DEQ Water Quality and Laboratory Divisions

State of Oregon Department of Environmental Quality

GROUNDWATER QUALITY REPORT FOR THE WILLAMETTE BASIN, OREGON

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EXECUTIVE SUMMARY

Preventing groundwater contamination and conserving and restoring this resource are statewide goals in Oregon. Groundwater monitoring and assessment programs provide statewide groundwater quality information. Oregon's Willamette Basin includes one of the major river and watershed systems in the state, as well as significant groundwater aquifers. The groundwater is an important natural resource in the basin, providing drinking water to over 1,700 public water systems and over 100,000 private residential systems.

The following elements comprise this report:

- basinwide groundwater resource background information,
- groundwater quality information, compiled from 17 studies conducted in the basin,
- data summaries,
- sampling results,
- related reports and data access information,
- current groundwater use information,
- identification of potential pollutant sources in the basin,
- overall basinwide groundwater quality status evaluation,
- conclusions and recommendations.

Willamette Basin groundwater quality studies have shown impacts from several pollutants, including nitrate, bacteria, pesticides, and volatile organic compounds. Nitrate in groundwater is widespread on both a regional scale and in localized areas. Elevated nitrate levels occur in the Southern Willamette Valley south of Albany, and in localized areas near north Salem, Albany, and Canby. Bacteria are found in groundwater throughout the basin and in local areas around Scio and North Albany. Pesticides at low levels are found in about one third of the wells sampled in a regional study, and in almost 70% of the wells sampled in the Southern Willamette Valley. Volatile organic compounds in the groundwater has led to removing four public water supply systems from use. Elevated groundwater arsenic levels occur in parts of Lane County, Linn County, and the Tualatin Basin.

Groundwater contaminant sources may be point sources or non-point sources. Many potential point and non-point sources exist in the Willamette Basin.

Southern Willamette Valley groundwater nitrate levels and occurrence warrant action to protect and restore the groundwater resource. Local areas where nitrate and bacteria have been found warrant further investigation and monitoring. More information is needed throughout the basin on groundwater pesticide levels and extent. Areas containing volatile organic compounds in the groundwater, with no identified point sources, warrant additional investigation and action. Groundwater quality information is unavailable for many areas in the basin. These areas should receive groundwater monitoring and assessment.

INTRODUCTION

In 1989, the Oregon Legislative Assembly passed a comprehensive set of laws known as the Groundwater Protection Act. These laws established the state goal to prevent groundwater contamination:

> "... it is the goal of the people of the State of Oregon to prevent contamination of Oregon's groundwater resource while striving to conserve and restore this resource and to maintain the high quality of Oregon's groundwater resource for present and future uses." (Oregon Revised Statutes 468B.155)

The Department of Environmental Quality (DEQ), the Water Resources Department, and Oregon State University are directed to:

> "… conduct an ongoing statewide monitoring and assessment program of the quality of the groundwater resource of this state." (Oregon Revised Statutes 468B.190)

Other state agencies, including the Department of Human Services, and local agencies, also conduct groundwater monitoring and assessment programs.

This report compiles groundwater quality data for the Willamette Basin (Figure 1) from the Oregon Department of Environmental Quality and other state and federal agency studies. The report presents information in summary format, provides references to other reports when available, links to data repositories or on-line information and data sources, and updates the status of local Willamette Basin studies.

Figure 1: Location of the Willamette Basin, Oregon

Source: Oregon State Service Center for Geographic Information Systems.

The report presents background information on the Willamette Basin's environmental setting, and general information about geology and hydrogeology. The report presents groundwater use information, and highlights potential pollutant sources in the basin.

Finally, the report evaluates the Willamette Basin's overall groundwater quality status, and recommends potential actions that could be taken.

ENVIRONMENTAL SETTING

Geography

The Willamette Basin is a 12,000 square mile area in northwestern Oregon (Figure 1). The Willamette and Sandy Rivers drain the basin. The Oregon Water Resources Department (WRD) (Water Resources Department Map No. 2.6) defines the Willamette Basin for water management purposes by. The Willamette Basin is one of the 18 major river drainage basins in the state. The Sandy Basin (WRD Map No. 3.6 or 2C.6) is a smaller basin at the Willamette Basin's northern end. In this report, the Sandy Basin is included as part of the Willamette Basin.

The Willamette Basin is roughly oval in shape, with the long axis oriented north-south. The basin occupies a trough between the Coast Range on the west, the Cascade Range on the east, the Umpqua Basin divide on the south, and the Columbia River on the north. The basin includes all or portions of the following ten counties: Columbia, Washington, Multnomah, Yamhill, Clackamas, Polk, Marion, Benton, Linn, and Lane. Figure 2 shows the Willamette Basin's main geographic features.

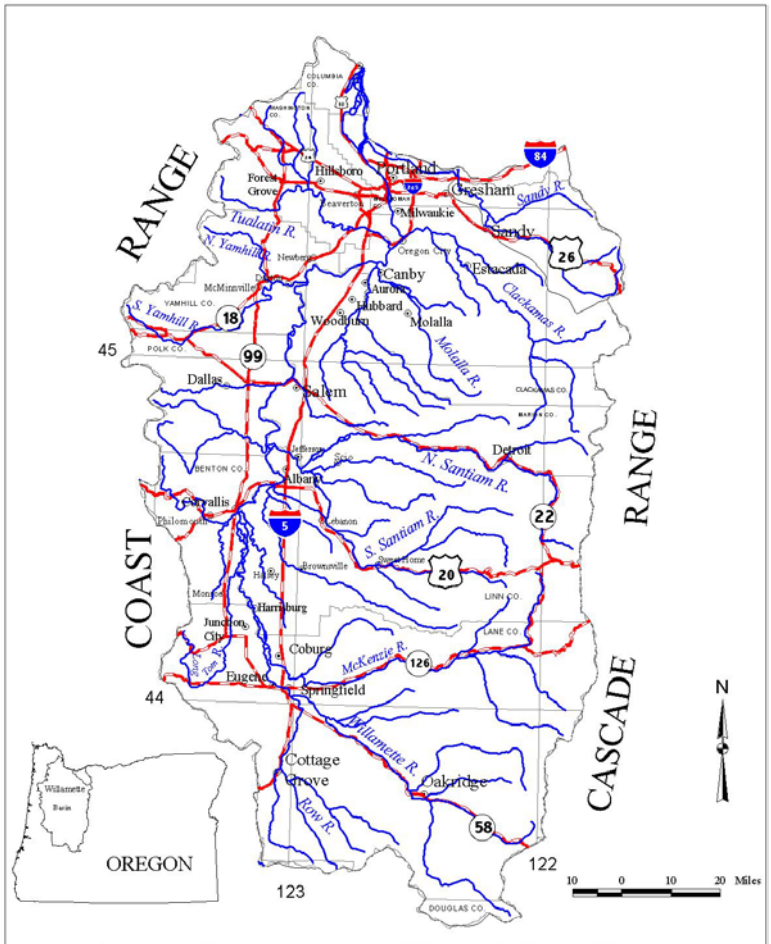

Figure 2. Geography of the Willamette Basin, Oregon.
Source: Oregon State Service Center for Geographic Information Systems.

Land Use and Population

Land uses in the Willamette Basin include forest, agriculture, and urban (Figure 3) (Pacific Northwest Ecosystem Consortium, 2003). About 70% of the basin is forest land, while about 22% of the land area, primarily in the Willamette River Valley, is used for agriculture (Hinkle, 1997). About 6% of the total basin area is urban land. The three largest cities in Oregon (Portland, Salem, and Eugene) are located in the Willamette Basin, and nearly 70% of the state's residents live within the basin (Population Research Center, 2003).

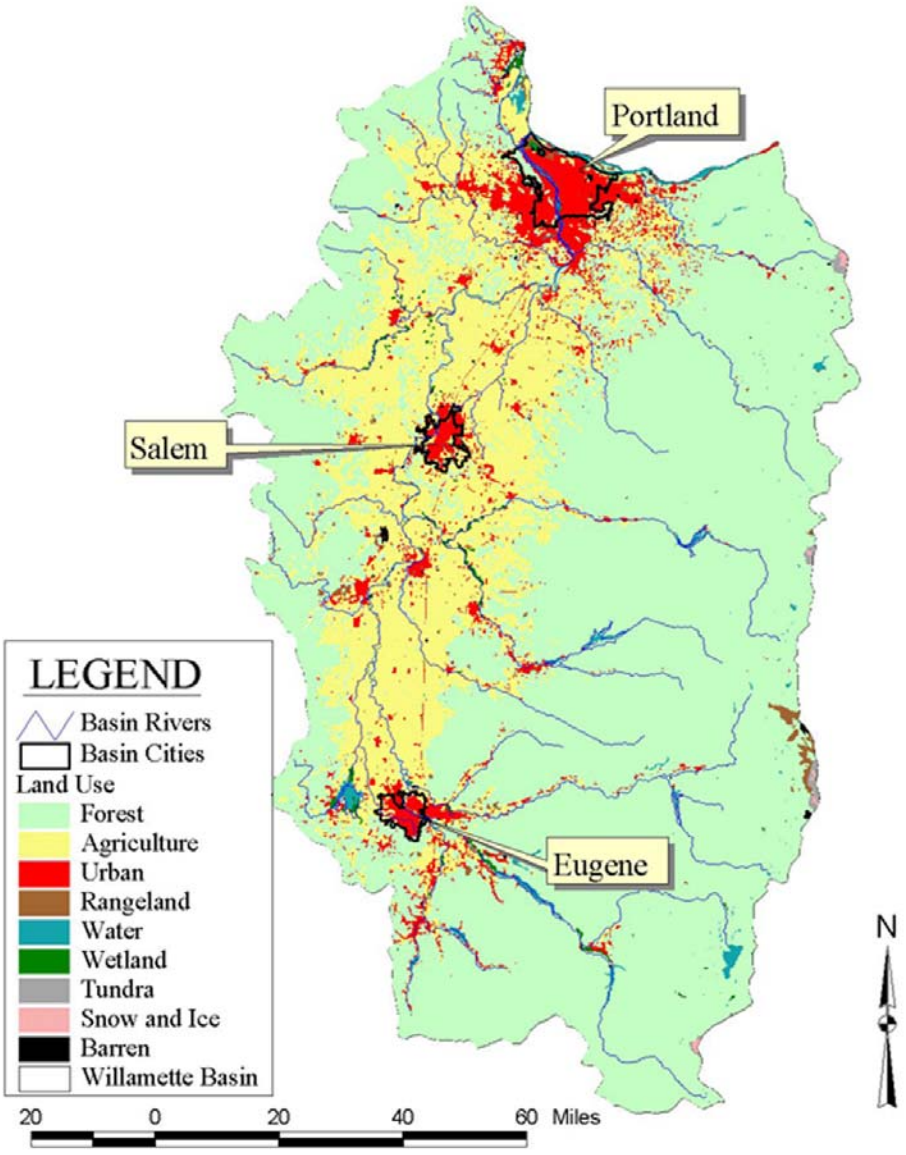

Figure 3: Land Use in the Willamette Basin, Oregon

Source: Oregon State Service Center for Geographic Information Systems; Pacific Northwest Ecosystem Research Consortium.

Climate and Precipitation

The climate in the Willamette Basin is generally mild and wet. Temperatures in the Willamette River Valley range from average lows of 32 degrees F to highs around 80 degrees F. The basin margins have slightly lower winter temperatures. The average annual precipitation in the valley is about 40 inches, with averages up to 85 inches annually along the basin margins (Figure 4) (Oregon Climate Service, 2003).

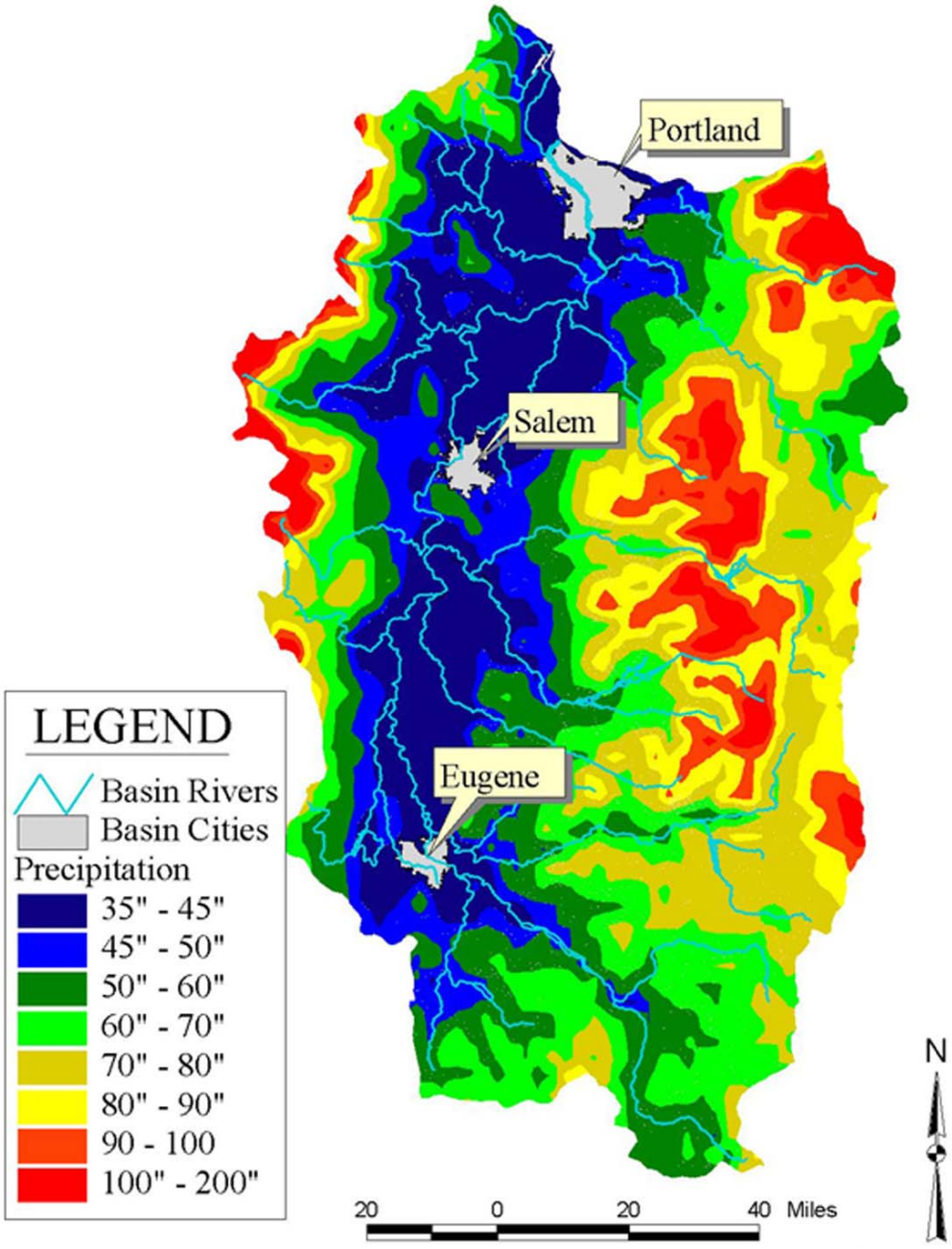

Figure 4: Annual Precipitation in the Willamette Basin, Oregon

Source: Oregon State Service Center for Geographic Information Systems.

Geology and Hydrogeology

A variety of rock types are present in the Willamette Basin (Figure 5). The Coast Range on the basin's west side consists predominantly of marine sedimentary rock such as sandstone, siltstone, and mudstone (Conlan, 2003). The Cascade Range on the basin's east side consists of numerous lava flows and volcanic sediments. During the early stages of basin development, basalt flows accumulated in the northern two-thirds of the basin. Tectonic forces folded and faulted the basalt into a series of uplands separating the valley into four smaller sub-basins. Alluvial sediments including unconsolidated and semiconsolidated clay, silt, sand, and gravel have accumulated in the sub-basins. Recent young alluvium (<10,000 years old) is present along the Willamette River and tributaries to depths of less than 60 feet. Older deposits of alluvium can be up to 1500 feet deep. A significant unit at the top of the older alluvium sequence is the Willamette Silt, consisting primarily silt and clay. The Willamette Silt is present in the basin's northern part to thicknesses of about 120 feet, but thins to zero in the southern end of the Willamette Valley near Eugene (Hinkle, 1997).

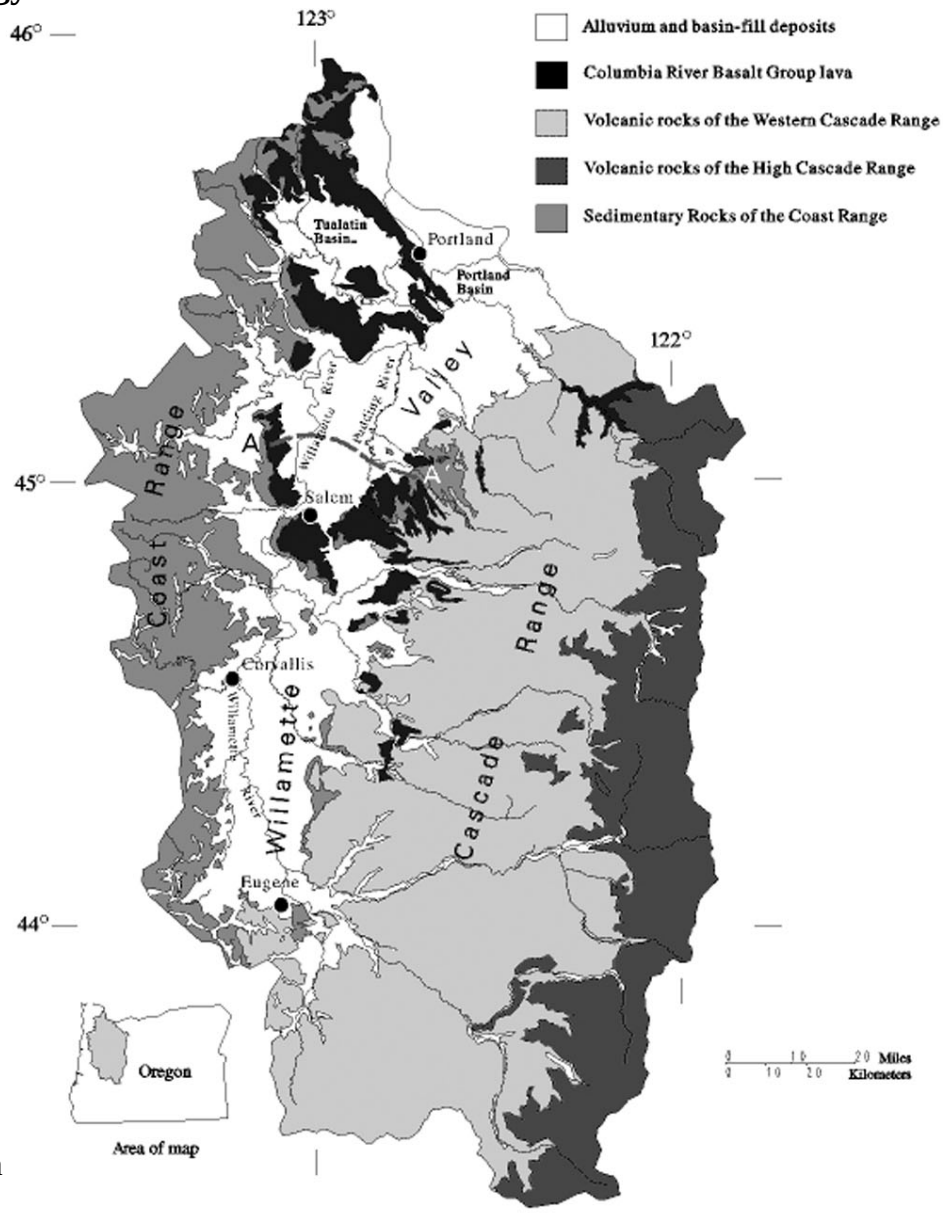

Figure 5: Generalized Geology of the Willamette Basin, Oregon
Sources: USGS and OWRD, 1997

The main groundwater aquifers in the Willamette Basin occur in the alluvial sediment and basalt geologic units (Conlan, 2003; Oregon Water Resources Department, 2003). Figure 6 is a map of the principal hydrogeologic units in the Willamette Basin, and shows areas of groundwater quality concern.

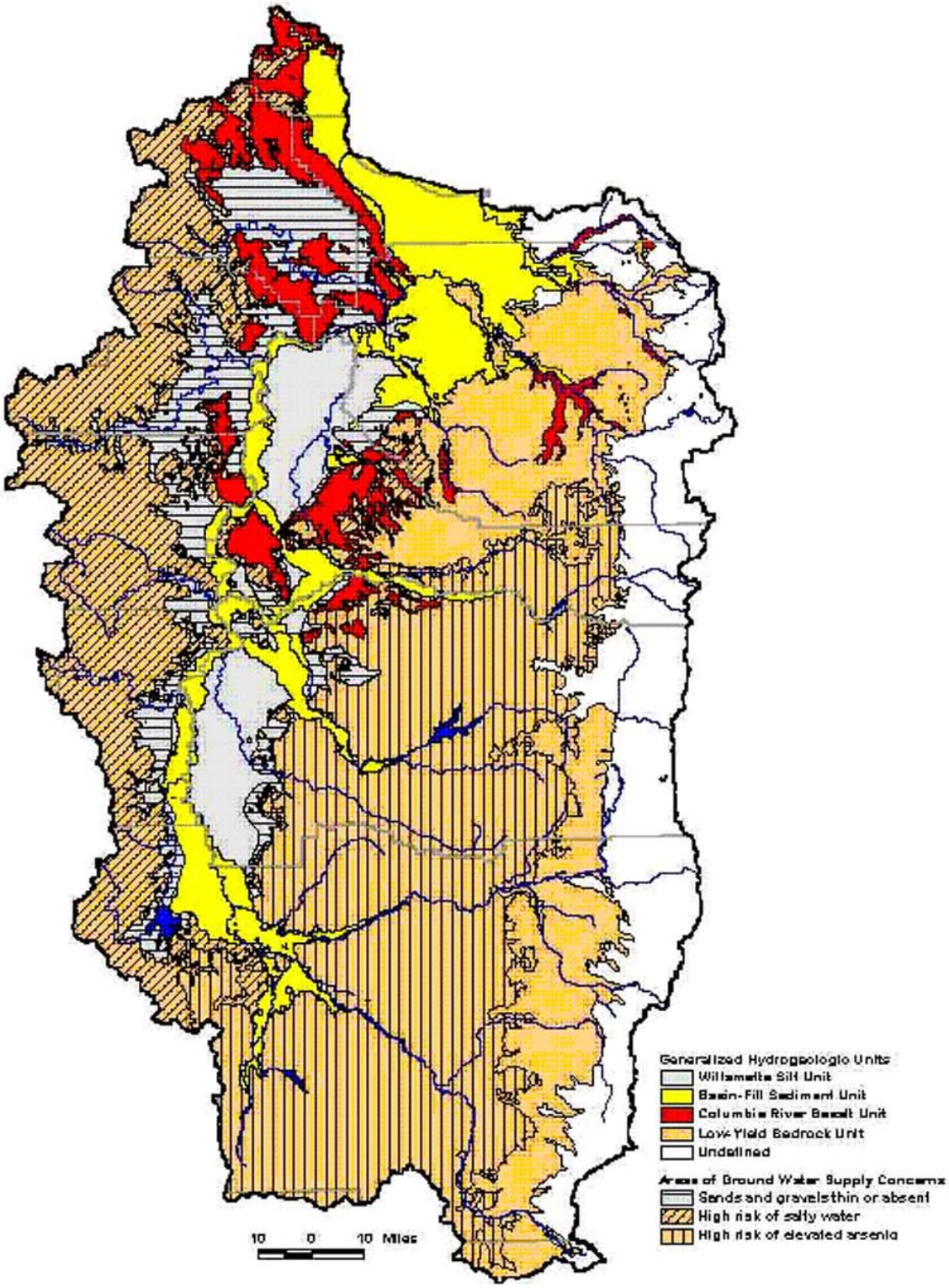

Figure 6: Generalized Hydrogeologic Units in the Willamette Basin, Oregon
Source: Oregon Water Resources Department

GROUNDWATER USE

Overview

The Oregon Water Resources Department (OWRD) manages statewide groundwater use through water right applications, permits, certificates, transfers, and leases. Groundwater in the Willamette Basin is available for such beneficial uses as domestic, livestock, irrigation, municipal, industrial, agricultural, commercial, power, mining, recreation, fish life, wildlife, pollution abatement, wetland enhancement, and statutorily exempt groundwater usage (OAR 690-502-0160). Exempt uses do not require any registration, permit, or groundwater right. Exempt uses include: domestic use under 15,000 gallons a day, stock watering, small lawn or garden watering, school grounds watering, down-hole heat exchange, industrial or commercial uses of less than 5,000 gallons a day, and land application under certain circumstances (ORS 537.545). Groundwater use in the Willamette Basin is discussed in more detail below. Water right information can be accessed through the OWRD website at http://www.wrd.state.or.us/waterrights/wris.shtml

Groundwater Rights

The Willamette Basin has 11,108 recorded groundwater rights for uses requiring permits or water rights. The recorded uses include campground, fish culture, fish and wildlife, irrigation, manufacturing, municipal, stock, and wildlife.

Public Water Systems

The Willamette Basin has over 1,765 groundwater-based Public Water Supply Systems (Figure 7). These systems use either groundwater exclusively, or a combination of groundwater and surface water, to supply various public uses, including municipal drinking water. Water quality information for individual systems is available through the Oregon Department of Human Services Drinking Water Program (http://www.ohd.hr.state.or.us/dwp/about.cfm) and can be accessed on-line (http://170.104.158.16/).

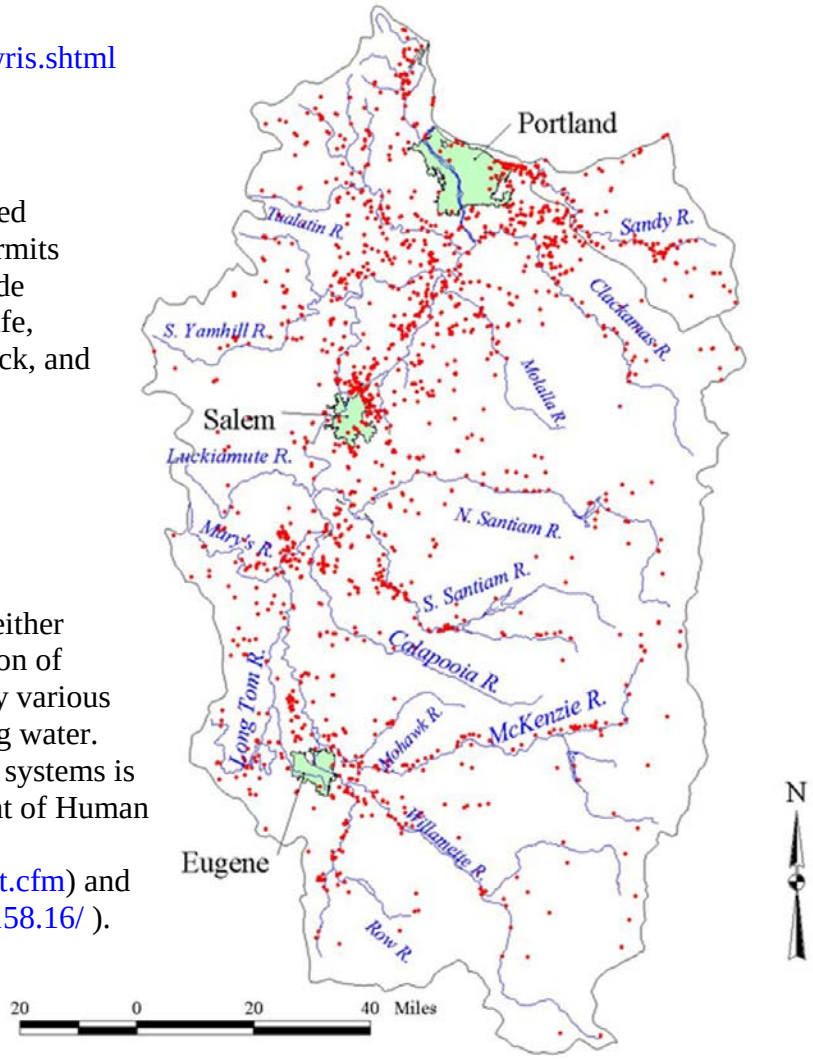

Figure 7: Public Water Systems Using Groundwater in the Willamette Basin, Oregon

Source: Department of Human Services Drinking Water Program data.

