OREGON GROUND-WATER QUALITY

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FOREWORD

This report contains summary information on ground-water quality in one of the 50 States, Puerto Rico, the Virgin Islands, or the Trust Territories of the Pacific Islands, Saipan, Guam, and American Samoa. The material is extracted from the manuscript of the *1986 National Water Summary*, and with the exception of the illustrations, which will be reproduced in multi-color in the *1986 National Water Summary*, the format and content of this report is identical to the State ground-water-quality descriptions to be published in the *1986 National Water Summary*. Release of this information before formal publication in the *1986 National Water Summary* permits the earliest access by the public.

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Ground water is a precious resource, and in some areas of Oregon (fig. 1) it is the only source of potable water. However, localized ground-water-quality problems exist at several locations in the State. These quality problems are of major concern because ground water is the source of drinking water for about 40 percent of the State's population (Winslow Ladue and Dave Leland, Oregon State Health Division, written commun., 1987). Ground water also is used for agricultural irrigation and industrial processes. Water quality in all the principal aquifer groups (fig. 2) generally does not exceed national drinking-water standards for hardness, dissolved solids, and nitrate plus nitrite—some of the properties used to evaluate the suitability of water for drinking as set forth by the U.S. Environmental Protection Agency (1986a,b) and the Health Division of the Oregon Department of Human Resources. The chemical quality of ground water, however, can be altered by human activities. Miller and Gonthier (1984) noted several areas in Oregon that showed evidence of ground-water-quality degradation as a result of urbanization and industrial activities.

Nine hazardous-waste sites in Oregon require monitoring of ground-water quality under the Federal Resource Conservation and Recovery Act (RCRA) of 1976. In addition to these nine RCRA sites, six sites have been included in the National Priorities List of hazardous-waste sites by the U.S. Environmental Protection Agency (1986c). These six Superfund sites (fig. 3) require additional evaluation under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. Contamination of ground water has been documented at seven of the RCRA and all CERCLA sites in Oregon; contamination is suspected, but has not been documented, at the two remaining RCRA sites. Many additional industrial and agricultural sites, where contamination has been documented or is suspected, are of concern to the U.S. Environmental Protection Agency (EPA) and the Oregon Department of Environmental Quality (DEQ).

In addition to ground-water monitoring conducted by the DEQ to detect migrating leachates near landfills, there are several ground-water-quality monitoring networks for specific sites in Oregon. The DEQ is the State agency responsible for the protection of ground-water quality and, as such, actively conducts or directs sampling designed to monitor the movement of known or suspected contaminants, while also requiring numerous source industries to conduct onsite monitoring. A small set of ambient ground-water-quality data has been collected by the U.S. Geological Survey as part of various projects through the years. This data set is stored and maintained in the Water Data Storage and Retrieval System (WATSTORE) data base, which is updated periodically by the U.S. Geological Survey.

