DEQ LABORATORY AND WATER QUALITY DIVISIONS

GROUNDWATER QUALITY REPORT FOR THE NORTH COAST BASIN, OREGON

State of Oregon
Department of Environmental Quality

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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. The North Coast Basin in Oregon includes several important coastal watersheds and a sensitive groundwater aquifer. The groundwater is an important natural resource in the basin, providing drinking water to over 200 public water systems serving 77,000 people and over 4,000 private residential systems.

The North Coast Basin is located in the northwest corner of Oregon and encompasses all or portions of seven counties. The land use in the area is mostly forest (84%) with about 7% urban, commercial or industrial, 5% agricultural, and the remainder estuary, residential, or other.

North Coast Basin geology includes volcanic rocks, marine sedimentary rocks, alluvium, and a dunal sand complex. Primary basin aquifers are shallow, occurring in unconfined and unconsolidated sedimentary material, primarily sand and gravel near the coastline and adjacent to the major rivers.

The DEQ and other state and local agencies have collected data and conducted several groundwater quality studies in the North Coast Basin. This report compiles and summarizes groundwater quality information from the following sources:

- the Oregon Department of Human Services (DHS) Domestic Well Testing for Real Estate Transactions program,
- the Oregon DHS Public Water Systems program,
- two DEQ studies, and
- one local study.

Over the course of these studies, the following constituents were analyzed:

- nitrate
- bacteria
- volatile organic compounds
- physical parameters
- metals
- pesticides

North Coast Basin studies show nitrate, bacteria, and lead impact shallow groundwater in some basin areas. Both the DHS databases and local DEQ studies showed elevated groundwater nitrate concentrations in the Clatsop Plains area. The DEQ study showed four wells out of 36 wells sampled had nitrate concentrations above 10 mg/L. On a regional scale, the real estate transaction database indicated 88 transactions involving drinking water wells, out of 924 such transactions, were positive for bacteria. In the Clatsop Plains area local studies detected bacteria in 30% to 66% of the drinking water wells. Bacteria concentrations likely reflect substandard well construction and poor maintenance activities, rather than a regional, aquifer-wide problem.

One pesticide, atrazine, was detected in a well at a concentration above the drinking water standard. This occurred adjacent to the Warrenton Landfill. Trace amounts of volatile organic compounds were detected but not confirmed on resampling. Lead above the drinking water action level was found in three public water supply wells (DHS database) in Columbia County.

In 1996 a local Clatsop Plains study detected lead above the drinking water action level (0.015 mg/L) in 20% of the wells. Confirmational resampling detected lead in only a few of these wells. Low levels of arsenic, copper, cadmium, chromium, and barium were also detected in the 1996 sampling event, but none were confirmed when the wells were resampled.

In a local DEQ Tillamook study, lead above the drinking water action level was found in one well in spring 1998, but had not been detected initially in fall 1997. Antimony was detected above the drinking water standard in 20% of the wells sampled in fall 1997, but was not confirmed on re-sampling in spring 1998.

Potential sources for North Coast Basin groundwater nitrate and bacteria contamination are high on-site septic system densities in areas with permeable, sandy soils. Poor well construction and maintenance activities can also lead to this contamination in the wells. Potential point sources for other toxic contaminants include the basin's landfills.

Further investigations and monitoring are warranted in local areas where nitrate and bacteria have been found. Recommendations include:

- Review the effectiveness of the current Clatsop Plains Geographic Rule (OAR 340-071-0400(5)).
- Determine if the 1970s and 1980s Clatsop Plains contaminant loading predictions have been met.
- Review the existing Clatsop Plains information to determine if the area should be declared an Area of Groundwater Concern, or a Groundwater Management Area.
- Conduct further groundwater investigations to determine lead levels and extent in the Clatsop Plains and Columbia County areas.

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 presents the following for the North Coast Basin (Figure 1):

- a compilation of groundwater quality data from the Oregon Department of Environmental Quality and other state and local agency studies,
- summary information with references to other reports when available,
- links to data repositories or on-line information and data sources,
- status updates for local studies in the North Coast Basin,
- background information on the North Coast's environmental setting,
- general information about geology and hydrogeology,
- groundwater use information,
- a discussion of potential pollutant sources in the basin,
- an evaluation of the North Coast's overall groundwater quality status, and
- recommendations for actions that could be taken.

ENVIRONMENTAL SETTING

Geography

The North Coast Basin occupies about 2,500 square miles in the northwest corner of Oregon (Figure 1). The Oregon Water Resources Department (OWRD) Map No. 1.6 defines the North Coast Basin for water management purposes (OAR 690-501). The North Coast Basin is one of the 18 major river drainage basins in the state.

Figure 1. Location of the North Coast Basin.

Source: Oregon State Service Center for Geographic Information Systems.

The Columbia River defines the basin's northern boundary. The western boundary is the Pacific Ocean. To the south is the Mid-Coast Basin, and on the east is the Willamette Basin. Rogers Peak (3,706 feet), in the headwaters of the Wilson River, is the basin's highest point.

The North Coast Basin encompasses all or portions of the following counties:

- Clatsop,
- Columbia,
- Lincoln,
- Polk,
- Tillamook,
- Washington, and
- Yamhill.

Figure 2 shows the North Coast Basin's major geographic features.

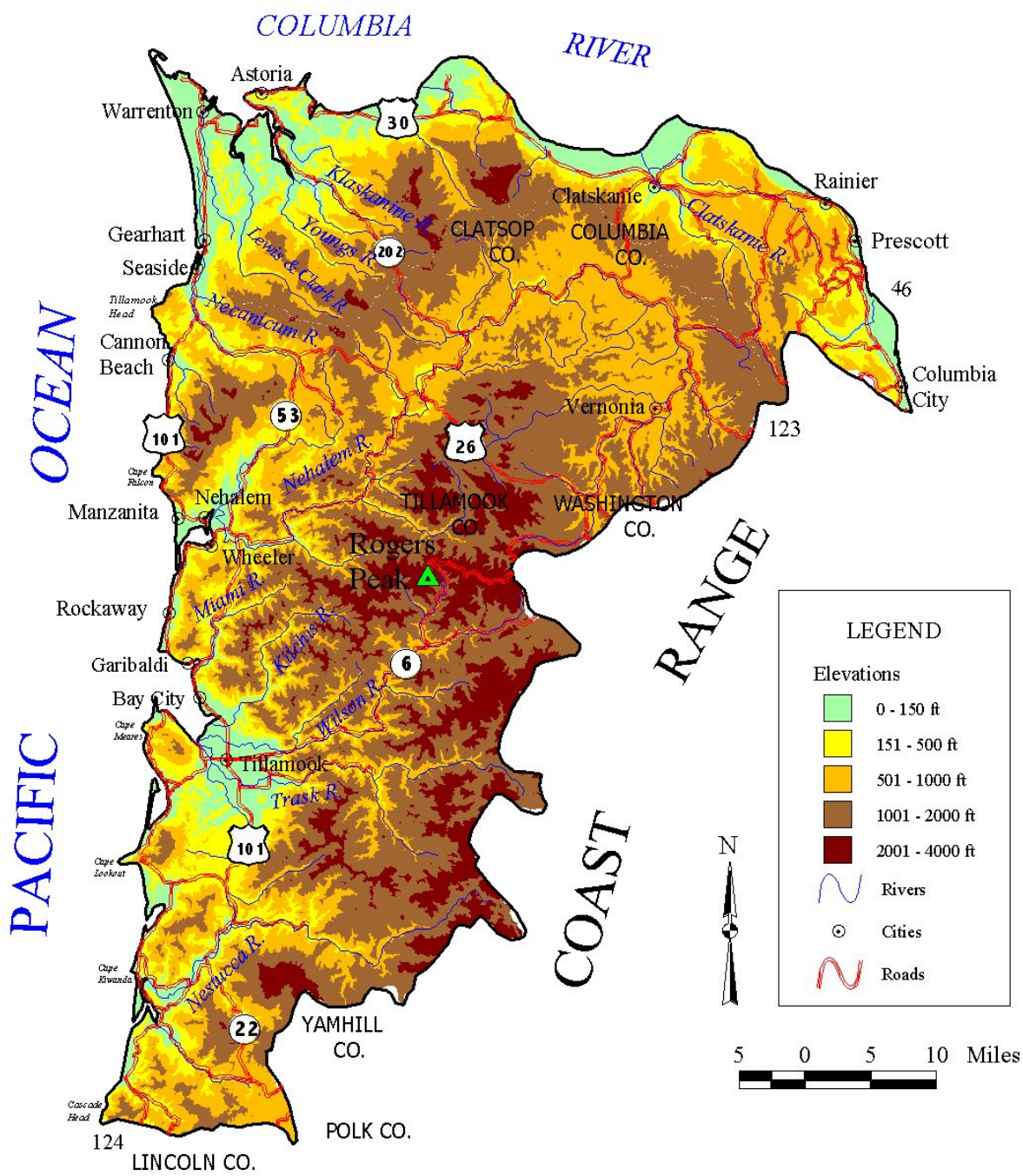


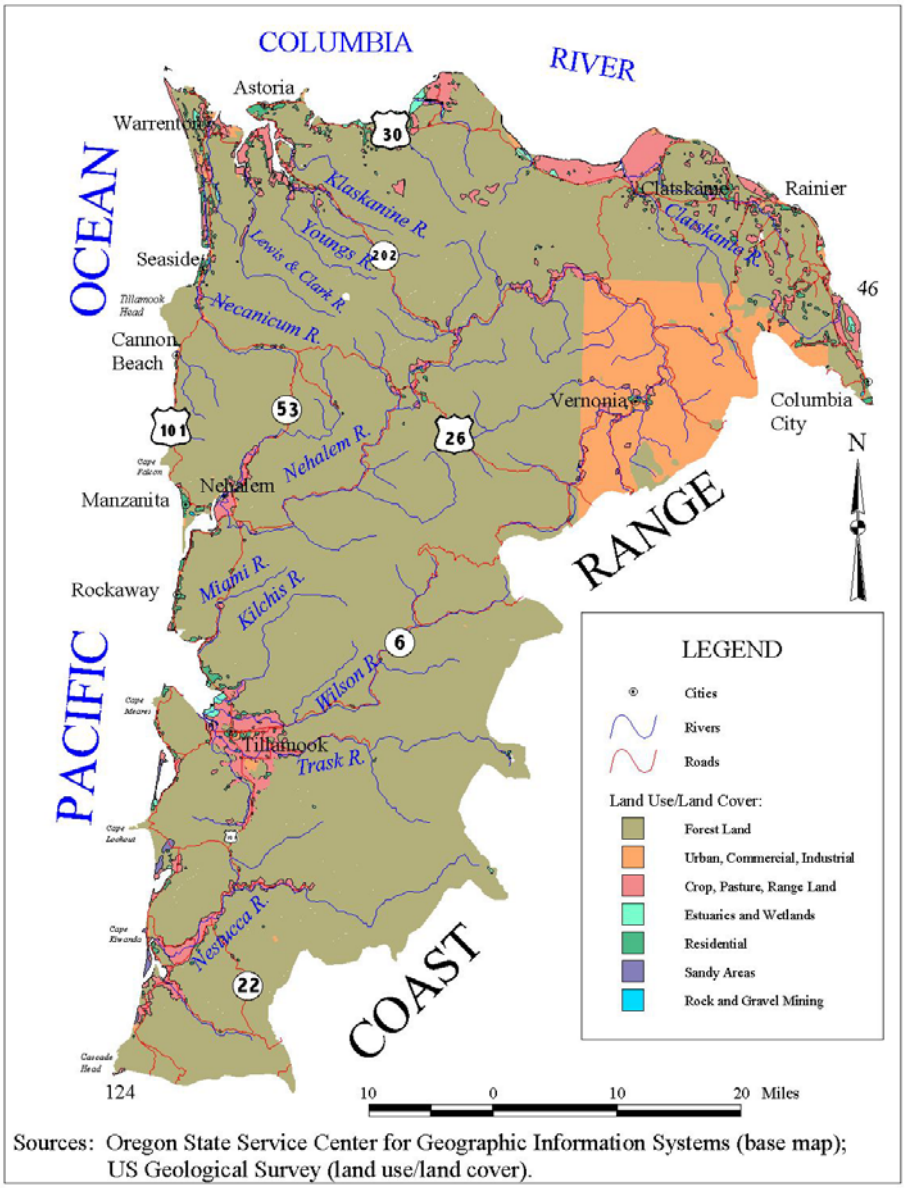
Figure 2. Map of the North Coast Basin showing major geographic features.

Source: Oregon State Service Center for Geographic Information Systems.

Land Use and Population

Land use in the North Coast Basin is 84% forest land; 7% urban, commercial, or industrial; 5% crop, pasture, or range; about 3% estuary; 1% residential, and less than 1% sandy areas or rock/gravel mining (Figure 3) (U.S. Geological Survey, 2003).

The resident population within the North Coast Basin is about 77,000 (U.S. Census Bureau, 2003). The North Coast Basin has many tourist attractions. Up to 200,000 people annually visit sites such as the Fort Clatsop National Memorial in Astoria (Astoria-Warrenton Chamber of Commerce, 2003).



Sources: Oregon State Service Center for Geographic Information Systems (base map); US Geological Survey (land use/land cover).

Figure 3. Land Use and Land Cover, North Coast Basin, Oregon.

Climate and Precipitation

The climate in the North Coast Basin is generally mild and wet. Temperatures along the coast vary from lows of about 36° F to highs around 72° F (Oregon Climate Service, 2003). The higher elevations in the Coast Range on the east have lower winter temperatures. The average annual precipitation ranges from 66 inches at Astoria to 180 inches in the upper headwaters of the coastal streams (Western Region Climate Center, 2003). Figure 4 shows the average annual precipitation distribution in the North Coast Basin. The wide range of rainfall, particularly the large amount in the coastal stream headwaters regions, are due to the orographic effects of mountains near the Pacific Coast. The prevailing winds come from the west, bringing moisture from the Pacific Ocean. When this moisture builds up against the Coast Range mountains where the coastal stream headwaters originate, the moisture condenses and the clouds release the moisture as large amounts of rain and snow.

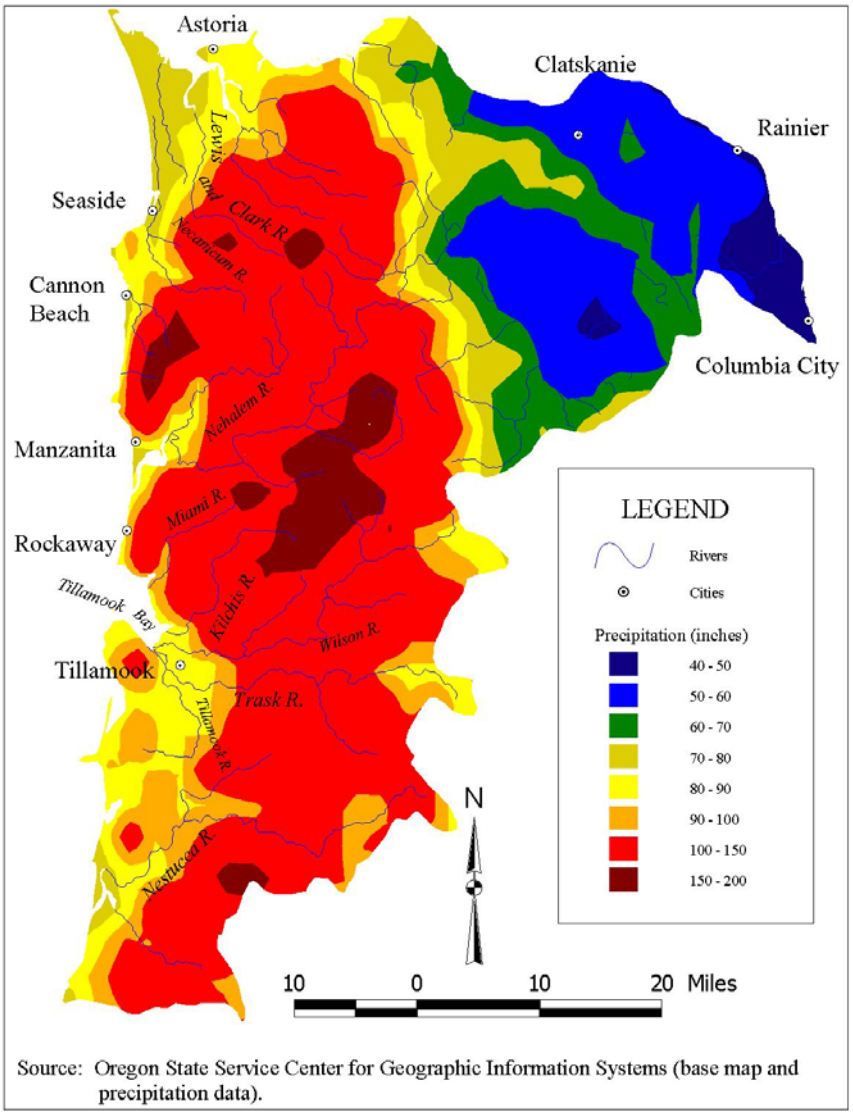


Figure 4. Annual Precipitation, North Coast Basin, Oregon.

Geology

The North Coast Basin geology is composed of volcanic rocks, marine sedimentary rocks, alluvium, and a prominent dunal sand complex (Orr and other, 1992) (Figure 5). The highlands on the basin's eastern border consist mainly of volcanic rocks, including basalt lava flows extruded on land and underwater. Lava extruded under water has a characteristic rounded, pillow-like appearance. Folding and faulting uplifted submarine lavas and other volcanic rocks. These rocks are exposed in the Coast Range, and in the prominent headlands along the basin's western coastline. From north to south these headlands include Tillamook Head, Cape Falcon, Cape Meares, Cape Lookout, and Cascade Head. Some layers of volcanic-derived sediments are associated with these rocks.

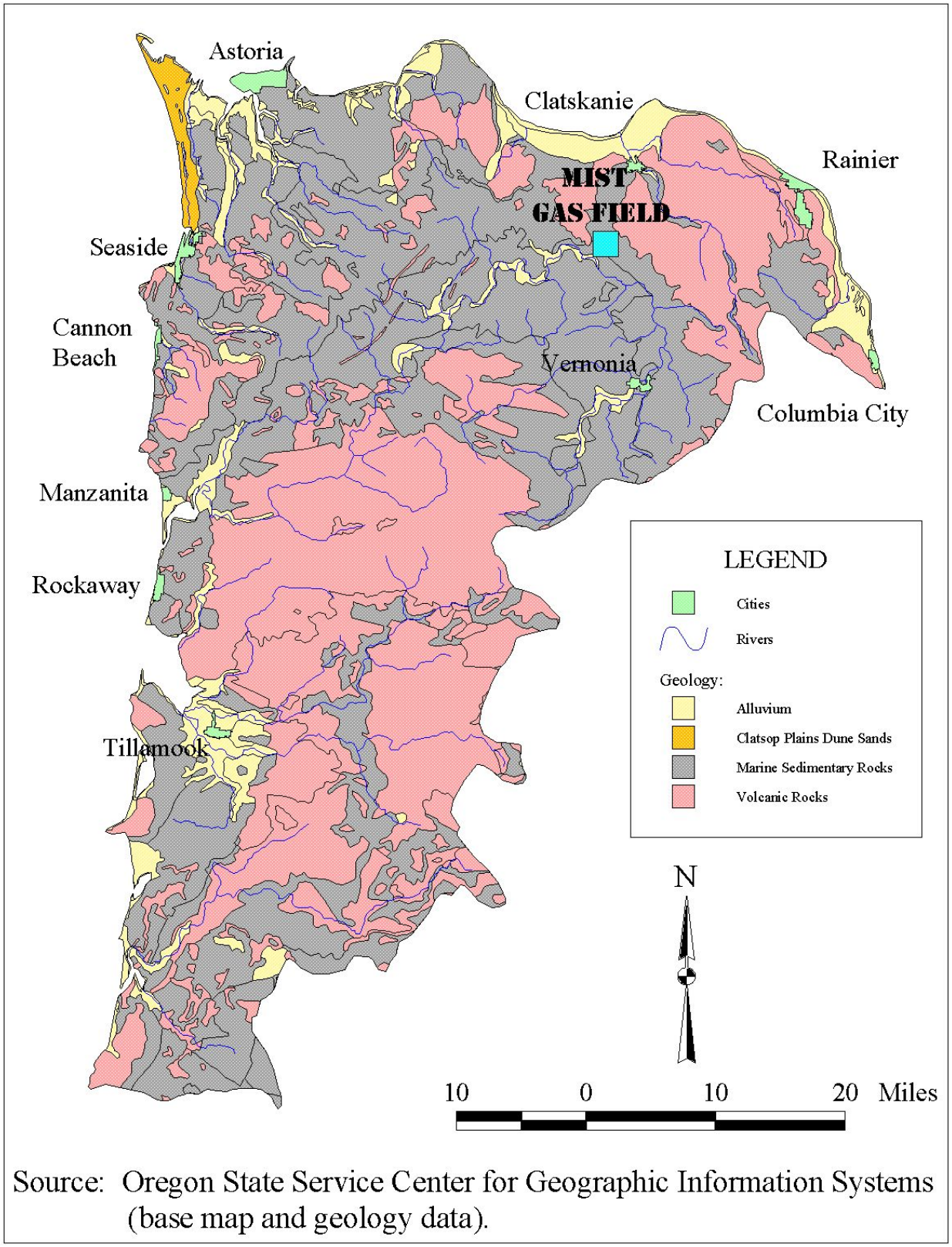
Marine sedimentary rocks including mudstone, siltstone, sandstone, and conglomerate are the second major rock type present in the North Coast Basin. Some of these rocks contain marine fossils. Cape Kiwanda, south of Tillamook, is composed of relatively erosion resistant marine sedimentary rocks.