Domestic and Other Exempt Uses

No permit is required to use groundwater for domestic purposes. No records are available on the amount of groundwater used to provide drinking water to households in the Willamette Basin. The number of private, domestic water wells constructed and reported to OWRD estimates how many potential domestic water users exist. Current statutes (ORS 537.765), and administrative rules (OAR 690-205-0210), require well drillers and well owners to file well logs with OWRD upon well completion.

The OWRD database (http://www.wrd.state.or.us/groundwater/index.shtml) contains 100,422 domestic water well logs on file for the Willamette Basin. The number of water wells in the basin is probably higher since, prior to 1955, state law did not require water well owners to file well logs for wells drilled and completed on their property (T. Eichenlaub, OWRD, oral communication to Dave Cole, DEQ, 8/11/03).

GROUNDWATER QUALITY STUDIES

Overview

DEQ and other local, state, and federal agencies have conducted groundwater quality studies in the Willamette Basin. The scope of these studies range from surveying local awareness of groundwater quality, to national scale, statistically-designed groundwater quality investigations.

The Groundwater Protection Act mandates DEQ and other state agencies to conduct ongoing statewide groundwater quality monitoring and assessment (ORS 468B.190). Statewide and regional assessments conducted in the 1980s provided initial information on groundwater quality. DEQ and other agencies have conducted additional assessments on a local scale, in response to specific concerns, or information from public water system monitoring. In 1993, DEQ and other agencies systematically reviewed available information about known or suspected groundwater contamination and areas susceptible to contamination. This work led to DEQ's Master Plan for a statewide groundwater monitoring program (Cole and Pollock, 1993). The Plan identified and prioritized several Willamette Basin areas, and through the 1990s DEQ conducted studies in these areas. These areas included Canby and Woodburn in the northern Willamette Basin, and Albany/Lebanon, Junction City, and Coburg in the southern Willamette Basin.

The U.S. Geological Survey (USGS) has evaluated conditions in the Willamette Basin as part of the National Water-Quality Assessment Program (NAWQA). The NAWQA Program studies water quality status and trends in large portions of the water resource (Hinkle, 1997; Wentz and others, 1998). The Oregon Water Resources Department and the USGS have been conducting a cooperative, multi-phase study of the Willamette Basin's water resources. The studies have included analysis of groundwater quality, groundwater flow, and other basin hydrogeological aspects (Orzol and others, 2000).

Study Summaries and Results

The studies summarized in this report are listed below in order of basinwide studies, studies in the northern basin, and studies in the southern basin, including Albany and south (Figure 8).

Basinwide Studies

1988 Assessment of Oregon's Groundwater for Agricultural Chemicals; Oregon Department of Environmental Quality.

National Water-Quality Assessment Program: Quality of Shallow Groundwater in Alluvial Aquifers of the Willamette Basin, Oregon, 1993-95; U.S. Geological Survey.

Willamette Basin Groundwater Study; U.S. Geological Survey and Oregon Water Resources Department.

Domestic Well Testing for Real Estate Transactions; Oregon Department of Human Services.

Northern Willamette Basin Studies

Mid and East Multnomah County Groundwater Study (1984-1997); Oregon Department of Environmental Quality.

Boring Groundwater Study (1986-1989); Oregon Department of Environmental Quality.

Scio Groundwater Study (1987); Oregon Department of Environmental Quality.

Milwaukie Groundwater Study (1988, 1989, 1993, 1994); Oregon Department of Environmental Quality.

Lakewood Estates Groundwater Study (1991-1996); Oregon Department of Environmental Quality.

Canby Groundwater Study (1993); Oregon Department of Environmental Quality.

Woodburn Groundwater Study (1993); Oregon Department of Environmental Quality.

Southern Willamette Basin Studies

North Albany Groundwater Study (1985-1986); Oregon Department of Environmental Quality.

Junction City Groundwater Study (1993); Oregon Department of Environmental Quality.

Albany/Lebanon Groundwater Study (1993); Oregon Department of Environmental Quality.

Coburg Groundwater Study (1994); Oregon Department of Environmental Quality.

Sweet Home Groundwater Study (1994-2003); Oregon Department of Environmental Quality.

Southern Willamette Valley Groundwater Study (2000-2002); Oregon Department of Environmental Quality.

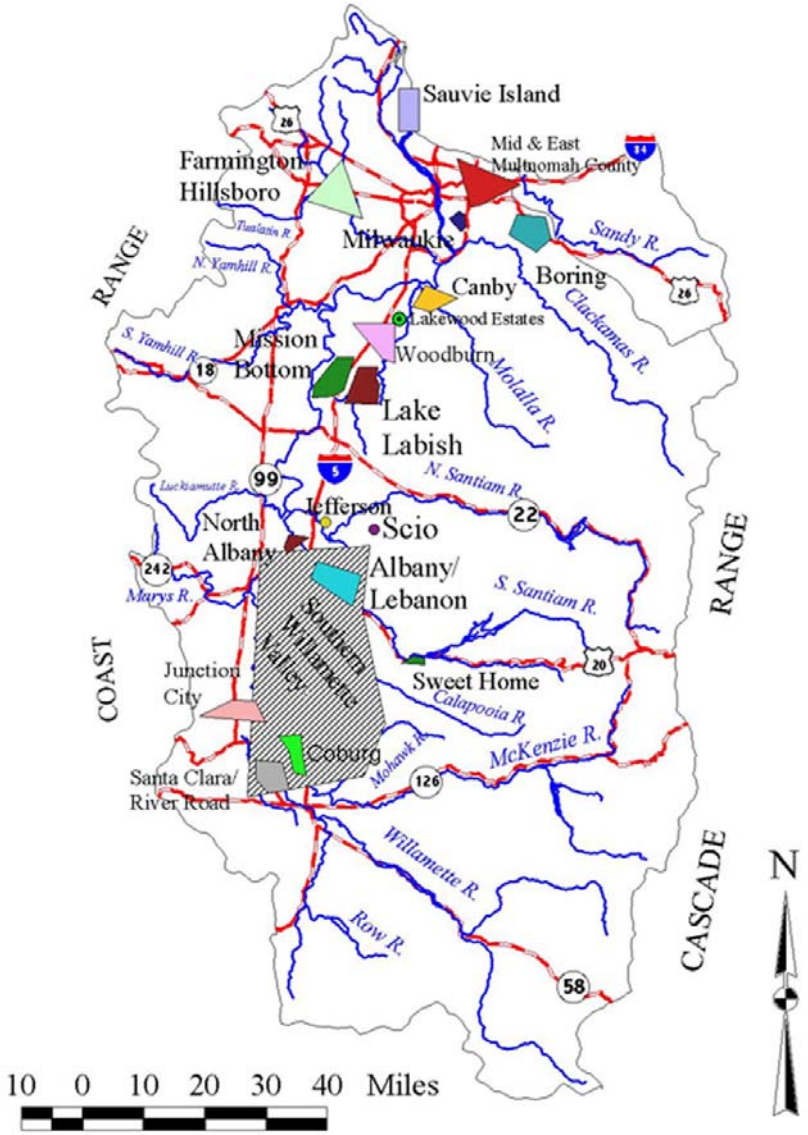

Figure 8: Groundwater Quality Study Areas in the Willamette Basin, Oregon

The following sections provide brief study descriptions, and groundwater quality data results summaries. Whenever possible, the data from the studies discussed below have been put into DEQ's Laboratory Analytical Storage and Retrieval (LASAR) database. These data are available through the internet at http://www.deq.state.or.us/wq/lasar/EventLocatorCriteria.htm and can be retrieved using the appropriate Sampling Event Name. Data from some studies done in the early years of the statewide monitoring program, or data for analyses done by laboratories other than the DEQ laboratory, is frequently missing from the LASAR system at this time. For information on these studies, contact the DEQ laboratory. Studies that were done by agencies other than DEQ are also typically not available in LASAR, but references to reports or links to on-line project information sites are provided in the study summary sections.

Basinwide Studies

1988 Assessment of Oregon's Groundwater for Agricultural Chemicals; Oregon Department of Environmental Quality.

Summary

In the mid 1980s, the EPA and Oregon state agencies began assessing the extent of groundwater contamination from agricultural chemicals (Fortuna and others, 1988). Typical agricultural chemicals used in Oregon included pesticides and fertilizers. With analytical techniques capable of detecting pesticides at low concentrations, groundwater pesticide contamination became a national concern. The Oregon groundwater characterization focused on pesticide and nitrate sampling and analysis. An EPA grant helped DEQ, the Oregon Department of Agriculture (ODA), Oregon State University (OSU), the Oregon State Health Division (now Department of Human Services), the Oregon Water Resources Department, and the U.S. Geological Survey, to choose areas of the state where groundwater was vulnerable to contamination, and to design the assessment and sampling project. The DEQ, EPA, ODA, and OSU laboratories conducted the analyses.

The agencies identified 12 areas in the state where groundwater was likely vulnerable to contamination, and where agricultural activities were predominant. Project funding was sufficient to conduct sampling wells in five of the 12 areas. The agencies identified the Willamette Valley as one of the target areas. The agencies selected specific wells using criteria including vulnerability and susceptibility to contamination, well log availability, shallow groundwater, no restrictive layers between land surface and groundwater, and local agricultural activities.

Within the Willamette Basin the study collected groundwater samples from the following areas:

- Sauvie Island (Multnomah County),
- Farmington/Hillsboro (Washington County),
- Mission Bottom, Lake Labish, Jefferson, Dever-Conner (Marion County),
- Albany (Linn County), and
- Coburg (Lane County).

Figure 9 shows the general Willamette Basin locations where wells were sampled in this study.

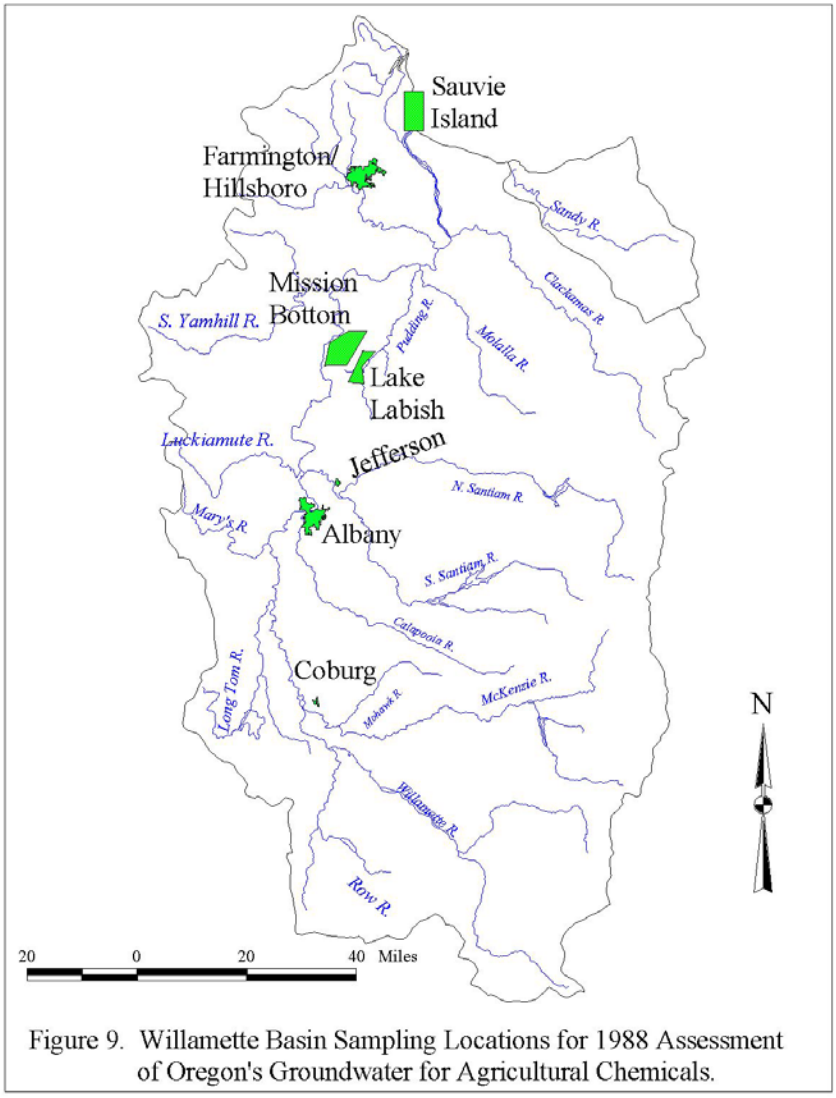

Figure 9. Willamette Basin Sampling Locations for 1988 Assessment of Oregon's Groundwater for Agricultural Chemicals.

The sampling program consisted of the following three phases:

1. Initial sampling of vulnerable domestic and irrigation wells (begun June 1985).
2. Follow-up (confirmational) sampling of wells where pesticides were detected (completed September 1987).
3. Sampling of the most vulnerable public water supply wells in the targeted areas.

The pesticide analyte list was chosen for each area based on the type and amount of local pesticide usage, and on the specific chemical ranking, based on the EPA national pesticide survey priority list. The EPA priority list ranked pesticides based on their likelihood of being a groundwater contaminant, using factors including persistence, toxicity, evidence of groundwater pesticide contamination, and leaching potential. Almost 100 different pesticides were identified in use in the Willamette Basin. Over 50 pesticides were used at an annual rate of over 1000 pounds. The analytes selected for the Willamette Basin study areas included 32 pesticides.

In the Willamette Basin areas, the DEQ, EPA, and ODA labs analyzed groundwater samples for various constituents including:

- Volatile organic compounds (VOCs) such as solvents;
- Pesticides (32 analytes), including atrazine, simazine, and ethylene dibromide (EDB, or 1,2-dibromoethane); and
- Others such as physical parameters, nutrients, and metals including arsenic, copper, and mercury.

Tables 1 through 3 in Appendix 1 list the constituents DEQ analyzed during this study, and provides the reporting limits. The method reporting limits for the pesticides analyzed in this study ranged from 0.005 to 2.0 mg/L (5 parts per billion to 2 parts per million). The reporting limit for ethylene dibromide when analyzed as a volatile organic compound was 0.00001 mg/L, which was lower than the drinking water Maximum Contaminant Level (MCL) of 0.00005 mg/L. For several of the pesticides, the reporting limits for the analyses conducted in the study were higher than the drinking water MCLs (Alachlor, Atrazine, Dinoseb, and Simazine).

Results

Results of the statewide assessment were presented in a 1988 DEQ report (Fortuna and others, 1988). Data from the study are not currently available electronically, but can be obtained by contacting DEQ. The following paragraphs and Table 1 summarize the sampling results in the Willamette Basin.

- Nitrate[1] concentrations in groundwater ranged from <0.005 to 36.0 mg/L. Nitrate was detected and confirmed at levels exceeding 10 mg/L (National Primary Drinking Water Maximum Contaminant Level (MCL)) in 29 of 124 wells (23%). The wells with nitrate levels above 10 mg/L were primarily located in the Mission Bottom area north of Salem (Figure 10). Nitrate concentrations between 5.0 and 10.0 mg/L were detected in 33 wells (27%).
- Initial sampling detected 5 pesticides, but only 3 pesticides were confirmed to be present on re-sampling.
- Ethylene dibromide (EDB or 1,2-dibromoethane)[2] was detected and confirmed in 4 out of 42 wells (10%). Concentrations ranged from 0.00002 to 0.00055 mg/L. The locations of the wells are shown on Figure 11. Two of the wells were in the Farmington area, and treatment units were installed on these wells. Two wells were in the Mission Bottom area. (Note: The two wells in the Mission Bottom area are close together and plot as one site in Figure 11.)

[1] Nitrate was analyzed as nitrate plus nitrite as nitrogen, and is assumed to be primarily in the form of nitrate.

[2] Ethylene dibromide (EDB) is used extensively as a soil and post-harvest fumigant for crops, and as a quarantine fumigant for citrus and tropical fruits and vegetables. It may also be used as a gas in termite and Japanese beetle control, beehive and vault fumigation, and spot fumigation of milling machinery. EPA cancelled the registration of this product for use in 1983. EDB may also be found as a gasoline additive. EDB can be detected and quantified using analytical methods for volatile organic compounds or pesticides.

- EDB was detected but not confirmed in 6 wells in Coburg. High levels in the blanks from the initial sampling led to the conclusion that the initial detections were laboratory artifacts.
- The pesticide Bromacil was detected and confirmed in one well at concentrations ranging from 0.005 to 0.0074 mg/L. Bromacil does not have an established drinking water standard. The well is located at a nursery near Jefferson (see Figure 12) and is installed at a shallow (30') depth.
- Initial sampling detected the pesticides Carbofuran, Dinoseb, and Fonofos in wells near Hillsboro. The presence of these pesticides was not confirmed on re-sampling.

Table 1
1988 Assessment of Oregon's Groundwater for Agricultural Chemicals
Willamette Basin Results

Contaminant	Number of Wells (Detected and Confirmed)	Average* Concentration (mg/L)	Maximum Concentration (mg/L)	NPDW MCL** (mg/L)	Number of Wells Over MCL
Nitrate	124	6.95	36.00	10	29
Bromacil	1	0.0062	0.0074	None	-
Ethylene dibromide (EDB)	4	0.00010	0.00055	0.00005	4

*Average concentration calculated for wells with detectable contaminant levels and may include multiple sampling events.

**NPDW MCL = National Primary Drinking Water Maximum Contaminant Level (mg/L = milligrams per liter = parts per million)

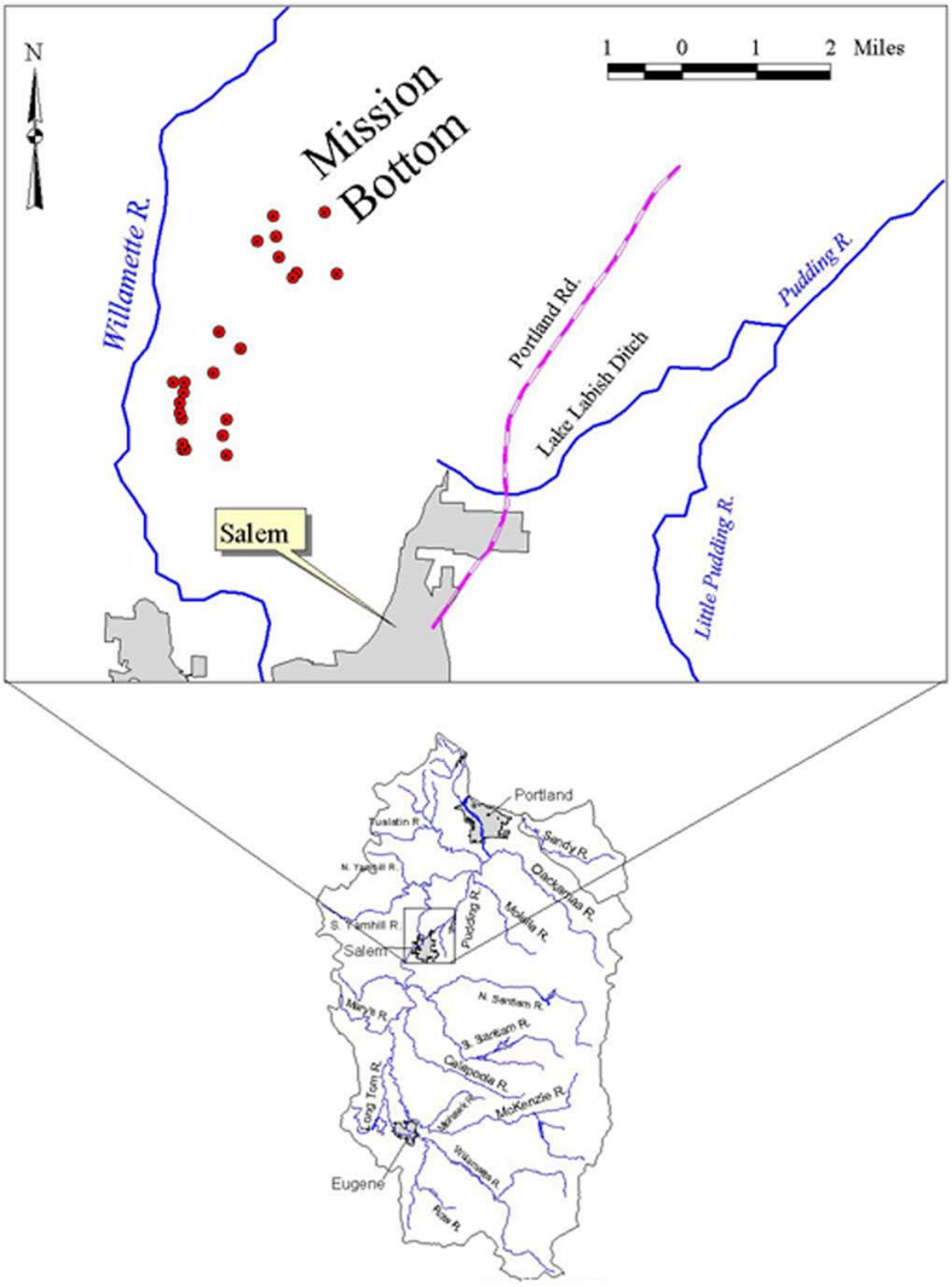

Figure 10: 1988 Assessment: Wells with Nitrate Above 10 mg/L

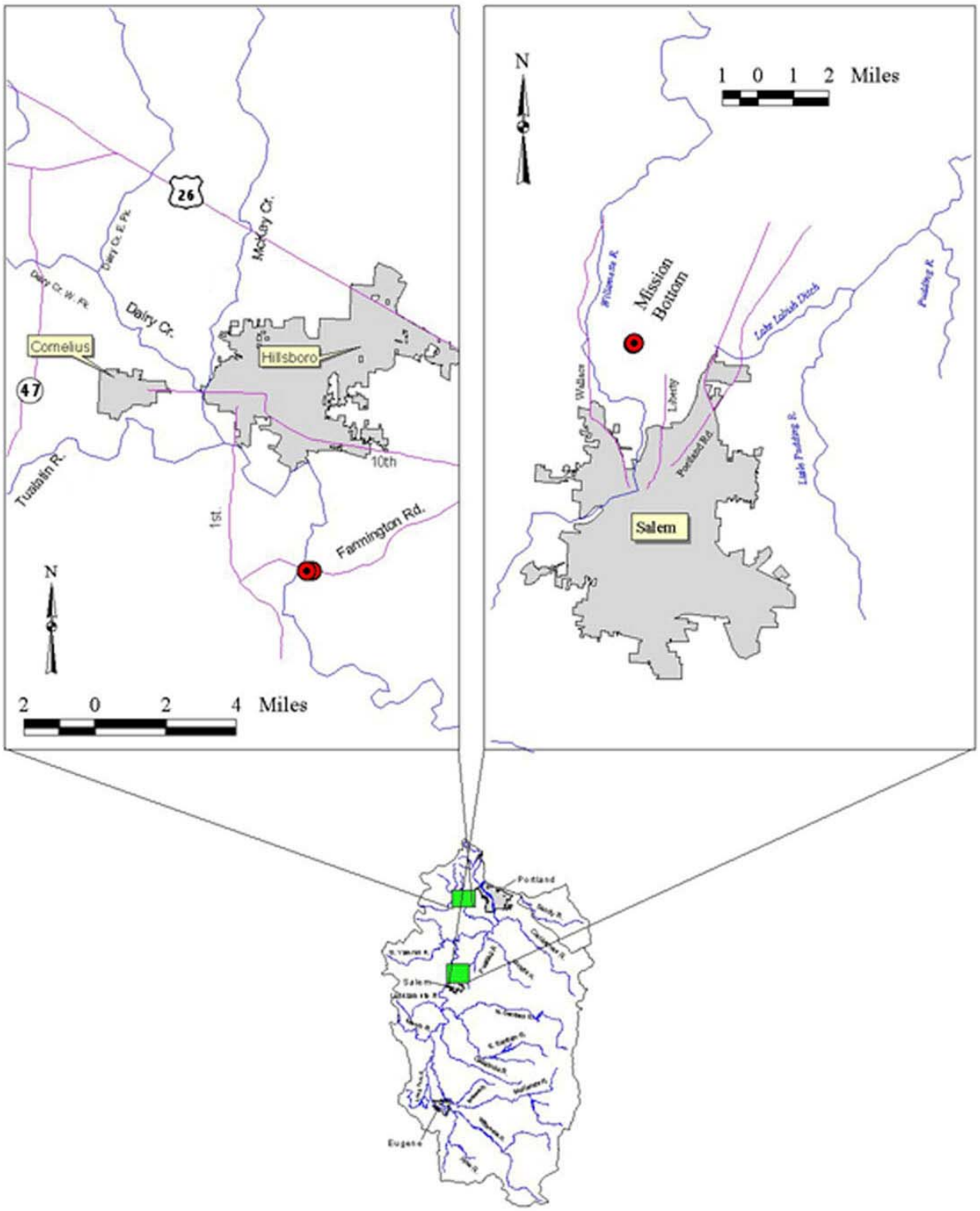

Figure 11: 1988 Assessment: Wells with Ethylene Dibromide (EDB)

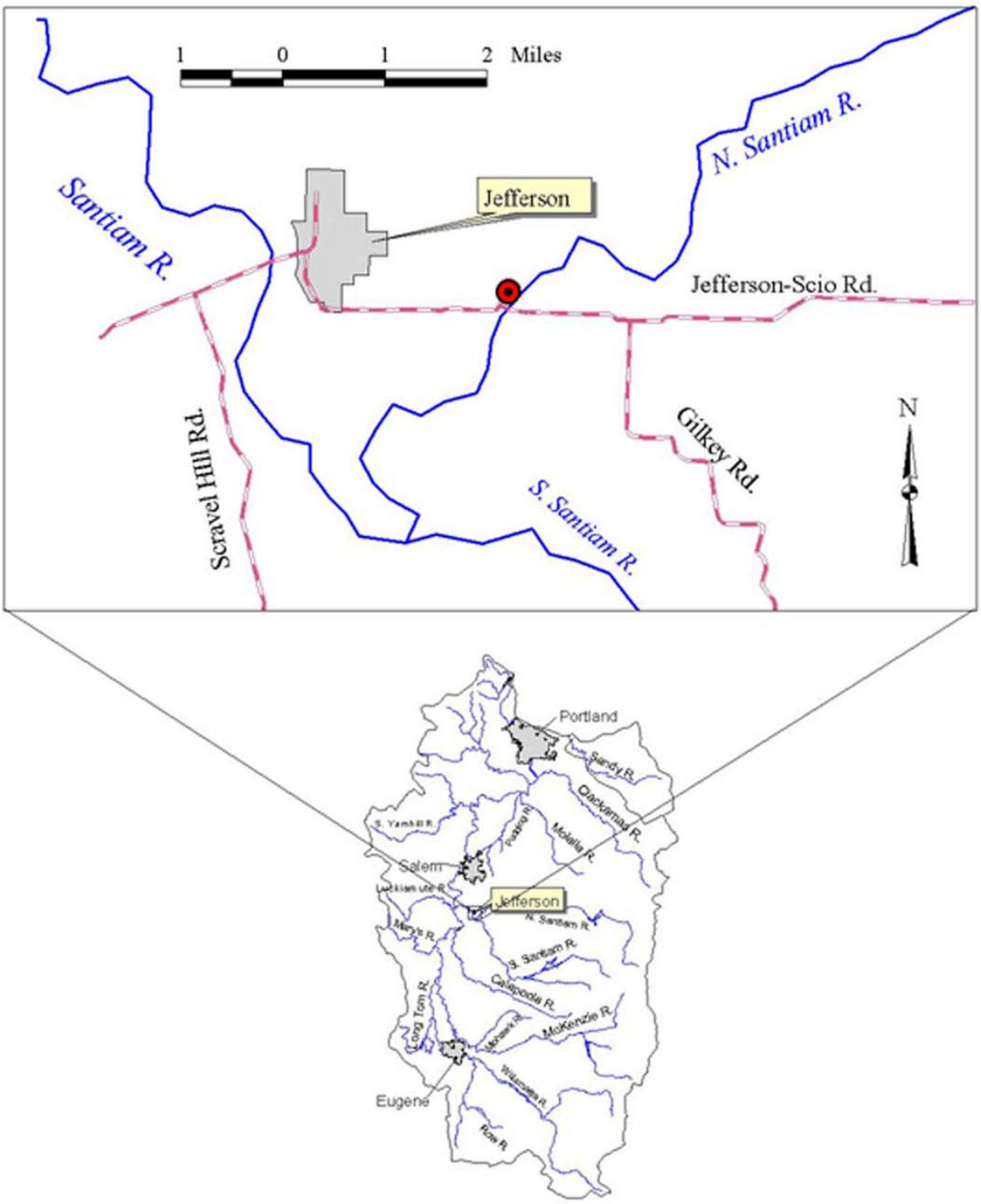

Figure 12: 1988 Assessment: Well with Bromacil

National Water-Quality Assessment Program: Quality of Shallow Groundwater in Alluvial Aquifers of the Willamette Basin, Oregon, 1993-95; U.S. Geological Survey.