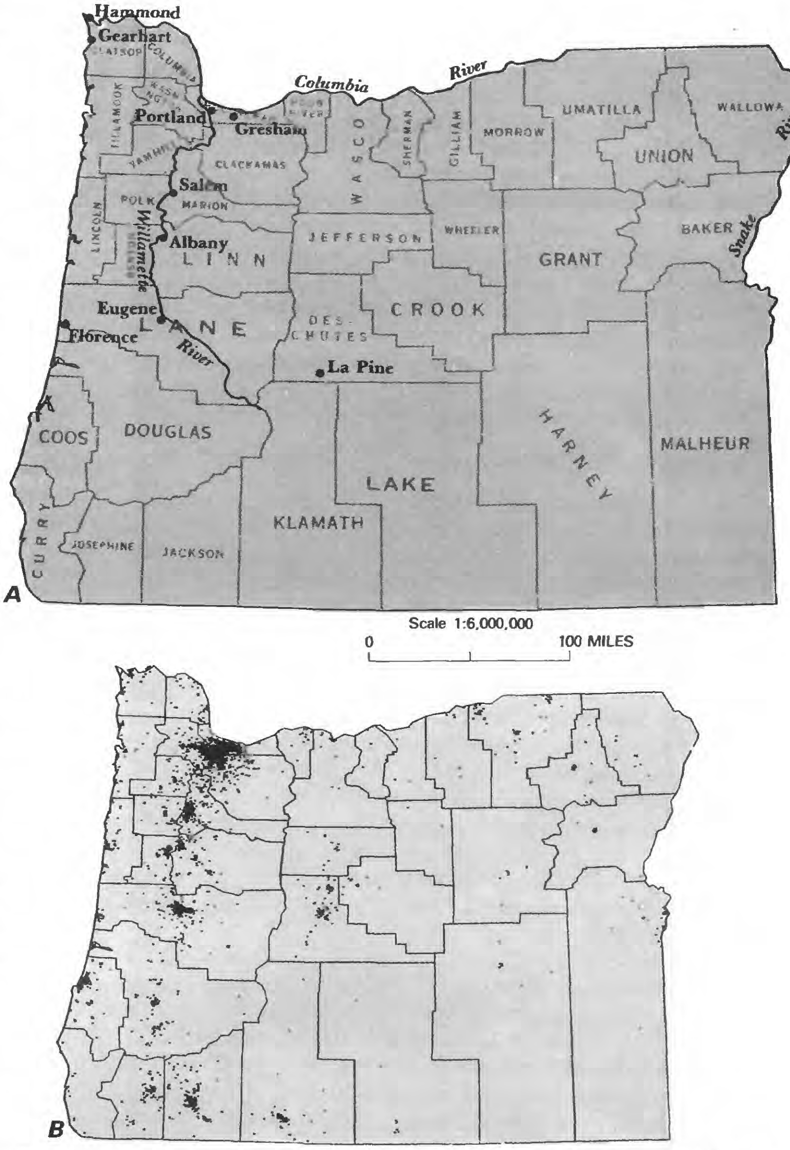

Figure 1. Selected geographic features and 1985 population distribution in Oregon. *A*, Counties, selected cities, and major drainages. *B*, Population distribution, 1985; each dot on the map represents 1,000 people. (Source: *B*, Data from U.S. Bureau of the Census 1980 decennial census files, adjusted to the 1985 U.S. Bureau of the Census data for county populations.)

WATER QUALITY IN PRINCIPAL AQUIFERS

Oregon has three principal aquifer groups, which consist of unconsolidated to consolidated sediments and several types of volcanic and pyroclastic rocks. These aquifer groups (fig. 2*A*, 2*B*) are basin-fill and alluvial deposits, volcanic and sedimentary rocks, and the Columbia River Basalt (U.S. Geological Survey, 1985, p. 357).

The basin-fill and alluvial aquifer group occurs in all parts of the State and consists of unconsolidated to consolidated sediments, alluvium, and coastal dune and beach deposits (U.S. Geological Survey, 1985). The thickness of this aquifer group differs markedly from basin to basin throughout the State. Water from this aquifer group has a median dissolved-solids concentration of 170 mg/L (milligrams per liter), and generally is suitable for most uses.

The volcanic and sedimentary aquifer group consists of a complex assemblage of basalts and andesites, interbedded with clastic sediments. The thickness of this aquifer group probably exceeds several thousand feet (U.S. Geological Survey, 1985). Aquifers of this group are generally developed only in small basins; therefore, little is known about the hydrology of this aquifer group outside the developed basins. Water from this aquifer group has a median dissolved-solids concentration of 160 mg/L and is suitable for most uses.

The Columbia River Basalt aquifer group underlies the north-central and northeastern parts of Oregon. This aquifer group consists of basalt flows interbedded with tuffaceous sediments, together comprising five separate formations. This group may be more than 5,000 feet thick and has been developed as much as 600 feet below land surface, primarily for irrigation (Gonthier, 1985). Water from this aquifer group has a median dissolved-solids concentration of 230 mg/L and generally is suitable for most uses.