Unconsolidated alluvial sediments are present as valley fill deposits and along streams in the basin. The Tillamook Valley lowlands contain terrace alluvium up to 120 feet thick. These deposits contain basalt pebbles and cobbles in a sand, silt, and clay matrix (ODEQ, 1997). Along the river flood plain, alluvium consisting of gravel layered with sand, silt, and clay is present in deposits up to 300 feet thick.

Along the basin's northwest margin, between the Columbia River on the north and Seaside on the south, is an area known as the Clatsop Plains. The Clatsop Plains is a complex of unconsolidated dunal sands from 125 to 400 feet thick (Sweet, Edwards, 1981; Pollock and Weick, 1996). Ocean currents and wind have deposited Columbia River sands to form beaches and parallel rows of stabilized dunes. The dunal area varies in width from 1 mile in the south near Seaside, to 3 miles in the basin's northwest corner. The dunes are arranged in a longitudinal manner, oriented parallel to the shoreline, and rise 10 to 100 feet above sea level. Numerous lakes and wetlands are present in the interdunal area. Sedimentary rocks (shale and sandstone) underlie the dunal sand.

Some of the sedimentary rocks are organic rich, and contain hydrocarbon traps. Economic volumes of natural gas were discovered in 1979 near the town of Mist in the basin's northern part (see Figure 5). The Mist gas field has produced about 65 billion cubic feet of gas (Orr and others, 1992).

Active tectonic forces of folding, faulting, and uplift, created the Coast Range's steep and rugged topography. Seasonal storms lead to widespread instability in the basin's mountainous areas. This instability is expressed as landslides occurring annually during periods of heavy rainfall (Orr and others, 1992).



Source: Oregon State Service Center for Geographic Information Systems (base map and geology data).

Figure 5. Generalized Geology of the North Coast Basin, Oregon.

Hydrogeology

Shallow alluvial aquifers are the North Coast Basin's primary aquifers (Pollack and Weick, 1996; ODEQ, 1997). The aquifers are present in unconfined and unconsolidated sedimentary materials, primarily sand and gravel, near the coastline, and adjacent to major rivers and streams. Sweet and others (1980) produced a statewide map of aquifers sensitive to contamination. Figure 6 shows the sensitive aquifers identified in the North Coast Basin. Fractured volcanic and marine sedimentary rocks can yield substantial groundwater volumes. However, these rocks' high salt content produces poor groundwater quality, and these formations provide only minor potable water supply sources.

One of the most important and best known North Coast Basin aquifers is the Clatsop Plains aquifer. F.J. Frank (1970) studied the Clatsop Plains dunal aquifer. Infiltrating precipitation is the primary aquifer recharge mechanism. He estimated about 80 percent of the precipitation infiltrates through the highly permeable sandy soils into the aquifer's dune sand. Minor aquifer recharge comes from irrigation and domestic sources. Sweet's (1981) hydrology model indicated surface water runoff from the Coast Range foothills contributes negligible quantities of water to the Clatsop Plains area water budget. During periods of drought with low or depressed water tables, surface water recharges the aquifer. The permanent groundwater table occurs at 3 to 33 feet below ground surface. In the central dune area, the saturated sand thickness ranges from 95 feet to more than 150 feet.

Frank performed water well pumping tests in the Clatsop Plains aquifer. He calculated an aquifer vertical hydraulic conductivity between 227 to 254 feet per day. Frank estimated a horizontal hydraulic conductivity 35 times greater than the vertical hydraulic conductivity. He said these values may be 50% too low, due to partial penetration effects and well loss in the test wells. Frank estimated up to 2,500 acre-feet of groundwater per year per square mile of area may be available in the 10 square mile area most favorable for development.

Many inter-dunal lakes are present in the Clatsop Plains (Frank, 1970; Sweet, 1981). The lakes fill one to two mile long elongate depressions or basins between the dunal ridges. Groundwater provides base flow to these lakes. Most of the lakes are independent of the local stream and river systems. No perennial surface water flows in or out of these lakes. The groundwater aquifer discharges water to the surface water bodies and the ocean. Despite abundant rainfall, little surface runoff occurs, and local streams lack well defined tributaries. Because of the two-way communication between groundwater and surface water, contaminants introduced into surface water impact the groundwater, and vice versa.

In the Tillamook Valley, the primary aquifers are present in the valley fill deposits (ODEQ, 1997). Groundwater is present in an upper zone of sand to clayey sand at 20 to 60 feet below ground surface. A deeper groundwater zone is present at depths greater than 80 feet below ground surface in permeable sand and gravel. The underlying sedimentary rocks are generally impermeable.

Sweet and others (1980) produced a statewide map of aquifers sensitive to contamination. Figure 6 shows the sensitive aquifers identified in the North Coast Basin.

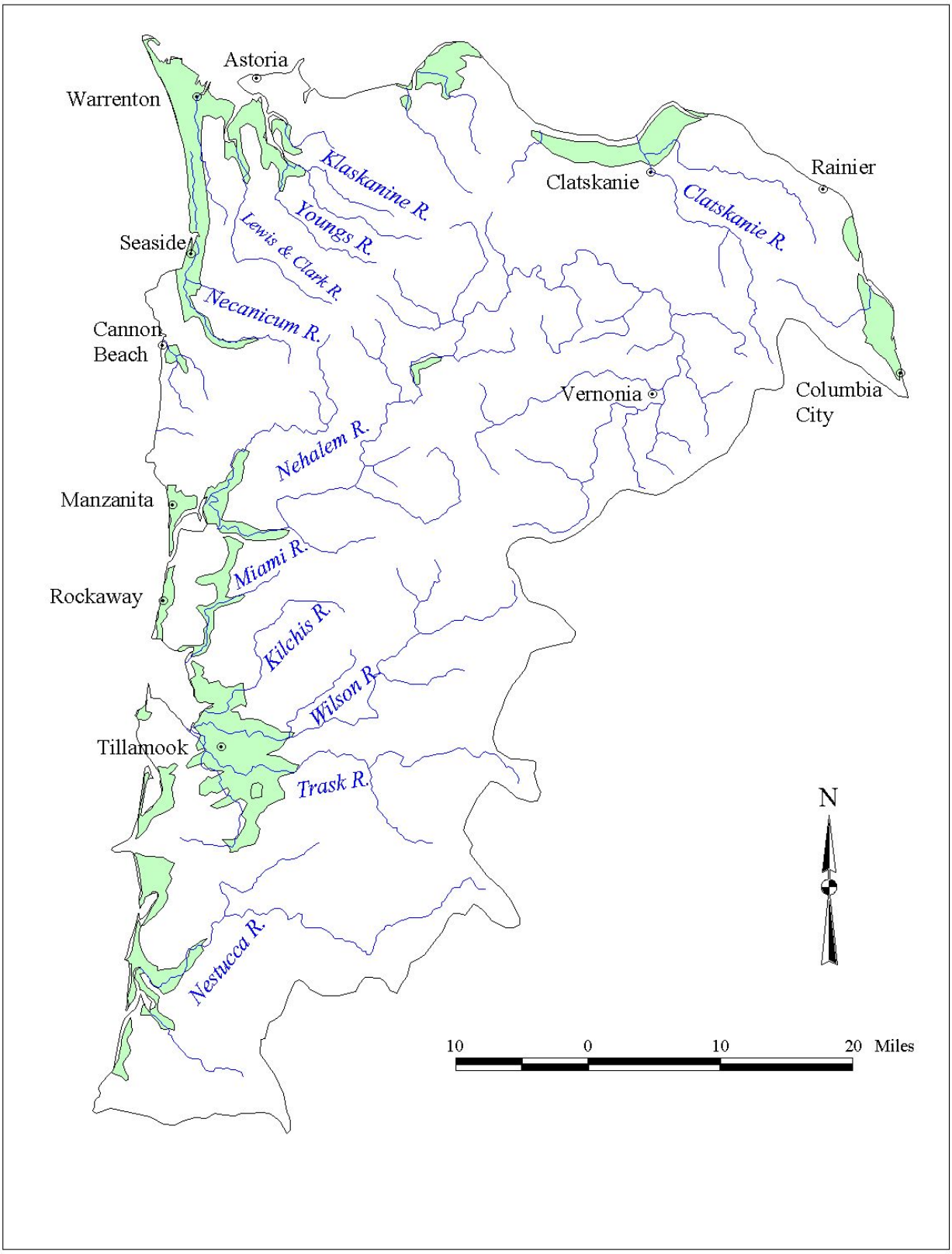


Figure 6. Sensitive Aquifers, North Coast Basin, Oregon.

GROUNDWATER USE

Overview

The Oregon Water Resources Department (OWRD) manages statewide groundwater use through water rights applications, permits, certificates, transfers, and leases. North Coast Basin groundwater is available for the following uses (OAR 690-501-0005):

- domestic,
- livestock,
- municipal,
- irrigation,
- power development,
- industrial,
- mining,
- recreation,
- wildlife, and
- fish life.

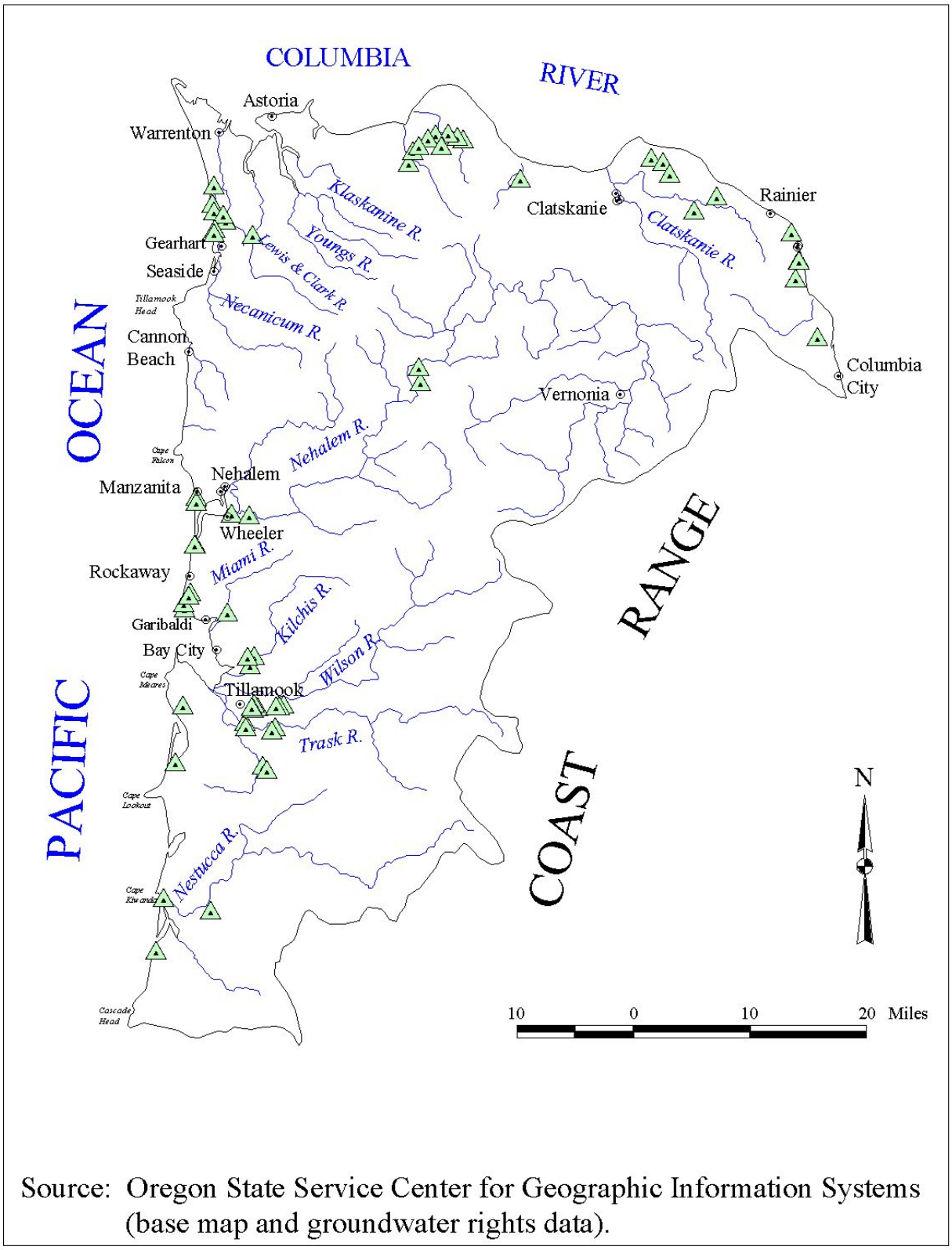
Exempt uses do not require a permit. Exempt uses (ORS 537.545) include the following:

- 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 use less than 5,000 gallons a day, and
- land application associated with permitted uses.

North Coast Basin groundwater use is discussed in more detail below. Specific water right information can be accessed through the OWRD website at:
http://www.wrd.state.or.us/waterrights/wris.shtml

Groundwater Rights

OWRD information shows a total of 2,500 water rights on record in the North Coast Basin. Of these, 74 are points of diversion (POD) rights, utilizing groundwater, or a combination of surface water and groundwater, for such uses as campground, domestic, fish, irrigation, manufacturing, municipal, stock, and wildlife (Figure 7). Another 39 water rights are points or areas of use (POU) for purposes such as irrigation and livestock.



Source: Oregon State Service Center for Geographic Information Systems (base map and groundwater rights data).

Figure 7. Groundwater Rights Points of Diversion, North Coast Basin, Oregon.

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 North Coast Basin households. Current statutes (ORS 537.765) and administrative rules (OAR 690-205-0210) require well logs to be filed with OWRD upon well completion. The number of private, domestic water wells constructed and reported to OWRD estimates how many potential domestic water users exist.

The OWRD database (http://www.wrd.state.or.us/groundwater/index.shtml) contains 4,070 domestic water well logs on file for the North Coast 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 David Cole, DEQ, 8/11/03).

Public Water Systems

The North Coast Basin has over 150 groundwater-based Public Water Systems (PWS). Figure 8 shows the locations of most of these systems. Latitude/longitude coordinates are not available for 48 of these systems, and are not shown on the figure. The PWS systems shown on Figure 8 use groundwater exclusively or use a combination of groundwater and surface water to supply various public uses, including municipal drinking water. These systems are designed to provide water for over 85,000 people. Over 140 of these systems rely solely on groundwater and are designed to provide drinking water for over 21,000 people. The remaining systems are designed to provide drinking water to over 64,000 people.

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 at: http://170.104.158.16/ .

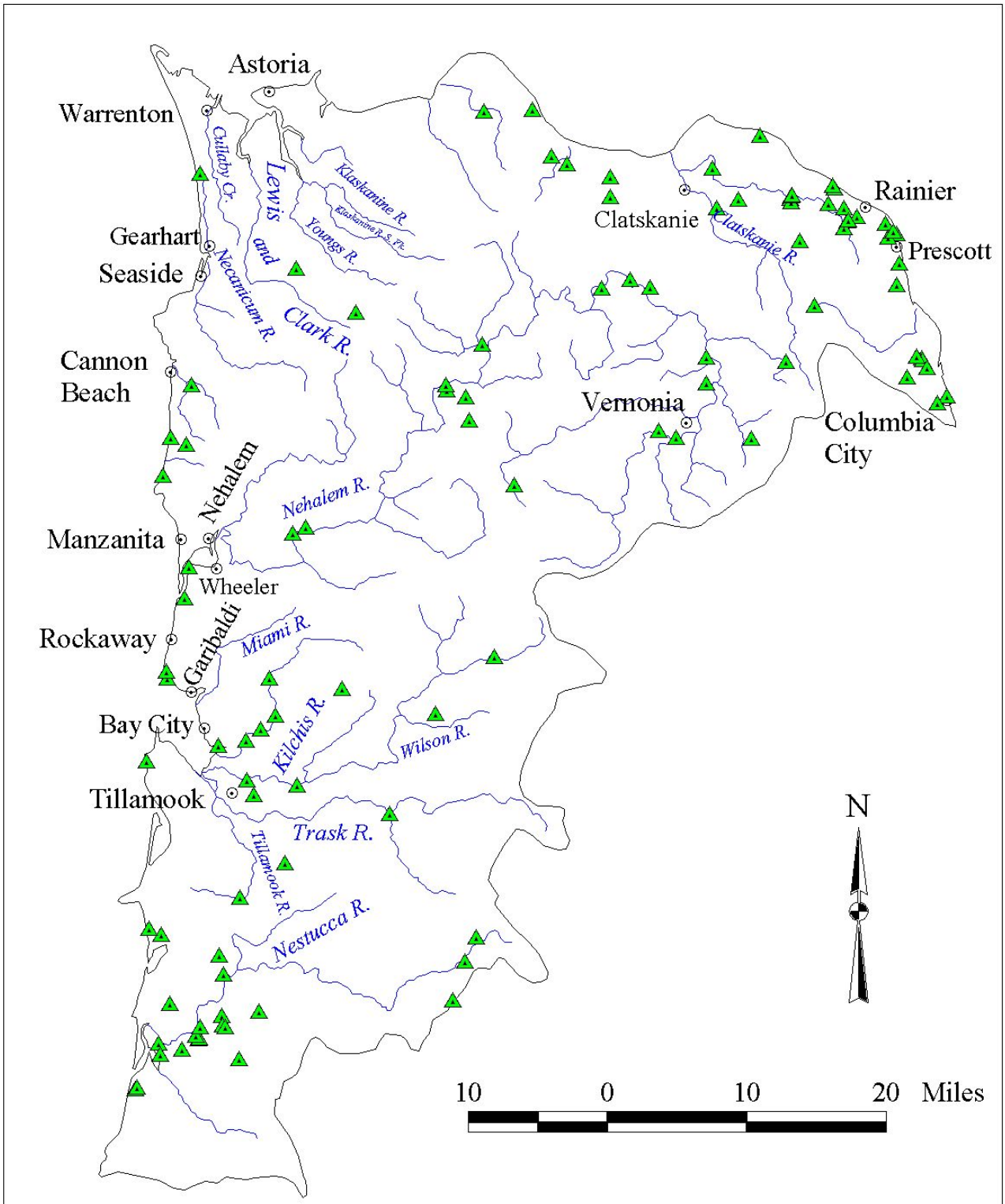


Figure 8. Public Water Supply Systems Using Groundwater in the North Coast Basin.

Sources: Oregon State Service Center for Geographic Information Systems (base map);
Department of Human Services, Drinking Water Program (Public Water Supply data).

GROUNDWATER QUALITY CONCERNS

A U.S. Geological Survey study characterized the Clatsop Plains area groundwater (Frank, 1970). Frank highlighted the following Clatsop Plains dunal aquifer characteristics:

- shallow (less than 100 feet deep),
- highly permeable,
- recharged primarily through precipitation and inputs from the ground surface.

Groundwater quality information collected from 1969 through 1976 showed increasing groundwater nitrate levels. The increases were related to increased housing density and on-site septic system use (summarized in Beck, 1982).

In 1970, the Environmental Quality Commission (EQC) moved to limit the use of septic tanks in the area for high density development and facilities serving 5 families or 50 people. In 1977, the EQC further restricted septic system use for any Clatsop Plains area development. Clatsop County and the DEQ commissioned a study to analyze the groundwater supply reserve, and to model the impact of various development scenarios and on-site septic system densities on groundwater quality. The study report (Sweet, 1977) recommended setting aside an area for future water supply, and establishing a minimum lot size of one acre for new residential developments using on-site septic systems.

Further studies conducted for Clatsop County (Sweet, 1981, Beck, 1982) recommended setting aside a minimum of 2.5 square miles of aquifer for water supply development. This included an area the City of Warrenton set aside, the area within Camp Rilea's boundaries, and the 40 acres of County-owned land at Del Rey Beach. These reports were the basis for the EQC adopting a special geographic area rule regarding on-site septic systems in the Clatsop Plains area (OAR 340-071-0400 (5)).

GROUNDWATER QUALITY STUDIES

Overview

The Groundwater Quality Protection Act mandates the DEQ and other state agencies to conduct on-going statewide monitoring and assessment of statewide groundwater quality (ORS 468B.190). The DEQ and other local and state agencies have collected data and conducted several groundwater quality studies in the North Coast Basin. Statewide and regional assessments conducted in the 1980s provided initial groundwater quality information. The DEQ and other agencies have conducted additional, local scale assessments, in response to specific local concerns.

In the North Coast Basin, one area of concern is the sensitive Clatsop Plains groundwater aquifer. In 1993, the DEQ and other agencies systematically reviewed available information about known or suspected groundwater contamination, and areas susceptible to contamination.