Summary

The goal of the U.S. Geological Survey National Water-Quality Assessment (NAWQA) Program is to describe regional scale water quality status and trends, and to understand factors affecting the resource's quality. The USGS is studying the water resources in the Willamette Basin (Wentz and others, 1998). Part of the 1993-95 project included evaluating Willamette Basin groundwater quality data (Hinkle, 1997). The study included a regional assessment of groundwater quality (Study-Unit Survey), and a reconnaissance study of groundwater quality associated with urban land use (Land-Use Study). The study focused on shallow alluvial aquifers that (1) recharge quickly, and (2) are susceptible to contamination, due to human activities.

The Study-Unit Survey (SUS) targeted groundwater in shallow alluvium on a regional scale. The USGS sampled groundwater from 70 domestic wells between June and August 1993. The USGS chose the wells using a grid-based, random-selection process. Figure 13 shows the well locations. Because most land associated with alluvium in the Willamette Basin is used for agriculture, the SUS results are more representative of groundwater underlying agricultural land rather than beneath urban or forest land.

The urban Land-Use Study (LUS) focused on another significant land-use setting in the Willamette Basin. The LUS included installing 10 monitoring wells in alluvium within the Portland city limits. The USGS located the wells in a long established area of residential use. Sanitary sewers serviced most of this area. The USGS collected groundwater samples in July 1995.

The USGS National Water Quality Laboratory analyzed groundwater

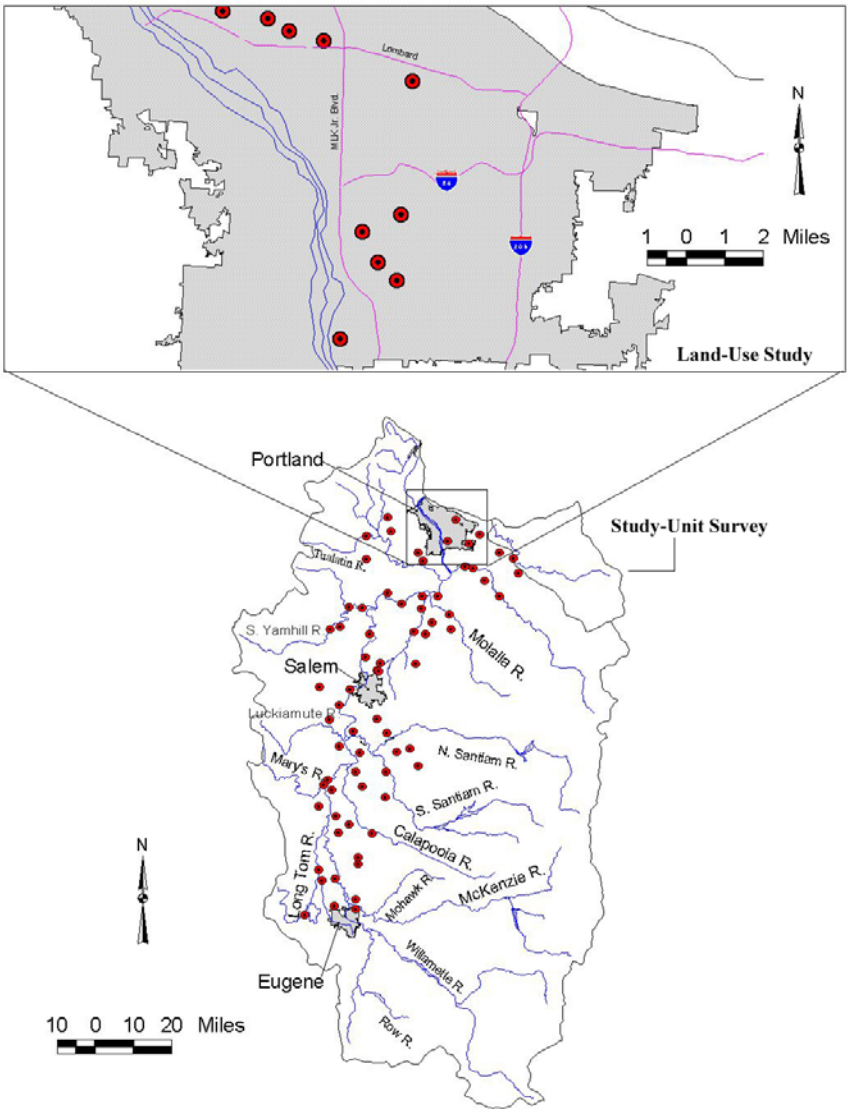

Figure 13: NAWQA Study Unit Survey and Land-Use Study Well Locations

samples for various constituents listed on Tables 4 through 7 in Appendix 1 including:

- Volatile organic compounds (59 analytes per site);
- Pesticides (86 analytes per site); and
- Others such as physical parameters, nutrients, metals, tritium, and radon.

The method reporting limits for the pesticides ranged from 0.000001 to 0.000050 mg/L (1 to 50 ng/L or parts per trillion). The pesticide analyte list for this study included approximately 50 pesticides not included as analytes in the 1988 DEQ study. Most USGS analyses achieved reporting limits three orders of magnitude lower than the reporting limit in the 1988 DEQ study (parts per trillion versus parts per billion).

Results

Table 2 summarizes the results for the SUS, and Table 3 summarizes the results for the LUS. Only those analytes detected above Minimum Reporting levels (MRLs) are listed.

Results included the following:

- Nitrate in groundwater from 6 of 70 (9%) SUS domestic wells exceeded the EPA drinking water standard of 10 parts per million.
- Pesticides were detected in 23 of 69 (33%) SUS domestic wells in the Willamette Valley, and 1 to 5 pesticides were found in any given well. Of 86 specific pesticides analyzed, a total of 13 different pesticides were detected. Atrazine, an herbicide used to control broadleaf weeds, was the most commonly detected pesticide. Only three of the 13 detected pesticides have established standards.
- Detected pesticides were generally at low concentrations (<0.001 mg/L). In one case, the detected pesticide (Dinoseb) exceeded the drinking water standard of 7.0 parts per billion.
- Trace levels of pesticides (0.000001 to 0.000005 mg/L), near detection limits, were reported in three of 10 LUS monitoring wells.
- Of the 13 detected pesticides, six were not included as analytes in previous DEQ studies, and seven were detected using lower analytical reporting limits than previous studies.
- Ethylene dibromide (EDB or 1,2-dibromoethane) was not detected in this study at a reporting limit of 0.0002 mg/L. Previous DEQ studies detected EDB using a lower reporting limit of 0.00001 mg/L.
- Volatile organic compounds were found in groundwater from 11 of 65 (11%) SUS domestic wells, and in eight of 10 (80%) additional shallow wells drilled in the Portland metropolitan area for the LUS. One VOC was detected in one sample in each study area at a concentration exceeding the MCL (Tetrachloroethylene at 0.0076 mg/L in the LUS; and 0.029 mg/L in the SUS; the MCL = 0.005 mg/L).
- Arsenic concentrations in 11 of 70 SUS domestic wells exceeded the health advisory level of 0.002 mg/L, but none exceeded the drinking water standard in effect at the time (0.050 mg/L). (Note: The drinking water standard was revised downward to 0.010 mg/L in 2001.)

The report for this study, with a detailed discussion of results and conclusions, is available from the USGS (Hinkle, 1997), and is available on-line at: http://oregon.usgs.gov/pubs_dir/Pdf/97-4082b.pdf.

Table 2
USGS NAWQA Study-Unit Survey

Contaminant	Number of Detections	Median Concentration (mg/L)	Maximum Concentration (mg/L)	NPDW MCL* (mg/L)	Number of Wells Over MCL
Nitrate	N.A.	0.40	26	10 mg/L	6
Phosphorus	N.A	0.17	2.2	None	N.A.
Atrazine	20	N.A.	0.000890	0.003	0
Bromacil	1	N.A.	0.000170	None	N.A.
Dacthal	2	N.A.	0.000002	None	N.A.
p,p'-DDE	1	N.A.	0.000001	None	N.A.
Desethylatrazine	11	N.A.	0.000180	None	N.A.
Dieldrin	1	N.A.	0.000030	None	N.A.
Dinoseb	1	N.A.	0.0079	0.007	1
Diuron	2	N.A.	0.000340	None	N.A.
Metolachlor	3	N.A.	0.000015	None	N.A.
Propachlor	1	N.A.	0.000004	None	N.A.
Propanil	3	N.A.	0.000015	None	N.A.
Simazine	4	N.A.	0.000044	0.004	0
Terbacil	1	N.A.	0.000015	None	N.A.
Chloroform	4	N.A.	0.0007	None	N.A.
1,1-Dichloroethylene	1	N.A.	0.0002	0.007	0
Tetrachloroethylene	3	N.A.	0.029	0.005	1
1,1,1-Trichloroethane	4	N.A.	0.002	0.2	0
Trichloroethylene	1	N.A.	0.0008	0.005	0
Trichlorofluoromethane	1	N.A.	0.0002	N.A.	N.A.
Arsenic	N.A.	<0.002	0.013	0.05 (currently 0.010)	0
Radon	51	N.A.	1,200 pCi/L	150 (RSDHA)	51

*NPDW MCL = National Primary Drinking Water Maximum Contaminant Level (mg/L = milligrams per liter = parts per million). This number reflects the MCL at the time of the study. Some MCLs may have changed.
N.A. = Not available or not applicable
pCi/L = picocuries per liter.

Table 3
USGS NAWQA Urban Land Use Study

Contaminant	Number of Detections	Median Concentration (mg/L)	Maximum Concentration (mg/L)	NPDW MCL* (mg/L)	Number of Wells Over MCL
Nitrate	10	N.A.	15	10	1
Atrazine	2	N.A.	Trace at detection limit	0.003	0
Desethylatrazine	2	N.A.	Trace at detection limit	None	N.A.
Triallate	1	N.A.	Trace at detection limit	None	N.A.
Carbon Tetrachloride	1	N.A.	0.0003	None	N.A.
Chloroform	5	N.A.	0.001	None	N.A.
Tetrachloroethylene	6	N.A.	0.0076	0.005	1
1,1,1-Trichloroethane	2	N.A.	0.0004	0.2	0
Trichloroethylene	5	N.A.	0.0033	0.005	0
Aluminum	N.A.	<0.003	0.011	None	N.A.
Antimony	N.A.	<0.001	<0.001	0.006	0
Arsenic	N.A.	0.002	0.002	0.05[3] (currently 0.010)	0
Barium	N.A.	0.008	0.030	2	0
Beryllium	N.A.	<0.001	<0.001	0.004	0
Cadmium	N.A.	<0.001	<0.001	0.005	0
Chromium	N.A.	<0.001	0.003	0.1	0
Cobalt	N.A.	<0.001	0.002	None	N.A.
Copper	N.A.	<0.001	0.003	1.3 (Action Level)	0
Lead	N.A.	<0.001	<0.001	0.015 (Action Level)	0
Manganese	N.A.	0.002	0.058	None	N.A.
Molybdenum	N.A.	<0.001	0.002	None	N.A.
Nickel	N.A.	0.002	0.004	None	N.A.
Selenium	N.A.	<0.001	0.002	0.05	0
Silver	N.A.	<0.001	<0.001	None	N.A.
Uranium	N.A.	<0.001	<0.001	None	N.A.
Zinc	N.A.	<0.003	0.005	None	N.A.

*NPDW MCL = National Primary Drinking Water Maximum Contaminant Level (mg/L = milligrams per liter = parts per million). This number reflects the MCL at the time of the study. Some MCLs may have changed.
N.A. = Not available or not applicable

Willamette Basin Groundwater Study; U.S. Geological Survey and Oregon Water Resources Department.

Summary

The U.S. Geological Survey (USGS) and the Oregon Water Resources Department (OWRD) are cooperating in a multi-phase study of the Willamette Basin's water resources. The study's groundwater portion will:

- analyze the regional groundwater flow system,
- consider the effects of groundwater pumping on stream flow,
- characterize the basalt aquifers in the region,
- provide information on low-yield aquifers, and
- provide information on areas of naturally occurring poor water quality.

Information about the project, a detailed study design description, and data are available at http://oregon.usgs.gov/projs_dir/willgw/willpage.html .

The first phase of the study considers the basin on a regional scale, and includes collecting information over the entire basin. The second phase focuses on specific basin hydrology aspects. This phase provides more detailed information on the scale needed for managing the resource. Another study focus is characterizing groundwater in the basin with naturally occurring poor quality, due to elevated arsenic concentrations.

Groundwater information was collected and compiled in the first phase, and included data from water well reports, water-level data recorded from observation networks and wells, and water chemistry for selected wells and springs. The USGS collected information for 1,234 wells and six springs. A USGS report compiles the data (Orzol and others, 2000). The groundwater chemistry data collected in this study phase are interpreted in a companion USGS report (Hinkle and Polette, 1999).

The USGS collected groundwater samples at 125 wells and 6 springs from August 1996 to September 1997. The selected wells included 116 domestic wells, three public water supply wells, three industrial wells, two irrigation wells, and one livestock well. Figure 14 shows the 125 well locations. The USGS collected additional data from 17 of these sites for one year to evaluate temporal

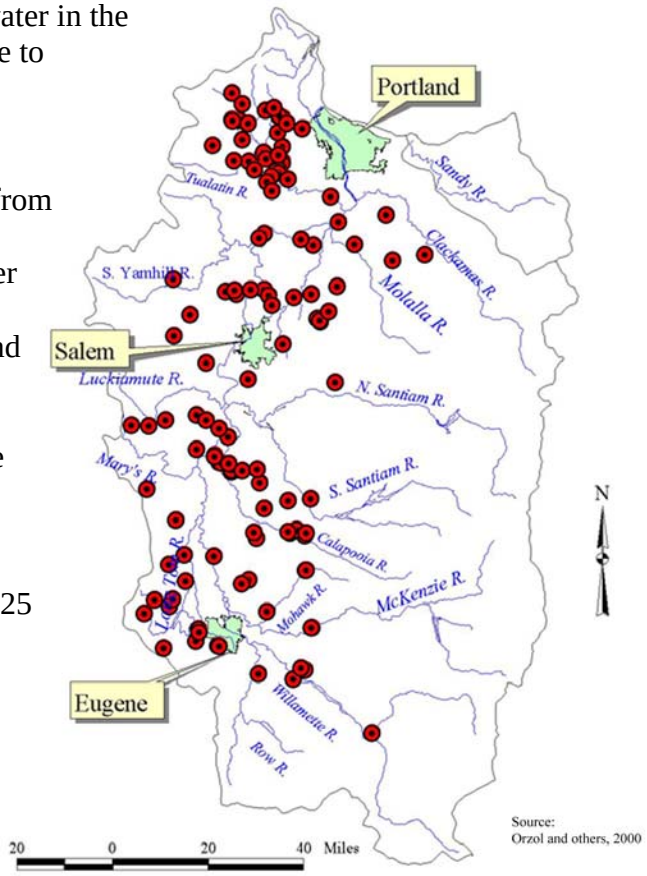

Figure 14: US Geology Survey/Oregon Water Resources Department Willamette Basin Groundwater Study Sample Locations

variability in arsenic concentrations. The study also evaluated historical data from USGS and Linn County Department of Health Services sampling projects from 597 Willamette Basin sites.

The USGS laboratory analyzed groundwater samples collected in 1996 and 1997 for arsenic, chloride, and specific conductance, as listed on Table 8 in Appendix 1.

Results

- Arsenic concentrations across the basin ranged from less than 0.001 mg/L to 2.000 mg/L.
- Arsenic concentrations in 58 samples (8.0 percent) exceeded 0.050 mg/L which was the drinking water standard at the time. (Note: The drinking water standard was revised downward to 0.010 mg/L in 2001.)
- High arsenic concentrations were related to aquifer geology and specific bedrock formations in parts of Lane County and Linn County.
- High concentrations of arsenic in groundwater in the Tualatin subbasin in Washington County were associated with alluvial deposits.

Domestic Well Testing for Real Estate Transactions; Oregon Department of Human Services

Summary

In 1989, Oregon established a program to monitor the quality of groundwater used for domestic purposes (ORS 448.271). For any real estate transaction that includes a water well supplying groundwater for domestic purposes, the seller must have the well water tested for nitrate and total coliform bacteria. The seller must complete a Water Systems Data Sheet and submit the form and laboratory test results to the Oregon Department of Human Services.

Results

Information submitted to DHS between 1989 and 1997 from transactions in the Willamette Basin shows the following:

- 4,593 real estate transactions occurred in the Willamette Basin in this time period.
- 67 wells (1%) had nitrate levels above the drinking water standard of 10 mg/L.
- 320 wells (7%) tested positive for bacteria.

Table 1, Appendix 2 summarizes the data. Information about the Real Estate Transaction Domestic Well Testing Program is available on-line at http://www.dhs.state.or.us/publichealth/dwp/dwt.cfm. Data can be obtained from DHS or DEQ.

Northern Willamette Basin Studies

Mid and East Multnomah County Groundwater Study (1984-1997); Oregon Department of Environmental Quality.

Summary

In the late 1970s, responding to public concern about potential contamination from cesspools in the mid-Multnomah County area, the DEQ began studying the area's groundwater for nitrate contamination. The DEQ assembled a well network for regular groundwater sampling. In the mid-1980s, volatile organic compound (VOC) contamination was found in the Parkrose public water supply well, and in monitoring wells around the Boeing industrial facility. The DEQ began an area wide groundwater study through the DEQ Site Assessment program. The EPA also conducted site inspections and sampling in the area. The DEQ added wells in east Multnomah County to the ongoing sampling program, including the Parkrose and Gilbert Water District supply wells, and analyzed samples for VOCs and nitrate. Figure 15 shows the well locations. Initially, the DEQ sampled 42 wells on a routine basis. The DEQ discontinued sampling the Parkrose and Gilbert Water District wells when they were taken offline from the public water supply system. Due to urbanization and development activities, some wells became unavailable for sampling. Some well owners withdrew permission to sample. The DEQ discontinued sampling the remaining domestic wells in 1997. The groundwater investigation and groundwater cleanup activities continued at the Boeing facility (ESCI Site ID 13), and the Cascade facility (ECSI Site ID 635).

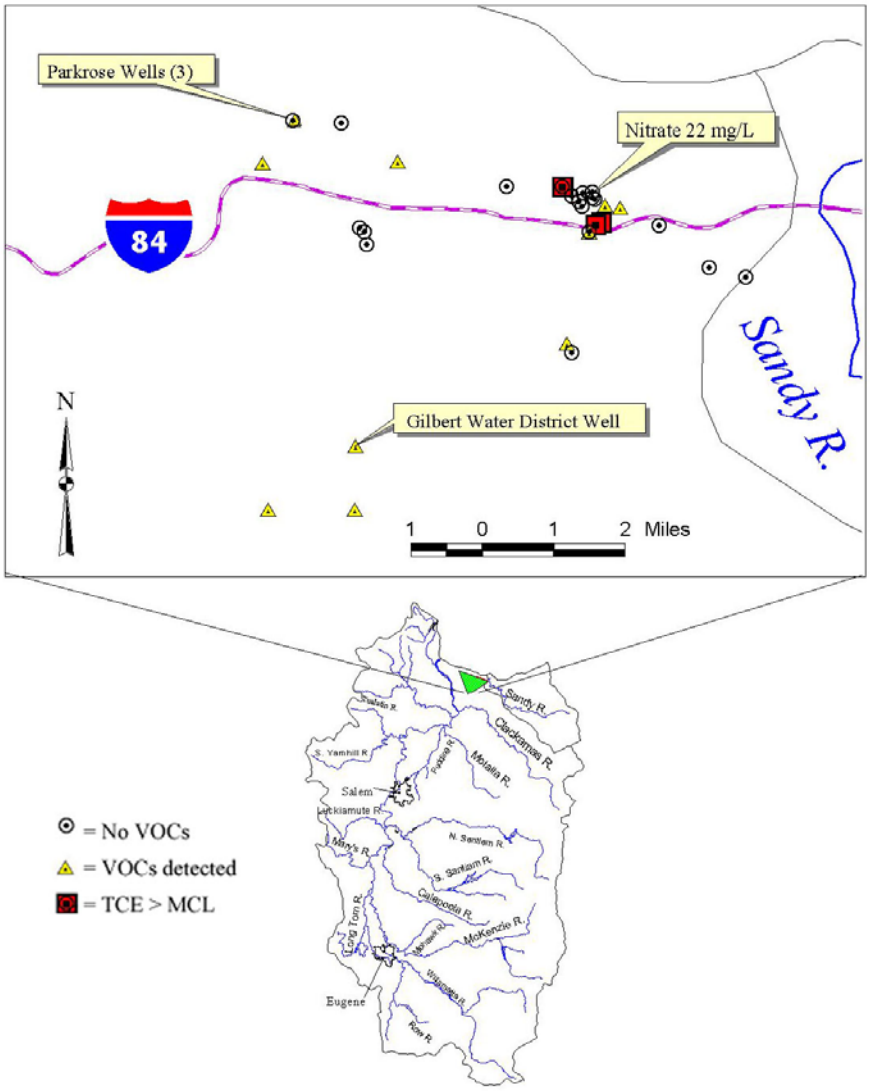

Figure 15: Mid- and East-Multnomah County Groundwater Study

The DEQ laboratory analyzed groundwater samples for various constituents listed on Tables 9 through 11 in Appendix 1 including:

- Volatile organic compounds (VOCs) including ethylene dibromide (EDB);
- Pesticides with a suite of 11 analytes including DDT, Endrin, and Aldrin; and
- Others such as physical parameters, nutrients, and metals.

Results

Table 4 summarizes the sampling results.

- Nitrate[3] was detected and confirmed at levels exceeding the 10 mg/L MCL in one well. Nitrate was present in other wells, but generally below the MCL. The values ranged from <0.02 to 22 mg/L. The average value over the sampling area and all sampling events was 4.52 mg/L. Eight of the wells (17%) consistently had values at or above 7 mg/L.

- Trichloroethylene (TCE) was detected and confirmed in four wells at concentrations exceeding the MCL of 0.005 mg/L. Due to volatile organic compounds in the Parkrose and Gilbert Water District supply wells, these wells were removed from the public water supply.

Figure 15 shows the study area location and results in the well network. Circles represent wells where VOCs were not detected. Triangles represent wells with detectable VOCs at levels below drinking water MCLs. Squares represent wells with TCE above drinking water MCLs. The well where nitrate exceeded drinking water MCLs is labeled.

Table 4
Mid & East Multnomah County (1984-1997)

Contaminant	Number of Wells (Detected and Confirmed)	Average* Concentration (mg/L)	Maximum Concentration (mg/L)	NPDW MCL** (mg/L)	Number of Wells Over MCL
Nitrate	40	4.20	22.00	10	1
Trichloroethylene	11	0.0222	0.0840	0.005	4
1,1,2,2-Tetrachloroethylene	7	0.0136	0.0800	None	-
Chloroform	6	0.0014	0.0030	0.080	0
1,1,1-Trichloroethane	1	0.0020	0.0020	0.2	0
Trichlorofluoromethane	2	0.0015	0.0020	None	-
1,2-Dichloropropane	1	0.0020	0.0020	0.005	0

*Average concentration calculated for wells with detectable contaminant levels.
**NPDW MCL = National Primary Drinking Water Maximum Contaminant Level (mg/L = milligrams per liter = parts per million)

[3] Nitrate was analyzed as nitrate plus nitrite as nitrogen, and is assumed to be primarily in the form of nitrate.

General information about the investigation is available through the Environmental Cleanup Site Information (ECSI) database at http://www.deq.state.or.us/wmc/ecsi/ecsiquery.htm (Site ID 1479 East Multnomah County Area Groundwater), or by contacting DEQ's Land Quality Division Site Response program. Information on the investigation and cleanup activities on the Boeing facility (ESCI Site ID 13) and the Cascade facility (ECSI Site ID 635) can also be obtained from these sources.

Sample results for individual wells are available from the DEQ LASAR database and can be accessed at: http://www.deq.state.or.us/wq/lasar/StationLocatorCriteria.htm. The data for each well can be retrieved using the following Station ID numbers and selecting "Wells" for "Station Type".

14745	14754	14760	14768	14784	14797	14803
14746	14755	14761	14769	14792	14798	
14748	14756	14762	14770	14793	14799	
14751	14757	14764	14771	14794	14800	
14752	14758	14766	14772	14795	14801	
14753	14759	14767	14773	14796	14802	

Boring Groundwater Study (1986-1989); Oregon Department of Environmental Quality

Summary

The Oregon Water Resources Department (OWRD) began a water quantity study in the Boring area in the mid-1980s. The DEQ began a supplemental groundwater quality study in the area in 1986. Between 1986 and 1989, the DEQ collected groundwater samples from 15 wells with repeat sampling in some wells. Figure 16 shows the well locations.

The DEQ laboratory analyzed groundwater samples for various constituents listed on Table 12 through 14 in Appendix 1 including:

- Volatile organic compounds (VOCs) including ethylene dibromide (EDB);
- Pesticides with a suite of 15 analytes including DDT, Endrin, and Aldrin; and
- Others such as physical parameters, nutrients, and metals.