Potential sources of contamination to these aquifer groups include elements dissolved from natural sources and human activities. The latter includes intrusion or upwelling of more mineralized waters as a result of overpumping, seepage from landfills and hazardous waste-disposal sites, infiltration of agricultural chemical products including fertilizers, pesticides and herbicides, and subsurface sewage disposal (Miller and Gonthier, 1984).

BACKGROUND WATER QUALITY

A graphic summary of selected water-quality variables compiled from the U.S. Geological Survey's WATSTORE data base is presented in figure 2*C*. The summary is based on dissolved-solids, hardness (as calcium carbonate), nitrate plus nitrite (as nitrogen), chloride, and iron analyses of water samples collected from 1958 to 1986 from the principal aquifers in Oregon. Percentiles of these variables are compared to national standards that specify the maximum concentration or level of a contaminant in a drinking-water supply as established by the U.S. Environmental Protection Agency (1986a,b). The primary maximum contaminant level standards are health related and are legally enforceable. The secondary maximum contaminant level standards apply to esthetic qualities and are recommended guidelines. The primary drinking-water standards include a maximum concentration of 10 mg/L nitrate (as nitrogen), and the secondary drinking-water standards include maximum concentrations of 500 mg/L dissolved solids, 250 mg/L chloride, and 300 μg/L (micrograms per liter) iron.

The summary (fig. 2*C*) illustrates the variability of the chemical quality of water from the three principal aquifer groups. Analytical data for a given aquifer were differentiated from the other aquifers by well location and the aquifer identification provided by Miller and Gonthier (1984) without regard to the possibility of interaquifer mixing of the sampled ground water. The data were further interpreted without distinction as to sampling depth or geographic location within an individual aquifer.

Generally, in the principal aquifer groups of Oregon, larger concentrations of dissolved solids correspond to increases in the water hardness. The median concentrations of hardness for the basin-fill and alluvial, volcanic and sedimentary, and Columbia River Basalt aquifer groups are 63 mg/L, 73 mg/L, and 90 mg/L, respectively; water of these concentrations is soft to moderately hard (U.S. Environmental Protection Agency, 1976, p. 75).

Figure 2*C* shows larger nitrate-plus-nitrite concentrations and wider ranges in the basin-fill and alluvial and the Columbia River Basalt aquifer groups than in the volcanic and sedimentary aquifer group. Median nitrate-plus-nitrite concentrations in the basin-fill and alluvial and the Columbia River Basalt aquifer groups are 0.34 mg/L, and in the volcanic and sedimentary aquifer group is 0.1 mg/L. The basin-fill and alluvial aquifer group occurs primarily in densely populated areas of the Willamette River valley, and the Columbia River Basalt aquifer group occurs in the agricultural area of the northeast part of the State. Specific areas of large nitrate concentrations occur in western Clatsop County near Hammond, in eastern Multnomah County near Gresham, in southern Deschutes County near La Pine, in Lane County north of Eugene, in west Lane County along the coast near Florence, in Malheur County near Ontario, in Umatilla County near Hermiston, in Morrow County near Boardman, and in Marion County near Salem (Oregon Department of Environmental Quality, 1980).

Chloride concentrations throughout the three principal aquifer groups do not exceed the national standard for drinking water (250 mg/L), with median concentrations of 9.7 mg/L, 2.5 mg/L, and 9.4 mg/L in the basin-fill and alluvial, volcanic and sedimentary, and Columbia River Basalt aquifer groups, respectively. Exceptions to the small concentrations are the 3,100 and 990 mg/L maximums measured in the basin-fill and alluvial and the volcanic and sedimentary aquifer groups, respectively. These large concentrations may indicate the intrusion of more saline waters from sources such as seawater or from underlying aquifers during periods of maximum withdrawals from the affected aquifer groups.

The median iron concentrations in the basin-fill and alluvial, volcanic and sedimentary, and Columbia River Basalt aquifer groups are 109, 40, and 29 μg/L, respectively. These median concentrations do not exceed the national drinking-water standard (300 μg/L). The 75th and 90th percentiles for the basin-fill and alluvial aquifer group are, however, 1,200 and 2,400 μg/L, respectively, indicating large iron concentrations within this aquifer. In particular, some iron concentrations are as large as 16,000 μg/L in the basin-fill and alluvial aquifer group near Coos Bay in western Coos County.