The DEQ then developed a Master Plan for a statewide groundwater monitoring program (Cole and Pollock, 1993). The Plan identified the Clatsop Plains area as needing further assessment. Toward this end the DEQ conducted a groundwater quality study in the spring and fall of 1996. The DEQ also identified the Tillamook area as a priority area, and conducted a groundwater quality study in fall 1997 and spring 1998.

Local residents raised specific groundwater quality concerns regarding the Astoria, Warrenton, and Tillamook landfills. The DEQ has collected and analyzed groundwater samples at these permitted landfills in the North Coast Basin. The Solid Waste Facilities section summarizes water quality monitoring results from sampling events conducted at these landfills.

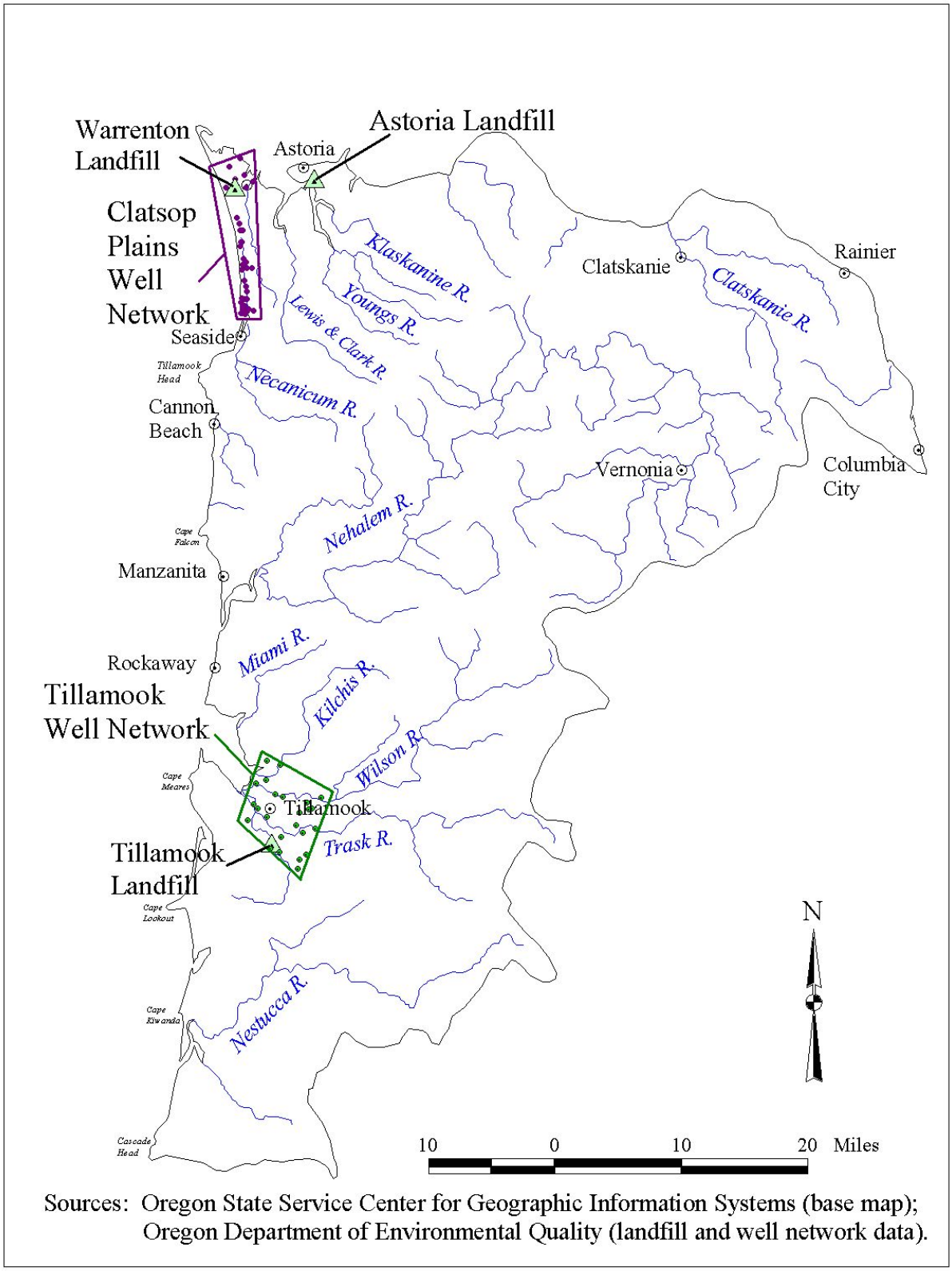
This report summarizes information and studies in order of basinwide studies and area studies. Figure 9 shows the study area locations. The following section discusses the results.

Basinwide Studies

- Domestic Well Testing for Real Estate Transactions; Oregon Department of Human Services.
- Public Water Systems; Oregon Department of Human Services.

Area Studies

- Clatsop Plains Groundwater Studies (1980 – 1998); Oregon Department of Environmental Quality (DEQ).
- Tillamook Groundwater Study (1997 – 1998); Oregon Department of Environmental Quality (DEQ).



Sources: Oregon State Service Center for Geographic Information Systems (base map); Oregon Department of Environmental Quality (landfill and well network data).

Figure 9. Groundwater Quality Studies, North Coast Basin, Oregon

Basinwide Studies

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 involving a domestic water supply well, the seller must test the well water for nitrate and total coliform bacteria. The seller must complete and submit a Water Systems Data Sheet, including the laboratory test results, to the Oregon Department of Human Services (DHS).

Results

Table 1, Appendix 2, summarizes information submitted to the DHS for transactions in the seven North Coast Basin counties between 1989 and 1997. The following statistics apply to transactions only. Since any given domestic drinking water well may be involved in more than one transaction, the actual number of wells tested may be lower. Thus the transaction statistics represent the maximum percentage of wells with nitrates and bacteria exceedances. The results include the following:

- 924 real estate transactions of properties with domestic wells occurred in the North Coast Basin during this time period.
- 14 transaction tests (1.5%) had nitrate levels above the drinking water standard of 10 mg/L.
- 23 transaction tests (2.5%) had nitrate levels over 7 mg/L, the trigger level for Groundwater Management Area declaration (see OAR 340-040-0090).
- 121 transaction tests (13%) had nitrate levels equal to or greater than 2 mg/L, indicative of anthropogenic influences.
- 88 transaction tests (9.5 %) were positive for bacteria.

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. Latitude and longitude coordinates are not available for the domestic wells, so their locations cannot be plotted on a map.

Public Water Systems

Oregon Department of Human Services

Summary

Over 200 groundwater-based public water systems (PWS) provide drinking water to North Coast Basin residents. The Oregon Department of Human Services Drinking Water Program maintains water quality information on these systems. 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 at: (http://170.104.158.16/).

Results

Table 1 summarizes testing results for groundwater-based PWS. Table 2, Appendix 2, presents additional data. Not all PWS have the same period of record for testing results. Also, not all PWS tested for the same constituents during their period of record. The results include the following:

- Nitrate was detected in 82 PWS, and exceeded the 10 mg/L MCL in three systems. Thirty-eight PWS had nitrate levels equal to or greater than 2 mg/L, indicative of anthropogenic influences.
- Bacteria was detected in 23 PWS.
- Lead was detected in 40 wells, and exceeded the Action Level in seven wells.
- Cadmium was detected in five wells, and exceeded the MCL in four wells.
- Thallium was detected in two wells, and exceeded the MCL in one well.
- Radium was detected in one well, and exceeded the MCL.
- Alpha radiation was detected in 26 wells, but none exceeded the MCL.
- Arsenic was detected in 25 wells, but none exceeded the MCL.
- Barium was detected in 23 wells, but none exceeded the MCL.
- Volatile organic compounds were detected in 22 wells, but none exceeded any MCLs.
- Copper was detected in 20 wells, but none exceeded the Action Level of 1.3 mg/L.
- Chromium was detected in 19 wells, but none exceeded the MCL.
- Selenium was detected in 16 wells, but none exceeded the MCL.
- Mercury was detected in nine wells, but none exceeded the MCL.

Figure 10 shows the distribution of nitrates in North Coast Basin groundwater-based Public Water Supply Systems. Latitude and longitude coordinates are not available for 48 PWS. This is the reason why two of the three PWS with nitrates over the MCL do not appear on the figure. The nitrate distribution uses 2 mg/L as an approximate indicator of anthropogenic influence (Department of Human Services, Drinking Water Program, Nitrate Fact Sheet, http://www.dhs.state.or.us/publichealth/dwp/docs/fact/nitrate.pdf).

Figure 11 shows the locations of the PWS in the North Coast Basin with other exceedances (i.e., Lead, Cadmium, Thallium, and Radium). The PWS with bacteria detections are not shown because none of those PWS have latitude and longitude coordinates. One of the PWS with a lead exceedance has no latitude and longitude coordinates, so that site is not on the map.

Table 1. North Coast Basin Public Water Systems

Contaminant	# of systems detected	# of Wells Over MCL	Maximum Value Detected	NPDW MCL* (mg/L)
Nitrate	82	3	12.1 mg/L	10
Bacteria	23	23	N.A.	5% positive/per month
Lead	40	7	0.058 mg/L	0.015 (Action Level)
Cadmium	5	4	0.05 mg/L	0.005
Thallium	2	1	0.0028 mg/L	0.002
Radium	1	1	9 pCi/L	5 pCi/L
Alpha Radiation	26	0	9.65 pCi/L	15 pCi/L
Arsenic	25	0	0.035 mg/L	0.01
Barium	23	0	0.79 mg/L	2
Volatile Organic Compounds	22	0	21 mg/L	various
Copper	20	0	0.07 mg/L	1.3 (Action Level)
Chromium	19	0	0.041 mg/L	0.1
Selenium	16	0	0.0141 mg/L	0.05
Mercury	9	0	0.0048 mg/L	0.002

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

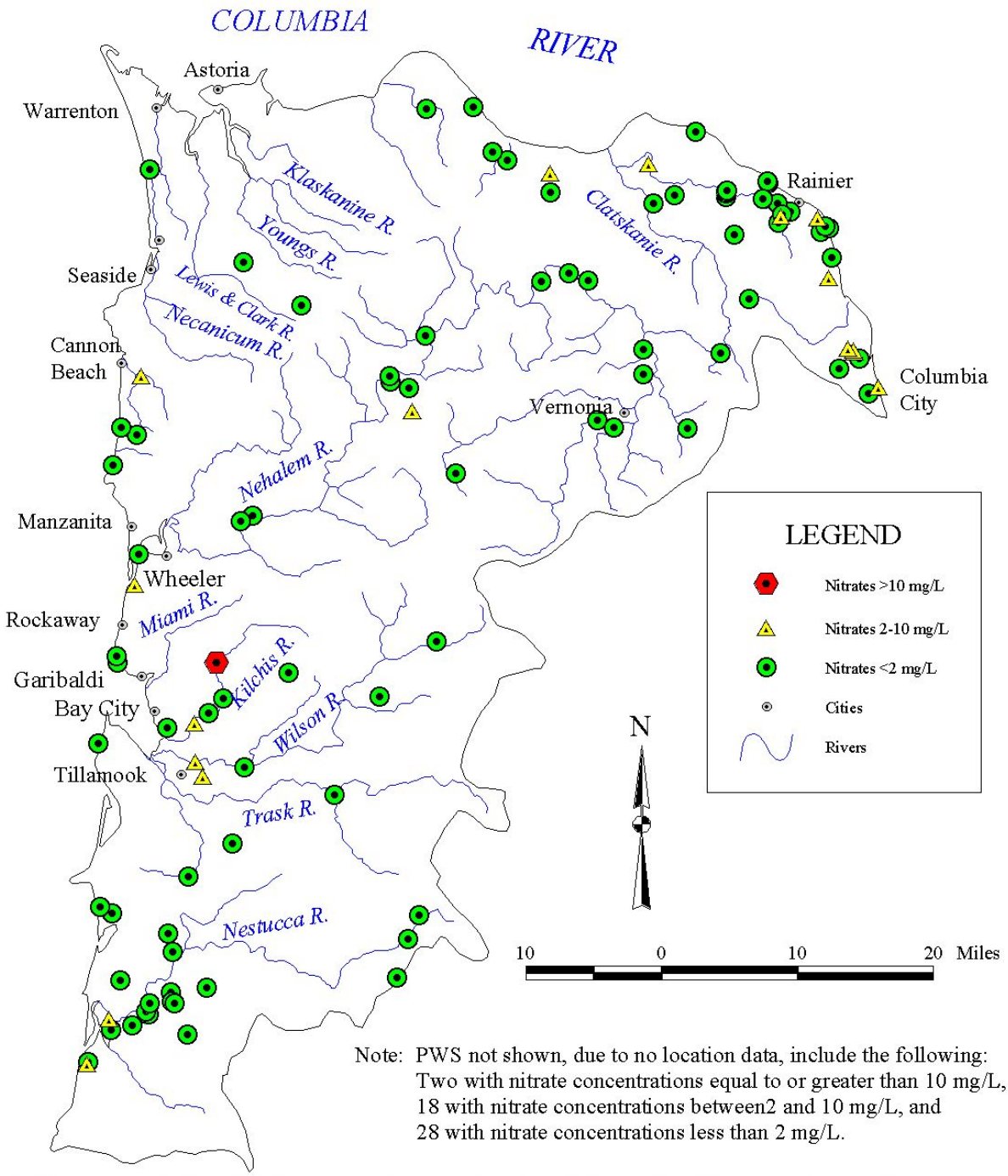


Figure 10. Nitrate Levels in North Coast Basin Groundwater-based Public Water Supplies (PWS).

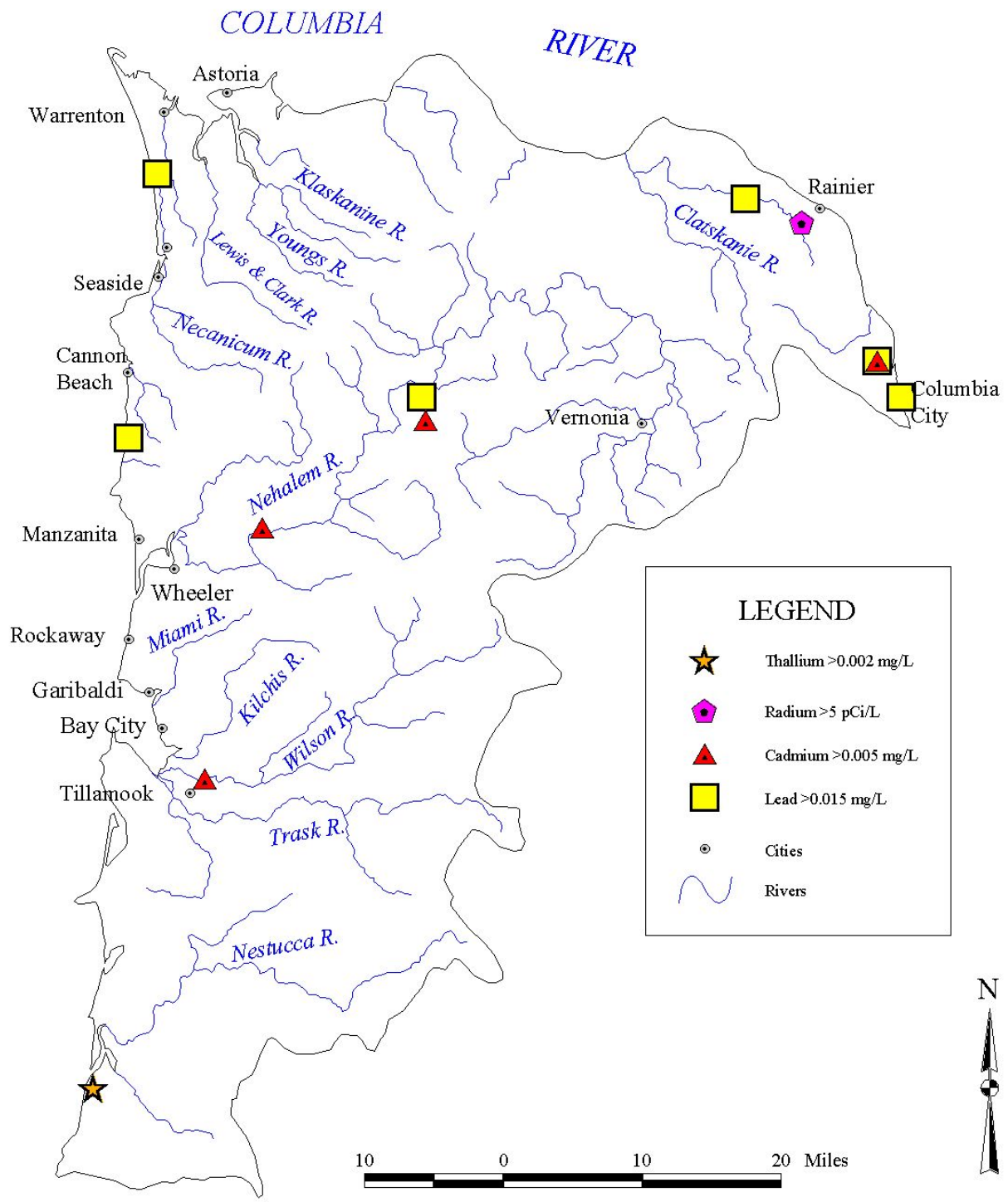


Figure 11. North Coast Basin Groundwater-based Public Water Supply Systems with Drinking Water Exceedances other than Nitrate and Bacteria.

Area Studies

Clatsop Plains Groundwater Studies (1980 – 1998)

Oregon Department of Environmental Quality

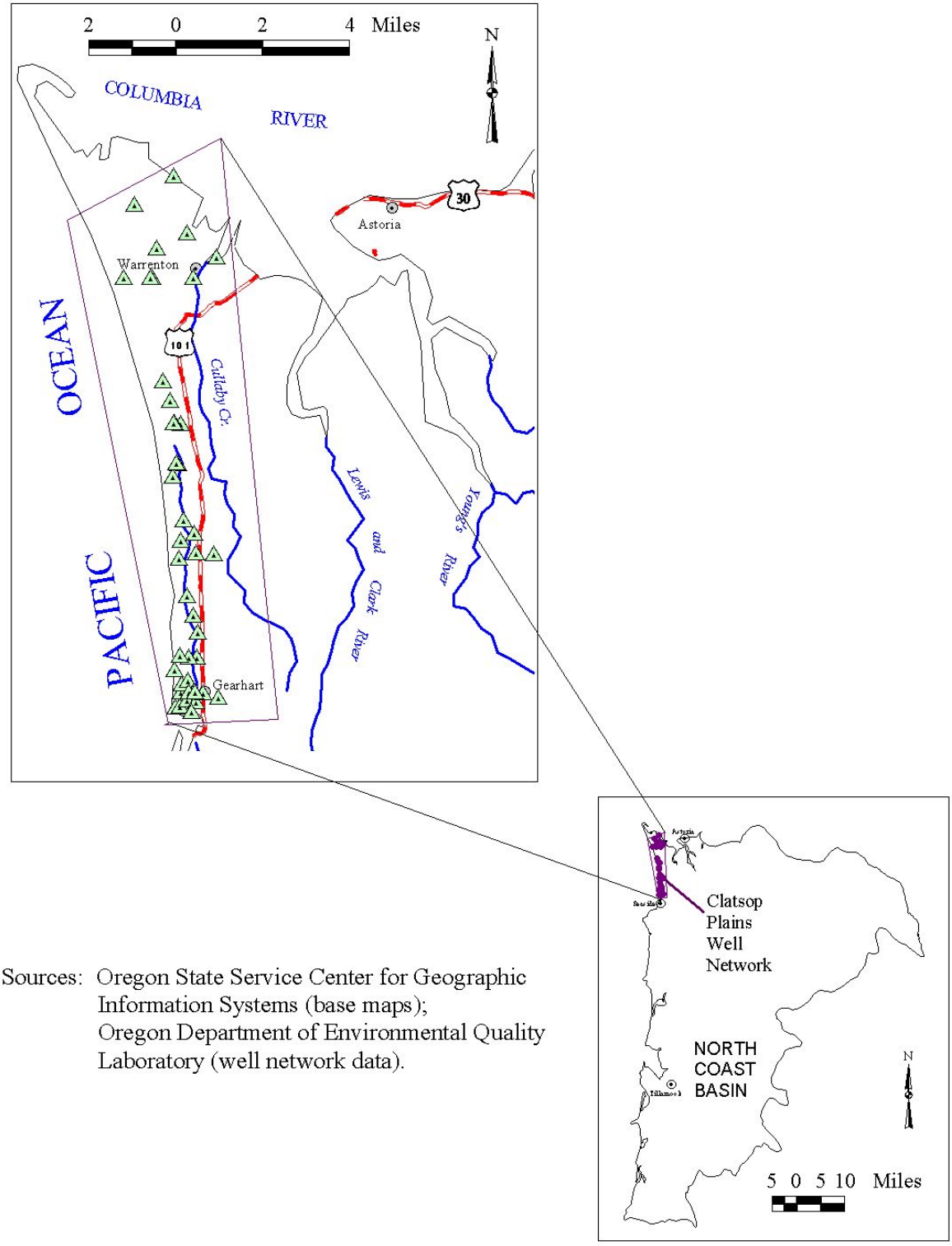
Summary

The DEQ collected water quality samples from 54 wells in the Clatsop Plains area for groundwater studies conducted in 1980, 1981, 1982, 1991, 1992, 1993, 1994, 1996, and 1998. This report focuses on the 1996 study because it analyzed a full suite of constituents, including volatile organic compounds (VOCs), pesticides, metals, nutrients, and physical parameters.

