured in picocuries per liter (pCi/l).

**Sedimentary Rocks-**Rocks formed by the accumulation, compaction and lithification of sediment.

**Trace Elements-**Elements present in minor amounts in the earth's crust. Includes arsenic, cadmium, chromium, iron, lead, mercury and others.

**Volatile Organic Compound-**Synthetic organic compounds with a tendency to volatilize, or pass into the gaseous state.

# References


Clement Associates, Inc., 1991, Toxicological profile for fluorides, hydrogen fluoride and fluorine (F), draft for public comment: Agency for Toxic Substances and Disease Registry, U.S. Public Health Service.

Gass, Tyler E., 1991, Drinking water and human health: parts I and II, chemical ground water quality: National Water Well Association.

Hay, DeLynn R., and Knudsen, Delno, 1985, Nitrate-Nitrogen in drinking water: Nebraska Department of Health NebGuide G85-763, 4 p.

Hem, John D., 1989, Study and interpretation of the chemical characteristics of natural water: United States Geological Survey Water-Supply Paper 2254, 264 pp.

Idaho Department of Water Resources, 1991, Idaho's statewide ground water quality monitoring program -The first six months and beyond- Idaho Department of Water Resources, 24 p.

Life Systems, Inc., 1989, Toxicological profile for arsenic: Agency for Toxic Substances and Disease Registry, U.S. Public Health Service in collaboration with the U.S. Environmental Protection Agency.

Mahler, Robert L., Porter, Ernestine and Taylor, Roy, 1990, Nitrate and groundwater: University of Idaho College of Agriculture, Cooperative Extension Service.

Parliman, D.J., 1983, Groundwater quality in the western Snake River Basin Swan Falls to Glenns Ferry, Idaho: U.S. Geological Survey Water Resource Investigations Report 83-4062, 83 pp.

Spruill, Timothy B., 1990, Monitoring regional ground-water quality--Statistical considerations and description of a monitoring network on Kansas: U.S. Geological Survey, Water Resources Investigation Report 90-4159, 41 p.

Taylor, Roy, Porter, Ernestine, and Mahler, Robert L., 1990, Drinking water standards: University of Idaho College of Agriculture, Cooperative Extension Service.

U.S. Environmental Protection Agency, 1991, Current and proposed national primary and secondary drinking water regulations: U.S. Environmental Protection Agency Region X - Drinking Water Program, 8 pp.

U.S. Environmental Protection Agency, 1989, Nitrate/Nitrite, U.S. Environmental Protection Agency Health Advisory Summary.

U.S. Environmental Protection Agency, 1991, National primary drinking water regulations for radionuclides, proposed rule: U.S. Environmental Protection Agency, Office of Drinking Water, Radionuclides in Drinking Water Fact Sheet, 12 p.

U.S. Environmental Protection Agency, 1991, National primary drinking water regulations for 38 inorganic and synthetic organic chemicals: U.S. Environmental Protection Agency, Office of Drinking Water, Phase II Fact Sheet, 8 p.

U.S. Geological Survey, 1987, National water summary 1986 - ground-water quality: Idaho: U.S. Geological Survey Water-Supply Paper 2325, pp. 229-236

Vanderlaan, Martin, Watkins, Bruce E., and Stanker, Larry, 1988. Environmental monitoring by immunoassay: Environmental Science Technology, American Chemical Society, Vol. 22, pp 247-254.

Wegner, Steven J., and Campbell, Linford J., 1989, Radionuclides, chemical constituents and organic compounds in water from designated wells and springs from the southern boundary of the Idaho National Engineering Laboratory to the Hagerman Area, Idaho: U.S. Geological Survey Open File Report 91-232, 44 p.

Wilfong, Rudy, 1991, Iron and manganese in water: National Drillers Buyers Guide.

*About the authors: Kenneth W. Neely, hydrogeologist, and Janet K. Crockett, senior ground water quality analyst, work for the Idaho Department of Water Resources, Ground Water Monitoring Section.*

*Maps were prepared by Tana Dace, geographic information system analyst, using ARC/INFO software and PostScript composite files. The status report was designed and formatted by Tondee Perry, information specialist, using PageMaker 4.0/IBM software. Both work for IDWR's Ground Water Monitoring Section.*