EFFECTS OF LAND USE ON WATER QUALITY

The chemical quality of ground water has been altered by human activities and land-use practices in localized areas in Oregon. These activities and practices include silviculture, various types of construction, mining, industrialization, urbanization, disposal of various types of wastes, irrigation, and application of agricultural chemicals (Miller and Gonthier, 1984).

Industry

Twenty-eight industrial sites have been identified where localized ground-water contamination is suspected or has been detected (fig. 3*A*). Industrial activities that contribute to this contamination include chemical manufacturing, metals plating, wood treatment, oil and gas storage and refueling, electronics, food processing, aluminum plants, and pulp and paper plants. Fifteen of these industrial sites are included in the RCRA and CERCLA classifications. Potential contaminants resulting from some of these industrial activities include organic chemicals, dissolved metals, nitrates, cyanide, and excessive dissolved solids.

Specific examples of industrial contamination problems in Oregon are increased turbidity in wells near a sand and gravel operation in the vicinity of Milton-Freewater in Umatilla County; oil in domestic wells near a railroad refueling facility in La Grande, Union County; and contamination of domestic wells by leachates seeping from a wood-products disposal pit in Turner, Marion County (Miller and Gonthier, 1984). Additionally, the DEQ has identified nitrate contamination near several potato and sugar-beet processing operations, increased levels of trichloroethylene and other volatile solvents in eastern Multnomah County and Washington County, chromium contamination at Corvallis in Benton County, and pentachlorophenol contamination at Hillsboro in Washington County.

Agriculture and Irrigation

The economy of Oregon depends largely on agriculture; the possibility exists, therefore, that additional ground-water contamination will occur, either directly or indirectly, from an agricultural practice. Some examples of these agricultural practices include excessive application of chemicals to croplands, poor irrigation practices, and overpumping of irrigation wells.

Figure 3*B* identifies the locations of sites in Oregon where ground water has become contaminated as a result of agricultural practices. In general, contamination at these sites has resulted from the leaching of chemicals and other dissolved substances into the ground water and the decrease of natural dilution and attenuation. Specific examples of agricultural-related ground-water contamination problems in Oregon include (1) large nitrate concentrations in localized areas of the Willamette River valley west of the Cascade Mountains and the Ontario area of Malheur County; and (2) contamination by pesticides such as ethylene dibromide in the Willamette River Valley, and dachthal and telone in the Ontario area of Malheur County.

Waste Disposal

Disposal of manufactured wastes is a major problem for all industrialized nations. In addition to industrial wastes, other waste categories of importance in Oregon are solid waste, onsite sewage, and municipal sewage.

The DEQ has identified 24 landfill sites (fig. 3*C*) where seepage through buried refuse has resulted in ground-water contamination. Typically the contaminating leachate contains large concentrations of ammonia, nitrate, chloride, sulfate, iron, manganese, and organic matter.

Onsite disposal of domestic sewage through septic tanks and cesspools takes advantage of the natural ability of the soils to cleanse the sewage by filtration and microbial activity. The DEQ has conducted studies at various locations in the State where the septic system density has rendered the soils inadequate to clean the sewage or where the ground water has become contaminated from effluents. Contaminants from onsite sewage disposal consist primarily of nitrate, chloride, organic solvents (such as trichloroethylene or TCE), and bacteria. These contaminants have been detected in the following areas of Oregon: Clatsop Plains along the north coast from Gearhart to Hammond, near La Pine, in mid-east Multnomah County between Gresham and Portland, near Florence, in the Santa Clara River Road area west of Eugene, and in North Albany.

Municipal sewage-treatment facilities are another potential source of ground-water contamination. These facilities typically incorporate sewage lagoons, sludge drying beds, and sludge disposal as part of the treatment process. Monitoring of municipal sewage-treatment facilities and disposal practices by the DEQ has been limited. However, where ground-water quality has been monitored, nitrate and bacterial contamination has been detected in the ground water near lagoons and sludge disposal areas.