The DEQ conducted the 1996 study as part of the Statewide Ambient Groundwater Monitoring Program. The DEQ developed a work plan for the Clatsop Plains area (Pollock and Weick, 1996). The DEQ collected groundwater samples from 35 wells and 7 surface water locations in the spring of 1996. The wells included monitoring, irrigation, and domestic wells, and one public water system well. Most of these wells had been sampled in previous studies. Additional wells were added to the sampling network to fill areas in the northern portion of the Clatsop Plains. In fall 1996, the DEQ resampled 31 of the original 35 wells, plus an additional well not sampled during the spring event. The DEQ analyzed all sample locations for the same set of constituents for both the spring and fall 1996 sampling events. Figure 12 shows all the 1996 sampling locations.

The Oregon Department of Agriculture (ODA) laboratory analyzed the pesticide samples, while the DEQ Lab analyzed all remaining constituents.

Table 4, Appendix 1, lists the pesticides included in the five screening analyses and the method detection limits. Analyses for wells re-sampled in fall 1996 included physical parameters, nitrate, and others listed on Table 3, Appendix 1, and VOCs or pesticides if detected in the initial sampling. Immediately upon data release the DEQ notified owners of drinking water wells of any drinking water standard exceedances.



Sources: Oregon State Service Center for Geographic Information Systems (base maps); Oregon Department of Environmental Quality Laboratory (well network data).

Figure 12. Sampling Locations for the 1996 DEQ Clatsop Plains Groundwater Study.

Results

Table 2 summarizes the results from the initial sampling in spring 1996. Table 3, Appendix 2, compiles the results in more detail. The results include the following:

- Of the 35 wells, 22 were monitoring wells, nine were domestic supply wells, three were irrigation wells, and one was a mobile home park supply well.
- Nitrate[1] was detected in 28 out of 36 wells (78%). Three wells (9%) exceeded the 10 mg/L MCL in the Gearhart urban area. Two of these three wells exceeding the MCL were PVC monitoring wells. The third well was an old galvanized monitoring well. All three of these wells exceeding the MCL were built to substandard conditions, making them particularly vulnerable to contamination from surface activities. Five of the 35 wells had nitrate levels at or above 2 mg/L, indicative of anthropogenic influences.
- Total coliform bacteria was detected in 16 out of 35 (46%) wells. Thirteen of these wells were monitoring wells, two were domestic wells, and one was an irrigation well.
- Atrazine was detected in a Warrenton Landfill monitoring well at 0.0039 mg/L, and exceeded the drinking water standard (0.003 mg/L).
- Pentachlorophenol was detected in one Gearhart area monitoring well at a concentration of 0.0073 mg/L, exceeding the MCL (0.001 mg/L).
- Chloroform was detected in one Gearhart area monitoring well below the MCL.
- Toluene was detected in one Gearhart area monitoring well below the MCL.
- Toluene and 1,4/1,3-Dimethylbenzene were detected in one Warrenton Landfill monitoring well below the MCL.
- Lead was detected in 11 out of 35 wells (31%), and exceeded the drinking water Action Level (AL = 0.015 mg/L) in 7 wells (20%). Nine of the 11 lead exceedances occurred in monitoring wells. The other two occurred in a domestic well and an irrigation well.
- Arsenic, copper, cadmium, barium, and chromium were detected, but concentrations did not exceed the MCLs. Ten wells had arsenic in them, three of which were domestic wells. The remaining constituents (barium, cadmium, chromium, and copper) all occurred in monitoring wells.

The DEQ resampled wells and surface water in October 1996. Table 3 summarizes the sampling results. Table 4, Appendix 2, compiles the results in more detail. The results include the following:

- Nitrate was detected in 24 out of 32 wells (75%), and exceeded the drinking water standard (10 mg/L) in 2 wells (6%). Both exceedances occurred in Gearhart area monitoring wells. These wells were built to substandard conditions, making them particularly vulnerable to contamination from surface activities. Seven of the 32 wells had nitrate levels at or above 2 mg/L, indicative of anthropogenic influences.
- Total coliform bacteria was detected in 18 out of 32 wells (56%). Thirteen of these wells were monitoring wells, four were domestic wells, and one was an irrigation well.

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

- Atrazine was detected in the same Warrenton Landfill monitoring well as in the spring sampling at 0.0102 mg/L, and exceeded the drinking water standard (0.003 mg/L).
- No volatile organic compounds were detected.
- Cadmium and lead were detected in one Gearhart area monitoring well below the drinking water standard and Action Level.

Figure 13 shows the distribution of nitrate detections throughout the study area. The figure uses nitrate data from both spring and fall 1996 sampling events. For all wells with nitrate detected during both sampling events, the higher value was used for plotting purposes. The shaded areas represent the Gearhart, Warrenton, and Astoria urban growth boundaries. The figure also shows the Warrenton Landfill monitoring well where Atrazine was detected.

Figure 14 shows the distribution of bacteria detections throughout the study area. The figure uses bacteria data from both spring and fall 1996 sampling events. Well locations are shown on the figure if they had bacteria detected in either the spring 1996 sampling event, the fall 1996 sampling event, or both. All together, bacteria was detected in 21 wells, 18 of which were old, poorly constructed monitoring wells.

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 Clatsop Plains Groundwater as the sampling event name.

Table 2. Clatsop Plains Groundwater Study (Spring 1996).

Contaminant	No. of wells detected out of 35 wells	Average* Concentration (mg/L)	Maximum Concentration (mg/L)	Detection Limit (mg/L)	NPDW MCL** (mg/L)	Number of Wells Over MCL
Nitrate	28	3.75	59	0.02	10	3
Total Coliform Bacteria	17	-	290 CFU/0.1 L	4 CFU/0.1 L	1 positive per month	17
Atrazine	1	0.0390	0.0390	0.0006	0.003	1
Pentachlorophenol	1	0.007	0.007	0.0001	0.001	1
Toluene	2	0.0002	0.0010	0.0005	1	0
Chloroform	1	0.0009	0.0009	0.0005	0.100	0
Dimethylbenzene	1	0.0006	0.0006	0.0005	-	-
Lead	11	0.051	1.400	0.005	0.015 (Action Limit)	7
Arsenic	10	0.006	0.040	0.005	0.05	0
Copper	4	0.02	0.12	0.02	1.3 (Action Limit)	0
Cadmium	1	0.001	0.001	0.01	0.05	0
Barium	1	0.02	0.09	0.03	2	0
Chromium	1	0.02	0.03	0.03	0.1	0

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

Table 3. Clatsop Plains Groundwater Study (Fall 1996).

Contaminant	No. of wells detected out of 32 wells	Average* Concentration (mg/L)	Maximum Concentration (mg/L)	Detection Limit (mg/L)	NPDW MCL** (mg/L)	Number of Wells Over MCL
Nitrate	24	2	12	0.02	10	2
Total Coliform Bacteria	18	93 CFU/0.1 L	1580 CFU/0.1 L	4 CFU/0.1 L	1 positive per month	18
Atrazine	1	0.0003	0.0102	0.0001	0.003	1
Lead	1	0.003	0.007	0.005	0.015 (Action Limit)	0
Cadmium	1	0.001	0.003	0.001	0.005	0

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

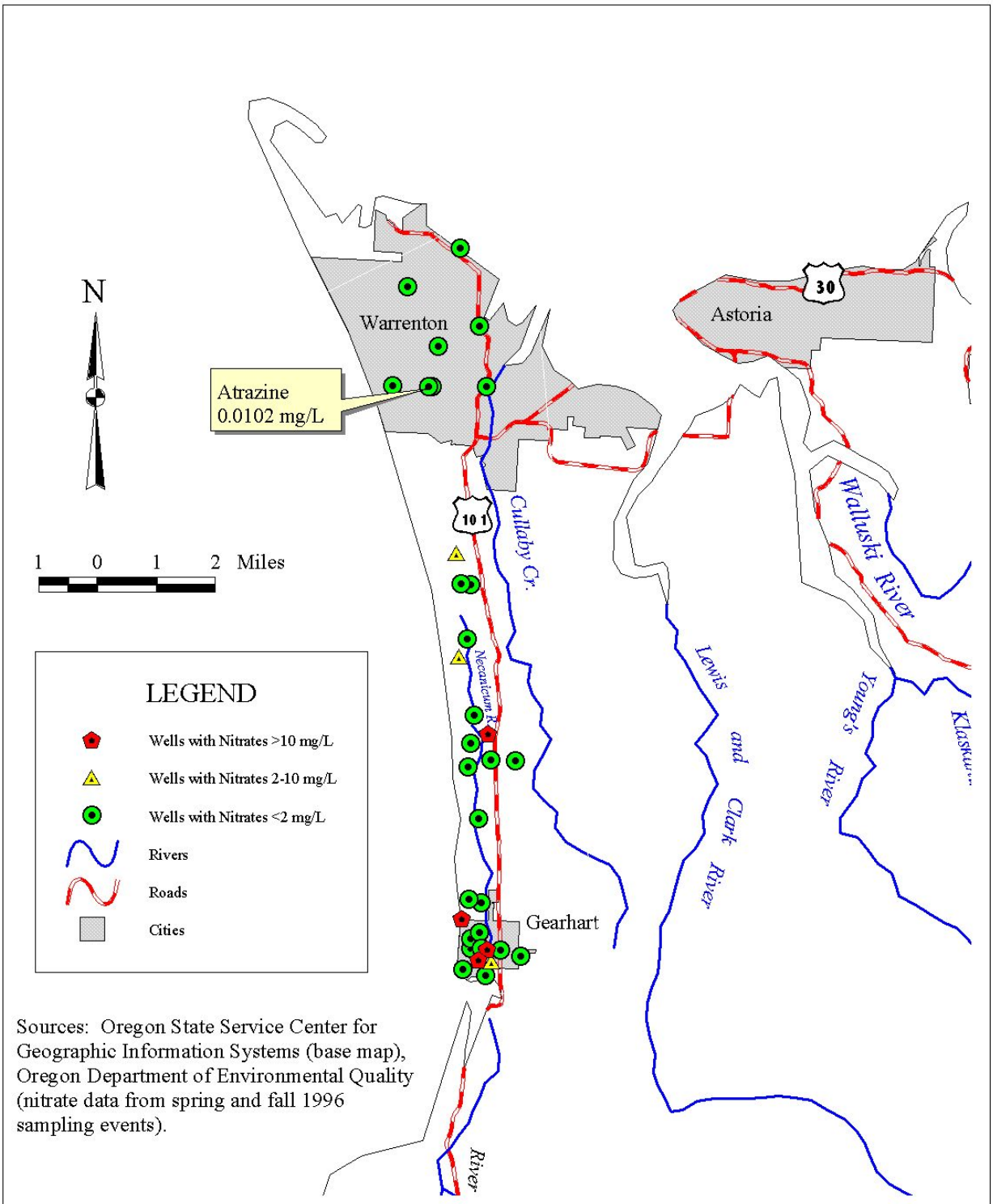


Figure 13. Clatsop Plains Nitrates.

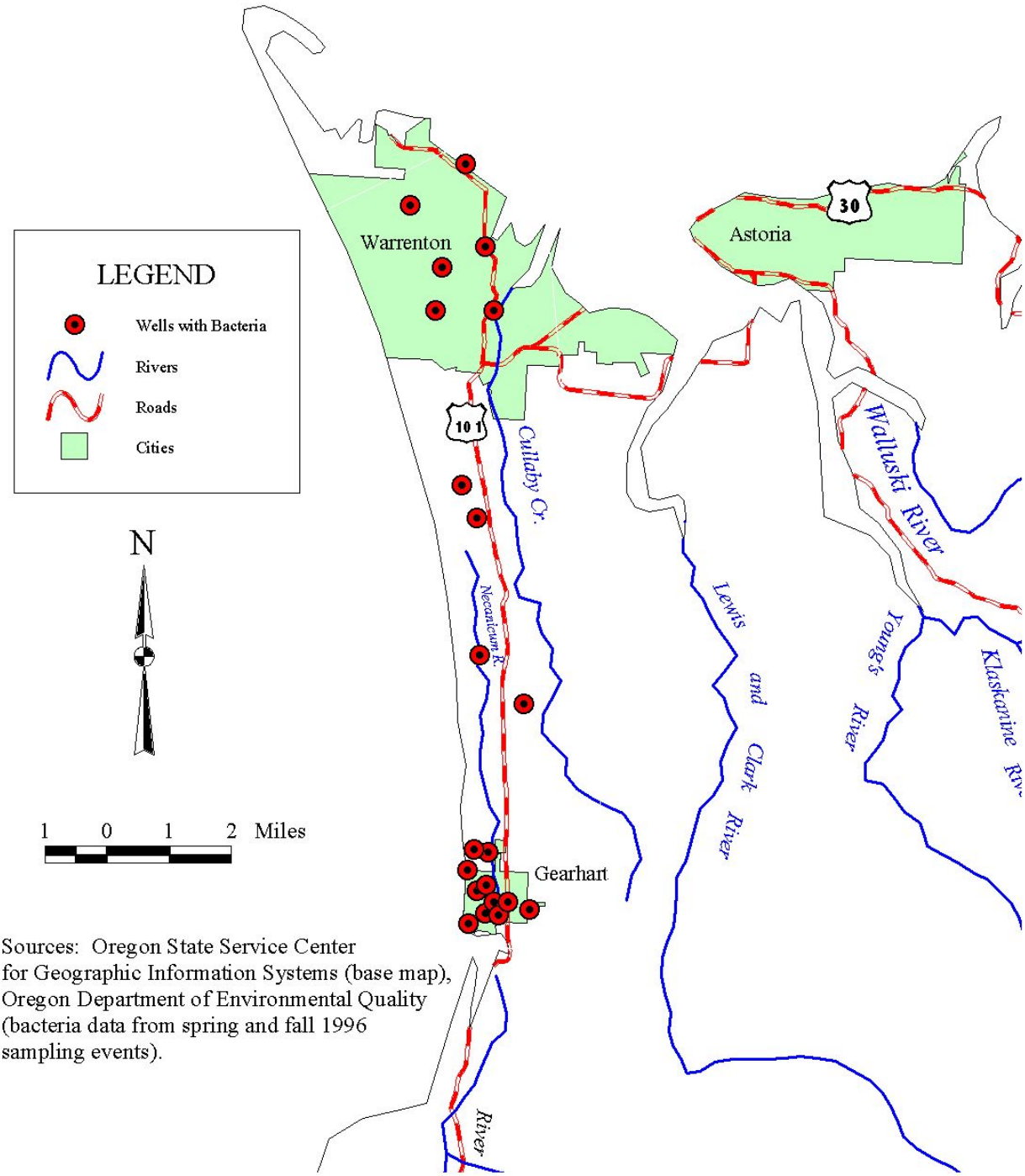


Figure 14. Clatsop Plains Well Locations with Bacteria.

1998 Clatsop Plains Groundwater Study

Clatsop Community College and Oregon Department of Environmental Quality

Summary

The Clatsop Community College (CCC) General Chemistry class conducted water quality sampling and analytical work in the Clatsop Plains. This work provided the students with practical experience in performing water quality monitoring. CCC requested the DEQ observe, assist, and conduct split sampling with them in May 1998. The DEQ and CCC collected samples from eight wells and two surface water sites, and conducted split sample analyses. Figure 15 shows the sample locations.

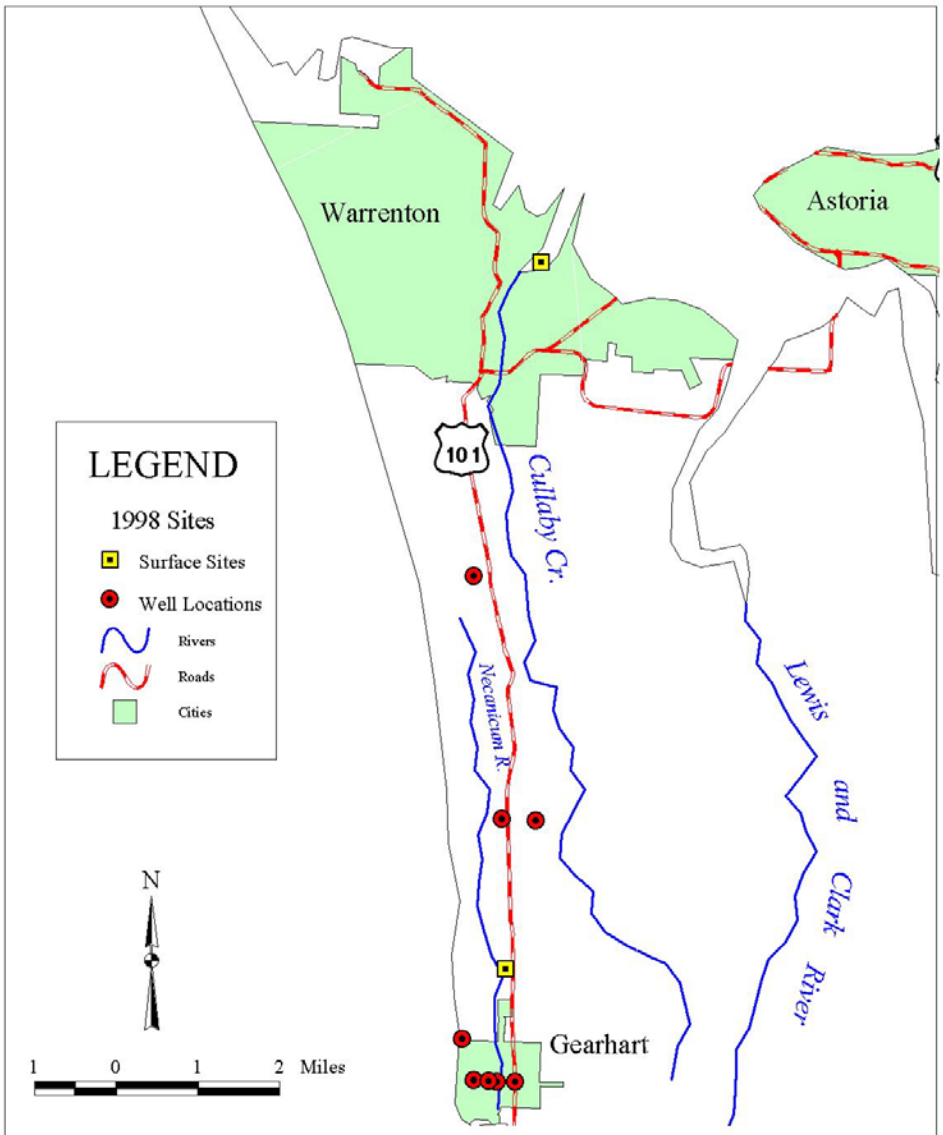


Figure 15. Sampling Locations for the 1998 DEQ/ CCC Clatsop Plains Water Quality Study.

Sources: Oregon State Service Center for Geographic Information Systems (base map); Oregon Department of Environmental Quality Laboratory (sampling data).

The DEQ and CCC analyzed samples for various constituents listed on Tables 5 and 6 in Appendix 1, including the following:

- Bacteria in surface water samples only, and
- Others such as physical parameters, nutrients, and metals.

Results

- Nitrate[2] was detected in one of eight wells at the drinking water standard (10 mg/L).

The following file summarizes the sampling results in greater detail.