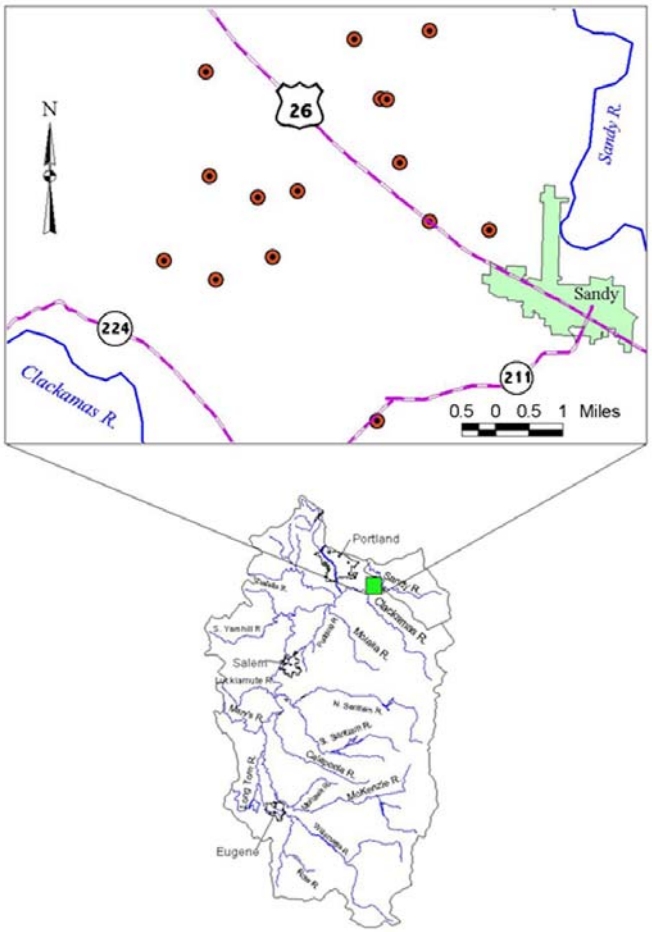

Figure 16: Boring Groundwater Study

Results

Table 5 summarizes the sampling results.

- Nitrate[4] concentrations ranged from <0.02 to 0.65 mg/L, well below the 10 mg/L MCL.
- Pesticides were initially detected but re-sampling did not confirm their presence.
- No volatile organic compounds were detected.

Table 5
Boring Groundwater Study (1986-1989)

Contaminant	Number of Wells (Detected and Confirmed)	Average* Concentration (mg/L)	Maximum Concentration (mg/L)	NPDW MCL** (mg/L)	Number of Wells Over MCL
Nitrate	10	0.14	0.65	10	0

*Average concentration calculated for wells with detectable contaminant levels.
**NPDW MCL = National Primary Drinking Water Maximum Contaminant Level (mg/L = milligrams per liter = parts per million)

Nitrate data are available in LASAR through the internet at http://www.deq.state.or.us/wq/lasar/EventLocatorCriteria.htm and can be retrieved using Boring Groundwater as the sampling event name. Data from volatile and pesticide analyses are not currently available on-line. For this information, contact the DEQ laboratory.

Scio Groundwater Study (1987); Oregon Department of Environmental Quality.

Summary

In 1987, the Linn County Health Department and the Oregon State Health Department sampled and tested several private domestic water wells in Scio, Oregon. The investigation responded to public concern about potential groundwater bacterial contamination from the City of Scio sewage lagoons.

In June and December 1987, the DEQ collected and analyzed groundwater samples from 15 wells, one utility manhole, and two sewage lagoons within Scio's city limits. Figure 17 shows the general location of the Scio study area. Sample locations are not plotted because latitude and longitude coordinates for the sample sites are not

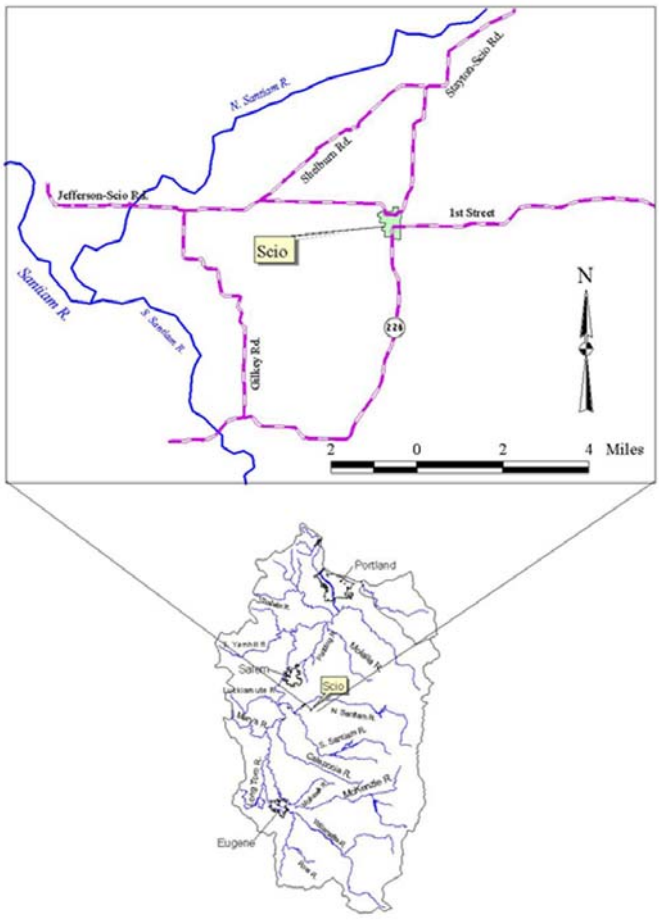

Figure 17: Scio Groundwater Study

[4] Nitrate was analyzed as nitrate plus nitrite as nitrogen, and is assumed to be primarily in the form of nitrate.

available. The DEQ laboratory analyzed groundwater samples for various constituents listed on Table 15 in Appendix 1 including:

- Bacteria, and
- Others such as physical parameters, nutrients, and common ions.

Results

Table 6 summarizes the study results. Data are not currently available in LASAR but are summarized in Tables 2 and 3 in Appendix 2.

- Nitrate[5] concentrations were below the 10 mg/L MCL.
- Eight of 15 wells (53%) tested positive for the presence of bacteria.
- The study did not conclusively determine the groundwater bacteria source.

Table 6
Scio Groundwater Study (1987)

Contaminant	Number of Detections	Average* Concentration (mg/L)	Maximum Concentration (mg/L)	NPDW MCL** (mg/L)	Number of Detections Over MCL
Nitrate	13	0.31	3.7	10	0
Bacteria	8	N.A. ***	400 colonies per 100 ml	1 positive	8

*Average concentration calculated for wells with detectable contaminant levels and may include multiple sampling events.
**NPDW MCL = National Primary Drinking Water Maximum Contaminant Level (mg/L = milligrams per liter = parts per million). Bacteria standard for systems with few routine samples is no more than 1 positive total coliform result per month
*** Analyses in June 1987 for fecal coliform and enterococcus; analyses in December 1987 for total and fecal coliform bacteria

[5] Nitrate was analyzed as nitrate plus nitrite as nitrogen, and is assumed to be primarily in the form of nitrate.

Milwaukie Groundwater Study (1988, 1989, 1993, 1994); Oregon Department of Environmental Quality.

Summary

In 1988, the City of Milwaukie discovered volatile organic compound (VOC) contamination in five of seven city public water supply wells. The City removed the wells from service until a treatment system was installed. The city placed the wells back in service in 1991, and the City currently treats groundwater prior to distribution.

To investigate the source of contamination, the DEQ conducted area-wide groundwater sampling in 1988, 1989, 1993, and 1994. The DEQ sampled a total of 25 wells in the area, including seven City of Milwaukie public water supply wells, several monitoring wells, and other private domestic and commercial/industrial supply wells. Figure 18 shows the well locations.

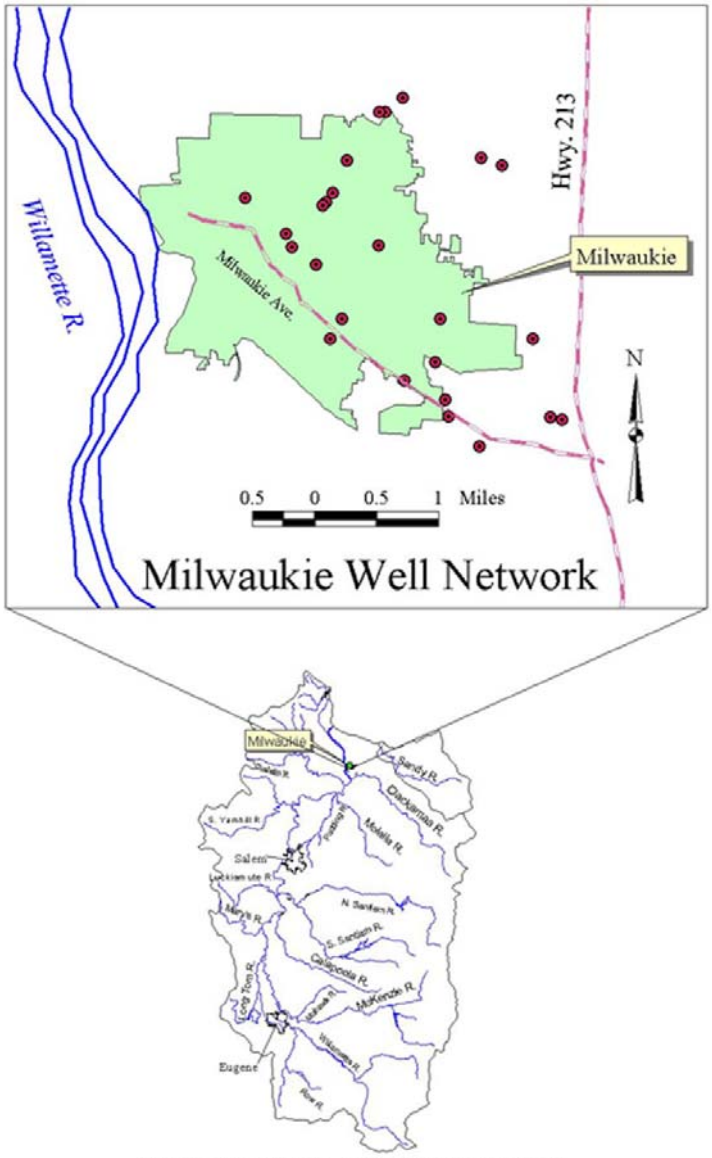

Figure 18: Milwaukie Groundwater Study

The DEQ laboratory analyzed groundwater samples for various constituents listed on Tables 16 and 17 in Appendix 1 including:

- Volatile organic compounds (VOCs) such as solvents, and
- Others such as physical parameters, nutrients, and metals.

Results

Table 7 summarizes the sampling results.

- Nitrate[6] was detected and confirmed at levels exceeding the 10 mg/L MCL in one well.
- Total coliform bacteria was detected in two wells and exceeded the bacteria MCL.
- Trichloroethylene was detected and confirmed in seven wells at concentrations exceeding the MCL of 0.005 mg/L.

[6] Nitrate was analyzed as nitrate plus nitrite as nitrogen, and is assumed to be primarily in the form of nitrate.

- Cis-1,2-dichloroethylene was detected and confirmed in one well at concentrations exceeding the MCL of 0.07 mg/L.
- The study did not conclusively determine the source for VOCs in the groundwater.

Table 7
Milwaukie Groundwater Study (1988-1994)

Contaminant	Number of Wells (Detected and Confirmed)	Average* Concentration (mg/L)	Maximum Concentration (mg/L)	NPDW MCL** (mg/L)	Number of Wells Over MCL
Nitrate	22	3.70***	37	10	1
Total Coliform Bacteria	2	271 counts/100 ml	540 counts/100 ml	5% positive/ month	2
1,1-Dichloroethylene	2	0.0035	0.004	0.007	0
cis-1,2-Dichloroethylene	10	0.2294	2.26	0.07	1
trans-1,2-Dichloroethylene	1	0.0284	0.0284	0.1	0
1,1-Dichloroethane	1	0.0038	0.0038	None	0
Chloroform	3	0.0008	0.001	0.080	0
1,1,1-Trichloroethane	5	0.0018	0.0020	0.2	0
Carbon Tetrachloride	1	0.0039	0.0039	0.005	0
Benzene	1	0.0011	0.0011	0.005	0
Trichloroethylene	11	0.1201	1.05	0.005	7
1,1,2,2-Tetrachloroethane	8	0.0057	0.021	None	-

*Average concentration calculated for wells with detectable contaminant levels.
**NPDW MCL = National Primary Drinking Water Maximum Contaminant Level (mg/L = milligrams per liter = parts per million).
***Average concentration calculated for all wells. Wells with non-detects are assigned a value of one half the detection limit.

Data from sampling in 1993 are available in LASAR through the internet at http://www.deq.state.or.us/wq/lasar/EventLocatorCriteria.htm and can be retrieved using Milwaukie Groundwater as the sampling event name. For other sampling information, contact the DEQ laboratory.

The DEQ's Site Assessment program reviewed information on potential contaminant sources in the Milwaukie area, and conducted 20 preliminary assessments. Several sites were identified as potential sources, and the DEQ and property owners are continuing remedial investigations at approximately 10 to 15 sites. General information is available through the Environmental Cleanup Site Information (ECSI) database at http://www.deq.state.or.us/wmc/ecsi/ecsiquery.htm (Site ID 706 Milwaukie Area Groundwater Contamination), or at http://www.deq.state.or.us/wmc/cleanup/orp-milw.htm or by contacting the DEQ's Land Quality Division Site Response program.

Lakewood Estates Groundwater Study (1991-1996); Oregon Department of Environmental Quality.

Summary

In 1990, contamination was detected in the public water supply well for the Lakewood Estates, a residential subdivision near Aurora, Oregon. The detected contaminants were the volatile organic compounds 1,1,1-trichloroethane and 1,1-dichloroethylene. The concentration of 1,1-dichloroethylene exceeded the MCL. Figure 19 shows the location of the Lakewood Estates Groundwater study area.

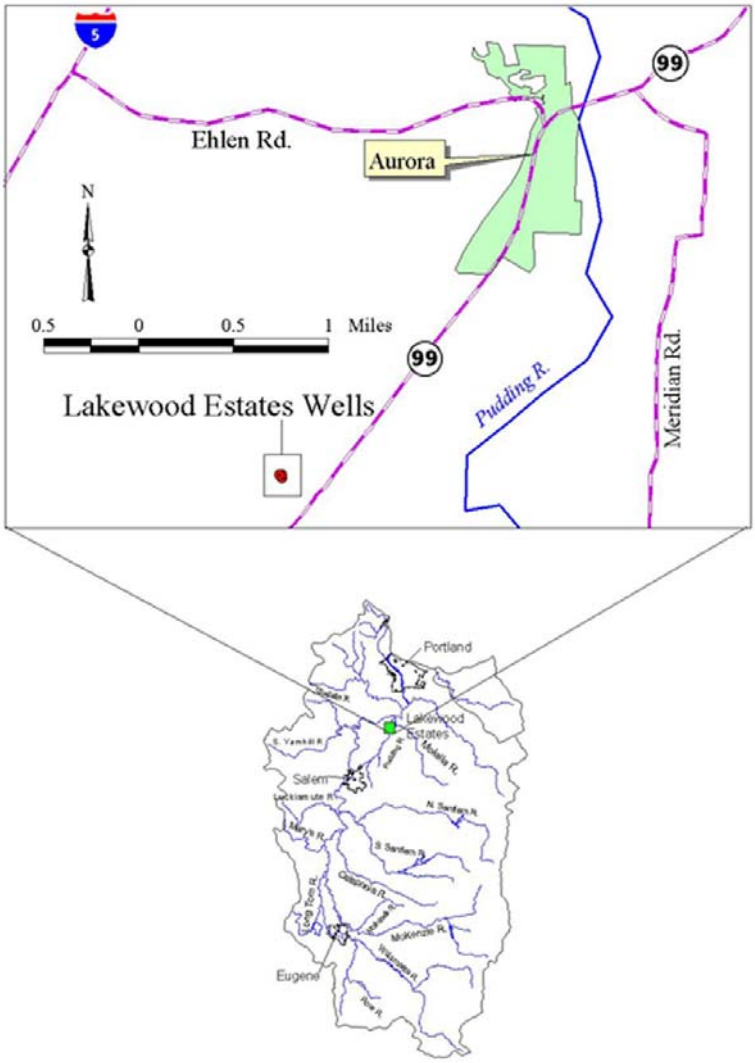

Figure 19: Lakewood Estates Groundwater Study

In 1991, contamination was detected in the backup water supply well. The problem was referred to the DEQ's Site Response program which investigated the groundwater contamination source. The DEQ installed an aeration treatment system on the main water supply well in 1992. Although nearby industrial operations were initially identified as potential sources, the investigations did not conclusively locate the contamination source. The investigation was discontinued in 1996. The project was designated a state Orphan Site in 1996. As part of the Orphan Site program, the DEQ sampled 16 residential water wells and one well at North Marion High School in August 2000. A private laboratory performed the analyses on the samples and found tetrachloroethene in one well. The 2000 data is not available for this report.

The DEQ laboratory analyzed groundwater samples for various constituents listed on Tables 18 and 19 in Appendix 1 including:

- Volatile organic compounds (VOCs) such as solvents
- Others such as physical parameters.

Results

Table 8 summarizes the sampling results.

- 1,1-dichloroethylene was detected and confirmed in the supply well at concentrations exceeding the MCL of 0.007 mg/L. The maximum detected concentration was 0.0295 mg/L.
- 1,1,1-trichloroethane was detected and confirmed in the supply and backup wells. Concentrations did not exceed the MCL of 0.2 mg/L. The maximum detected concentration was 0.0547 mg/L.
- Methylene chloride was detected and confirmed in the supply well at concentrations exceeding the MCL of 0.005 mg/L. The maximum detected concentration was 0.007 mg/L.
- Trichlorofluoromethane was detected in the supply and backup wells with a maximum concentration of 0.0074 mg/L. This VOC has no established MCL.
- The study did not conclusively determine the source for VOCs in the groundwater.

Table 8
Lakewood Estates Groundwater Study (1991-1996)

Contaminant	Number of Wells (Detected and Confirmed)	Average* Concentration (mg/L)	Maximum Concentration (mg/L)	NPDW MCL** (mg/L)	Number of Wells Over MCL
1,1,1-Trichloroethane	2	0.018	0.0547	0.2	0
1,1-Dichloroethylene	1	0.0168	0.0295	0.007	1
Trichlorofluoromethane	2	0.0022	0.0074	None	-
Methylene Chloride	1	0.006	0.007	0.005	1

*Average concentration calculated for wells with detectable contaminant levels and may include multiple sampling events.
**NPDW MCL = National Primary Drinking Water Maximum Contaminant Level (mg/L = milligrams per liter = parts per million)

Data from DEQ's sampling are available in LASAR through the internet at http://www.deq.state.or.us/wq/lasar/EventLocatorCriteria.htm and can be retrieved using Lakewood Estates as the sampling event name. For other sampling information, contact the DEQ laboratory. General information on the investigation to identify contaminant sources is available through the Environmental Cleanup Site Information (ECSI) database at http://www.deq.state.or.us/wmc/ecsi/ecsiquery.htm (Site ID 1038 Lakewood Estates Area Groundwater Contamination). Remedial investigation project reports are available through DEQ's Western Region.

Canby Groundwater Study (1993); Oregon Department of Environmental Quality.

Summary

As part of the Statewide Ambient Groundwater Monitoring Program, the DEQ sampled Canby area groundwater in February 1993. The main contaminants of concern were nitrate and pesticides associated with agricultural land use and on-site septic systems. The DEQ collected groundwater samples from 21 water wells in February 1993. In August 1993, the DEQ resampled 10 wells to confirm the initial results. Figure 20 shows the well locations.

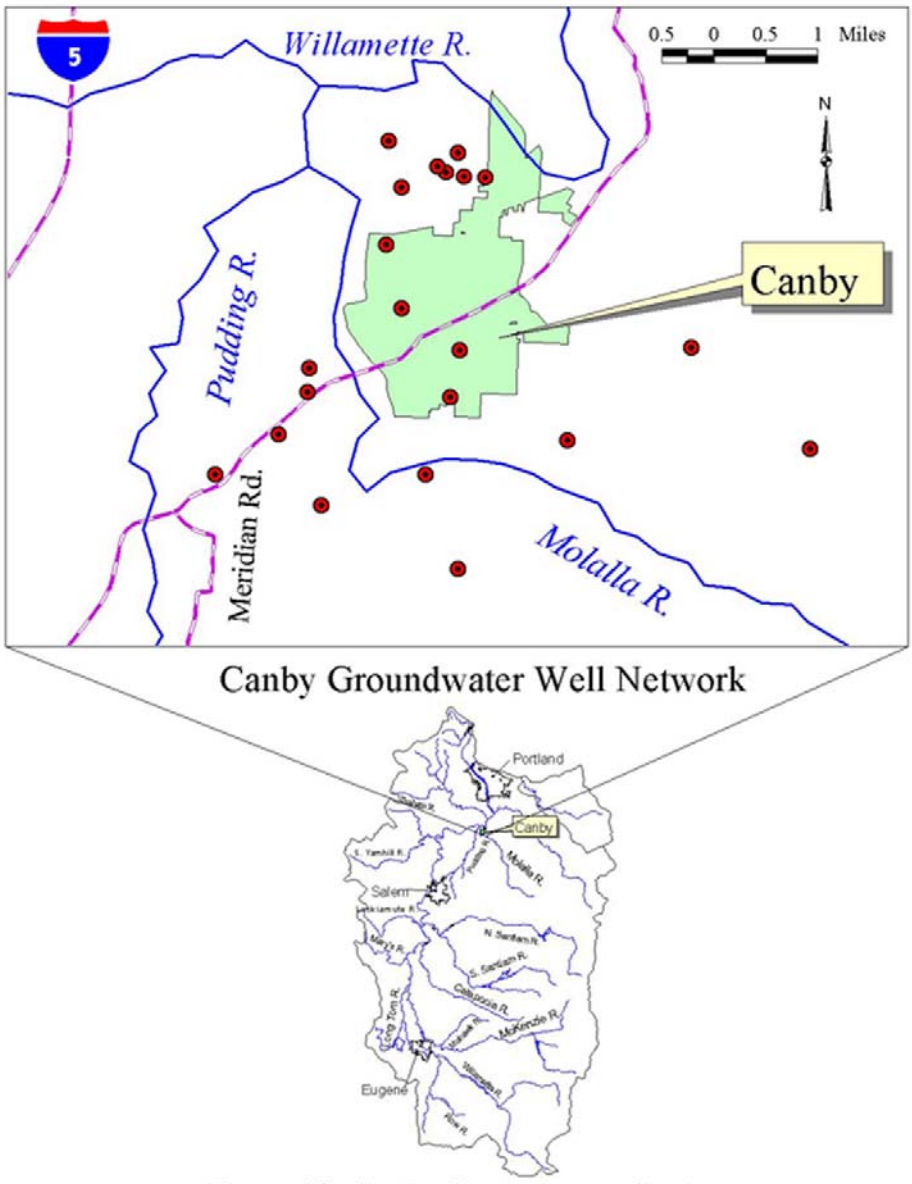

Figure 20: Canby Groundwater Study

The DEQ and ODA laboratories analyzed groundwater samples for various constituents listed on Tables 20, 21, and 22 in Appendix 1 including:

- Volatile organic compounds (VOCs) including solvents and ethylene dibromide (EDB),
- Pesticides with a suite of 10 analytes and screening analyses for nitrogen-phosphorous, organophosphate, organochloride, phenoxy herbicides, carbamates, and miscellaneous pesticides, and
- Others such as physical parameters, nutrients, and metals.

The pesticides included in the five screening analyses, along with the method reporting limits, are listed in Table 23, Appendix 1. The analyses for wells the DEQ re-sampled included physical parameters, nitrate, and VOCs or pesticides if detected in the initial sampling.

Results

Table 9, below, and Table 4, Appendix 2, summarize the sampling results.

- Nitrate[7] was detected in 16 of 21 wells and exceeded the 10 mg/L MCL in 3 wells (14%).
- Dacthal, a pesticide, was detected in one well but not confirmed by re-sampling.
- Toluene, a volatile organic compound, was detected in 2 wells at concentrations below the MCL, but was not confirmed on re-sampling.
- 1,1,2,2-tetrachloroethylene was detected in one well at concentrations below the MCL of 0.005 mg/L.

Figure 21 shows the Canby well network, highlighting the locations where nitrates exceeded the drinking water MCL of 10 mg/L (yellow triangles).

Table 9
Canby (1993)

Contaminant	Number of Wells (Detected)	Average* Concentration (mg/L)	Maximum Concentration (mg/L)	NPDW MCL** (mg/L)	Number of Wells Over MCL
Nitrate	16	4.04***	27.00	10.00	3
1,1,2,2-Tetrachloro ethylene	1	0.0031	0.0031	0.005	0
Toluene	2	0.0013	0.0014	1	0
Copper	3	0.07	0.14	1.3 (Action Limit)	0
Barium	2	0.09	0.15	2	0

*Average concentration calculated for wells with detectable contaminant levels and may include multiple sampling events.
**NPDW MCL = National Primary Drinking Water Maximum Contaminant Level (mg/L = milligrams per liter = parts per million)
***Average concentration calculated for all wells. Wells with non-detects are assigned a value of one half the detection limit.

Data from the DEQ's sampling are available in LASAR through the internet at http://www.deq.state.or.us/wq/lasar/EventLocatorCriteria.htm and can be retrieved using Canby Groundwater as the sampling event name.

[7] Nitrate was analyzed as nitrate plus nitrite as nitrogen, and is assumed to be primarily in the form of nitrate.

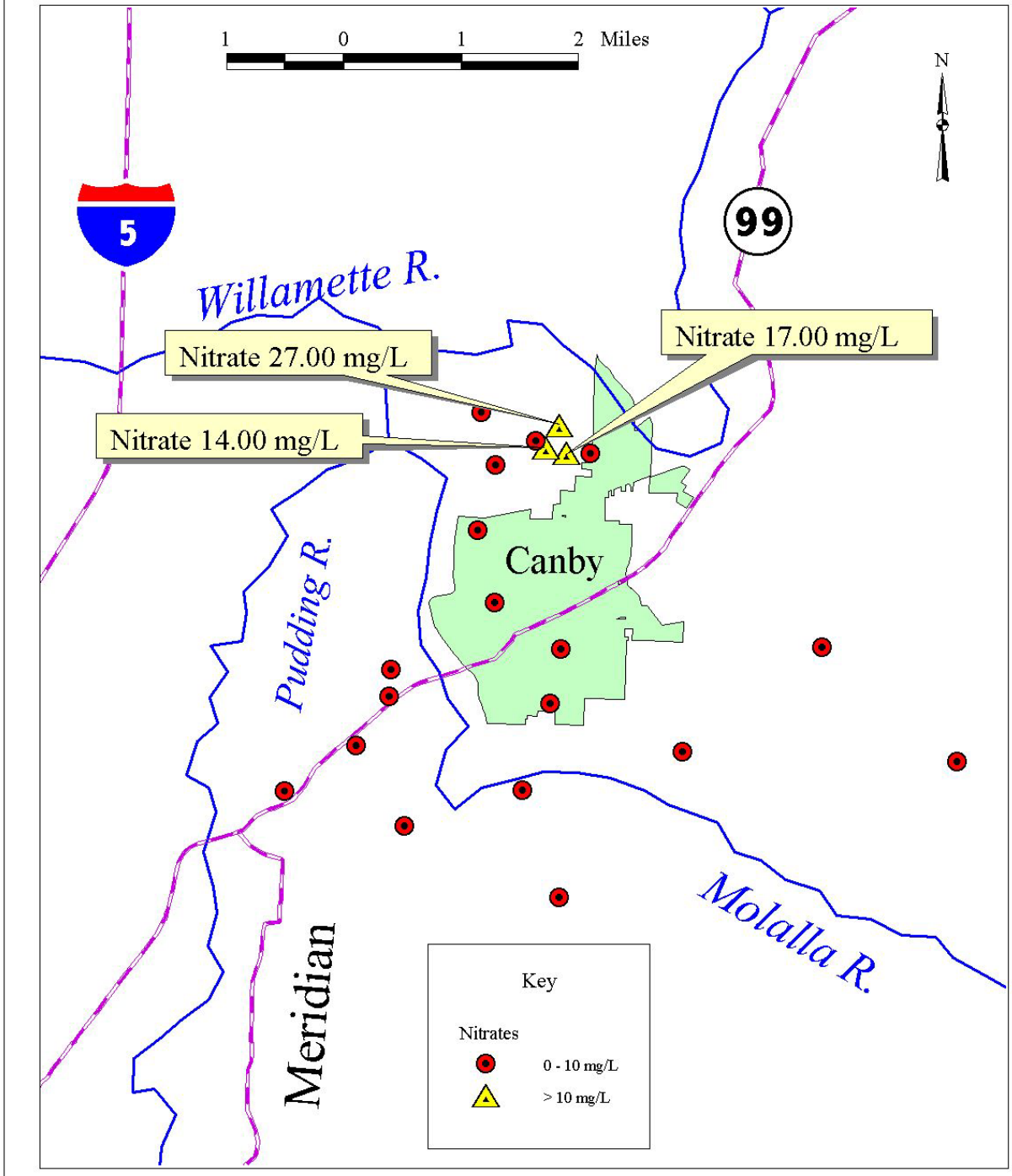

Figure 21. Canby Well Network, showing wells with Nitrates over MCL (yellow triangles).