POTENTIAL FOR WATER-QUALITY CHANGES

Presently (1986), ground water in Oregon generally is unpolluted and is suitable for most uses; however, contamination may exist and yet be undetected in many areas. If existing areas of contamination are allowed to remain unchecked, the indiscriminate use of chemical contaminants and the uncontrolled disposal of waste products could pose the greatest threat to Oregon's ground-water resources.

The quality of ground water in Oregon can be protected for the future by assessing the resource, preventing contamination, and planning necessary strategies, as outlined here by the DEQ:

"Assessment–The characteristics and extent of the resource must be known to adequately evaluate the effects of contamination. That is, the ground-water flow characteristics, the types and characteristics of the contaminants present, and the distribution of the contaminant within the aquifer must be known.

Prevention–Because of the difficult nature of aquifer cleanup and the present state-of-the-art ability to detect pollution problems, the initial contamination of the ground water must be prevented if at all possible.

Planning–All Federal, State, and local governmental agencies responsible for the regulation of ground-water quality must work in a coordinated effort to ensure the protection of the resource."

GROUND WATER-QUALITY MANAGEMENT

Ground-water quality in Oregon is the responsibility of the DEQ, whereas ground-water quantity is the responsibility of the Oregon Water Resources Department. Local governments also have participated in developing ground-water-quality protection plans, chiefly for certain aquifers. The EPA, with the cooperation of the DEQ, implements several ground-water-quality programs in Oregon.

The Federal Safe Drinking Water Act contains three programs concerning ground-water quality. In Oregon, primary responsibility for these three programs is divided among three different agencies.

(1) The Health Division of the Oregon Department of Human Services has primary responsibility for the Public Water System Supervision Program. Under this program the Health Division provides technical assistance and regulatory oversight of public water supplies. Included are the assessment and review of required water-quality analyses. When ground-water contamination is detected, the Health Division works cooperatively with the DEQ in risk assessment and public notification.

(2) The DEQ has primary responsibility of the Underground Injection Control (UIC) program. Oregon UIC rules prohibit the use of injection wells for hazardous-waste disposal and for in-situ mining.

(3) The EPA implements the Sole Source Aquifer Program. The Florence Dunal Aquifer, within the basin-fill and alluvial aquifer (1) group, has been proposed for designation as a Sole Source Aquifer under this program.

Both CERCLA and the Toxic Substances Control Act are non-delegated Federal programs. Those two Federal programs are administered by the DEQ under a cooperative agreement with the EPA.

On behalf of the EPA, the DEQ implements both Hazardous and Solid Waste Programs of RCRA. Extensive site investigations required under these programs include: hydrologic investigations, ground-water-quality monitoring, risk assessments, geologic studies and, where necessary, remedial action. In 1985, the department received enabling legislation for the development of a State underground storage tank (UST) regulatory program. More recently, the department received a grant from the EPA to assist in the development of a UST program.

Water-quality programs included in the Federal Clean Water Act are implemented by the EPA through the DEQ. Federal support for the development of State ground-water-quality protection programs comes from Sections 106 and 205J of the Clean Water Act.

The DEQ is responsible for establishing and enforcing rules designed to prevent contamination of Oregon's ground-water resources. The department's ground-water protection practices are guided by the Oregon Ground-Water Protection Policy (Administrative Rule 340-41-029). This policy, which was adopted by the Oregon Environmental Quality Commission in August 1981, provides an overall strategy for protecting ground-water quality. Since its adoption, the policy has been the foundation of the State's ground-water-quality protection efforts.

The Ground-Water Protection Policy establishes antidegradation as the prime objective; this policy protects the natural quality from impairment that could affect the present and future beneficial use of ground water. The policy does not discriminate—that is, protection applies equally to all ground waters of the State. However, sensitive aquifers are identified so that priorities can be assigned to ground-water quality protection efforts. The policy contains three sections: (1) general policies, (2) source control policies, and (3) problem abatement policies. The best practical treatment and control are required to minimize potential pollutant loading to ground water. The policy is implemented through permit programs for facilities responsible for hazardous waste, solid waste, underground injection control, onsite sewage disposal, and water pollution control. Waste discharges to ground water are not allowed. Nonpoint-source pollution is minimized through the use of best management practices.