Clatsop 1998 Summary.pdf

Tillamook Groundwater Study (1997 – 1998)

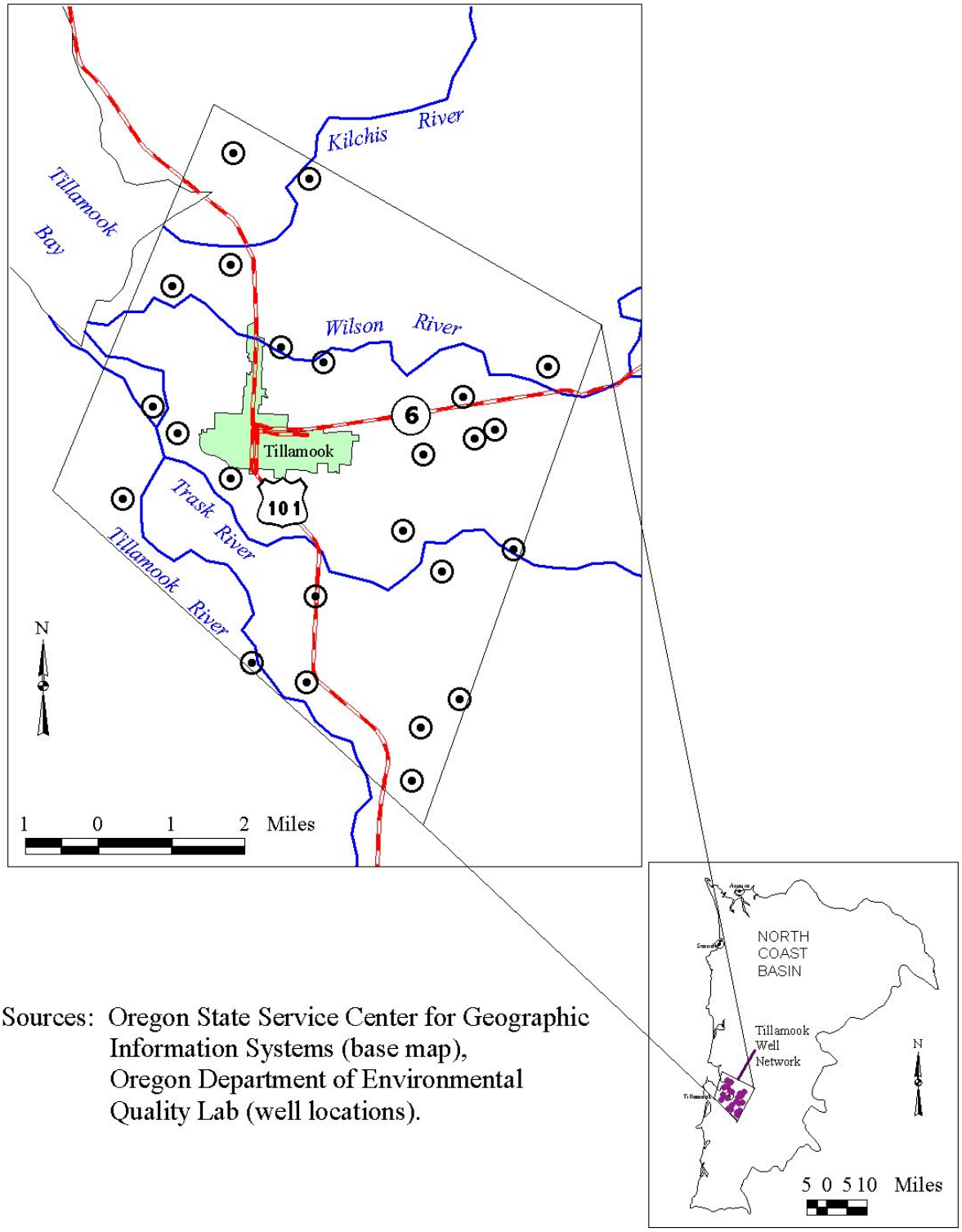
Oregon Department of Environmental Quality

Summary

To comply with the Statewide Ambient Groundwater Monitoring Program, the DEQ sampled Tillamook area groundwater in November 1997. The principle contaminants of concern were nitrate and pesticides associated with agricultural land use and on-site septic systems. The DEQ collected groundwater samples from 24 water wells.

In April 1998, the DEQ sampled the wells for volatile organic compounds (VOCs), and to confirm initial results. Figure 16 shows the well locations.

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



Sources: Oregon State Service Center for Geographic Information Systems (base map), Oregon Department of Environmental Quality Lab (well locations).

Figure 16. Well Locations for the Tillamook Groundwater Study.

The DEQ selected wells constructed to depths between 36 and 197 feet below ground surface (bgs). The average well depth was about 80 feet bgs. No wells were available to sample the shallow groundwater table found at depths from 10 to 20 feet bgs.

The DEQ and the Oregon Department of Agriculture (ODA) laboratories analyzed groundwater samples for various constituents listed on Tables 7, 8, and 9 in Appendix 1 including:

- Volatile organic compounds (VOCs) including solvents and ethylene dibromide (EDB),
- Pesticides including a suite of 12 specific analytes, and screens designed to detect the following classes of pesticides: nitrogen-phosphorous, organophosphate, organochloride, phenoxy herbicides and pesticides; and
- Others such as physical parameters, nutrients, and metals.

Results

Table 5 summarizes the results for the November 1997 sampling event. Table 6 summarizes the results for the April 1998 sampling event. Table 6, Appendix 2, presents a more detailed summary of the results.

- Nitrate[3] was detected in 16 out of 25 wells (64%), but did not exceed the drinking water standard (10 mg/L). Seven wells (28%) had concentrations between 2 and 8.6 mg/L. This concentration range is indicative of anthropogenic influences. All remaining wells (9 = 36%) were below 2 mg/L.
- Bacteria were detected in one well, but were not confirmed on re-sampling.
- Ethylbenzene, a volatile organic compound, was detected in one well at trace levels. Resources were not available to conduct confirmation resampling for VOCs.
- Antimony was initially detected in 16 wells and exceeded the drinking water standard of 0.006 mg/L in five wells (20%). The presence and concentrations of antimony were not confirmed on re-sampling in spring 1998.
- Lead was detected in four wells in the 1997 fall sampling at concentrations below the drinking water action level (0.015 mg/L). In the 1998 spring sampling, three different wells had concentrations of lead; one of these wells exceeded the action level with 0.0221 mg/L
- Barium, cadmium. chromium, copper, and nickel were detected, but concentrations did not exceed the MCLs.

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 Tillamook Groundwater as the sampling event name.

Figure 17 shows the distribution of nitrates and bacteria in the Tillamook area wells. The figure uses nitrate data from both the November 1997 and April 1998 sampling events. For all wells with nitrate detected during both sampling events, the higher value was used for plotting purposes.

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

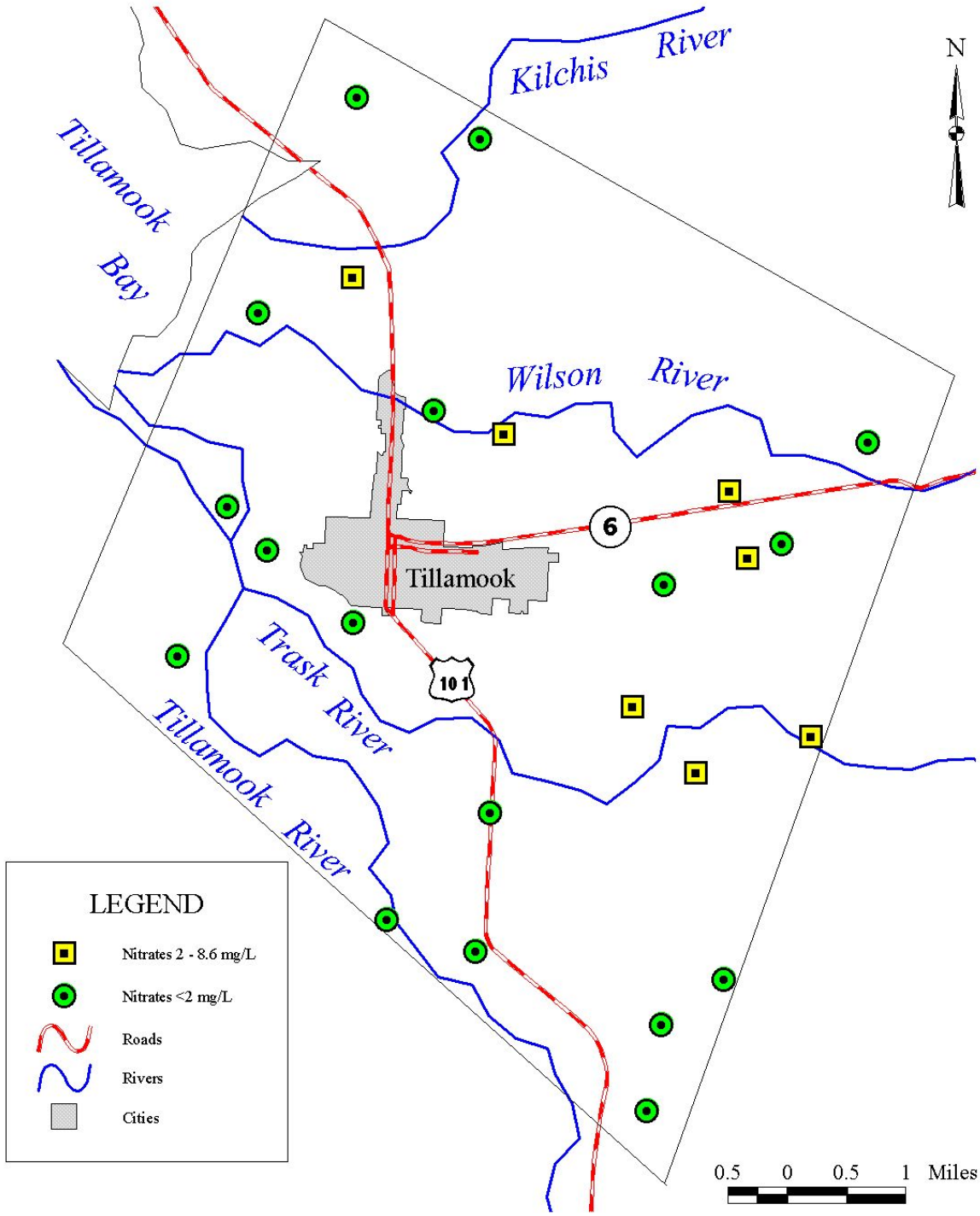


Figure 17. Nitrate and Bacteria Distribution in Tillamook Wells.

Sources: Oregon State Service Center for Geographic Information Systems (base map), Oregon Department of Envirnmental Quality Lab (well locations & data).

Table 4. Tillamook Groundwater Study (November 1997).

Contaminant	No. of Wells Detected out of 24 wells	Average* Concentration (mg/L)	Maximum Concentration (mg/L)	Detection Limit (mg/L)	NPDW MCL** (mg/L)	Number of Wells Over MCL
Nitrate	16	1.28	8.60	0.02	10	0
Bacteria	1	12 CFU/0.1 L	280 CFU/0.1 L	2 CFU/0.1 L	1 positive per month	1
Antimony	16	0.0038	0.0069	0.0030	0.006	5
Lead	4	0.0064	0.0114	0.0030	0.015	0
Barium	25	0.00713	0.05270	0.00010	2	0
Chromium	18	0.00118	0.00582	0.00020	0.1	0
Copper	24	0.03907	0.46500	0.00030	1.3	0
Nickel	24	0.00143	0.00643	0.00040	0.1	0

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

Table 5. Tillamook Groundwater Study (April 1998).

Contaminant	No. of Wells Detected out of 24 wells	Maximum Concentration (mg/L)	Detection Limit (mg/L)	NPDW MCL** (mg/L)	Number of Wells Over MCL
Bacteria	0	0	2 CFU/0.1 L	1 positive per month	0
Ethylbenzene	1	0.0007	0.0005	0.7	0
Lead	3	0.0221	0.0030	0.015	1
Antimony	1	0.0039	0.0030	0. 006	0
Barium	5	0.07190	0.00010	2	0
Cadmium	1	0.00013	0.00010	0.005	0
Chromium	4	0.00045	0.00020	0.1	0
Copper	5	0.52000	0.00030	1.3	0
Nickel	4	0.00182	0.00020	0.1	0

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

Overall Status of North Coast Basin Groundwater

Nitrate

North Coast Basin studies have found areas with nitrate in the groundwater. Nitrate levels above 2 mg/L indicate anthropogenic activities have adversely affected the groundwater. Nitrate sources include dispersed non-point sources such as agricultural activities and on-site septic systems, and point sources generating nutrient rich waste products.

Some Public Water Systems (PWS) in the region have reported nitrate levels between 2 to 10 mg/L. A few PWS in the Clatsop Plains area have reported nitrate levels above the MCL (10

mg/L). For domestic wells sampled as part of a real estate transaction, two percent of the wells have nitrate above the MCL.

In local area studies, elevated nitrate was found in the Clatsop Plains area. Nitrate was above the MCL in four wells out of a network of 36 wells (11%). Three of these wells were in the Gearhart area. This area has no centralized sewage collection and treatment system. Area residents use on-site septic systems for sewage disposal.

In the Tillamook area, a large majority of wells sampled (18 out of 25 = 72%) had nitrate levels less than 2 mg/L. None of the remaining wells had nitrate levels exceeding the drinking water standard of 10 mg/L. The groundwater sampled in this study represents deeper groundwater zones used for domestic drinking water, and does not indicate shallow, near surface groundwater quality, more susceptible to contamination from anthropogenic activities. To monitor the shallow groundwater, permission from owners of shallow wells would have to be obtained, or new monitoring wells would have to be installed.

Bacteria

Positive groundwater bacteria detections may indicate contamination from non-point sources including on-site septic systems, or point sources including facilities handling or disposing septage or manure. Bacteria from well water may indicate poor well construction and maintenance practices, rather than an area wide aquifer problem.

On a regional scale, the domestic well real estate transaction data collected throughout the North Coast Basin counties showed 88 tests out of 924 were positive for bacteria.

In the Clatsop Plains area, widespread bacterial contamination is present. Local studies show bacteria present in 30% to 66% of the wells sampled. Bacteria prevalent in Clatsop Plains area water wells is likely due to poor well construction and maintenance practices. The presence of bacteria had no apparent correlation with well depth. Bacteria was present in the shallowest well (11.5 feet deep monitoring well), and in one of the deepest wells (100 foot irrigation well).

In the Tillamook area study, groundwater sampled from deeper water zones used for domestic drinking water showed only one well testing positive for bacteria. Resampling results for this well were negative for bacteria.

Toxics – Pesticides

In the Clatsop Plains area studies, groundwater samples were analyzed for pesticides using screening analytical methods with reporting limits generally higher than 0.001 mg/L. The reporting limit for 1,2-dibromomethane (EDB) was 0.0005 mg/L. This is higher than the MCL of 0.00005 mg/L. At these levels, pesticides were generally not detected. One pesticide, atrazine, was detected in one well at a concentration above the drinking water standard. The well location is near the Warrenton Landfill. Resources were unavailable to conduct confirmational resampling. Another pesticide, pentachlorophenol, was detected in one location in a monitoring well, but was not found when the well was re-sampled in the fall.

In the Tillamook area, no pesticides were detected using analytical methods with reporting limits generally higher than 0.001 mg/L.

Toxics – Volatile Organic Compounds

Some Public Water Systems (PWS) in the region have reported detections of volatile organic compounds (VOCs). Two PWS wells have detected VOCs above the MCL.

In the Clatsop Plains area, VOCs were generally not detected in groundwater. Low levels of toluene, chloroform, and dimethylbenzene were detected in one to two wells at concentrations below the MCLs, but were not detected when wells were re-sampled.

In the Tillamook area, VOCs were not present except for one trace detection of ethylbenzene.

Toxics - Metals

Some Public Water Systems in the region have reported elevated metal levels. Three PWS wells have detected lead above the drinking water action level. These systems are in Columbia County.

In the Clatsop Plains area studies, several metals were detected in groundwater samples from one sampling event, but were not detected when the wells were re-sampled. Lead was detected above the drinking water action level (0.015 mg/L) in 11 of 35 wells (31%) on initial sampling in spring 1996. Lead was present in only one well when the network was re-sampled six months later in fall 1996. The resampled lead level was below the MCL. Low levels of arsenic, copper, cadmium, chromium, and barium were also detected in the spring sampling event, but were not present above detection levels when re-sampled.

In the Tillamook area, lead was found exceeding drinking water action levels in one well that was sampled in spring 1998, but was not detected when sampled initially in the previous fall. Antimony was initially detected and exceeded the drinking water standard of 0.006 mg/L in five out of 25 wells (20%) in fall 1997, but concentrations were not confirmed on re-sampling in spring 1998.

POLLUTANT SOURCES

Overview

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

Waste Dischargers

The DEQ regulates 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 surface waters of the United States. 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 (340-045-0010(12)). State requirements and procedures (OAR 340-045 or OAR 340-071) distinguish these facilities from those discharging to navigable waters. 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 discharge a variety of wastewater including sewage, pulp and paper waste, food processing waste, smelting/refining waste, cooling water, industrial storm water, mining waste, municipal wastewater, and others.

The DEQ has regional offices in various locations around the state. The Northwest Region (NWR) manages permits within the North Coast Basin. Information on NPDES and WPCF permits is available on-line at http://www.deq.state.or.us/wq/SISData/FacilityHomenew.asp. Figure 18 shows the locations of 198 facilities permitted in the North Coast Basin. Eight of these facilities are major permits handling potentially high pollutant loads or serving a large number of people. Many facilities have more than one permit record associated with them. The database has 473 records associated with the198 facilities.

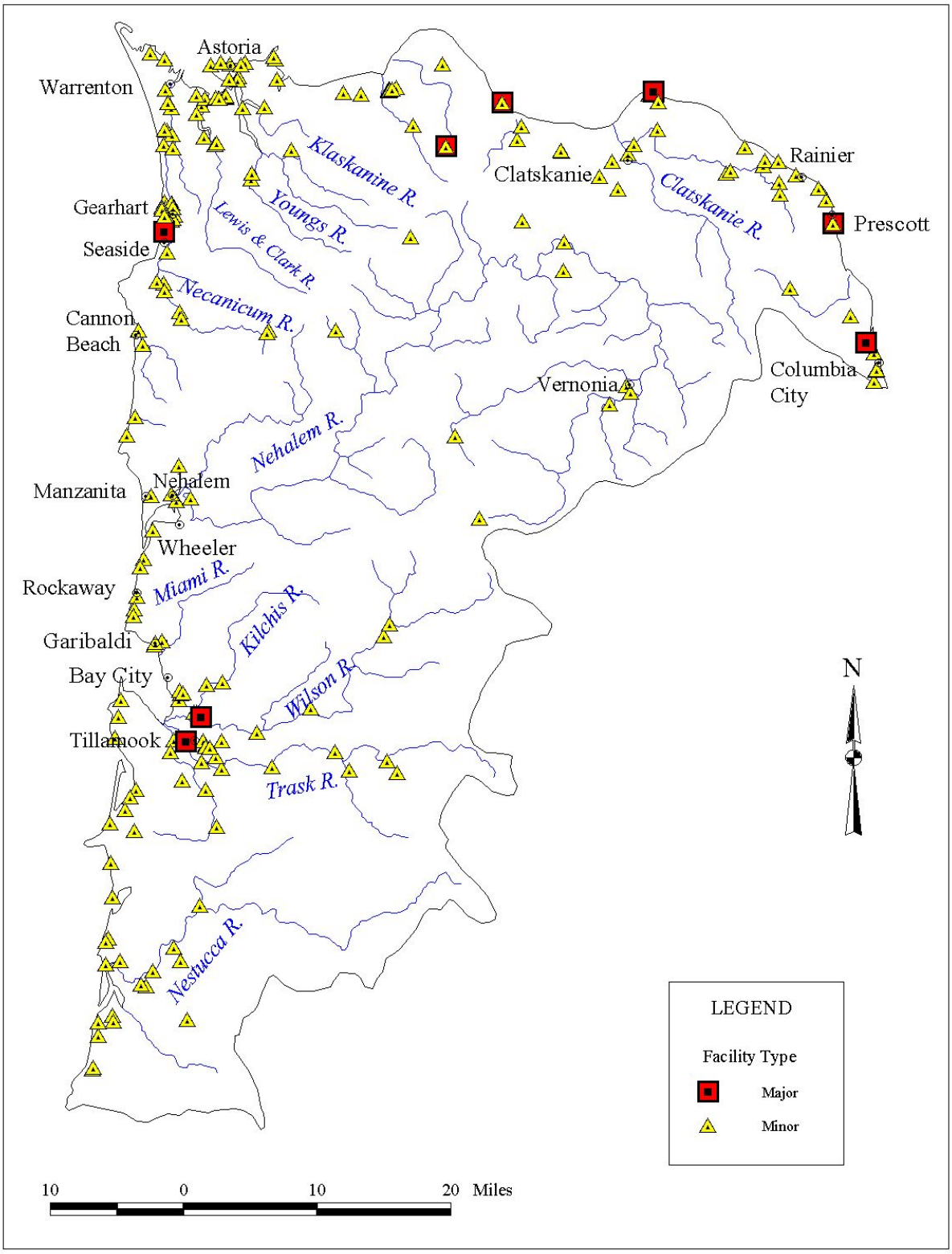


Figure 18. Locations of Permitted Waste Discharge Facilities, North Coast Basin, Oregon.

Underground Injection Control (UIC)

The DEQ Underground Injection Control (UIC) program regulates subsurface waste injection 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 drain fields above a certain service or design size, and other wells used for injection purposes. In the not too distant past, businesses routinely disposed of waste fluids in UICs. Considering that only several ounces of gasoline can contaminate a million gallons of drinking water, UICs hold great potential for being the source of much groundwater contamination.

The DEQ maintains a database of known UIC systems which is available at http://www.deq.state.or.us/wq/groundwa/UIChome.htm. The current database shows 271 injection systems at 51 facilities in the North Coast Basin. Figure 19 is a map of the North Coast Basin showing the locations of all individual UIC injection systems having available latitude/longitude coordinates information.