Woodburn Groundwater Study (1993); Oregon Department of Environmental Quality.

Summary

As part of the Statewide Ambient Groundwater Monitoring Program, the DEQ sampled Woodburn area groundwater in March 1993. The main contaminants of concern were nitrate and pesticides associated with agricultural land use and on-site septic systems. The DEQ collected groundwater samples from 19 water wells. The DEQ resampled one of two wells in August 1993 to confirm initial results suggesting VOC contamination. The DEQ could not resample the second well because it was out of service. Figure 22 shows the well locations.

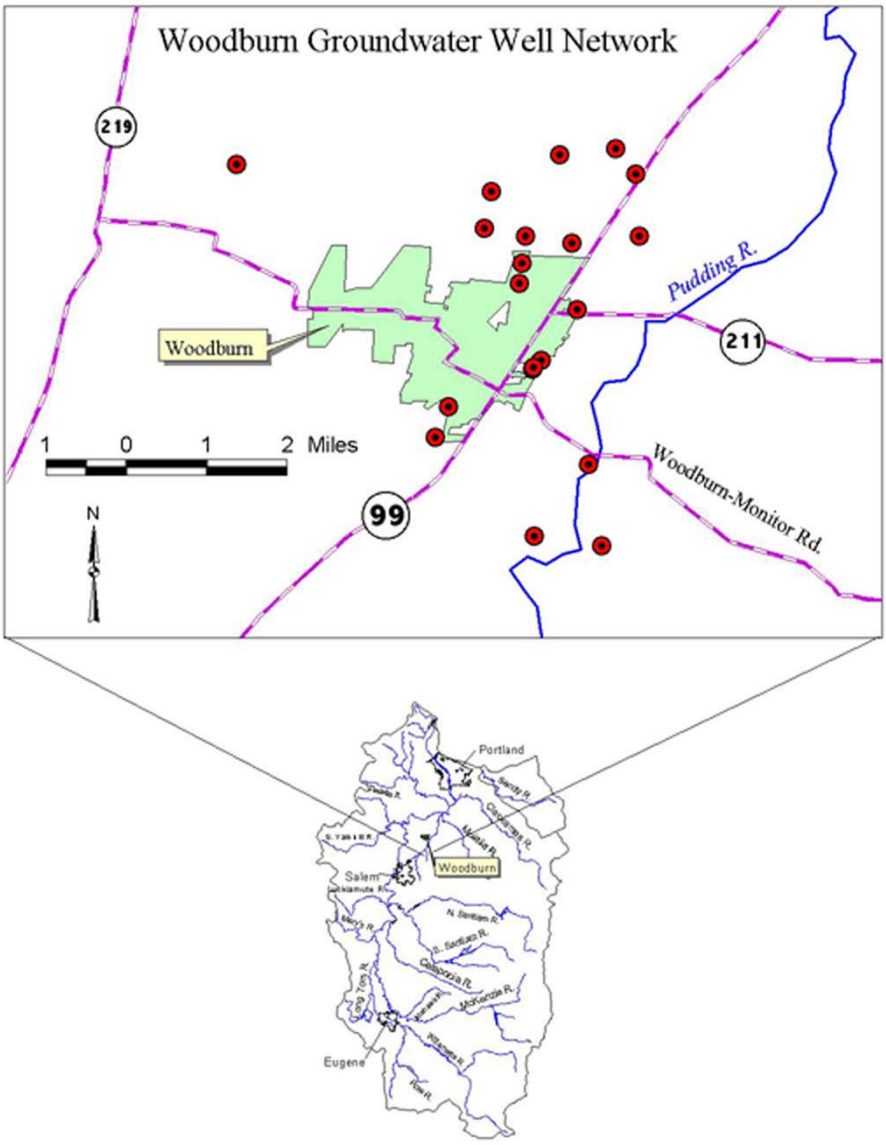

Figure 22: Woodburn Groundwater Study

The DEQ and ODA laboratories analyzed groundwater samples for various constituents listed on Tables 24, 25, and 26 in Appendix 1 including:

- Volatile organic compounds (VOCs) including solvents and ethylene dibromide (EDB);
- Pesticides with a suite of 12 analytes and screening analyses for nitrogen-phosphorous, organophosphate, organochloride, phenoxy herbicides, carbamates, and miscellaneous pesticides; and
- Others such as physical parameters, nutrients, and metals.

The pesticides included in the five screening analyses, along with the method detection limits, are listed in Table 23, Appendix 1. The analyses for the well that was re-sampled included physical parameters, nitrate, and VOCs. Resources at the time of resampling were available to confirm initial detections of VOCs, pesticides, physical parameters, and nutrients.

Results

Table 10, below, and Table 5, Appendix 2, summarize the sampling results.

- Nitrate[8] was detected in seven of 19 (37%) wells but none exceeded the 10 mg/L MCL.
- 1,1,2,2-tetrachloroethylene was detected in two wells at concentrations below the MCL (0.005 mg/L), but was not confirmed on re-sampling.
- Arsenic was detected in 12 wells and exceeded the MCL of 0.01 mg/L in 7 wells (37%).
- Barium was detected in three wells at concentrations below the MCL (2 mg/L).
- Copper was detected in one well at concentrations below the Action Level (1.3 mg/L).

Figure 23 shows the Woodburn well network, highlighting the locations where arsenic exceeded the drinking water MCL (yellow triangles).

Table 10
Woodburn Groundwater Study (1993)

Contaminant	Number of Wells (Detected)	Average* Concentration (mg/L)	Maximum Concentration (mg/L)	NPDW MCL** (mg/L)	Number of Wells Over MCL
Nitrate	8	0.57***	5.60	10.00	0
Arsenic	12	0.012***	0.022	0.01	7
Barium	3	0.04	0.05	2	0
Copper	1	0.03	0.03	1.3 (Action Limit)	0

*Average concentration calculated for wells with detectable contaminant levels and includes multiple sampling events.
**NPDW MCL = National Primary Drinking Water Maximum Contaminant Level (mg/L = milligrams per liter = parts per million)
***Average concentration calculated for all wells. Wells with non-detects are assigned a value of one half the detection limit.

Data from the DEQ's sampling are available in LASAR through the internet at http://www.deq.state.or.us/wq/lasar/EventLocatorCriteria.htm and can be retrieved using Woodburn Groundwater as the sampling event name.

[8] Nitrate was analyzed as nitrate plus nitrite as nitrogen, and is assumed to be primarily in the form of nitrate.

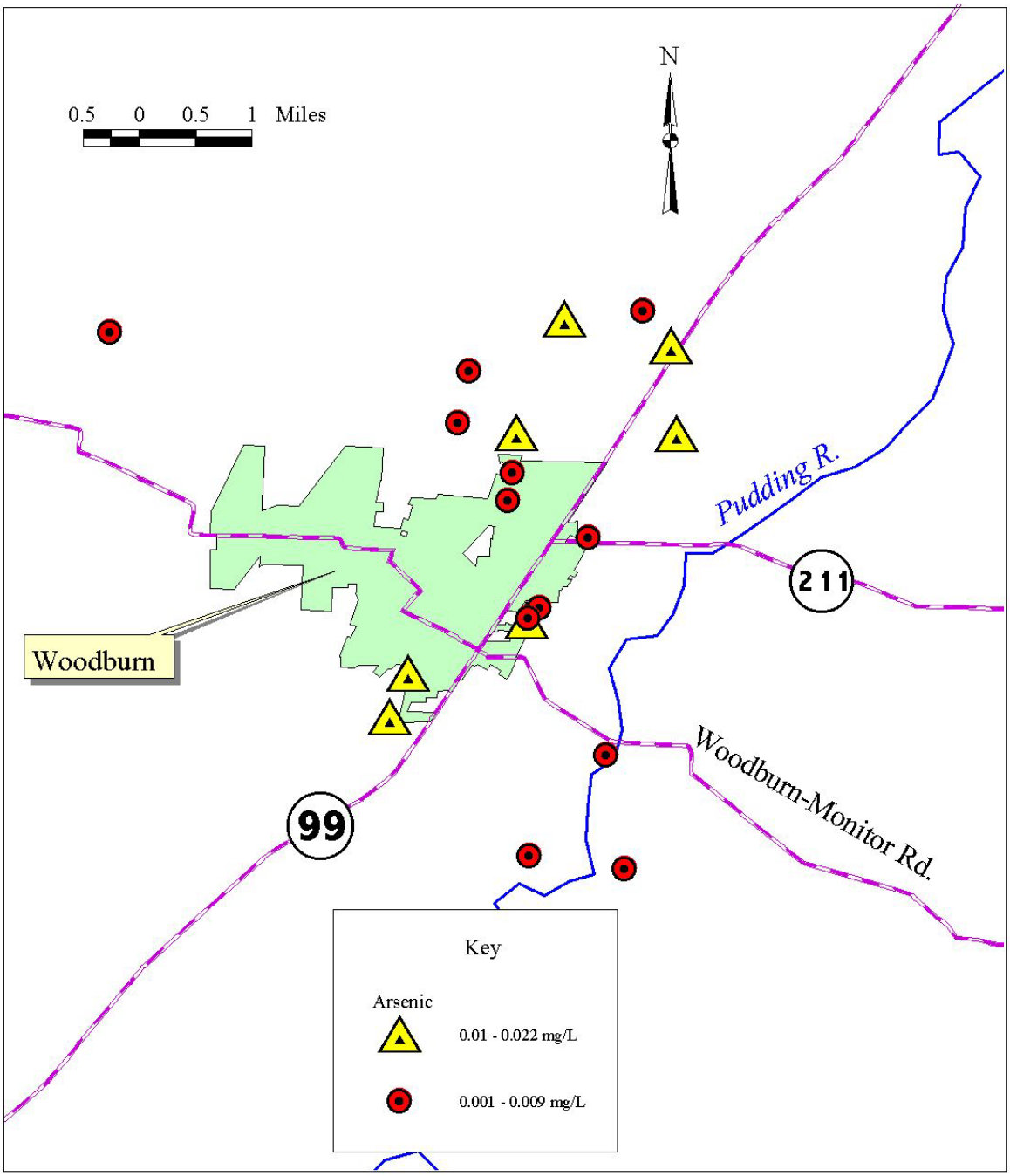

Figure 23. Woodburn Well Network, showing well locations where Arsenic exceeded the MCL (yellow triangles).

Southern Willamette Basin Study Results

North Albany Groundwater Study (1985-1986); Oregon Department of Environmental Quality.

Summary

Between September 1985 and October 1986, the DEQ conducted a groundwater study in the North Albany area. The main contaminants of concern were nitrate and volatile organic compounds associated with a high density of septic systems in an urban setting. The DEQ collected groundwater samples from 30 wells. Figure 24 shows the well locations.

The DEQ laboratory analyzed groundwater samples for various constituents listed on Tables 27 and 28 in Appendix 1 including:

- Volatile organic compounds (VOCs) including solvents and ethylene dibromide (EDB);
- Others such as physical parameters, nutrients, and metals.

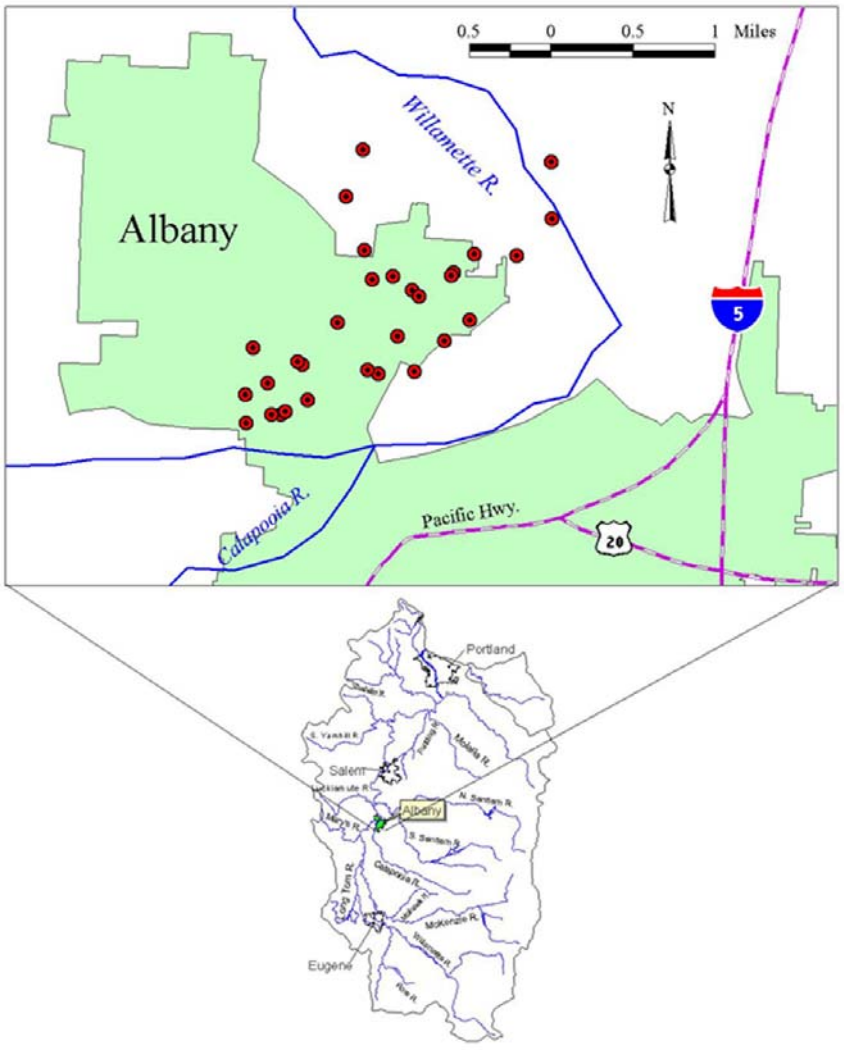

Figure 24: North Albany Groundwater Study

Results

Table 11 summarizes the sampling results.

- Nitrate[9] was detected in all wells, and concentrations in one well exceeded the 10 mg/L MCL.
- Total coliform bacteria were detected in 2 wells.
- Trichloroethylene was detected in 3 wells. Concentrations in one well exceeded the MCL.
- Chromium, arsenic, copper, and chloroform were detected, but concentrations did not exceed the MCLs.

[9] Nitrate was analyzed as nitrate plus nitrite as nitrogen, and is assumed to be primarily in the form of nitrate.

Figure 25 shows the groundwater sampling network and highlights locations where samples exceeded MCLs. The groundwater sampling data is available from the DEQ in hard copy format or on microfilm.

Table 11
North Albany Groundwater Study (1985-1986)

Contaminant	Number of Wells (Detected and Confirmed)	Average* Concentration (mg/L)	Maximum Concentration (mg/L)	NPDW MCL** (mg/L)	Number of Wells Over MCL
Nitrate	30	4.91	14.00	10	1
Total Coliform Bacteria	2	20 (colonies/100 ml)	20 (colonies/100 ml)	1 positive per month	2
Trichloroethylene	3	0.014	0.037	0.005	1
Chloroform	2	0.002	0.002	0.080	0
Chromium	5	0.004	0.008	0.1	0
Copper	7	0.22	0.124	1.3 (Action Level)	0
Arsenic	5	0.005	0.006	0.010	0

*Average concentration calculated for wells with detectable contaminant levels.
**NPDW MCL = National Primary Drinking Water Maximum Contaminant Level (mg/L = milligrams per liter = parts per million)

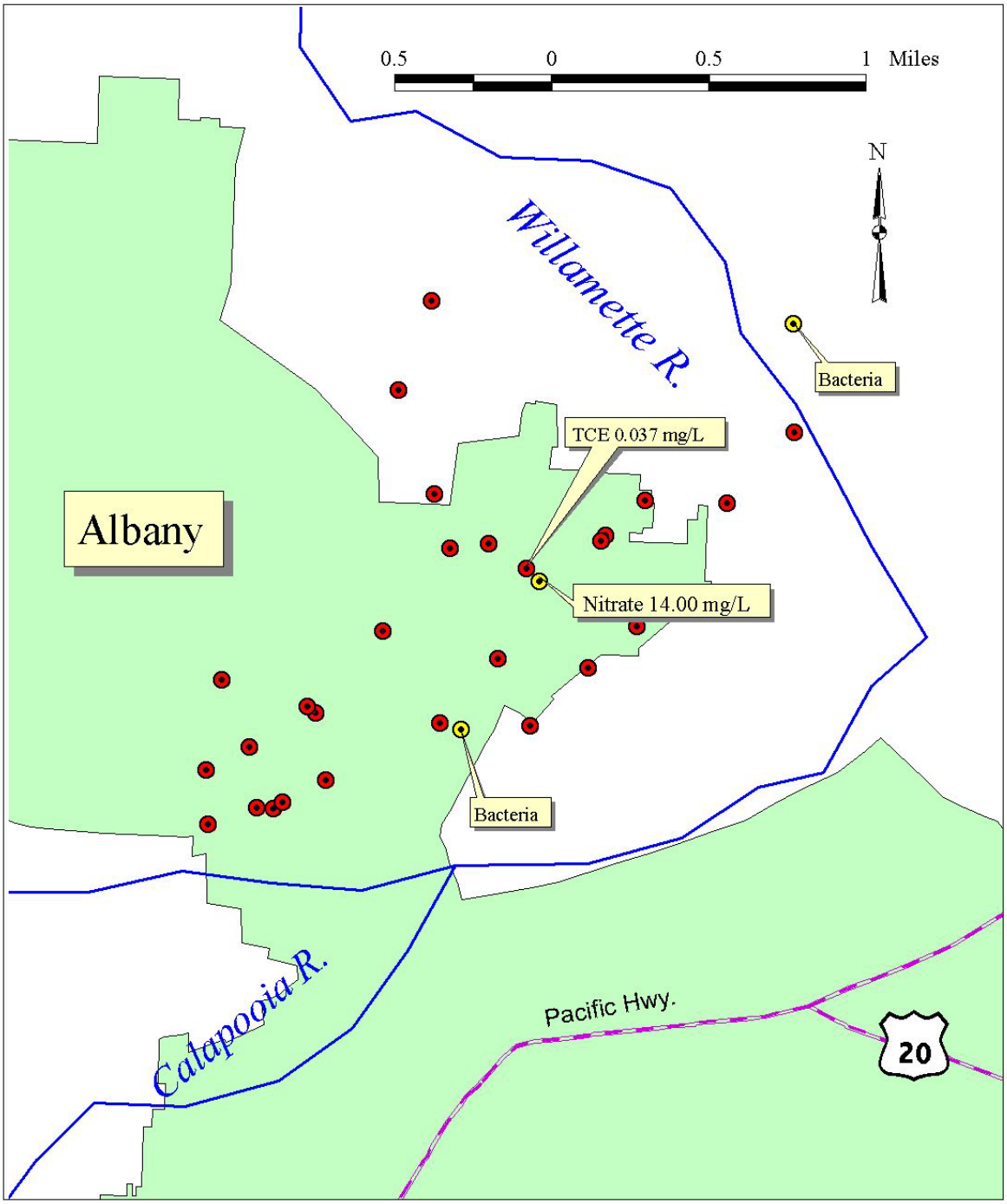

Figure 25. North Albany Well Network, showing locations where MCLs were exceeded.

Junction City Groundwater Study (1993); Oregon Department of Environmental Quality.

Summary

As part of the Statewide Ambient Groundwater Monitoring Program, the DEQ sampled Junction City area groundwater in April 1993. The main contaminants of concern were nitrate and pesticides associated with agricultural land use and on-site septic systems. The DEQ collected groundwater samples from 20 water wells. In August 1993, the DEQ resampled 11 wells to confirm the initial results. Figure 26 shows the well locations.

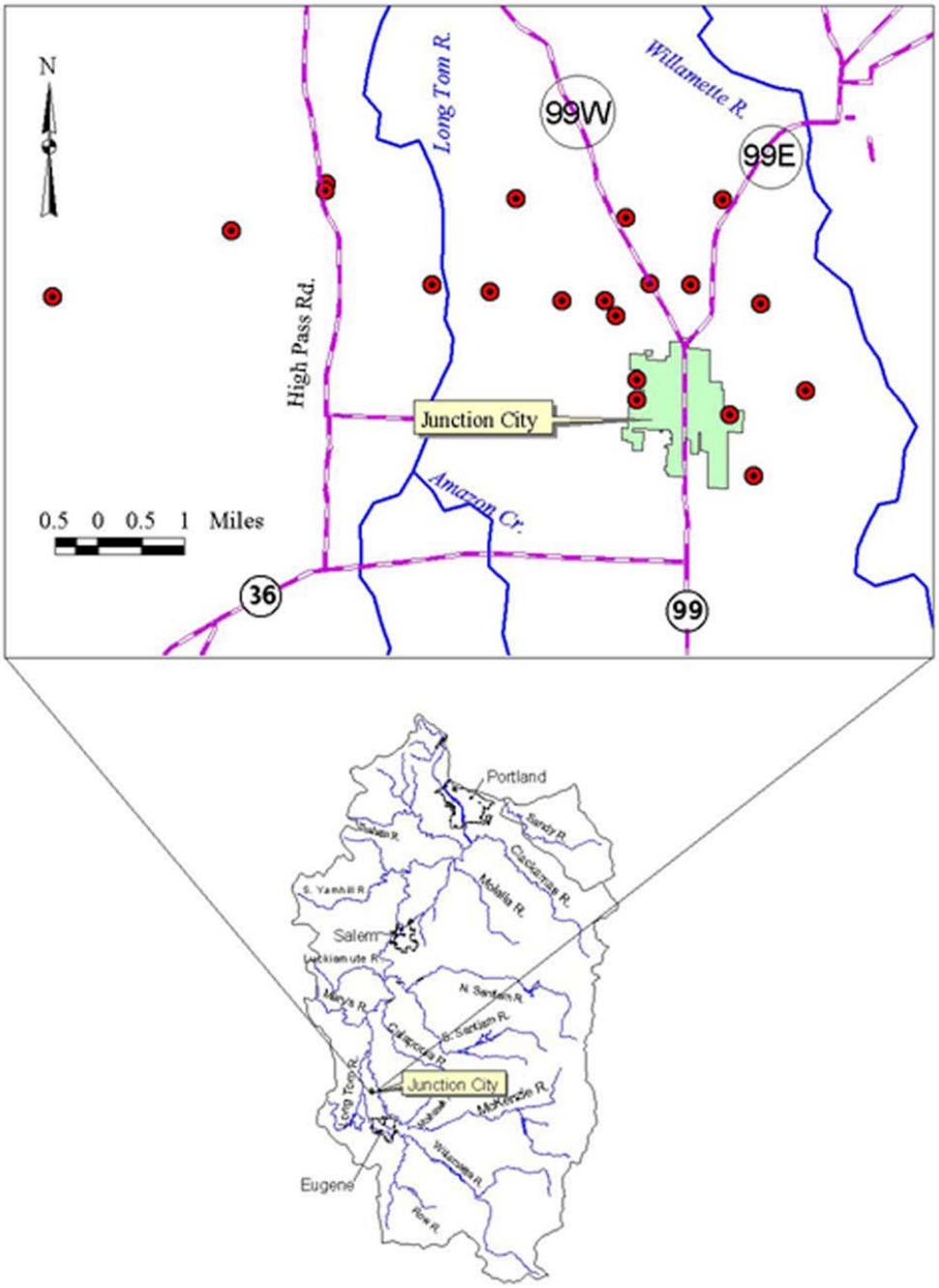

Figure 26: Junction City Groundwater Study

The DEQ and ODA laboratories analyzed groundwater samples for various constituents listed on Tables 29, 30, and 31 in Appendix 1 including:

- Volatile organic compounds (VOCs) including solvents and ethylene dibromide (EDB);
- Pesticides with a suite of 13 analytes and screening analyses for carbamate pesticides; and
- Others such as physical parameters, nutrients, and metals.

The pesticides included in the carbamate screening analysis, along with the method detection limits, are listed in Table 23, Appendix 1. The analyses for wells DEQ resampled included physical parameters, nitrate, and VOCs or pesticides if detected in the initial sampling.

Results

Table 12, below, and Table 6, Appendix 2, summarize the sampling results.

- Nitrate[10] was detected in 14 of 20 wells (70%) and exceeded the MCL (10 mg/L) in eight wells (40%).
- Atrazine, a pesticide, was detected in two wells at concentrations of 0.00035 mg/L and 0.0008 mg/L, but was not detected on resampling. The detection limit for this analysis was 0.0002 mg/L.
- 1,1,1,-trichloroethane was detected in four wells at concentrations below the MCL (0.2 mg/L), but was only detected in two wells on resampling
- Barium was detected in one well at concentrations below the MCL (2 mg/L).
- Copper was detected in two wells at concentrations below the Action Level (1.3 mg/L).
- Lead was detected in three wells at concentrations below the Action Level (0.015 mg/L).

Figure 27 shows the Junction City well network, highlighting the well locations where nitrate exceeded the drinking water MCL (yellow triangles).

Table 12
Junction City Groundwater Study (1993)

Contaminant	Number of Wells (Detected and Confirmed)	Average* Concentration (mg/L)	Maximum Concentration (mg/L)	NPDW MCL** (mg/L)	Number of Wells Over MCL
Nitrate	14	8.28***	31	10	8
1,1,1-Trichloroethane	4	0.0017	0.0037	0.2	0
Barium	1	0.03	0.03	2	0
Lead	3	0.007	0.012	0.015 (Action Level)	0
Copper	2	0.02	0.02	1.3 (Action Level)	0

*Average concentration calculated for wells with detectable contaminant levels.
**NPDW MCL = National Primary Drinking Water Maximum Contaminant Level (mg/L = milligrams per liter = parts per million)
***Average concentration calculated for all wells. Wells with non-detects are assigned a value of one half the detection limit.

Data from the DEQ's sampling are available in LASAR through the internet at http://www.deq.state.or.us/wq/lasar/EventLocatorCriteria.htm and can be retrieved using Junction City Groundwater as the sampling event name.

[10] Nitrate was analyzed as nitrate plus nitrite as nitrogen, and is assumed to be primarily in the form of nitrate.