Under the statewide land-use planning law, cities and counties in Oregon must develop and adopt comprehensive land-use plans to comply with State land-use planning goals. The DEQ has a statutorily mandated memorandum of understanding with the Oregon Land Conservation and Development Commission, which requires that all land-use plans comply with agency water-quality management plans, rules, and laws before approval.

The DEQ conducts ground-water-quality monitoring, which focuses on the identification and quantification of known or suspected ground-water-quality problems. Additionally, industrial waste disposers are regulated by permit and audited by the Department.

During 1986, the DEQ formed a citizen advisory committee to review the need for changes in the Ground-Water Quality Protection Policy. Changes considered by the committee include additional ground-water-quality standards, and aquifer classification system, more specific policy-implementation instructions, and more stringent nonpoint-source pollution control. The Department also publishes ground-water-quality information for public distribution and presents information to groups interested in various ground-water-quality protection programs.

Recent ground-water-quality monitoring by the DEQ has identified numerous occurrences of contamination in Oregon, including the presence of organic and toxic substances in ground water. These discoveries have led to demands for sampling and analyses that exceed current fiscal resources. General information is available for many of the aquifers of the State, but detailed information is lacking, particularly with regard to natural background and variability of ground-water quality. The Department has entered into a long-term project with the Oregon Water Resources Department to characterize the natural water quality of the aquifers of the State. This study will include analyses for organic and toxic substances. Because of limited fiscal resources, this study will focus on only a few selected aquifers. However, a more comprehensive, statewide, monitoring network for ambient ground-water quality is needed.

SELECTED REFERENCES

Gonthier, J.B., 1985, A description of aquifer units in eastern Oregon: U.S. Geological Survey Water-Resources Investigations Report 84-4095, 39 p.

McFarland, W.D., 1983, A description of aquifer units in western Oregon: U.S. Geological Survey Open-File Report 82-165, 35 p.

Miller, T.L., and Gonthier, J.B., 1984, Oregon ground-water quality and its relation to hydrogeologic factors—A statistical approach: U.S. Geological Survey Water-Resources Investigations Report 84-4242, 88 p.

Oregon Department of Environmental Quality, 1980, Assessment of Oregon's water-quality and water pollution control program: p. 324-339.

U.S. Environmental Protection Agency, 1976, Quality criteria for water: 256 p.

_____ 1986a, Maximum contaminant levels (subpart B of part 141, National interim primary drinking-water regulations): U.S. Code of Federal Regulations, Title 40, Parts 100 to 149, revised as of July 1, 1986, p. 524-528.

_____ 1986b, Secondary maximum maximum contaminant levels (section 143.3 of part 143, National secondary drinking-water regulations): U.S. Code of Federal Regulations, Title 40, parts 100 to 149, revised as of July 1, 1986, p. 587-590.

_____ 1986c, Amendment to National Oil and Hazardous Substances Contingency Plan; national priorities list, final rule and proposed rule: Federal Register, v. 51, no. 111, June 10, 1986, p. 21053-21112.

U.S. Geological Survey, 1985, National water summary 1984—Oregon ground-water resources: U.S. Geological Survey Water-Supply Paper 2275, p. 355-360.