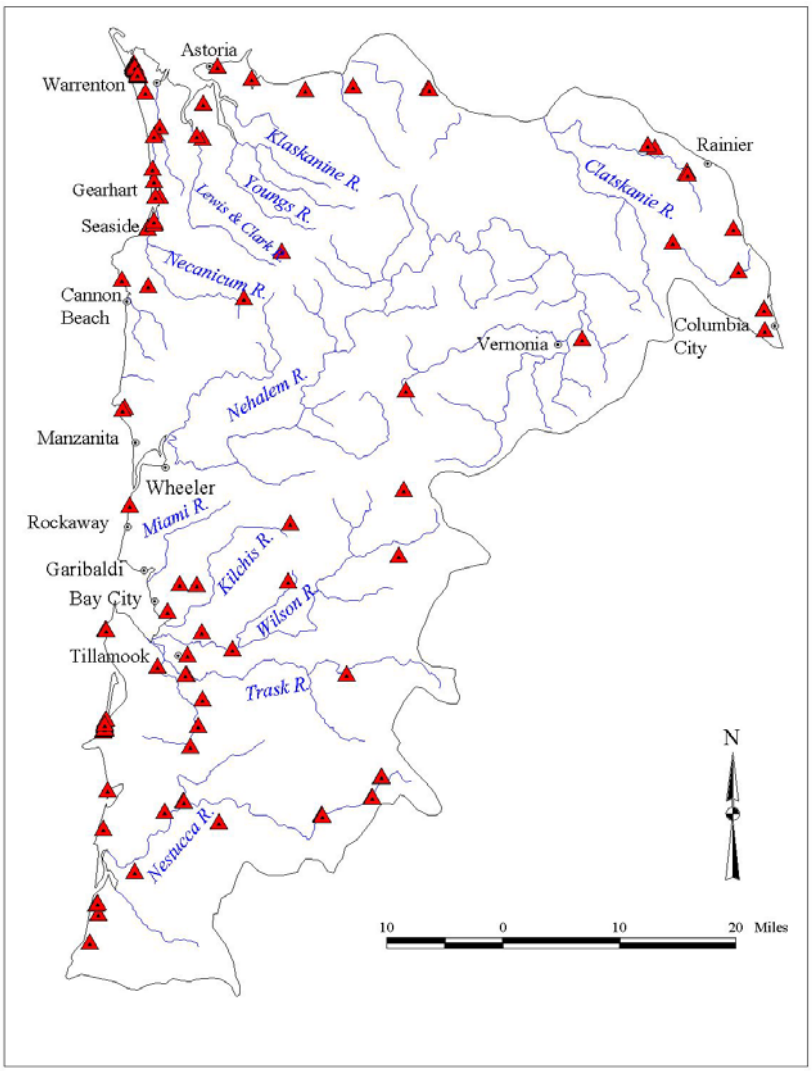


Figure 19. Underground Injection Systems in the North Coast Basin.

Confined Animal Feeding Operations (CAFOs)

The Oregon Department of Agriculture (ODA), in conjunction with DEQ, reviews applications and issues wastewater permits for Confined Animal Feeding Operations (CAFOs). This includes reviewing animal waste management system plans and specifications for animal waste control facilities. The types of CAFO 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. Without proper waste containment and processing systems, CAFOs can concentrate and introduce nitrate and bacterial contamination into underlying groundwater aquifers. Figure 20 shows the locations of the 198 permitted CAFOs in the North Coast Basin.

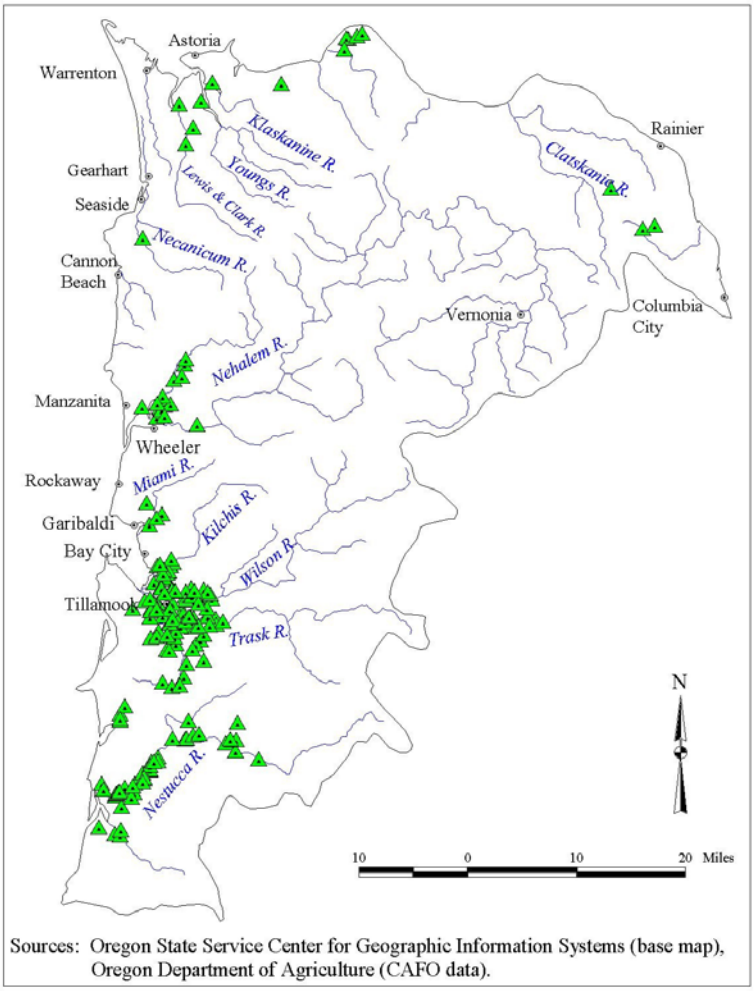


Figure 20. Confined Animal Feeding Operations in the North Coast Basin.

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 (2/18/04), the database shows 84 sites in the North Coast Basin. Figure 21 shows all 84 sites, and distinguishes them, according to the following four site types:

1. Administrative action (11 sites).
2. Further investigation or cleanup underway (7 sites).
3. No further action (20 sites).
4. Further investigation or cleanup recommended (46 sites).

Many of the sites are very close to each other, causing some symbols to overlap and hide others.

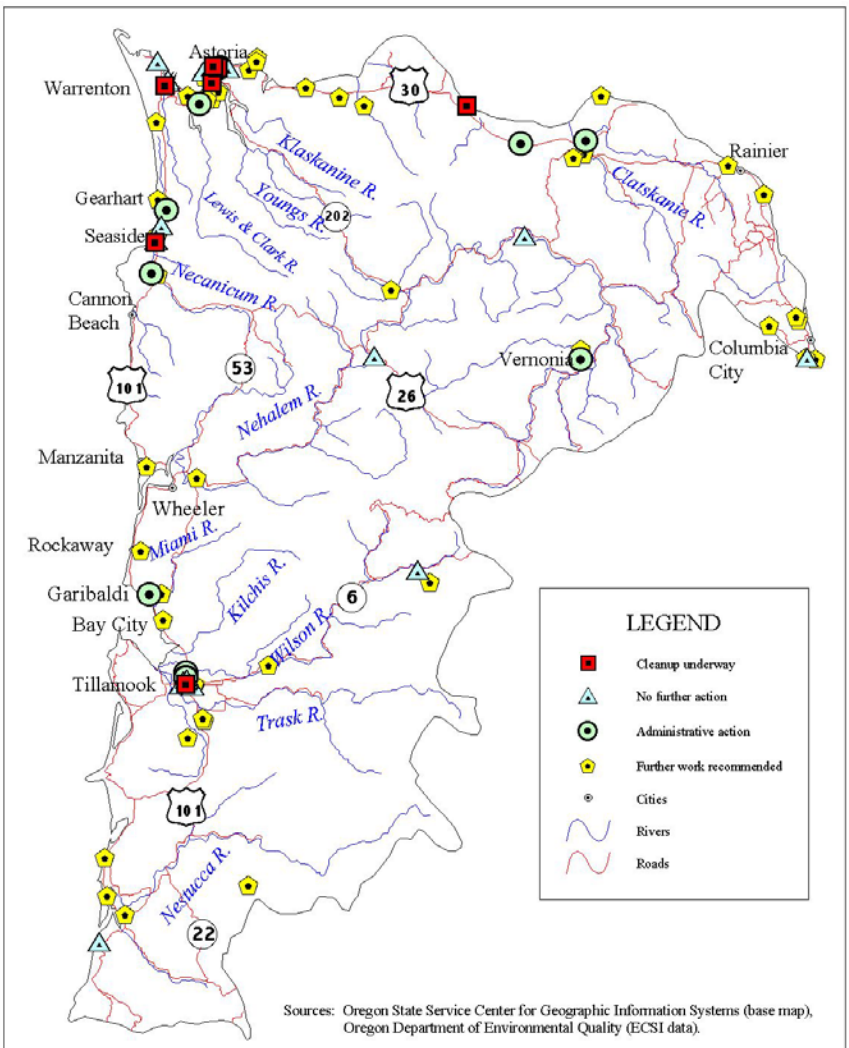


Figure 21. North Coast Basin Hazardous Substance Relase Site Locations.

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

The DEQ Underground Storage Tank (UST) program regulates tanks storing petroleum or certain hazardous substances, and regulates tank release cleanups, 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 Leaking Underground Storage Tanks (LUST) where releases from tanks have been reported. This database is available on-line at: http://www.deq.state.or.us/wmc/tank/LustPublicLookup.asp. Underground storage tank leaks can lead to widespread aquifer contamination.

The database, updated 10/23/01, has 322 records on file for LUST sites in the North Coast Basin. Active sites account for 92 of these sites, while the remaining 230 sites are closed. Active sites are those with continuing cleanup activities, or where compliance with cleanup standards has not yet been demonstrated. The closed sites are those where cleanup and cost recovery is complete. Figure 22 shows all active and closed LUST sites in the North Coast Basin.

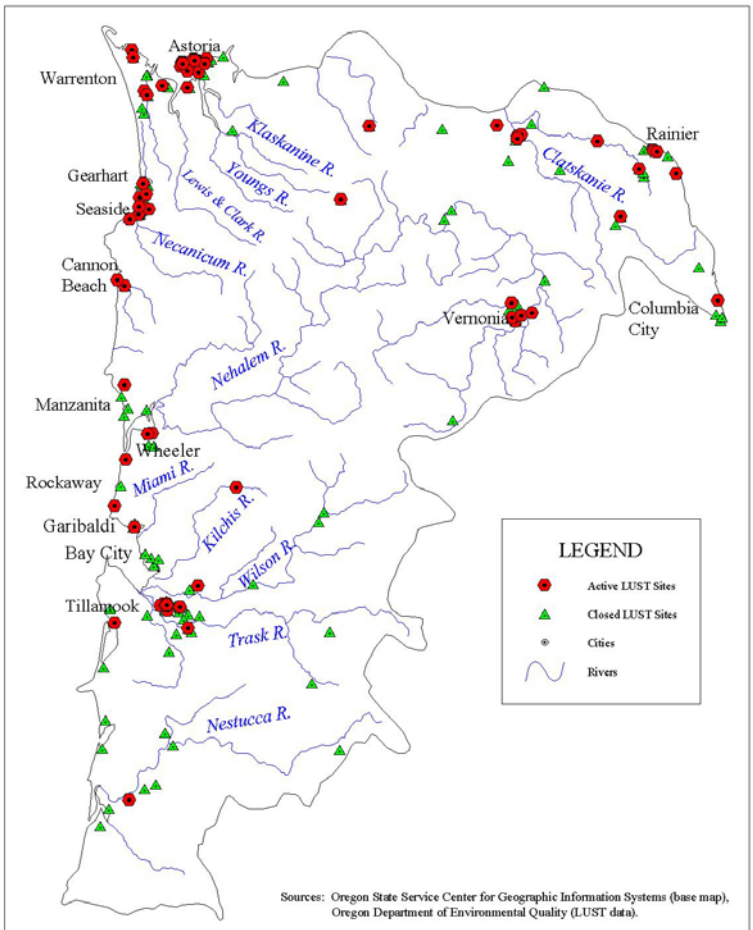


Figure 22. Locations of active and closed LUST sites in the North Coast Basin.

Solid Waste Facilities

The DEQ has collected groundwater, surface water, and leachate monitoring data at three landfills in the North Coast Basin. These are the Astoria, Warrenton, and Tillamook Landfills, shown on Figure 9. Each of these landfills has a Solid Waste Closure Permit. The DEQ Northwest Region Solid Waste Section has information about the landfill status, monitoring results, and annual reports.

Astoria Landfill (1987 – 1996).
Summary

Solid Waste Closure Permit Number 118 regulates activities at the Astoria Landfill. The DEQ collected and analyzed surface and groundwater samples at the Astoria Landfill 10 times between 1987 and 1996.

The Astoria Landfill is completed in highly weathered sandstone and siltstone of the Astoria Formation. This formation does not readily transmit water, making groundwater sample collection difficult and time consuming.

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 Astoria Landfill as the sampling event name.

Results

A review of monitoring data from all three monitoring wells and all three surface water sites yielded the following:

- Bacteria was present in all surface water sites.
- Several metals were present at some sites. Arsenic and chromium were present above drinking water standards at MW-2, and chromium was present above drinking water standards at MW-3.
- Nitrates were present at all sites, but levels did not exceed drinking water standards.
- No volatile organic compounds were detected at any of the sites.

The shallow aquifer underlying the landfill has low permeability and transmissivity. No surface water sites have had detections of either arsenic or chromium. These factors suggest the landfill poses no significant threat to downgradient beneficial uses.

Warrenton Landfill (1980 – 1996).

The City of Warrenton acquired the landfill in July 1977. The landfill closed in Fall 1985. Following landfill capping, a soccer field, parking lot, and concession area were built at the site. The DEQ collected and analyzed groundwater samples from three monitoring wells at the Warrenton Landfill 13 times between 1980 and 1996. The DEQ also collected groundwater samples from the landfill monitoring network as part of the 1996 Clatsop Plains Groundwater

study. Solid Waste Closure Permit Number 120 regulates activities at the Warrenton Landfill. The permit requires continued periodic monitoring and split sampling with the DEQ Lab. The DEQ analyzed samples in October 2002 as a split sampling event.

The shallow aquifer underlying the Warrenton Landfill is composed of beach sand. This material is highly permeable and transmissive. Water level data from the three monitoring wells around the landfill show the groundwater flow direction is to the northeast, with a gradient of 1.25 feet in 1,000 feet (1:800, Sprecher, 2002).

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 Warrenton Landfill as the sampling event name.

Results

A review of monitoring data from all three monitoring wells yielded the following:

- MW-1 (upgradient): Nitrate, barium, and two volatile organic compounds (VOCs) were detected, all below drinking water standards. Atrazine was detected above the drinking water standard. Bacteria was detected above the drinking water standard.
- MW-2 (downgradient): Nitrate, arsenic, barium, selenium, and one VOC were detected, all below drinking water standards.
- MW-3 (downgradient): Nitrate, arsenic, barium, chromium, and lead were detected, all below drinking water standards. Bacteria was detected above the drinking water standard.

The presence of atrazine in the upgradient well, next to the road bordering the landfill's west side, is attributed to roadside maintenance activities. The area immediately downgradient of the landfill is a wetland, with wildlife habitat. Monitoring data show the only adverse impact to downgradient groundwater quality is bacteria. Although the shallow aquifer underlying the landfill is permeable and transmissive, bacteria in the groundwater is not expected to adversely impact the downgradient receptors.

Tillamook Landfill (1980 – 2000).
Summary

During the late 1940s the Tillamook Landfill was operated as an open burning dump. To meet RCRA standards the dump was converted to a sanitary landfill in 1980. The landfill was closed in 1982. In 1986 the landfill was expanded with two new cells. A third cell was prepared in 1987 but never used. The third cell was closed in Fall 1990. That year the site became a transfer station. Solid waste is now trucked to the Coffin Butte landfill, north of Corvallis, Oregon.

The Tillamook Landfill is constructed in highly weathered fine-grained sandstone and siltstone of the Astoria Formation. The soils overlying the aquifer have a permeability coefficient of approximately $3x10^{-6}$ ft/sec. (CES, 1992). The aquifer underlying the landfill transmits groundwater very slowly, on the order of 0.01 feet/day (McFarland, 1983).

Solid Waste Closure Permit Number 148 regulates activities at the Tillamook Landfill. The DEQ collected and analyzed surface and groundwater samples from the Tillamook Landfill between 1980 and 2000. Over this time period the DEQ sampled various combinations of 15 wells, 11 surface sites, five lysimeters, a leachate sump, and a cistern. 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 Tillamook Landfill as the sampling event name.

Results

A review of monitoring data from one surface site, five monitoring wells, and the leachate sump, yielded the following:

- Bacteria was present in the leachate sump and surface water sites.
- Metals were present in all sites, but below MCLs.
- Nitrates were present at all sites, but none exceeded drinking water standards.
- Volatile organic compounds were present in the sump, but below MCLs.

The combination of poorly permeable and low transmissive aquifer materials, and low levels of constituents in the groundwater underlying the landfill, suggest adverse impacts to downgradient beneficial uses are not likely.

CONCLUSIONS

The North Coast Basin in the northwestern part of Oregon includes the headwaters of several coastal rivers, and a unique and sensitive groundwater aquifer. While much of the basin area is forest land, groundwater studies have focused on the areas with the highest population and commercial and agricultural activity. The sensitive Clatsop Plains dunal aquifer is present in an area that has been the focus of growth and development in the basin. Productive groundwater aquifers are present in the Tillamook Valley in shallow alluvial sediments that are vulnerable to pollution from human activities on the land surface overlying these aquifers.

Groundwater in the North Coast Basin is a significant natural resource. There are over 2,000 water rights for groundwater use in the basin. Over 200 public drinking water systems serving 77,000 people in the basin use groundwater either exclusively or in combination with surface water. Another 4,000 domestic water wells in the basin provide drinking water to rural residences and areas not served by public water providers.

Groundwater quality studies in the North Coast Basin have shown impacts from several pollutants, including nitrate, bacteria, and lead.

Nitrate contamination is present in the North Coast Basin, particularly in the Clatsop Plains area. In and around the City of Gearhart, with a high density of housing using on-site septic systems, groundwater nitrate contamination occurs. Out of 14 wells sampled in Gearhart, 1 well (7%) had a nitrate level of 3.8 mg/L, indicative of anthropogenic influences. Three of the wells (21%) had nitrate levels exceeding the drinking water standard of 10 mg/L. In the Tillamook area, the deeper groundwater aquifer shows levels of nitrate below the drinking water standard. Information is not available on the area's shallow groundwater quality.

The Department of Human Services' (DHS) testing of domestic drinking water wells involved in real estate transactions, shows bacteria contamination is present throughout the basin in up to 10% of the wells. The DEQ has no control over the DHS data quality. Sampling practices and sample handling procedures may lead to false positive results. These detections are more likely due to poor well construction and maintenance activities, rather than a region-wide groundwater problem.

In the Clatsop Plains area, DEQ sampling has shown bacteria were present in 30% to 60% of the wells sampled in the 1996 and 1998 sampling events. The vast majority of these detections (18 out of 23 wells, 78%), have come from old, poorly constructed monitoring wells with inadequate or absent surface seals. Bacteria from any source can migrate down along the well casing and enter the well at its bottom where the well screen is located.

Pesticides and certain volatile organic compounds (chlorinated or halogenated VOCs) have been found in only a few isolated North Coast Basin locations (two Warrenton Landfill monitoring wells, and two Gearhart area monitoring wells). Penta, a VOC commonly used in wood preservative, was detected in one of the Gearhart area monitoring wells. This well was located adjacent to a telephone pole, with highly visible quantities of preservative oozing out and down

the pole, onto the ground, next to the monitoring well. The paucity of pesticide and VOC detections may reflect the lack of major industrial, urban, and agricultural land uses in the basin.

Potential sources for the nitrate and bacteria contamination in areas within the North Coast Basin are high densities of on-site septic systems in areas with permeable, sandy soils. A potential point source for other toxic contaminants include the Warrenton Landfill, in the basin's northwest corner.

RECOMMENDATIONS

Additional investigation and action are warranted in areas in the North Coast Basin where nitrate, bacteria, and lead contamination occur. Specific recommendations are as follows: .

- In the Clatsop Plains area, with a special emphasis in and around the City of Gearhart, a sampling strategy should be developed and implemented to address the following:

  - Evaluate the effectiveness of the geographic rule, particularly as it pertains to nitrate.
  - Determine the implementation status of local regulations regarding aquifer reserves.
  - Assess the models and predictions for groundwater impacts from permitted development using on-site septic systems.
  - Identify nitrate and bacteria sources (e.g., septic versus agricultural).
  - Determine lead levels, source(s), and its distribution.

- Where sufficient information is available in the Clatsop Plains area, the DEQ could pursue declaring an Area of Groundwater Concern, or a Groundwater Management Area (ORS 468b.175 & ORS 468b.180, and OAR 340-040-0105(7)). After such a declaration, the DEQ and other agencies would develop an action plan to reduce existing contamination and prevent further contamination of the affected groundwater.

More work should also be done to ascertain ambient groundwater quality conditions in the Tillamook area's shallow alluvial aquifer system. This would mean getting permission from owners of wells completed in the shallow aquifer, or constructing a network of new monitoring wells in the shallow aquifer.

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APPENDIX 1
SAMPLE PARAMETER TABLES

Each table in this appendix provides sample parameter information for the groundwater studies discussed in this report including:

- Sample parameter name(s).
- Sample parameter CAS Number [in brackets].
- Sample parameter measurement units.
- Sample parameter detection or reporting limits.
- Sample parameter drinking water standard (if applicable).

Table 1
Clatsop Plains Groundwater Studies (1980 – 1998)
Volatile Organic Compounds

Notes:
1. All measurements in mg/L.
2. N.A. = Not Available or Not Applicable.