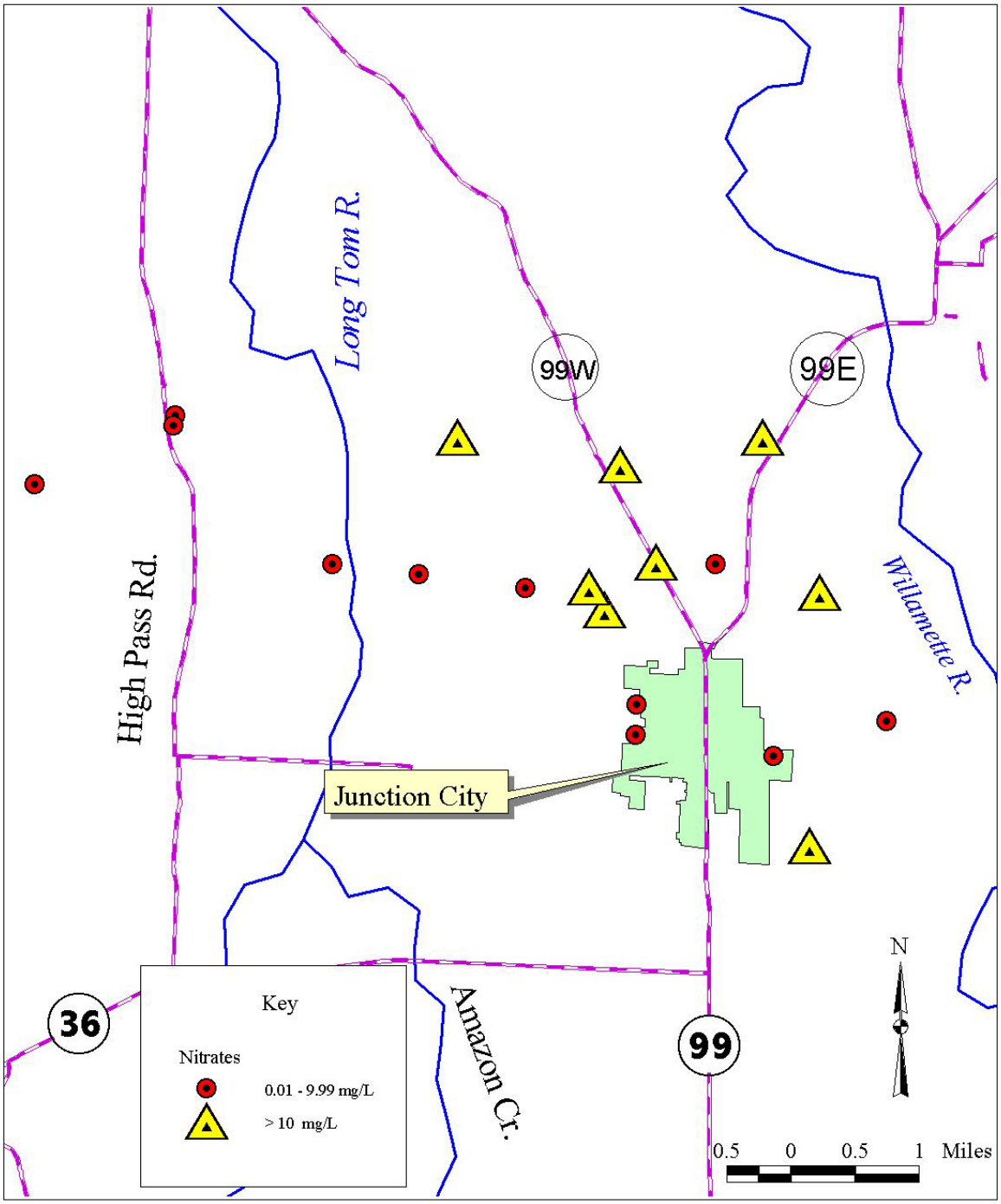

Figure 27. Junction City Well Network, showing the locations where Nitrates exceeded the MCL (yellow triangles).

Albany/Lebanon Groundwater Study (1993); Oregon Department of Environmental Quality.

Summary

As part of the Statewide Ambient Groundwater Monitoring Program, the DEQ sampled Albany/Lebanon area groundwater in August 1993. The main contaminants of concern were nitrate and pesticides associated with agricultural land use and on-site septic systems. Figure 28 shows the well locations.

The DEQ and ODA laboratories analyzed groundwater samples for various constituents listed on Tables 32, 33, and 34 in Appendix 1, including:

- Volatile organic compounds (VOCs) including solvents and ethylene dibromide (EDB);
- Pesticides including a suite of 15 analytes; and
- Others such as physical parameters, nutrients, and metals.

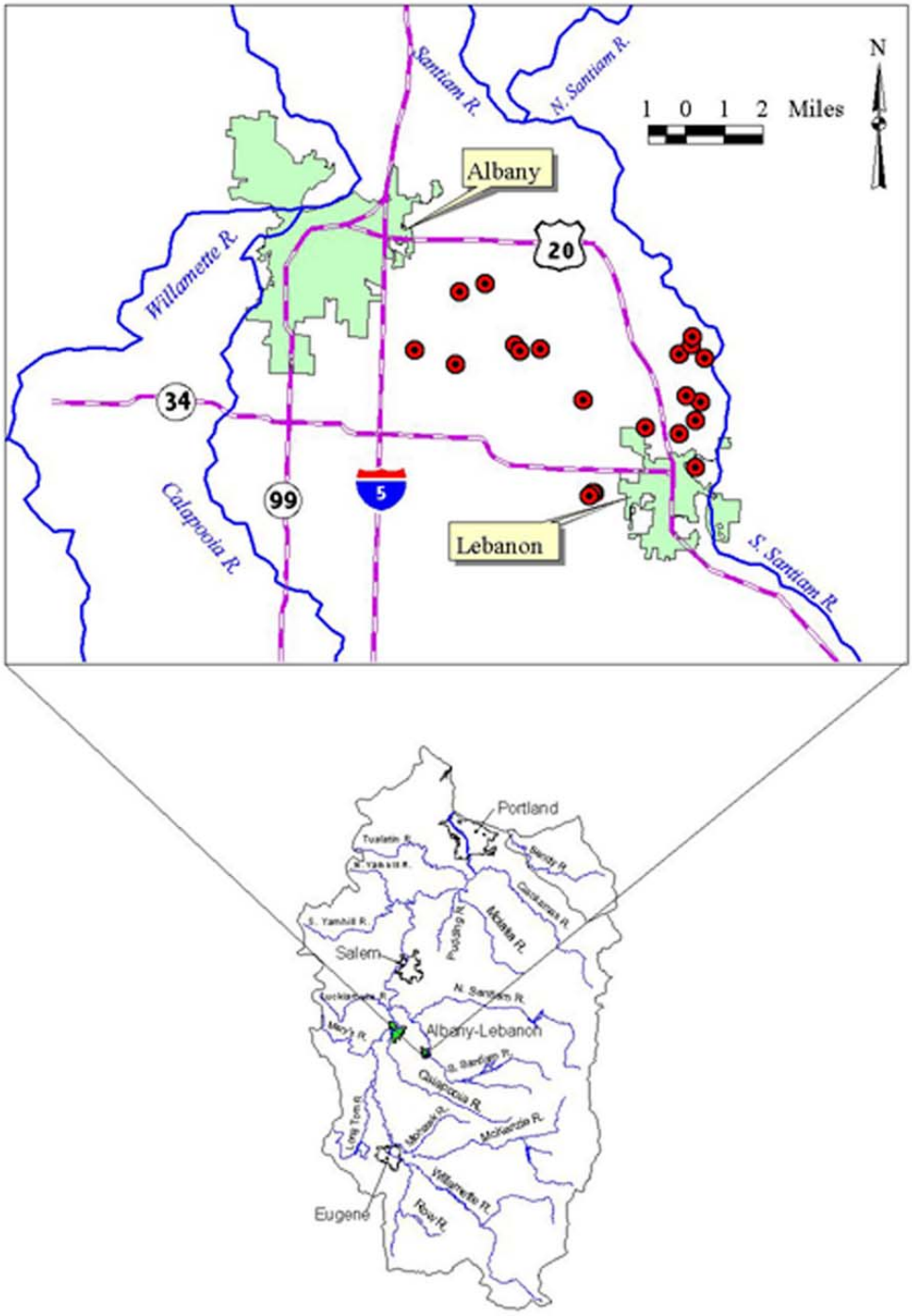

Figure 28: Albany/Lebanon Groundwater Study

Results

Table 13, below, and Table 7, Appendix 2, summarize the sampling results.

- Nitrate[11] was detected in 17 of 21 (81%) wells at concentrations ranging from 0.02 to 6.5 mg/L, all of which were below the MCL (10 mg/L).
- No pesticides were detected. The reporting limit for Atrazine in this study was 0.0009 mg/L.
- Copper was detected in one well at concentrations below the Action Level (1.3 mg/).

Table 13
Albany/Lebanon Groundwater Study (1993)

Contaminant	Number of Wells (Detected and Confirmed)	Average* Concentration (mg/L)	Maximum Concentration (mg/L)	NPDW MCL** (mg/L)	Number of Wells Over MCL
Nitrate	18	1.91***	6.50	10	0
Copper	1	0.02	0.02	1.3 (Action Level)	0

*Average concentration calculated for wells with detectable contaminant levels.
**NPDW MCL = National Primary Drinking Water Maximum Contaminant Level (mg/L = milligrams per liter = parts per million)
***Average concentration calculated for all wells. Wells with non-detects are assigned a value of one half the detection limit.

Data from the DEQ's sampling are available in LASAR through the internet at http://www.deq.state.or.us/wq/lasar/EventLocatorCriteria.htm and can be retrieved using Lebanon/Albany Groundwater as the sampling event name.

Coburg Groundwater Study (1994); Oregon Department of Environmental Quality.

Summary

As part of the Statewide Ambient Groundwater Monitoring Program, the DEQ sampled Coburg area groundwater in June 1994. The main contaminants of concern were nitrate and pesticides associated with agricultural land use and on-site septic systems. The DEQ collected groundwater samples from 20 water wells. Figure 29 shows the well locations.

[11] Nitrate was analyzed as nitrate plus nitrite as nitrogen, and is assumed to be primarily in the form of nitrate.

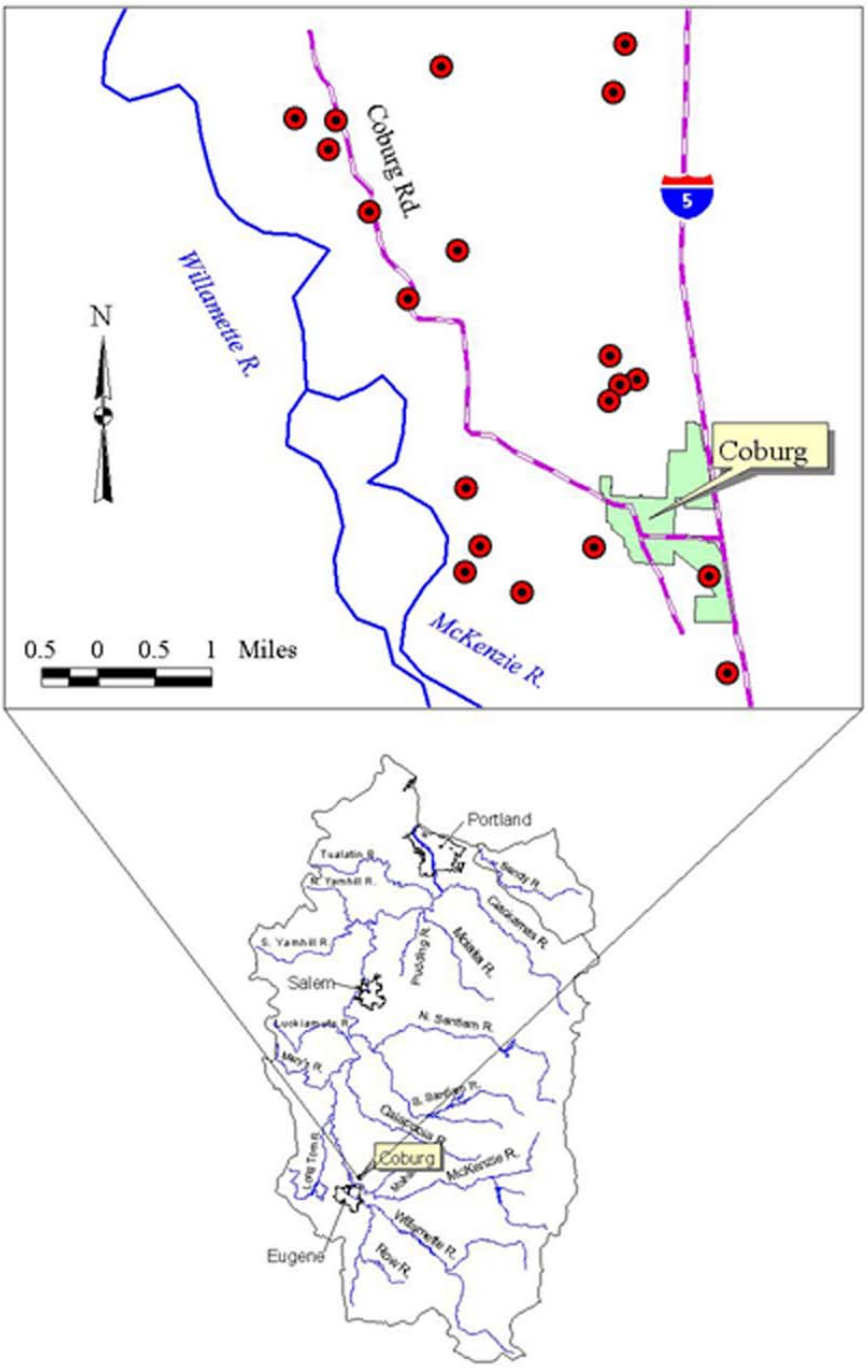

Figure 29: Coburg Groundwater Study

The DEQ and ODA laboratories analyzed groundwater samples for various constituents listed on Tables 35, 36, 37 in Appendix 1, including:

- Volatile organic compounds (VOCs) including solvents and ethylene dibromide (EDB);
- Pesticides with a suite of 20 analytes; and
- Others such as physical parameters, nutrients, and metals.

Results

Table 14, below, and Table 8, Appendix 2, summarize the sampling results.

- Nitrate[12] was detected in 20 wells and exceeded the MCL (10 mg/L) in five wells (25%). Nitrate concentrations ranged from 0.58 to 15 mg/L.
- No pesticides were detected. The reporting limit for Atrazine in this study was 0.00024 mg/L.
- Copper was detected in one well at concentrations below the Action Level (1.3 mg/L).

Figure 30 shows the well locations where nitrate exceeded the drinking water MCL.

Table 14
Coburg Groundwater Study (1994)

Contaminant	Number of Wells (Detected and Confirmed)	Average* Concentration (mg/L)	Maximum Concentration (mg/L)	NPDW MCL** (mg/L)	Number of Wells Over MCL
Nitrate	20	5.81	15	10	5
Copper	1	0.03	0.03	1.3 (Action Level)	0

*Average concentration calculated for wells with detectable contaminant levels.
**NPDW MCL = National Primary Drinking Water Maximum Contaminant Level (mg/L = milligrams per liter = parts per million)

Data from the DEQ's sampling are available in LASAR through the internet at http://www.deq.state.or.us/wq/lasar/EventLocatorCriteria.htm and can be retrieved using Coburg Groundwater as the sampling event name.

[12] Nitrate was analyzed as nitrate plus nitrite as nitrogen, and is assumed to be primarily in the form of nitrate.

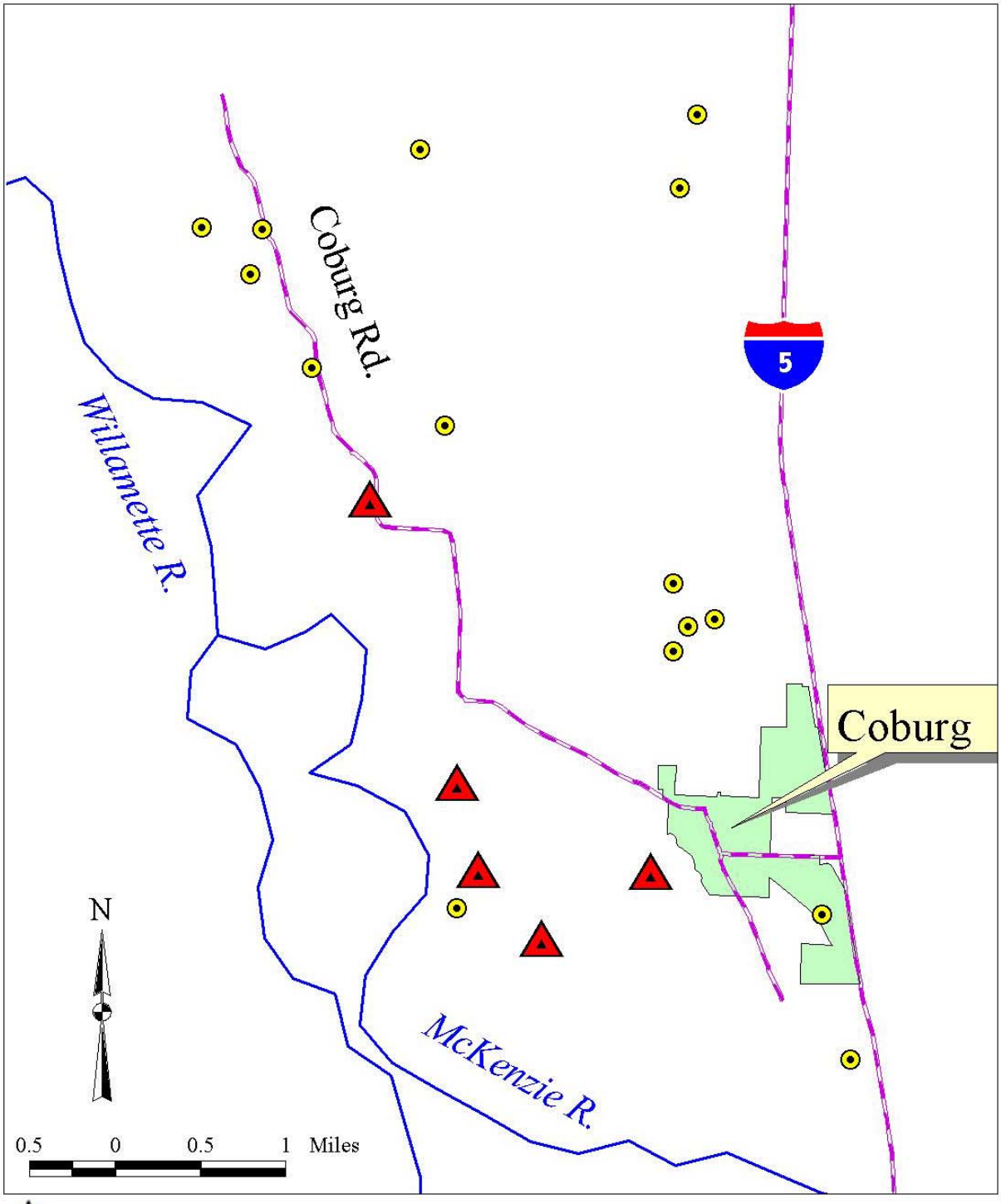

Figure 30: Coburg: Nitrates Above 10 mg/L

Sweet Home Groundwater Study (1994-2003); Oregon Department of Environmental Quality.

Summary

In 1988, testing of the Wagon Wheel Mobile Home Park water supply well in Sweet Home detected volatile organic compound (VOC) contamination. The Oregon Health Division, Drinking Water Program (now the Department of Human Services), assessed the area's domestic water supplies in 1991 and 1992. The Health Division found perchloroethylene (PCE) and trichloroethylene (TCE) in several wells, but did not identify the contamination source. The problem was referred to DEQ's Site Assessment program.

In 1994 and 1995, the DEQ sampled 33 domestic water wells in the area. Of these wells, 17 (52%) had detectable levels of VOCs, and nine (27%) of those wells had VOCs above federal Drinking Water Maximum Contaminant Levels (MCLs). The DEQ began supplying bottled water to the users of the nine affected wells. Figure 31 shows the locations of some of the wells sampled in the Sweet Home groundwater study.

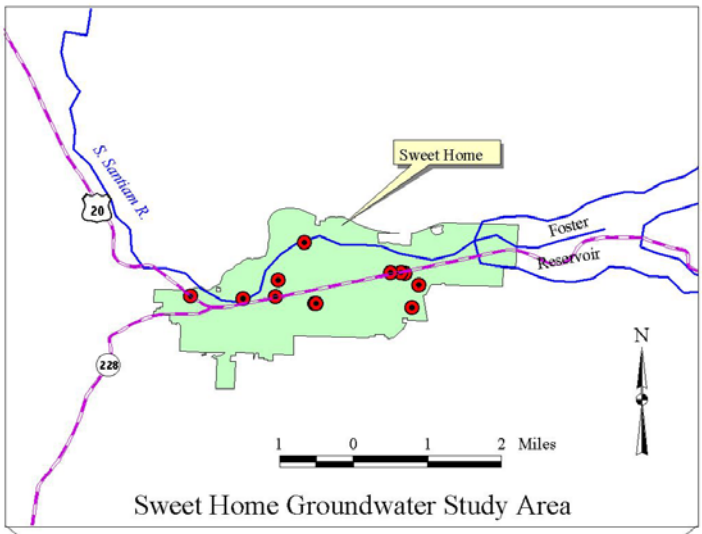

Figure 31. Sweet Home Groundwater Study Area.

The DEQ and the U.S. Environmental Protection Agency (EPA) continued investigations in 1995 and 1996 to determine the contamination source. The DEQ designated the project a state Orphan Site in 1996. In 1997 the DEQ installed monitoring wells to study aquifer conditions and groundwater quality. The DEQ also continued sampling domestic wells to identify water supplies with VOC concentrations above the MCLs. The DEQ installed carbon filtration systems on four wells, and connected 17 other households to the municipal water supply system. In 2000, the City of Sweet Home completed connecting all affected households to the municipal water supply system.

Results

Table 15 summarizes the sampling results. Note: The following factors explain why the table has fewer columns than the other summary tables in this report. Sampling information was insufficient to assign LASAR database station numbers to individual sample sites. The DEQ LASAR web page lists 14 cases for Sweet Home Groundwater, but several of those cases have no data in LASAR. The raw data is in LASAR, but none of the data can be linked to a particular sample location. Hence, several statistics cannot be computed for the compounds detected.

Table 15
Sweet Home Groundwater Study (1994-2003)

Contaminant	Maximum Concentration (mg/L)	NPDW MCL* (mg/L)
Tetrachloroethylene	62	0.005
Cis-1,2-Dichloroethylene	1.09	0.07
Trichloroethylene	0.545	0.005
Perchloroethylene	0.85	None
Total hydrocarbons as diesel	24	None
Phenol	0.002	None
Trans-1,2-Dichloroethylene	0.7	0.1
1,1,1-Trichloroethane	0.0486	0.2
1,1,2-Trichloroethane	0.0046	0.005
1,1,2,2-Tetrachloroethylene	0.065	None
1,1-Dichloroethylene	0.028	0.007
1,1-Dichloroethane	0.0047	None
Methylene Chloride	0.0007	None
Chloroform	0.0382	0.08
Bromodichloromethane	0.0046	0.08

*NPDW MCL = National Primary Drinking Water Maximum Contaminant Level (mg/L = milligrams per liter = parts per million)

Data from the DEQ's sampling are available in LASAR through the internet at http://www.deq.state.or.us/wq/lasar/EventLocatorCriteria.htm and can be retrieved using Sweet Home Groundwater as the sampling event name. For other sampling information, contact the DEQ laboratory. General information on the investigation to identify contaminant sources is

available through the Environmental Cleanup Site Information (ECSI) database at http://www.deq.state.or.us/wmc/ecsi/ecsiquery.htm (Site ID 1240 Sweet Home Area groundwater Contamination). Remedial investigation project reports are available on-line at http://www.deq.state.or.us/wmc/cleanup/sweethome.htm or by contacting DEQ's Land Quality Division Site Response program.

Southern Willamette Valley Groundwater Study (2000-2002); Oregon Department of Environmental Quality.

Summary

As a follow up to the 1993 and 1994 Statewide Ambient Groundwater Monitoring studies in the Coburg and Junction City areas, the DEQ conducted further groundwater quality assessments in the Southern Willamette Valley in 2000, 2001, and 2002. Over the course of this study, the DEQ collected groundwater samples from 476 water wells. Figure 32 shows the study area and the well locations. In 2002, the DEQ resampled wells that previously had nitrate levels 7 mg/L or greater.

The DEQ and ODA laboratories analyzed groundwater samples for various constituents listed in Tables 38 and 39, Appendix 1, including:

- Nitrate (2000, 2001, 2002).
- Field parameters .(temperature, pH, and specific conductance) (2000, 2001, 2002).
- Metals (2002).
- Pesticides with a suite of 31 analytes, and screening for other pesticides and caffeine (2002).
- Bacteria (2002) using a semi-quantitative method.

The Oregon Department of Agriculture (ODA) laboratory analyzed the pesticides using a solid phase extraction (SPE) method. This method achieved detection limits on the order of parts per trillion (ppt) or

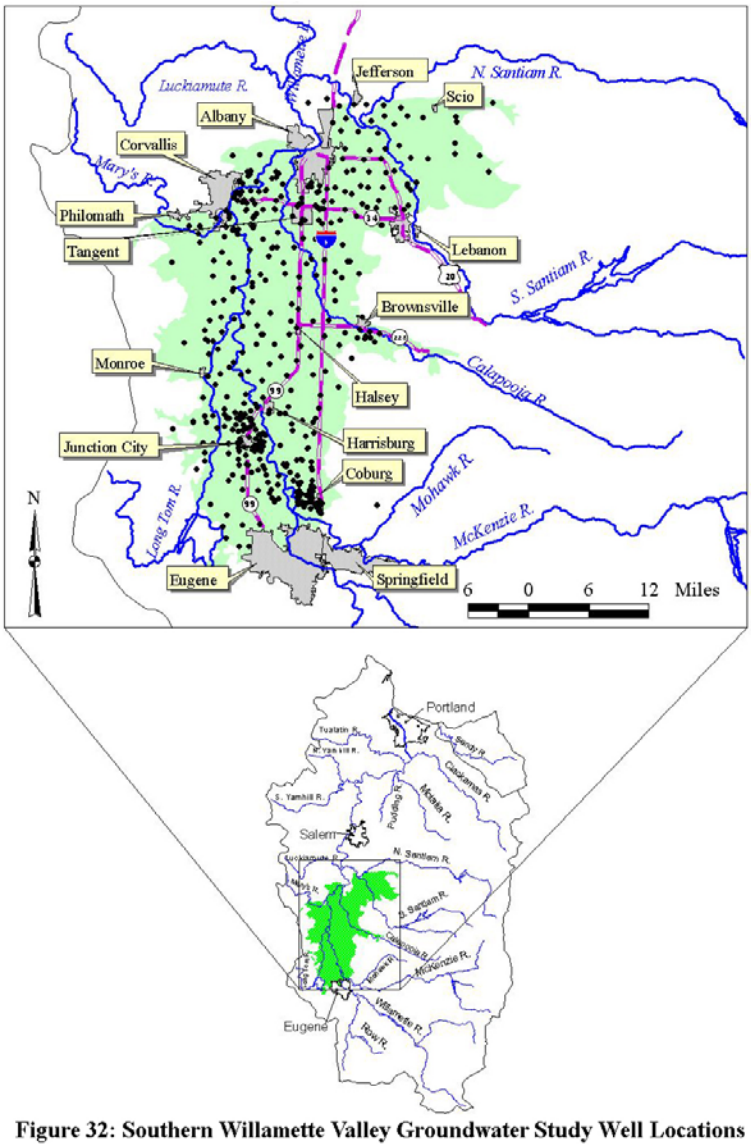

Figure 32: Southern Willamette Valley Groundwater Study Well Locations

nanograms per liter (ng/L) for pesticides in the dissolved phase. Detection limits for previous statewide ambient monitoring studies were on the order of parts per billion.

Results

Table 16 summarizes the sampling results from 486 wells sampled during the course of the study (2000-2002).

- Nitrate[13] was detected in 231 wells (48%) at concentrations less than 3 mg/L.
- Nitrate was detected in 200 wells (41%) at concentrations between 3 and 10 mg/L.
- Nitrate was detected in 55 wells (11%) at concentrations exceeding the MCL of 10 mg/L.
- Bacteria were present in 29 wells (6%).
- Pesticides were detected in 64 of 93 wells (69%). Fifteen different pesticides were detected. Three of the detected pesticides have MCLs, and the detected concentrations were below these levels. Atrazine was detected in 33 % of the samples; desethyl atrazine was detected in 58% of the samples; and simazine was detected in 12% of the samples.