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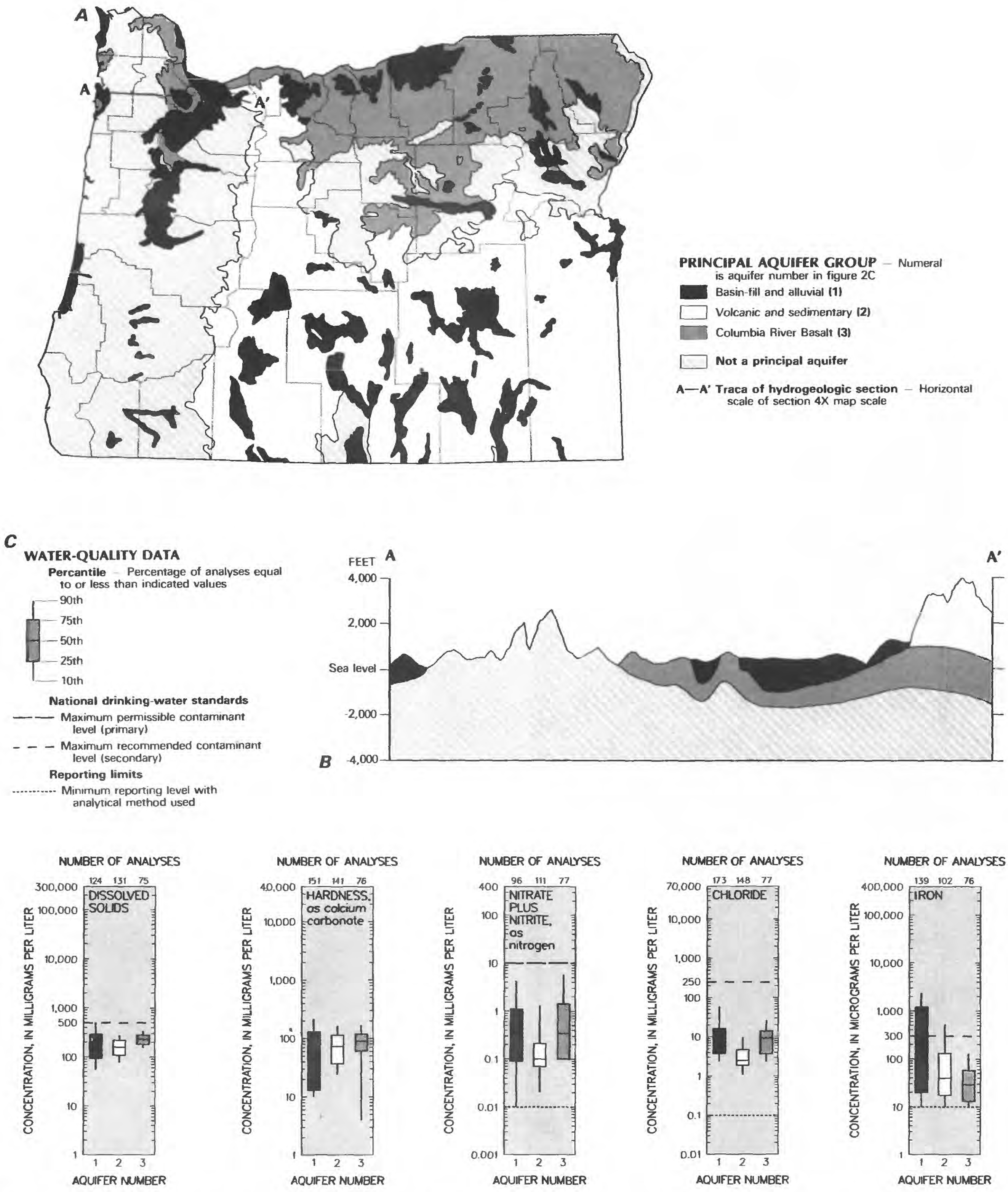

Figure 2. **Principal aquifers and related water-quality data in Oregon.** *A* Principal aquifers. *B*, Generalized hydrogeologic section. *C*, Selected water-quality constituents and properties, as of 1958-86. (Sources: *A*, U.S. Geological Survey, 1985. *B*, McFarland, 1982. *C*, Analyses compiled from U.S. Geological Survey files; national drinking-water standards from U.S. Environmental Protection Agency, 1986 a, b.)