Constituent	CAS Number	Method Reporting Limit	Drinking Water Standard
Acrolein (2-Propenal)	107-02-8	0.0015	N.A.
Benzene	71-43-2	0.0005	0.005
Bromobenzene	108-86-1	0.0005	N.A.
Bromodichloromethane	75-27-4	0.0005	0.08
Bromoform	75-25-2	0.0005	0.08
Bromomethane	74-83-9	0.0005	N.A.
2-Butanone (MEK)	78-93-3	0.05	N.A.
n-Butylbenzene	104-51-8	0.0005	N.A.
Carbon Tetrachloride	56-23-5	0.0005	0.005
Chlorobenzene	108-90-7	0.0005	0.1
Chloroethane	75-00-3	0.0005	N.A.
2-Chloroethyl Vinyl Ether	110-75-8	0.005	N.A.
Chloroform	67-66-3	0.0005	0.08
Chloromethane	74-87-3	0.0005	N.A.
2-Chlorotoluene	95-49-8	0.0005	N.A.
4-Chlorotoluene	106-43-4	0.0005	N.A.
Dibromochloromethane	124-48-1	0.0005	0.08
1,2-Dibromoethane (EDB)	106-93-4	0.0005	0.00005
1,2-Dichlorobenzene	95-50-1	0.0005	0.6
1,3-Dichlorobenzene	541-73-1	0.0005	N.A.
1,4-Dichlorobenzene	106-46-7	0.0005	0.075
1,1-Dichloroethane	75-34-3	0.0005	N.A.
1,2-Dichloroethane	107-06-2	0.0005	0.005
cis-1,2-Dichloroethylene	156-59-2	0.0005	N.A.
trans-1,2-Dichloroethylene	156-60-5	0.0005	N.A.
1,1-Dichloroethylene	75-35-4	0.0005	0.007
1,2-Dichloropropane	78-87-5	0.0005	0.005
1,3-Dichloropropane	142-28-9	0.0005	N.A.
2,2-Dichloropropane	594-20-7	0.0005	N.A.
cis-1,2-Dichloropropene	6923-20-2	0.0005	N.A.
trans-1,3-Dichloropropene	10061-02-6	0.0005	N.A.
1,2-Dimethylbenzene	95-47-6	0.0005	N.A.
1,3-Dimethylbenzene	108-38-3	0.0005	N.A.
1,4-Dimethylbenzene	106-42-3	0.0005	N.A.
Ethylbenzene	100-41-4	0.0005	0.7
Hexachloro-1,3-Butadiene	87-68-3	0.0005	N.A.
4-isopropyltoluene	99-87-6	0.0005	N.A.
Methylene Chloride	75-09-2	0.0005	0.005
2-Methyl-4-Pentanone (MIBK)	108-10-1	0.005	N.A.
n-Propylbenzene	103-65-1	0.0005	N.A.
Styrene	100-42-5	0.0005	0.1
1,1,2,2-Tetrachloroethane	79-34-5	0.0005	N.A.
1,1,2,2-Tetrachloroethylene	127-18-4	0.0005	0.005

Toluene	108-88-3	0.0005	1
1,2,4-Trichlorobenzene	120-82-1	0.0005	0.07
1,1,1-Trichloroethane	71-55-6	0.0005	0.2
1,1,2-Trichloroethane	79-00-5	0.0005	0.005
Trichloroethylene	79-01-6	0.0005	0.005
Trichlorofluoromethane	75-69-4	0.0005	N.A.
1,2,4-Trimethylbenzene	95-63-6	0.0005	N.A.
Vinyl Chloride	75-01-4	0.0005	0.002

Table 2
Clatsop Plains Groundwater Studies (1980 – 1998)
Pesticides

Notes:
1. All measurements in mg/L.
2. N.A. = Not Available or Not Applicable.

Constituent	CAS Number	Method Reporting Limit	Drinking Water Standard
AMPA	N.A.	0.020	N.A.
Chlorpyrifos	2921-88-2	0.0001	N.A.
2,4-D	94-75-7	0.0003	N.A.
Dicamba	1918-00-9	0.0002	N.A.
Dichlobenil	1194-65-6	0.0002	N.A.
Diuron	330-54-1	0.001	N.A.
Garlon	55335-06-3	0.0002	N.A.
Glyphosate	1071-83-6	0.020	0.7
Iprodione	36734-19-7	0.0001	N.A.
Nitrogen/Phosphorus Screen	Various	N.A.	N.A.
OCL Screen	Various	N.A.	N.A.
OP Screen	Various	N.A.	N.A.
Pentachlorophenol	87-86-5	0.0001	0.001
Phenoxyherbicide Screen	Various	N.A.	N.A.
Picloram	1918-02-1	0.0002	0.5

Table 3
Clatsop Plains Groundwater Studies (1980 – 1998)
Metals, Nutrients, Physical Parameters

Notes:
1. All measurements in mg/L.
2. N.A. = Not Available or Not Applicable.

Constituent	CAS #	Method Reporting Limit	Drinking Water Standard
Alkalinity	N.A.	1	N.A.
Aluminum	7429-90-5	0.1	N.A.
Ammonia	7664-41-7	0.02	N.A.
Arsenic	7440-38-2	0.005	0.01
Barium	7440-39-3	0.03	2
Beryllium	7440-41-7	0.01	0.004

Biochemical Oxygen Demand	N.A.	1	N.A.
Boron	7440-42-8	0.03	N.A.
Cadmium	7440-43-9	0.01	0.005
Calcium	7440-70-2	0.1	N.A.
Chemical Oxygen Demand	N.A.	5	N.A.
Chloride	16887-00-6	0.5	N.A.
Chromium	7440-47-3	0.03	0.1
Cobalt	7440-48-4	0.06	N.A.
Conductivity	N.A.	1 µmhos/cm	N.A.
Copper	7440-50-8	0.02	1.3 (Action Level)
Dissolved Oxygen	N.A.	0.1	N.A.
Enterococcus	N.A.	4 colonies/100 ml	N.A.
Fecal Coliform	N.A.	4 colonies/100 ml	0
Hardness	N.A.	3	N.A.
Iron	7439-89-6	0.04	N.A.
Lanthanum	7439-91-0	0.05	N.A.
Lead	7439-92-1	0.005	0.015 (Action Level)
Lithium	7439-93-2	0.05	N.A.
Magnesium	7439-95-4	0.5	N.A.
Manganese	7439-96-5	0.01	N.A.
Nickel	7440-02-2	0.04	N.A.
Nitrate/Nitrite-N	N.A.	0.02	10
pH	N.A.	0.1 S.U.	6.5-8.5
Potassium	7440-09-7	0.5	N.A.
Silica	7631-86-9	0.3	N.A.
Silver	7440-22-4	0.01	N.A.
Sodium	7440-23-5	0.5	N.A.
Sulfate	14808-79-8	0.2	N.A.
Temperature	N.A.	0.1°C	N.A.
Total Coliform	N.A.	16 colonies/100 ml	≤ 5% positive samples/month
Total Dissolved Solids	N.A.	1	N.A.
Total Organic Carbon	N.A.	1	N.A.
Total Suspended Solids	N.A.	1	N.A.
Vanadium	7440-62-2	0.03	N.A.
Zinc	7440-66-6	0.02	N.A.

Table 4
Statewide Ambient Monitoring Program
Oregon Department of Agriculture Pesticide Screens

Notes:

1. Reporting limits in ug/L; Drinking water standards in mg/L.
2. N.A. = Not Available or Not Applicable.

Constituent	CAS #	Reporting Limit (ug/L)	Drinking Water Standard (mg/L)
Nitrogen-Phosphorus & Organo Phosphate Screens*			
Alachlor	15972-60-8	0.5	0.002
Atrazine	1912-24-9	0.1	0.003
Bromacil	314-40-9	2.2	N.A

Butachlor	23184-66-9	1.5	N.A
Butylate	2008-41-5	2.0	N.A
Carboxin	5234-68-4	3.0	N.A
Chlorpropham	101-21-3	1.0	N.A
Cycloate	1134-23-2	10.0	N.A
Diphenamid *	957-51-7	2.0	N.A
EPTC (Eptam)	759-94-4	1.0	N.A
Ethoprop *	13194-48-4	0.2	N.A
Fenamiphos *	22224-92-6	0.2	N.A
Hexazinone	51235-04-2	1.0	N.A
Mevinphos *	7786-34-7	0.3	N.A
Metolachlor	51218-45-2	1.0	N.A
Metribuzin	21087-64-9	1.0	N.A
Napropamide	15299-99-7	0.5	N.A
Prometon	1610-18-0	2.0	N.A
Prometryn	7287-19-6	0.2	N.A
Propazine	139-40-2	0.2	N.A
Simazine	122-34-9	0.2	0.004
Tebuthiuron	34014-18-1	0.45	N.A
OCL/Organo Chlorides Screen			
4,4-DDD	72-54-8	0.50	N.A
4,4-DDE	72-55-9	0.50	N.A
4,4-DDT	50-29-3	0.50	N.A
Aldrin	309-00-2	0.50	N.A
Alpha-Chlordane	5103-71-9	0.30	0.002
Alpha-HCH	319-84-6	0.12	N.A
Beta-HCH	319-85-7	0.12	N.A
Chlorothalonil	1897-45-6	0.20	N.A
cis-Permethrin	54774-45-7	1.80	N.A
Dieldrin	60-57-1	0.50	N.A
Endosulfan Sulfate	1031-07-8	0.50	N.A
Endrin	72-20-8	0.10	0.002
Gamma-Chlordane	12789-03-6	0.30	0.002
Gamma-HCH	58-89-9	0.09	N.A
Heptachlor	76-44-8	0.10	0.0004
Heptachlor-epoxide	1024-57-3	0.10	0.0002
Hexachlorobenzene	118-74-1	0.10	0.001
Methoxychlor	72-43-5	0.10	0.04
Propachlor	1918-16-7	1.30	N.A
trans-Permethrin	51877-74-8	1.00	N.A
Trifluralin	1582-09-8	0.50	N.A
Phenoxy Herbicide Screen			
2,4,5-T	93-76-5	0.20	N.A
2,4,5-TP	93-72-1	0.20	N.A
2,4-D	94-75-7	0.30	0.07
2,4-DB	94-82-6	1.00	N.A
DCPA Acid (Dacthal)	1861-32-1	0.10	N.A
Dicamba	1918-00-9	1.00	N.A
Dichlorprop	120-36-5	0.50	N.A
Dinoseb	88-85-7	1.00	0.007
PCP	87-86-5	0.10	0.001
Picloram	1918-02-1	2.00	0.5
HPLC/UV Screen			

Diuron	330-54-1	3	N.A
PCNB (Terachlor)	82-68-8	3.6	N.A
Demeton	8065-48-3	0.2	N.A
Other Pesticides Tested			
Garlon (Triclopyr)	55335-06-3	N.A	N.A
MCPA	94-74-6	N.A	N.A
Terbacil	5902-51-2	N.A	N.A
Triademefon	N.A.	N.A	N.A
Chlordane	12789-03-6	N.A	0.002
Diazinon	333-41-5	N.A	N.A
Captan	133-06-2	N.A	N.A
Silvex	93-72-1	N.A	N.A
Glyphosate	1071-83-6	N.A	0.7
Phorate	298-02-2	N.A	N.A
Dimethoate	60-51-5	N.A	N.A
Dichlobenil	1194-65-6	N.A	N.A
Iprodione	36734-19-7	N.A	N.A
Bladex/Cyanazine	21725-46-2	N.A	N.A
Chlorpyrifos	2921-88-2	N.A	N.A
Norflurazon	27314-13-2	N.A	N.A
Disulfotan	298-04-4	N.A	N.A
Dyfonate/Fonofos	944-22-9	N.A	N.A
AMPA (Glyphosate by product)	N.A.	N.A.	N.A.
Carbamate Screen			
3-Hydroxycarbofuran	16655-82-6	5	N.A
Aldicarb	116-06-3	1	N.A
Aldicarb Sulfone	1646-88-4	1	N.A
Aldicarb Sulfoxide	1646-87-3	1	N.A
Baygon	114-26-1	1	N.A
Carbaryl	63-25-2	1	N.A
Carbofuran	1563-66-2	1	0.04
Methiocarb	2032-65-7	1	N.A
Methomyl	16752-77-5	1	N.A
Oxamyl	23135-22-0	1	0.2

Table 5
1998 Clatsop Plains Groundwater Study
Well Sites

Notes:
1. All measurements in mg/L.
2. N.A. = Not Available or Not Applicable.

Constituent	CAS Number	Method Reporting Limit	Drinking Water Standard
Ammonia	7664-41-7	0.02	N.A.
Conductivity	N.A.	1 µmhos/cm	N.A.
Nitrate/Nitrite-N	N.A.	0.02	10
pH	N.A.	0.1 S.U.	6.5-8.5
Temperature	N.A.	0.1^{o}C	N.A.

Table 6
1998 Clatsop Plains Groundwater Study
Surface Water Sites

Notes:
3. All measurements in mg/L.
4. N.A. = Not Available or Not Applicable.

Constituent	CAS Number	Method Reporting Limit	Drinking Water Standard
Ammonia	7664-41-7	0.02	N.A.
Conductivity	N.A.	1 µmhos/cm	N.A.
Escherichia coli	N.A.	colonies/100 ml	No positive detections
Fecal Coliform	N.A.	colonies/100 ml	No positive detections
Nitrate/Nitrite-N	N.A.	0.02	10
pH	N.A.	0.1 S.U.	6.5-8.5
Temperature	N.A.	0.1^{o}C	N.A.

Table 7
Tillamook Groundwater Study (1997 - 1998)
Volatile Organic Compounds

Notes:
1. All measurements in mg/L.
2. N.A. = Not Available or Not Applicable.

Constituent	CAS Number	Method Reporting Limit	Drinking Water Standard
Acrolein (2-Propenal)	107-02-8	0.0015	N.A.
Benzene	71-43-2	0.0005	0.005
Bromobenzene	108-86-1	0.0005	N.A.
Bromochloromethane	74-97-5	0.0005	N.A.
Bromodichloromethane	75-27-4	0.0005	0.08
Bromoform	75-25-2	0.0005	0.08
Bromomethane	74-83-9	0.0005	N.A.
2-Butanone (MEK)	78-93-3	0.05	N.A.
n-Butylbenzene	104-51-8	0.0005	N.A.
sec-Butylbenzene	135-98-8	0.0005	N.A.
tert-Butylbenzene	98-06-6	0.0005	N.A.
Carbon Tetrachloride	56-23-5	0.0005	0.005
Chlorobenzene	108-90-7	0.0005	0.1
Chloroethane	75-00-3	0.0005	N.A.
2-Chloroethyl Vinyl Ether	110-75-8	0.005	N.A.
Chloroform	67-66-3	0.0005	0.08
Chloromethane	74-87-3	0.0005	N.A.
2-Chlorotoluene	95-49-8	0.0005	N.A.
4-Chlorotoluene	106-43-4	0.0005	N.A.
Dibromochloromethane	124-48-1	0.0005	0.08
1,2-Dibromo-3-chloropropane	96-12-8	0.0005	N.A.
1,2-Dibromoethane (EDB)	106-93-4	0.0005	0.00005
Dibromomethane	74-95-3	0.0005	N.A.
1,2-Dichlorobenzene	95-50-1	0.0005	0.6
1,3-Dichlorobenzene	541-73-1	0.0005	N.A.
1,4-Dichlorobenzene	106-46-7	0.0005	0.075
Dichlorodifluoromethane	75-71-8	0.0005	N.A.

1,1-Dichloroethane	75-34-3	0.0005	N.A.
1,2-Dichloroethane	107-06-2	0.0005	0.005
cis-1,2-Dichloroethylene	156-59-2	0.0005	N.A.
trans-1,2-Dichloroethylene	156-60-5	0.0005	N.A.
1,1-Dichloroethylene	75-35-4	0.0005	0.007
1,2-Dichloropropane	78-87-5	0.0005	0.005
1,3-Dichloropropane	142-28-9	0.0005	N.A.
2,2-Dichloropropane	594-20-7	0.0005	N.A.
cis-1,2-Dichloropropene	6923-20-2	0.0005	N.A.
trans-1,3-Dichloropropene	10061-02-6	0.0005	N.A.
1,1-Dichloropropene	563-58-6	0.0005	N.A.
1,2-Dimethylbenzene	95-47-6	0.0005	N.A.
1,3-Dimethylbenzene	108-38-3	0.0005	N.A.
1,4-Dimethylbenzene	106-42-3	0.0005	N.A.
Ethylbenzene	100-41-4	0.0005	0.7
Hexachloro-1,3-Butadiene	87-68-3	0.0005	N.A.
Isopropylbenzene	98-82-8	0.0005	N.A.
4-isopropyltoluene	99-87-6	0.0005	N.A.
Methylene Chloride	75-09-2	0.0005	0.005
2-Methyl-4-Pentanone (MIBK)	108-10-1	0.005	N.A.
Naphthalene	91-20-3	0.0005	N.A.
n-Propylbenzene	103-65-1	0.0005	N.A.
Styrene	100-42-5	0.0005	0.1
1,1,2,2-Tetrachloroethane	79-34-5	0.0005	N.A.
1,1,2,2-Tetrachloroethylene	127-18-4	0.0005	0.005
Toluene	108-88-3	0.0005	1
1,2,3-Trichlorobenzene	87-61-6	0.0005	N.A.
1,2,4-Trichlorobenzene	120-82-1	0.0005	0.07
1,1,1-Trichloroethane	71-55-6	0.0005	0.2
1,1,2-Trichloroethane	79-00-5	0.0005	0.005
Trichloroethylene	79-01-6	0.0005	0.005
Trichlorofluoromethane	75-69-4	0.0005	N.A.
1,2,4-Trimethylbenzene	95-63-6	0.0005	N.A.
1,3,5-Trimethylbenzene	108-67-8	0.0005	N.A.
Vinyl Chloride	75-01-4	0.0005	0.002

Table 8
Tillamook Groundwater Study (1997 - 1998)
Pesticides

Notes:
1. All measurements in mg/L.
2. N.A. = Not Available or Not Applicable.

Constituent	CAS Number	Method Reporting Limit	Drinking Water Standard
Alachlor	15972-60-8	0.0016	0.002
Atrazine	1912-24-9	0.00037	0.003
Bromacil	314-40-9	0.0019	N.A.
Chlorpyrifos	2921-88-2	0.00014	N.A.
2,4-D	94-75-7	0.0001	0.07
2,4-DP	120-36-5	0.00286	N.A.

Diazinon	333-41-5	0.00022	N.A.
Dicamba	1918-00-9	0.0001	N.A.
Fenamiphos	22224-92-6	0.0008	N.A.
Malathion	121-75-5	0.00045	N.A.
Nitrogen/Phosphorus Screen	Various	N.A.	N.A.
OCL (Organo Chloride) Screen	Various	N.A.	N.A.
OP (Organo Phosphate) Screen	Various	N.A.	N.A.
Phenoxyherbicide Screen	Various	N.A.	N.A.
Simazine	122-34-9	0.0012	0.004
Triademefon	N.A.	0.001	N.A.

Table 9
Tillamook Groundwater Study (1997 - 1998)
Metals, Nutrients, Physical Parameters

Notes:

1. All measurements in mg/L, unless otherwise noted.
2. N.A. = Not Available or Not Applicable.

Constituent	CAS #	Method Reporting Limit	Drinking Water Standard
Alkalinity	N.A.	1	N.A.
Aluminum	7429-90-5	0.01	N.A.
Ammonia	7664-41-7	0.02	N.A.
Antimony	7440-36-0	0.003	0.006
Arsenic	7440-38-2	0.002	0.01
Barium	7440-39-3	0.0005	2
Beryllium	7440-41-7	0.00001	0.004
Boron	7440-42-8	0.003	N.A.
Cadmium	7440-43-9	0.0001	0.005
Calcium	7440-70-2	N.A.	N.A.
Chloride	16887-00-6	0.5	N.A.
Chromium	7440-47-3	0.0002	0.1
Cobalt	7440-48-4	0.0002	N.A.
Conductivity	N.A.	1 µmhos/cm	N.A.
Copper	7440-50-8	0.0003	1.3 (Action Level)
Escherichia coli	N.A.	2 colonies/100 ml	N.A.
Fecal Coliform	N.A.	2 colonies/100 ml	0
Iron	7439-89-6	N.A.	N.A.
Lanthanum	7439-91-0	0.001	N.A.
Lead	7439-92-1	0.003	0.015 (Action Level)
Lithium	7439-93-2	0.0004	N.A.
Magnesium	7439-95-4	0.01	N.A.
Manganese	7439-96-5	N.A.	N.A.
Mercury	7439-97-6	0.0005	0.002
Molybdenum	7439-98-7	0.0004	N.A.
Nickel	7440-02-2	N.A.	N.A.
Nitrate/Nitrite-N	N.A.	0.02	10
pH	N.A.	0.1 S.U.	6.5-8.5
Potassium	7440-09-7	0.01	N.A.
Selenium	7782-49-2	0.003	0.05
Silica	7631-86-9	N.A.	N.A.