Figures 33, 34, 35, and 36 show the locations where nitrate concentrations were below 3 mg/L, 3 and 10 mg/L, exceeded the MCL of 10 mg/L, and where pesticides were detected, respectively.

Table 16
Southern Willamette Valley Groundwater Study (2000-2002)

Contaminant	Number of Wells (Detected and Confirmed)	Average* Concentration (mg/L)	Maximum Concentration (mg/L)	NPDW MCL** (mg/L)	Number of Wells Over MCL
Bacteria – Total Coliform	29	N.A.[1]	N.A.	1 positive per month	29
Nitrate	445	4.51	27.8	10	55
Desethyl Atrazine	55	0.000133	0.000633	None	N.A.
Atrazine	31	0.000069	0.000156	0.003	0
Metolachlor	2	0.000035	0.000044	None	N.A.
Terbacil	5	0.000161	0.000308	None	N.A.
3,4-Dichloroaniline	2	0.000081	0.000124	None	N.A.
Bromacil	4	0.000178	0.000273	None	N.A.
Simazine	12	0.000082	0.000239	0.004	0
Malathion	7	0.000049	0.000118	None	N.A.
Bisphenol A	11	0.000867	0.001469	None	N.A.
Metribuzin	5	0.000114	0.00024	None	N.A.
Diazinon	1	0.000072	0.000072	None	N.A.
p,p'-DDT	1	0.000012	0.000012	None	N.A.
Picloram	1	0.00012	0.00012	0.5	0
Clopyralid	1	0.00016	0.00016	None	N.A.
Ethofumesate	1	0.000028	0.000028	None	N.A.

[13] Nitrate was analyzed as nitrate plus nitrite as nitrogen, and is assumed to be primarily in the form of nitrate.

*Average concentration calculated for wells with detectable contaminant levels.
**NPDW MCL = National Primary Drinking Water Maximum Contaminant Level (mg/L = milligrams per liter = parts per million)

Data from the DEQ's sampling are available in LASAR through the internet at http://www.deq.state.or.us/wq/lasar/EventLocatorCriteria.htm and can be retrieved using Upper Willamette Valley Groundwater as the sampling event name.

Reports on the 2000, 2001, and 2002 studies are available on-line at http://www.deq.state.or.us/wq/groundwa/UpperWillBasin.htm or by contacting the DEQ's Western Region office (Aitken and others, 2003; Eldridge, 2003).

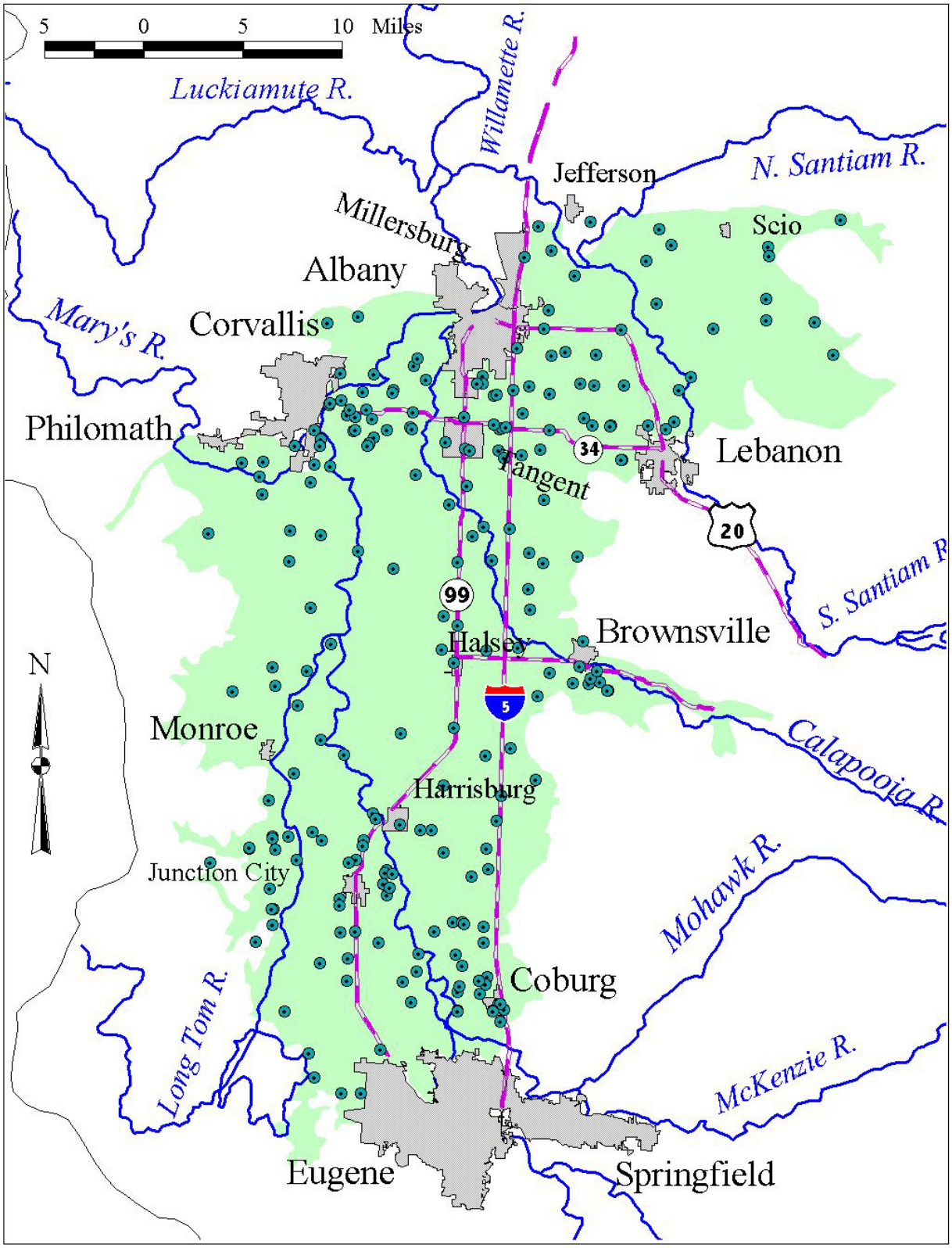

Figure 33: Southern Willamette Valley: Nitrate < 3 mg/L

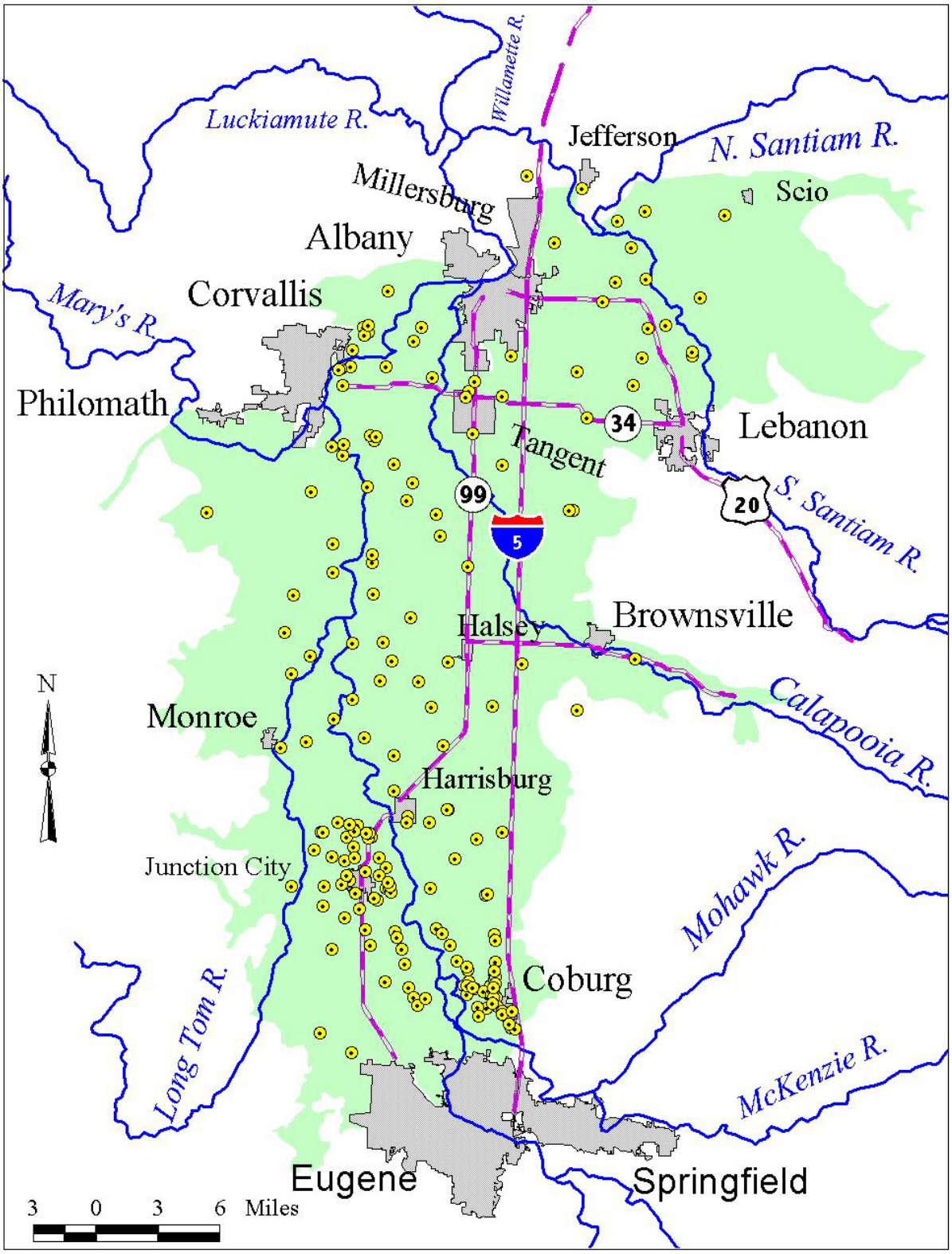

Figure 34: Southern Willamette Valley: Nitrates Between 3-10 mg/L

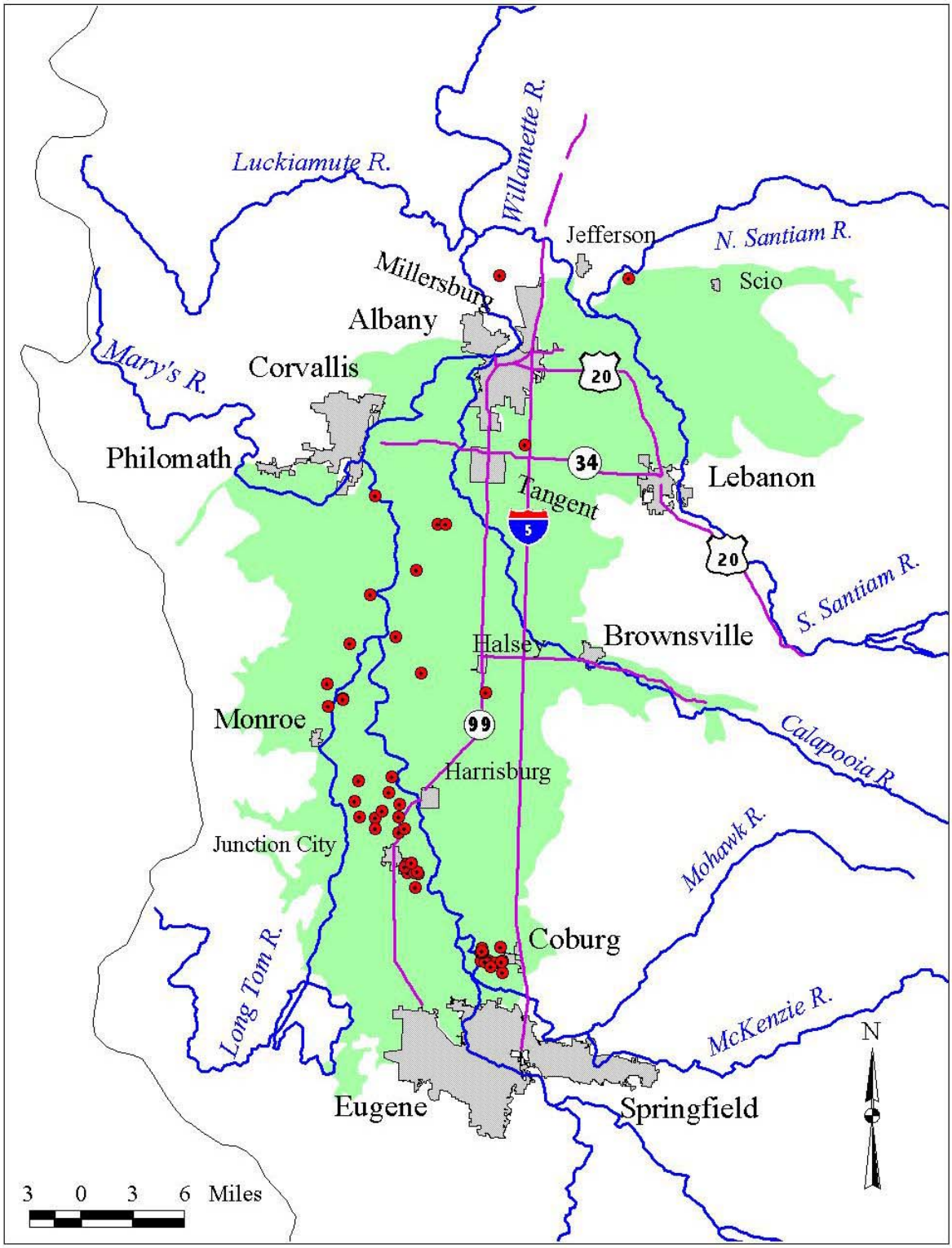

Figure 35: Southern Willamette Valley: Nitrate > 10 mg/L

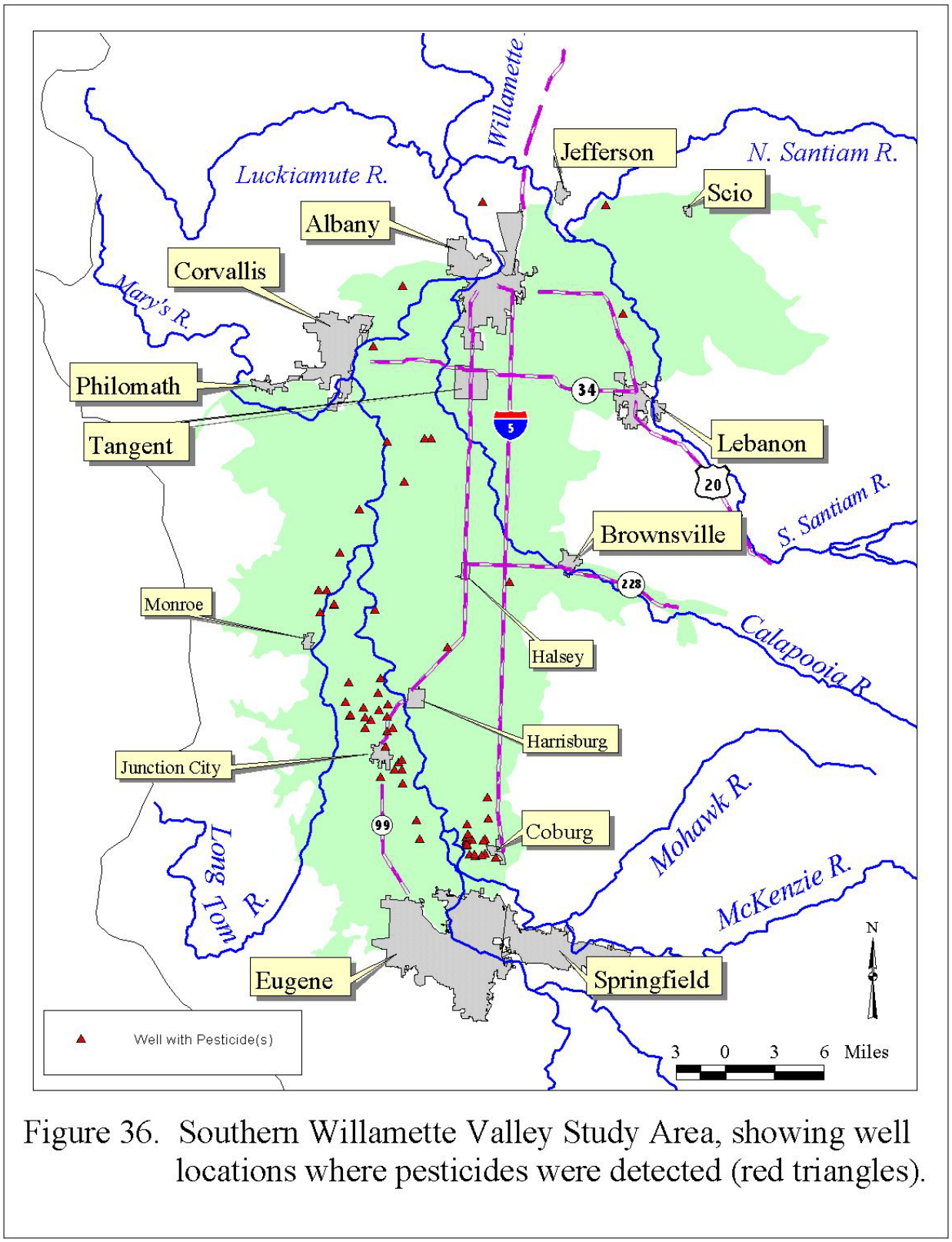

Figure 36. Southern Willamette Valley Study Area, showing well locations where pesticides were detected (red triangles).

Overall Status of Willamette Basin Groundwater Quality

Nitrate

Groundwater studies on both a regional scale and in local areas have indicated groundwater nitrate contamination throughout the Willamette Basin. Although some level of nitrate may be naturally occurring, levels higher than 3 mg/L indicate anthropogenic causes. Nitrate sources include dispersed non-point sources such as agricultural activities and on-site systems, and point sources generating nutrient rich waste products or producing and distributing fertilizer products.

In a 1988 basin wide groundwater assessment in areas where agricultural activities were predominant, nitrate concentrations were found to exceed the MCL (10 mg/L) in 23% of the wells sampled. Nitrates in 28 Mission Bottom area wells (north of Salem) exceeded the MCL. Nitrate concentrations between 5.0 and 10.0 mg/L were found in 27% of the wells. In the USGS NAWQA regional study, 9% of the groundwater samples from domestic wells in agricultural land use areas exceeded the MCL. The domestic well real estate transaction data collected throughout counties in the Willamette Basin report nitrate above 10 mg/L in 1% of the tested wells.

In the following areas, elevated nitrate (3 or more mg/L) was found:

- In the Canby area, nitrate was above the MCL in 14% of the sampled wells.
- Nitrate in the North Albany and the Albany/Lebanon areas was found at elevated levels, but not exceeding the MCL.
- Nitrate in the Junction City area was elevated in 70% of the wells, and exceeded the MCL in 40% of the wells sampled.
- Nitrate in the Coburg area was elevated in most wells, and exceeded the MCL in 25% of the wells.

In the focused Southern Willamette Valley groundwater study, nitrate was found in elevated concentrations in almost 50% of the wells sampled. Nitrate concentrations in about 11% of the wells exceed MCLs.

Groundwater in the following areas did not indicate elevated nitrate:

- In the Multnomah County study, in an urban residential area, nitrate levels were generally below 5 mg/L.
- Insignificant nitrate concentrations were found in the Boring, Scio, and Woodburn groundwater studies.

Figure 37 is a map of the Willamette Basin showing the well locations where DEQ studies have detected nitrates. Many wells plot so close together they are indistinguishable. The figure includes total counts of all wells with nitrate detections in the three categories (i.e., less than 3 mg/L, 3 to 10 mg/L, and over 10 mg/L).

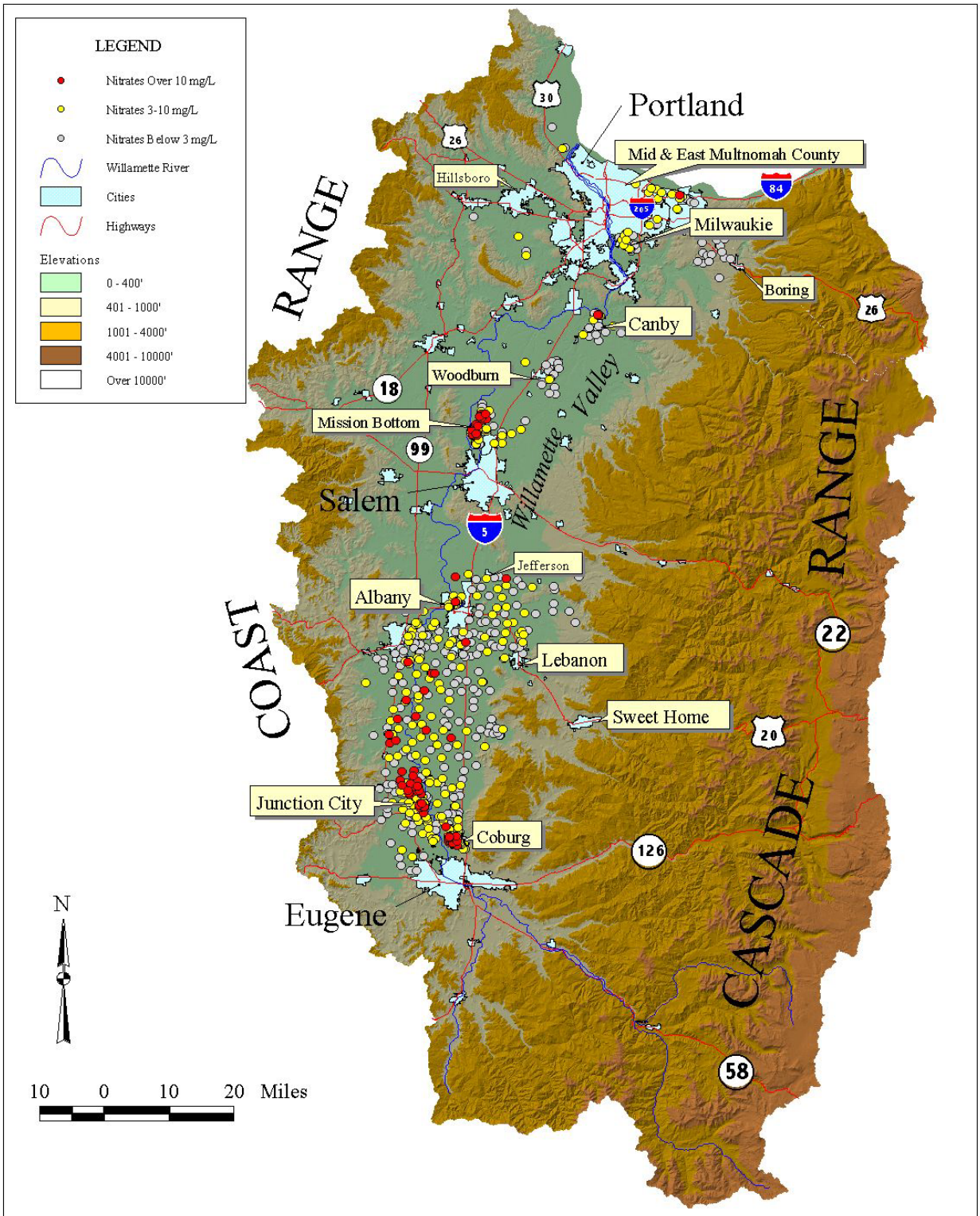

Figure 37. Wells with Nitrates <3 (373, gray), 3-10 (306, yellow), and >10 mg/L (97, red). See text for details.

Bacteria
Positive groundwater bacteria detections may indicate contamination from non-point sources such as on-site septic systems, or point sources such as facilities handling or disposing septage or manure.

On a regional scale, the domestic well real estate transaction data collected throughout Willamette Basin counties show 7% of the wells tested positive for bacteria.

In the Southern Willamette Valley groundwater study, bacteria was found in 6% of the wells sampled.

On a local scale, the groundwater study in Scio showed 53% wells positive for bacteria contamination. The source is not clearly identified. In North Albany, 7% of the wells were positive for bacteria.

Toxics - Pesticides
In a 1988 basin wide groundwater assessment in areas where agricultural activities were predominant, the pesticide ethylene dibromide (EDB or 1,2-dibromoethane) was found in 10% of the tested wells. This study analyzed groundwater samples using a method with detection limits below the MCL of 0.00005 mg/L (or 50 parts per trillion). The MCL was exceeded in two Farmington area wells and two Mission Bottom area wells. Later regional assessments and statewide ambient groundwater quality studies have not reported detections of EDB, but the detection limit for these studies was higher than the MCL. Another pesticide that was detected and confirmed in groundwater was Bromacil which does not have an MCL.

The USGS NAWQA study of regional Willamette Basin water quality in areas with predominant agricultural land use, found pesticides in 33% of the wells. Thirteen different pesticides were detected using methods with detection limits in the parts per trillion range. Atrazine was the most commonly detected pesticide. Three of the detected pesticides have established MCLs. One pesticide, Dinoseb, exceeded the established MCL in one sample.

In the Junction City area, Atrazine was detected but not confirmed when resampled several months later. Detection limits of 0.0002 mg/L were used for this sampling. In Coburg no pesticides were detected using similar detection limits.

In the Southern Willamette Valley groundwater study, pesticides were found in 69% of the wells sampled. Samples were analyzed using methods with detection limits in the parts per trillion range. Three of the 15 detected pesticides have established MCLs. None of the results exceeded MCLs. The most commonly detected pesticides were Atrazine, Desethyl Atrazine, and Simazine.

No pesticides were detected in the Multnomah County, Boring, Woodburn, North Albany, or Albany/Lebanon areas. Dacthal was detected in the Canby area, but not confirmed when resampled several months later. No other pesticides were detected at reporting limits generally greater than 0.001 mg/L for pesticide screening analyses. Appendix 3 summarizes pesticide sampling results in the Willamette Basin.

Toxics - Volatile Organic Compounds

In the USGS study of urban land-use areas, 80% of the groundwater samples had volatile organic compounds (VOCs), while 11 % of the domestic wells in agricultural land use areas contained VOCs. Two wells exceeded MCLs for Tetrachloroethylene.

VOC contamination has affected the following eight Willamette Basin areas:

- In Multnomah County, public water supply wells were taken out of service due to VOC contamination. Area investigations have identified two industrial facilities as the VOC contamination sources.
- In Milwaukie, VOCs contaminate city groundwater supply wells. The city has installed treatment systems. The source of VOCs has not been conclusively determined. Scattered incidents of nitrate and bacteria contamination have also been detected in the area.
- Near Aurora, in the Lakewood Estates subdivision, chlorinated solvents have contaminated the public water supply wells. No conclusive source has been identified.
- In Sweet Home, chlorinated solvents affected the public water supply well for a mobile home park. Twenty-seven percent of the domestic wells sampled in the area had chlorinated solvents above MCLs. The Sweet Home municipal water system replaced groundwater well use in the area.
- In Canby, the DEQ detected VOCs in three wells. Resampling confirmed one well with one VOC.
- Near Woodburn, the DEQ detected VOCs in two wells. Resampling did not confirm the initial detections.
- In North Albany, the DEQ detected VOCs in 10% of the wells. One well had a VOC concentration above the MCL.
- In Junction City, the DEQ detected chlorinated solvents in four wells below the MCLs. Resampling showed VOCs in two of the four wells, with concentrations below the MCLs.

The DEQ detected no VOCs in the Albany/Lebanon, Boring, or Coburg areas. Appendix 4 summarizes the VOC sampling results in the Willamette Basin.