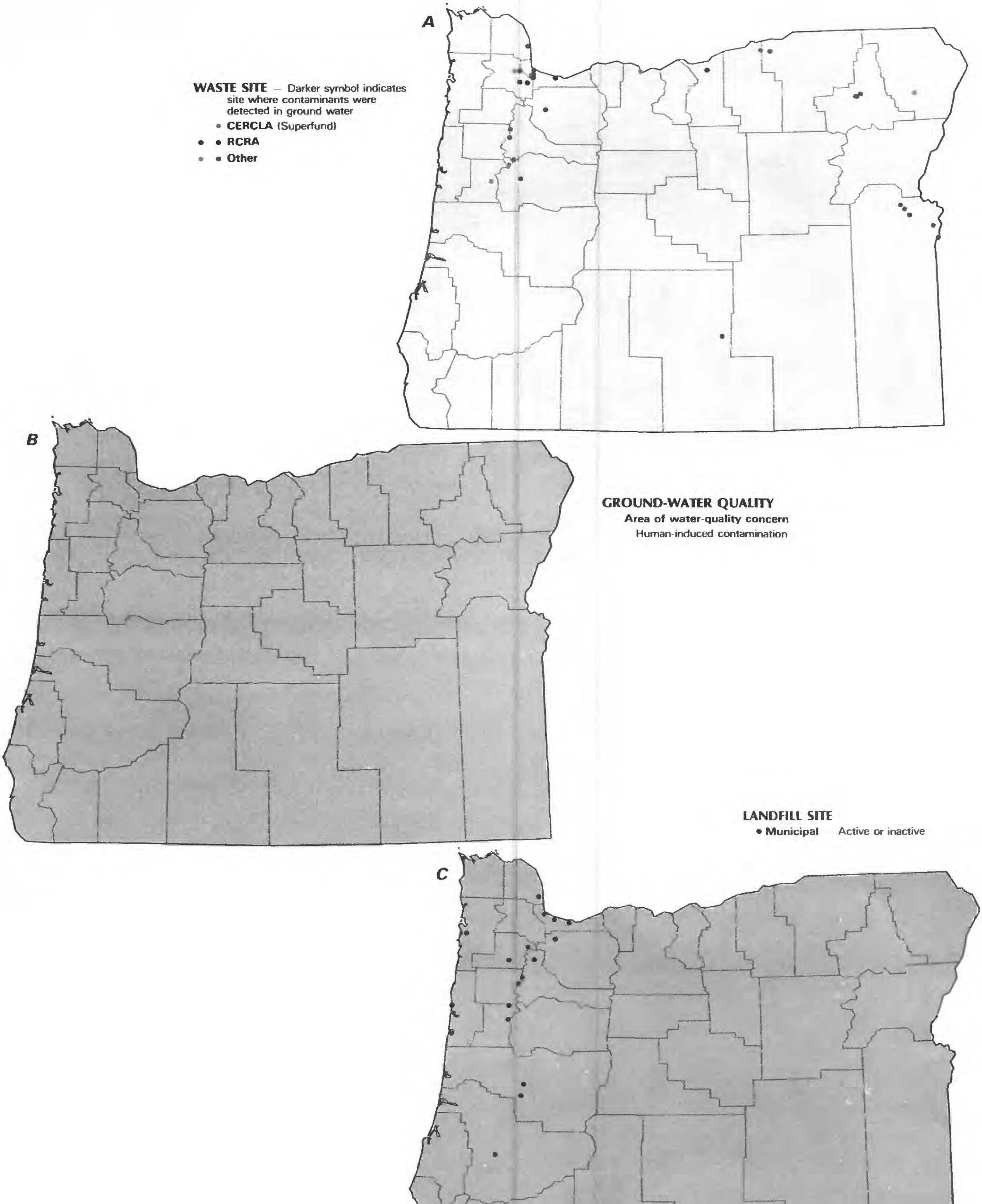

Figure 3. Selected waste sites and ground-water-quality information in Oregon. *A*, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites; Resource Conservation and Recovery Act (RCRA) sites; and other selected waste sites, as of August 1986. *B*, Areas of human-induced contamination, as of August 1986. *C*, Municipal landfills, as of August 1986. (Source: Oregon Department of Environmental Quality.)