Toxics - Metals

Regional studies have found groundwater with elevated arsenic in some Willamette Basin areas. The USGS found arsenic in 16% of the NAWQA domestic well studies at levels greater than 0.02 mg/L; however, none exceeded the MCL current at the time of the study (0.050 mg/L). Regional USGS and WRD investigations show arsenic in 8% of the wells exceeding 0.050 mg/L, primarily in areas of Lane County and Linn County, and in the Tualatin Basin in Washington County. On a local scale, arsenic was detected at levels exceeding the current MCL (0.010 mg/L) in the Woodburn area.

Toxic metals have generally not affected groundwater in the following areas:

- The DEQ found trace levels of some metals in the North Albany, Junction City, and Coburg areas.
- The DEQ detected no metals in the Boring or Milwaukie study areas.

POLLUTANT SOURCES

Overview

Various state and federal programs regulate pollution sources in Oregon. Point sources are confined or discrete sources of pollution where contaminants can enter into public waters (OAR 340-040-0010(14)). Nonpoint sources are diffuse or unconfined sources of pollution (OAR 340-040-0010(12)). The state and federal regulatory goal is to prevent or minimize adverse impacts to groundwater quality from activities on the ground surface. Several types of point sources found in the Willamette Basin are discussed below.

Waste Dischargers

The DEQ regulates several types of waste discharges through permits. Permit types include:

- National Pollutant Discharge Elimination System (NPDES) These permits must meet Federal Water Pollution Control Act requirements and procedures (OAR 340-045-0010(9)). NPDES permits generally cover all discharges, whether direct or indirect, to waters of the United States (surface water). NPDES permits cover direct discharges into a river or stream, or indirect discharges into a drain or ditch conveying wastewater to a river or stream, and may also cover discharges to land.

- Water Pollution Control Facilities (WPCF) These permits regulate disposal system construction and operation with no discharge to navigable waters (OAR 340-045-0010(12)). State requirements and procedures (OAR 340-045 or OAR 340-071) distinguish these facilities from those discharging to navigable waters. The DEQ issues WPCF permits for discharges not covered by an NPDES permit. WPCF permitted facilities may discharge wastewater onto land through irrigation, into drain fields, or into lagoons and holding ponds.

NPDES and WPCF permitted facilities include those discharging the following kinds of wastewater:

- sewage
- pulp and paper waste
- food processing waste
- smelting/refining waste
- cooling water
- industrial storm water
- mining
- municipal wastewater

The DEQ has regional offices in various locations around the state. The Northwest Region (NWR) and Western Region (WR) offices manage permits within the Willamette Basin. Information on NPDES and WPCF permits is available on-line at http://www.deq.state.or.us/wq/SISData/FacilityHomenew.asp.

Figure 38 shows the locations of the following permitted facilities in the Willamette Basin:

- 27 major permits for industries with large pollutant loads, toxic discharges, or large domestic waste treatment facilities (9 in NWR, and 18 in WR), and
- 1,208 minor permits for other types (419 in NWR, and 789 in WR).

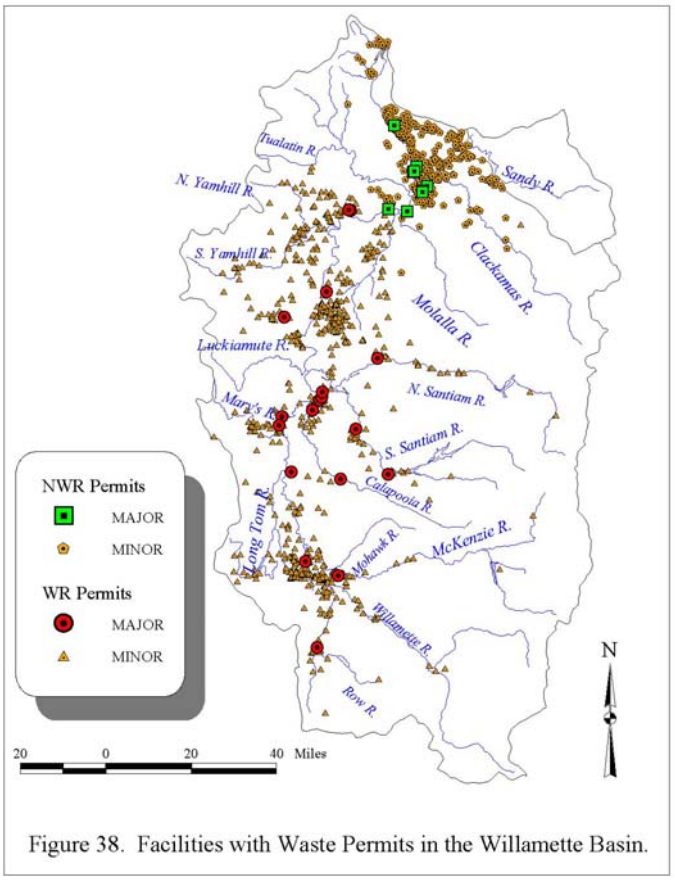

Figure 38. Facilities with Waste Permits in the Willamette Basin.

Underground Injection Control (UIC)

The DEQ Underground Injection Control (UIC) program regulates waste injection into the subsurface to protect groundwater quality. A UIC system includes structures or activities placing or discharging fluids into the subsurface. Examples of UICs include drywells, sumps, septic system drainfields above a certain service or design size, and other wells used for injection purposes.

The DEQ maintains a database of known UIC systems. The database is available at http://www.deq.state.or.us/wq/groundwa/UIChome.htm. The current database shows 20,146 injection systems in the Willamette Basin. Figure 39 is a map of the Willamette Basin showing the locations of all individual UIC injection systems with available latitude/longitude coordinate information.

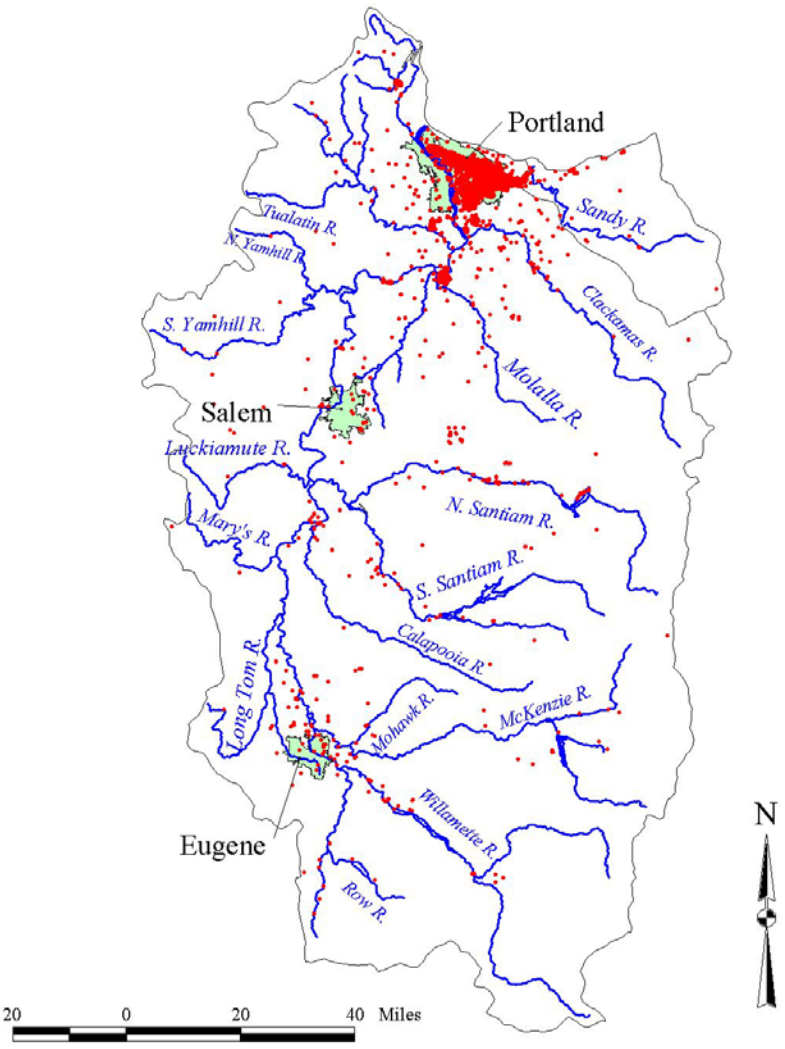

Figure 39. Underground Injection Systems in the Willamette Basin.

Confined Animal Feeding Operations (CAFOs)

The Oregon Department of Agriculture (ODA), in conjunction with the DEQ, reviews applications and issues wastewater permits for CAFOs. This includes reviewing animal waste management system plans and specifications for animal waste control facilities. The covered facilities include the following:

- Production areas, such as animal confinement areas;
- Manure storage areas, such as lagoons, runoff ponds, storage sheds, stockpiles, and liquid impoundments; and
- Waste containment areas, such as settling basins.

The waste management systems may also include land application areas. Figure 40 shows the locations of the 259 permitted CAFOs in the Willamette Basin.

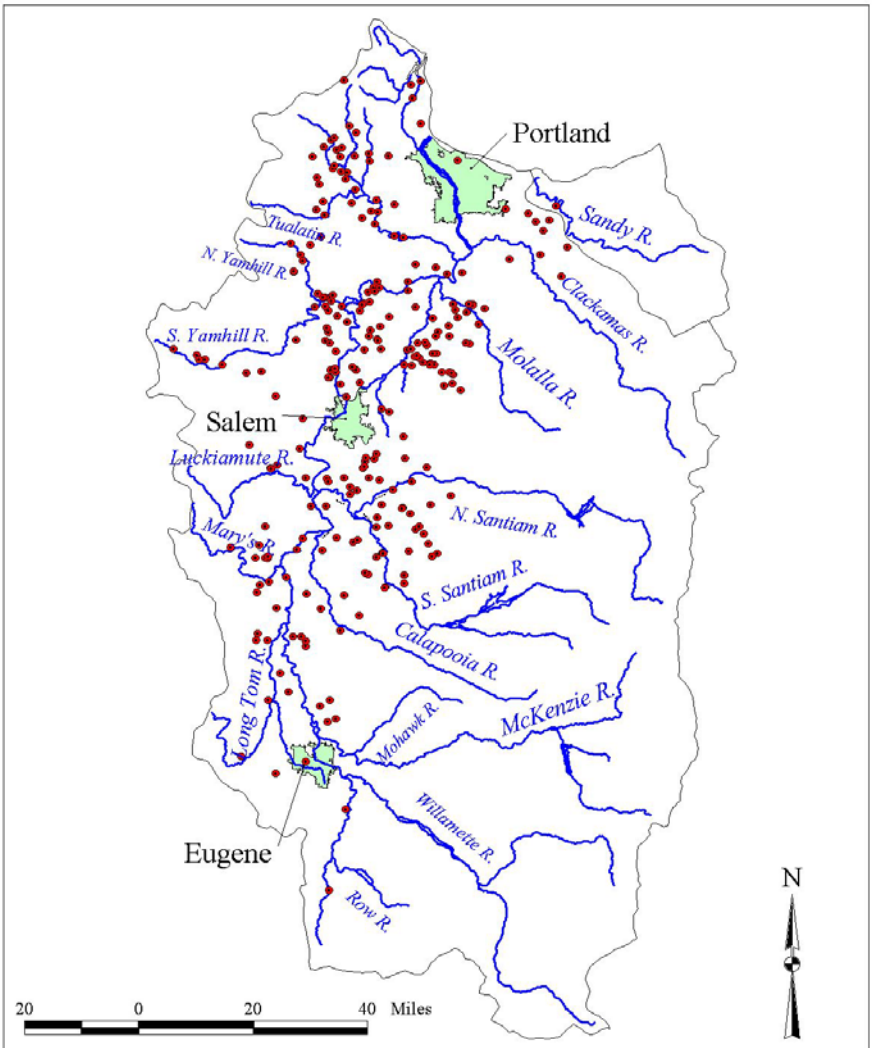

Figure 40. Confined Animal Feeding Operations in the Willamette Basin.

Hazardous Substance Release Sites

The DEQ maintains a list of known hazardous substance release sites in the Environmental Cleanup Site Information (ECSI) database. Information on specific sites is available through on-line queries at http://www.deq.state.or.us/wmc/ECSI/ecsiquery.htm. Currently the database shows 334 sites in the Willamette Basin (Figure 41) including:

- 7 sites on the National Priority List (NPL), also known as Superfund sites,
- 121 sites on the Confirmed Release List (CRL) or the Inventory,
- 139 suspect sites requiring further investigation, and
- 74 sites requiring no further action.

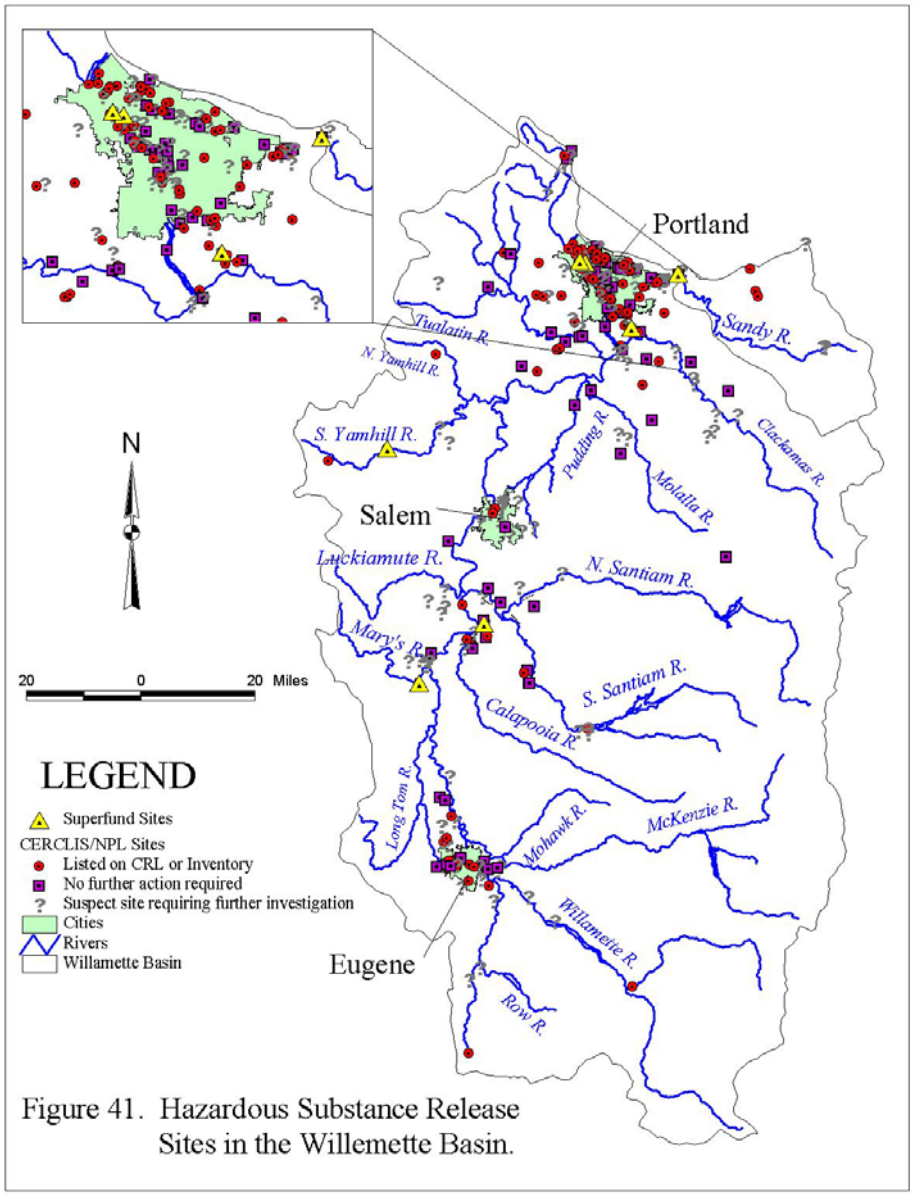

Figure 41. Hazardous Substance Release Sites in the Willemette Basin.

Underground Storage Tanks (USTs) and Leaking Underground Storage Tanks (LUSTs)

The DEQ UST program regulates tanks storing petroleum or certain hazardous substances and cleanups of releases from tanks, including home heating oil tanks. The DEQ maintains the UST List for regulated underground storage tank facilities in Oregon. This list is available on-line at: http://www.deq.state.or.us/wmc/tank/ustfaclist.htm . The UST program also maintains a database of LUSTs where releases from tanks have been reported. This database is available on-line at: http://www.deq.state.or.us/wmc/tank/LustPublicLookup.asp. The following DEQ web site has more information and statistics: http://www.deq.state.or.us/wmc/tank/stats.htm.

There are 21,681 LUST sites reported in the Willamette Basin. Figure 42 shows the LUST locations. Many locations have more than one tank that has been cleaned up, or is in the cleanup process.

Statewide, the DEQ has cleaned up more than 75% of regulated, leaking tanks. The national average is 68%.

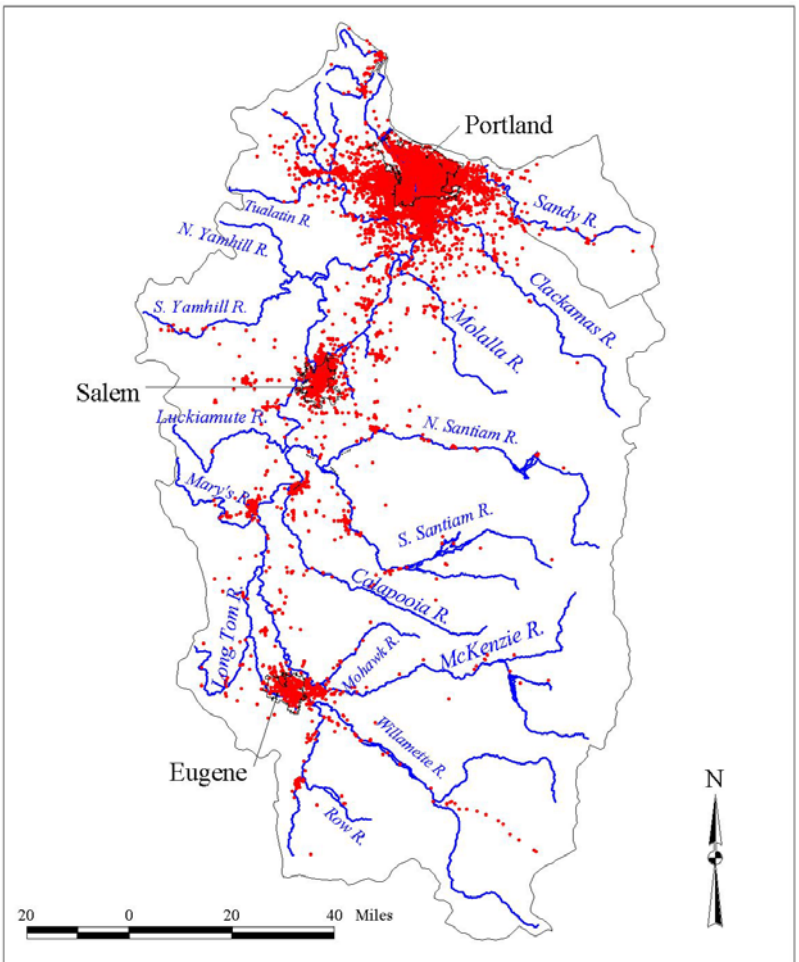

Figure 42. Leaking Underground Storage Tank Sites in the Willamette Basin.

Solid and Hazardous Waste Facilities

There are 22 landfills in the Willamette Basin for which the DEQ has groundwater, surface water, or leachate monitoring data. The landfill locations are shown in Figure 43.

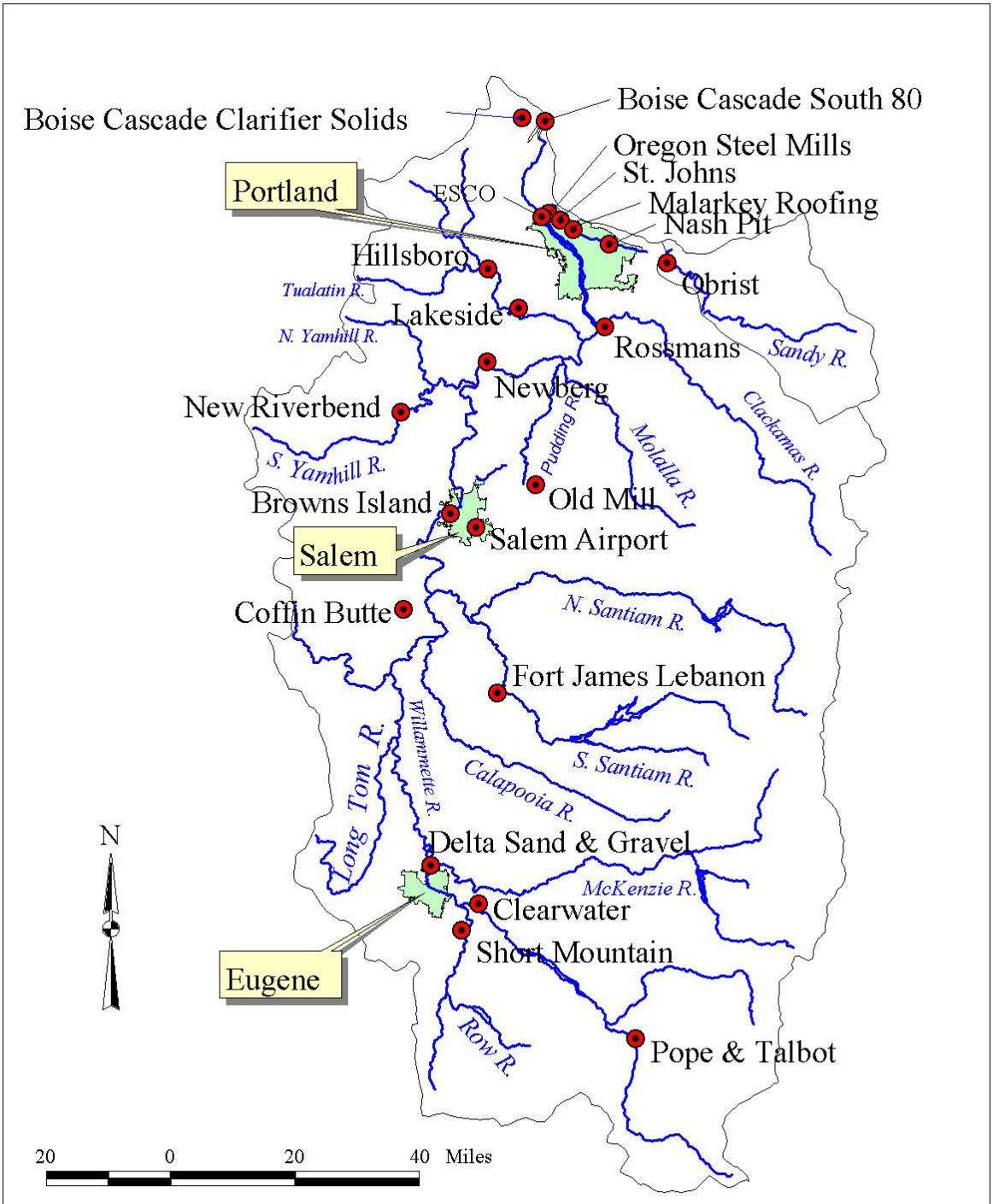

Figure 43. Landfills in the Willamette Basin.

CONCLUSIONS

The Willamette Basin in the northwestern part of Oregon includes a major river system and significant groundwater aquifers. While much of the basin is forest land, the focus areas for groundwater studies have included the following:

- Willamette Valley agricultural lands,
- areas of significant Willamette Valley population density, and
- urban areas, including the three largest cities in Oregon (Portland, Salem, Eugene).

Shallow Willamette Valley alluvial sediments contain productive groundwater aquifers. These aquifers are vulnerable to pollution from anthropogenic activities.

Groundwater in the Willamette Basin is an important natural resource. The basin has over 11,000 water rights for groundwater use. Over 1,765 public drinking water systems in the basin use groundwater either exclusively or in combination with surface water. Another 100,000 domestic water wells in the basin provide drinking water to rural residences and areas with no public water supply systems.

Groundwater quality studies in the Willamette Basin have shown impacts from several pollutants, including nitrate, pesticides, and volatile organic compounds (VOCs).

Willamette Basin nitrate contamination is widespread, particularly in the Southern Willamette Valley, including the Coburg and Junction City areas. Another area with significant nitrate levels includes the Mission Bottom area north of Salem.

Bacteria contamination is present in scattered locations throughout the basin, and in local areas around Scio and North Albany.

Pesticide contaminated groundwater has been found throughout the basin at levels generally in the part per trillion range. These levels are below risk-based standards and relevant MCLs. The USGS basinwide assessment found pesticide contaminated groundwater in one third of the wells. Atrazine is the most commonly detected pesticide. It is present in 31 of the 93 wells tested in the Southern Willamette Valley (2002 study) at levels far below the drinking water standard. Ethylene dibromide (EDB or 1,2-dibromomethane) was found in early groundwater assessments. It has not been found in assessments done in the later 1990s; however, later analyses were not as sensitive to low levels of this pesticide, with a drinking water standard of 50 parts per trillion. In some of the focused area studies, pesticides have not been detected using analytical methods with detection limits in the part per billion range.

Groundwater contaminated with VOCs has been found in several urban areas in the basin, and in areas of dense population. The USGS found VOCs in eight of ten monitoring wells sampled in an urban Land-Use Study. VOCs have contaminated public drinking water supplies in four basin study areas. These areas either lost use of the groundwater resource, or installed systems to treat the groundwater prior to use. In three of these areas, no point sources for the contamination has

been identified. In these areas, the contamination sources may be more diffuse, or may be the result of cumulative impacts from multiple activities using or discharging these pollutants.

Many potential point sources of nitrate and VOC pollution exist within the Willamette Basin. These sources include the following:

- permitted waste discharge facilities,
- underground injection control systems,
- confined animal feeding operations,
- hazardous substance release sites,
- leaking underground storage tanks,
- on-site sewage disposal systems, and
- solid waste facilities.

Non-point sources of nitrate and pesticide pollution include agricultural land use areas, and areas with high population densities using on-site sewage disposal systems. The occurrence of VOCs in some areas may also be a non-point source problem from area-wide industrial or other activities typically using chlorinated solvents.

RECOMMENDATIONS

The presence of nitrate and bacteria in Willamette Basin groundwater may warrant additional action.

Nitrate: The DEQ has proposed a Groundwater Management Area (GWMA) for parts of Lane, Linn, and Benton counties. The GWMA would include a management plan specifying actions, such as Best Management Practices (BMPs), to address high nitrate levels. Depending on sufficient resources and regional priorities, the DEQ should examine other portions of the basin, such as Mission Bottom, and East Multnomah County. In these areas the DEQ should conduct periodic groundwater sampling to determine groundwater nitrate level trends. The DEQ should determine if plans are in place to adequately address high groundwater nitrate areas. The DEQ, together with the Department of Human Services and Water Resources, should continue educational outreach efforts to individual well owners. The outreach program encourages well owners to test their wells for nitrate.

Bacteria: The DEQ believes bacterial contamination is localized, and not a basinwide problem. This implies well construction and maintenance problems. The DEQ, together with the Department of Human Services and Water Resources, should continue educational outreach efforts to individual well owners. The outreach program encourages well owners to test their wells for bacteria. The program also informs well owners about proper well construction, maintenance, and abandonment.

The DEQ has detected and confirmed volatile organic compounds, metals, and pesticides in some Willamette Basin wells. The DEQ's Cleanup Program has evaluated the compounds in

these wells. For wells where contaminant levels represent public health risks, the DEQ's Cleanup Program conducts remediation activities to address the risks.

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