Silver	7440-22-4	0.0002	N.A.
Sodium	7440-23-5	N.A.	N.A.
Sulfate	14808-79-8	0.2	N.A.
Temperature	N.A.	0.1^{o}C	N.A.
Thallium	7440-28-0	0.002	0.002
Total Kjeldahl Nitrogen	7727-37-9	0.2	N.A.
Total Organic Carbon	N.A.	1	N.A.
Total Phosphate	7723-14-0	0.01	N.A.
Vanadium	7440-62-2	0.0001	N.A.
Zinc	7440-66-6	N.A.	N.A.

APPENDIX 2

SAMPLING RESULTS

Each table in this appendix summarizes the sampling results for the various study areas discussed in this report.

Each table names the study area and provides the page number where the report discusses the study area.

Each table provides the following information:

- Contaminant name(s).
- Number of wells found in.
- Maximum concentration in mg/L.
- Method Detection Limit in mg/L.
- National Primary Drinking Water Standard in mg/L.
- Number of wells over MCL.

Table 1
Department of Human Services, Drinking Water Program
Real Estate Transaction Well Testing Data

County	Date Collected	Coliform	Nitrate
Clatsop	1/5/1995	N	0.24
Clatsop	3/21/1995	N	0.25
Clatsop	4/18/1995	N	0.25
Clatsop	11/14/1995	N	4.2
Clatsop	12/6/1989	N	1.52
Clatsop	11/15/1989	N	0.09
Clatsop	6/26/1990	P	0.5
Clatsop	7/18/1990	N	0.2
Clatsop	5/28/1990	N	1
Clatsop	9/27/1990	N	0.2
Clatsop	5/28/1990	N	1
Clatsop	6/23/1990	N	0.6
Clatsop	1/8/1991	N	0.27
Clatsop	1/22/1991	N	0.1
Clatsop	4/10/1991	N	0.45
Clatsop	11/25/1991	N	0.1
Clatsop	9/19/1990	P	0.01
Clatsop	4/15/1992	P	1.07
Clatsop	3/31/1993	N	0
Clatsop	12/15/1994	N	1
Clatsop	12/4/1994	N	0.24
Clatsop	3/5/1997	N	0.5
Columbia	12/15/1994	N	0.37
Columbia	1/19/1995	N	0.24
Columbia	12/26/1994	N	0.35
Columbia	3/15/1995	N	0.25
Columbia	3/27/1995	N	0.25
Columbia	3/27/1995	N	0.25
Columbia	3/1/1995	N	0.25
Columbia	2/9/1995	N	0.02
Columbia	2/16/1995	N	0
Columbia	12/9/1994	N	0.25
Columbia	2/23/1995	N	0.25
Columbia	1/20/1995	P	0
Columbia	2/3/1995	N	0
Columbia	3/9/1995	N	0.25
Columbia	5/18/1995	N	0.25
Columbia	5/25/1995	N	0.51
Columbia	5/11/1995	N	0.25
Columbia	3/16/1995	N	0.25
Columbia	6/8/1995	N	0.25
Columbia	4/20/1995	N	0.25

Columbia	6/8/1995	N	0.5
Columbia	5/25/1995	N	0.25
Columbia	6/15/1995	N	0.25
Columbia	5/30/1995	N	7.05
Columbia	6/28/1995	N	2.33
Columbia	7/6/1995	N	0.4
Columbia	6/15/1995	N	0.25
Columbia	5/22/1995	N	0.77
Columbia	5/22/1995	N	0.77
Columbia	8/3/1995	N	1.08
Columbia	8/10/1995	N	2.9
Columbia	8/1/1995	N	0.11
Columbia	8/16/1995	N	0.32
Columbia	8/4/1995	N	0.25
Columbia	8/3/1995	N	0.56
Columbia	8/22/1995	N	1.5
Columbia	8/30/1995	N	0.25
Columbia	6/22/1995	N	0
Columbia	10/17/1995	N	0.34
Columbia	9/21/1995	N	0
Columbia	10/12/1995	N	0.68
Columbia	10/26/1995	N	0
Columbia	11/21/1995	N	0
Columbia	11/21/1995	P	0
Columbia	10/11/1995	N	0
Columbia	12/7/1995	N	0.8
Columbia	12/14/1995	N	0
Columbia	12/21/1995	N	0
Columbia	1/22/1996	N	0
Columbia	1/11/1996	N	0
Columbia	12/3/1989	N	0.5
Columbia	12/3/1989	N	0.5
Columbia	12/14/1989	P	8.2
Columbia	12/21/1989	N	1.3
Columbia	1/18/1990	N	3.4
Columbia	2/22/1990	N	22.5
Columbia	3/8/1990	N	3.2
Columbia	12/14/1989	N	1.8
Columbia	1/18/1990	N	1
Columbia	11/21/1989	N	0.14
Columbia	2/4/1990	P	6.6
Columbia	3/2/1990	N	9.2
Columbia	11/29/1989	N	0.15
Columbia	2/22/1990	N	1.2
Columbia	3/16/1990	N	57
Columbia	3/30/1990	N	2.3
Columbia	4/13/1990	N	0.3

Columbia	4/23/1990	N	0.05
Columbia	4/13/1990	N	0.1
Columbia	5/10/1990	N	0.3
Columbia	4/11/1990	N	1.5
Columbia	5/8/1990	N	0.35
Columbia	5/16/1990	N	0.6
Columbia	5/3/1990	N	1
Columbia	5/9/1990	N	0.01
Columbia	5/21/1990	N	0.5
Columbia	6/14/1990	N	0.5
Columbia	6/14/1990	N	0.5
Columbia	7/26/1990	N	0.5
Columbia	8/2/1990	N	0.1
Columbia	8/2/1990	N	0.1
Columbia	8/9/1990	N	1.14
Columbia	8/2/1990	N	0.1
Columbia	10/8/1990	N	2.01
Columbia	5/22/1990	N	0.7
Columbia	10/23/1990	N	0.1
Columbia	11/8/1990	N	0.27
Columbia	11/2/1990	N	0.38
Columbia	10/11/1990	N	0.54
Columbia	5/28/1990	N	1
Columbia	12/10/1990	N	0.5
Columbia	12/10/1990	N	0.1
Columbia	11/13/1990	N	7.2
Columbia	2/8/1991	N	0.9
Columbia	3/13/1990	N	5.7
Columbia	3/7/1991	N	2.7
Columbia	2/21/1991	N	3.8
Columbia	11/29/1990	N	2
Columbia	4/16/1991	N	0.5
Columbia	3/28/1991	N	0.3
Columbia	5/17/1991	P	0.7
Columbia	1/23/1991	N	0.76
Columbia	5/3/1991	N	1.8
Columbia	6/20/1991	N	3.8
Columbia	6/26/1991	N	0.1
Columbia	7/3/1991	N	0.1
Columbia	6/6/1991	N	1.47
Columbia	7/15/1991	N	0.2
Columbia	7/19/1991	N	0.5
Columbia	7/15/1991	N	2.38
Columbia	7/23/1991	N	0.14
Columbia	7/15/1991	N	1.1
Columbia	5/9/1991	N	1.1
Columbia	9/30/1991	N	0.6

Columbia	10/24/1991	N	1
Columbia	11/29/1991	P	1.3
Columbia	1/17/1992	P	0.16
Columbia	2/6/1992	N	0.35
Columbia	2/12/1992	N	2.6
Columbia	1/16/1992	N	0.16
Columbia	3/5/1992	N	1.5
Columbia	2/28/1992	P	0.88
Columbia	4/2/1992	N	0.1
Columbia	6/3/1991	N	0.2
Columbia	6/3/1991	N	0.1
Columbia	5/20/1991	N	1.3
Columbia	10/10/1991	N	0.55
Columbia	12/12/1991	N	0.1
Columbia	4/16/1992	N	0.1
Columbia	4/30/1992	N	0.22
Columbia	4/15/1992	N	0.1
Columbia	5/28/1992	N	0.15
Columbia	5/14/1992	N	0.25
Columbia	6/10/1992	N	4.4
Columbia	5/26/1992	N	0.1
Columbia	3/4/1992	N	0.1
Columbia	6/17/1992	N	0
Columbia	6/23/1992	N	4
Columbia	5/28/1992	N	0.1
Columbia	6/25/1992	N	0.1
Columbia	9/12/1991	N	0.1
Columbia	7/15/1992	N	0.16
Columbia	6/4/1992	N	0.15
Columbia	8/6/1992	N	0.2
Columbia	7/22/1992	P	0.3
Columbia	8/15/1992	N	0.1
Columbia	8/20/1992	N	0.1
Columbia	3/12/1993	N	0.1
Columbia	3/22/1993	N	0.3
Columbia	3/18/1993	N	2.6
Columbia	2/18/1993	N	0.17
Columbia	3/15/1993	N	0
Columbia	2/21/1993	P	0.64
Columbia	10/28/1991	P	0
Columbia	4/23/1993	N	0.01
Columbia	5/6/1993	N	0.05
Columbia	4/22/1993	N	0
Columbia	8/2/1992	N	0.27
Columbia	6/10/1993	N	0
Columbia	4/8/1993	N	0.1
Columbia	11/4/1992	P	0

Columbia	2/11/1993	N	0.45
Columbia	4/8/1993	N	0.2
Columbia	8/25/1994	N	0.5
Columbia	8/29/1994	N	1.02
Columbia	12/11/1992	N	0.1
Columbia	8/11/1994	N	0.8
Columbia	8/4/1994	N	0
Columbia	7/7/1994	N	1.4
Columbia	5/16/1994	N	0.5
Columbia	9/20/1994	N	0.49
Columbia	8/25/1994	N	0.7
Columbia	6/16/1994	N	0.25
Columbia	11/10/1993	N	0.25
Columbia	2/1/1994	P	
Columbia	1/21/1994	P	0.24
Columbia	4/13/1994	P	0.24
Columbia	11/17/1994	N	0.24
Columbia	11/18/1994	N	0.24
Columbia	12/1/1994	N	0.24
Columbia	12/17/1994	N	0.14
Columbia	2/22/1996	N	0
Columbia	2/27/1996	N	0
Columbia	2/22/1996	N	0
Columbia	11/21/1995	N	0.48
Columbia	3/21/1996	N	0
Columbia	4/26/1996	N	3.6
Columbia	3/21/1996	N	0
Columbia	5/9/1996	N	0.7
Columbia	5/8/1996	N	0.4
Columbia	3/7/1996	N	0
Columbia	3/5/1996	N	0
Columbia	4/11/1996	N	0
Columbia	4/4/1996	N	0
Columbia	5/16/1996	N	0
Columbia	5/14/1996	N	0.35
Columbia	4/25/1996	N	0
Columbia	4/25/1996	N	0
Columbia	4/25/1996	N	0
Columbia	4/25/1996	N	0
Columbia	4/25/1996	N	0
Columbia	4/25/1996	N	0
Columbia	6/11/1996	N	0
Columbia	5/16/1996	N	0
Columbia	8/7/1996	N	0
Columbia	8/8/1996	N	0
Columbia	7/11/1996	N	0
Columbia	6/20/1996	N	0

Columbia	7/18/1996	N	0
Columbia	6/6/1996	N	0
Columbia	6/21/1996	N	0
Columbia	8/6/1996	N	0.04
Columbia	7/15/1996	N	0
Columbia	9/13/1996	N	0
Columbia	7/11/1996	N	0
Columbia	6/6/1996	N	0.66
Columbia	7/18/1996	N	0
Columbia	2/12/1997	N	1.2
Columbia	2/28/1997	N	2.8
Columbia	3/1/1997	N	0
Columbia	2/11/1997	N	0
Columbia	1/28/1997	N	0
Columbia	1/14/1997	N	0
Columbia	12/30/1997	N	0
Columbia	10/19/1996	N	0
Columbia	2/27/1997	N	3.8
Columbia	3/12/1997	N	0
Columbia	10/21/1996	N	7.6
Columbia	12/12/1996	N	0
Columbia	12/12/1996	N	0
Columbia	8/15/1996	N	0.08
Columbia	10/9/1996	N	0
Columbia	7/25/1996	N	0
Columbia	2/26/1997	N	0.3
Columbia	12/26/1996	N	5.1
Columbia	2/20/1997	N	0
Columbia	9/23/1996	N	0
Columbia	11/27/1996	N	0.8
Columbia	6/21/1996	N	0
Columbia	4/19/1997	N	
Columbia	4/29/1996	N	0
Columbia	4/3/1997	N	0
Columbia	10/24/1996	N	0
Tillamook	12/13/1994	N	0
Tillamook	1/15/1995	N	1.1
Tillamook	3/2/1995	N	1.8
Tillamook	3/9/1995	N	0
Tillamook	4/26/1995	N	0.12
Tillamook	8/14/1995	N	0
Tillamook	7/5/1995	M	0.04
Tillamook	10/30/1995	N	0.01
Tillamook	8/14/1995	N	
Tillamook	1/22/1996	P	0
Tillamook	1/4/1990	N	2.4
Tillamook	1/4/1990	N	2.1

Tillamook	1/31/1990	N	0
Tillamook	2/16/1990	N	1.09
Tillamook	12/26/1989	N	1.71
Tillamook	4/2/1990	N	0.75
Tillamook	3/8/1990	N	0.1
Tillamook	4/23/1990	N	3.7
Tillamook	4/30/1990	N	1.34
Tillamook	5/17/1990	N	2.8
Tillamook	5/16/1990	N	0.3
Tillamook	6/7/1990	N	0.5
Tillamook	4/17/1990	N	0.81
Tillamook	6/20/1990	P	0.53
Tillamook	6/14/1990	N	0.12
Tillamook	7/23/1990	N	1.13
Tillamook	1/1/1990	N	1.59
Tillamook	10/22/1990	N	0
Tillamook	10/29/1990	N	0
Tillamook	1/7/1991	N	0
Tillamook	9/10/1990	N	0.5
Tillamook	1/24/1991	N	1.9
Tillamook	11/19/1990	N	1.5
Tillamook	3/7/1991	N	2.9
Tillamook	4/2/1991	N	0.42
Tillamook	4/9/1991	N	0.5
Tillamook	4/19/1991	N	4.1
Tillamook	4/23/1991	N	0.3
Tillamook	5/16/1991	N	1
Tillamook	10/29/1990	N	1.25
Tillamook	5/21/1991	N	0.75
Tillamook	5/18/1991	N	1.1
Tillamook	6/5/1991	N	1
Tillamook	8/29/1991	N	0.43
Tillamook	10/21/1991	N	0.1
Tillamook	9/21/1991	N	1.2
Tillamook	11/22/1991	N	0
Tillamook	12/23/1991	P	2
Tillamook	11/21/1991	P	1.2
Tillamook	12/20/1991	N	0
Tillamook	3/7/1992	N	1.8
Tillamook	4/13/1992	P	0.5
Tillamook	1/21/1992	P	0.1
Tillamook	1/7/1992	N	0
Tillamook	2/24/1992	P	0.5
Tillamook	11/7/1991	N	0.5
Tillamook	5/4/1992	N	1
Tillamook	2/24/1992	N	0.5
Tillamook	4/18/1992	N	0

Tillamook	9/5/1991	N	1
Tillamook	8/7/1992	N	0.8
Tillamook	12/23/1992	N	0.1
Tillamook	4/7/1993	N	0.07
Tillamook	7/28/1994	N	0.77
Tillamook	4/14/1993	N	5
Tillamook	3/22/1994	P	0.49
Tillamook	9/19/1994	P	3.4
Tillamook	11/28/1994	N	0.1
Tillamook	12/9/1994	N	0.24
Tillamook	12/8/1994	N	2.1
Tillamook	9/15/1994	N	
Tillamook	9/27/1994	N	0
Tillamook	11/7/1994	N	0.13
Tillamook	5/29/1996	N	5.8
Tillamook	5/29/1996	P	0.37
Tillamook	8/8/1996	N	0
Tillamook	6/24/1996	N	0
Tillamook	8/30/1996	N	0
Tillamook	12/4/1996	N	0
Tillamook	7/8/1996	N	0.6
Tillamook	10/2/1996	N	0
Tillamook	4/14/1997	N	3.9
NOTES:	N = Not Present		
	P = Present		
	Nitrate Values in mg/L		

TABLE 2
Department of Human Services, Drinking Water Program
Public Water Supply Testing Data

PWS #	PWS Name	County	SW ?	Population	Detections
00044	CANNON VIEW PARK, INC.	Clatsop	N	75	ND
00045	FALCON-COVE BEACH WATER DIST.	Tillamook	N	200	ND
00061	KNAPPA WATER ASSOCIATION	Clatsop	N	1400	TCE, 0293, <MCL
00079	KILCHIS REGIONAL WATER DIST.	Tillamook	N	1095	ND
00080	KILCHIS WATER DISTRICT	Tillamook	N	500	ND
00164	CANNON BEACH, CITY OF	Clatsop	Y	3100	ND
00195	WESTPORT HEIGHTS	Clatsop	N	75	ND
00196	QUINCY WATER ASSOCIATION	Columbia	N	275	TCE, 0993, <MCL
00311	GARIBALDI WATER SYSTEM	Tillamook	N	980	ND
00367	HEBO JOINT WATER & SANITARY AUTH.	Tillamook	N	220	ND
00506	NEAHKAHNIE WATER DISTRICT	Tillamook	N	600	Cd, 1291, ~MCL
00609	PACIFIC CITY JOINT WATER-SAN. AUTH.	Tillamook	N	1200	Cd, 0491, ~MCL
00688	J & M MOBILE HOME PARK	Columbia	N	58	Pb, 1095, ~MCL
00690	GOBLE WATER ASSOCIATION	Columbia	N	130	VOCS, 0391-0601, <MCL>
00691	LAURELWOOD W.S. (SPRING)	Columbia	N	24	ND
00692	PRESCOTT, CITY OF	Columbia	N	90	As, 0499-0899, <MCL
00708	ROCKAWAY BEACH WATER DEPT.	Tillamook	Y	2500	ND
00724	ST. HELENS, CITY OF	Columbia	N	10500	NO3, 0596, <MCL
00725	McNULTY WATER ASSOCIATION	Columbia	N	2412	ND
00726	WARREN WATER ASSOCIATION	Columbia	N	2040	ND
00792	SCAPPOOSE, CITY OF	Columbia	Y	3500	Cd, 0392, ~MCL
00793	COUNTRY VILLA MOBILE ESTATES	Columbia	N	114	NO3, 1296, <MCL
00804	ELDERBERRY-NEHALEM WATER SYS.	Clatsop	N	120	ND
00805	EVERGREEN ACRES	Clatsop	N	90	ND
00886	CLOVERDALE WATER DISTRICT	Tillamook	N	300	ND
00887	FAIRVIEW WATER DISTRICT	Tillamook	N	1550	ND

00893	TILLAMOOK WATER DEPT, CITY OF	Tillamook	Y	4000	Hg, 0692, ~MCL, 111-TCE, 0393, <MCL
00896	WILSON RIVER WATER DISTRICT	Tillamook	N	350	ND
00933	SUNSET LAKE RV PARK	Clatsop	N	40	ND
00951	WAUNA WATER DISTRICT	Clatsop	N	195	ND
00982	DEER ISLAND VILLAGE MOBILE HP	Columbia	N	150	TCE, 0698, <MCL, NO3, 0691, <MCL
00983	MAPLE TERRACE MOBILE HOME PARK	Columbia	N	50	Xylene, 0793, <MCL
01026	BIRKENFELD WATER ASSOCIATION	Columbia	N	55	ND
01038	FERNVIEW MOBILE HOME COURT #2	Columbia	N	24	ND
01041	RUDD'S MOBILE HOME COURT	Columbia	N	37	ND
01042	GREEN MEADOWS MOBILE COURT	Columbia	N	75	ND
01043	CEDAR TREE MOBILE HOME PARK	Columbia	Y	85	NO3, 0798, <MCL
01046	DEER POINTE MEADOWS	Columbia	N	70	ND
01047	RAINIER GARDENS MOBILE PARK	Columbia	N	30	ND
01054	SOUTH FORK CAMP - DEPT OF CORRECTIONS	Tillamook	N	117	ND
01148	COLUMBIA ACRES WATER ASSOC.	Columbia	N	100	111-TCE, 0291-0801, <MCL
01172	WESTERN HILLS MOBILE HOME EST.	Columbia	N	300	Toluene, 0993-0997, <MCL, Phthalates, 1098, <MCL, Radiation, 0900-0401, <MCL>
01173	WATSECO-BARVIEW WATER DISTRICT	Tillamook	N	540	Xylene, 0801, <MCL, VOCs, 0497-0801, <MCLs
01186	GRAHAM WATER ASSOCIATION	Columbia	N	25	ND
01233	DEER ISLAND WATERWORKS	Columbia	N	90	NO3, 0491-0394, <=MCL, Pb, 0797, >MCL
01278	WI-NE-MA WATER ASSOCIATION	Tillamook	N	200	Phthalates, 1200, <MCL
01304	LOST CREEK HEIGHTS WATER ASSOC.	Columbia	N	66	TCE, 0791-1291, <MCL>, NO3, <MCL, Pb, <MCL
01310	TAMARACK MOBILE HOME PARK	Columbia	N	80	ND
01311	RIVERWOOD MOBILE HOME PARK	Columbia	N	120	ND
01312	GOSS MOBILE HOME PARK	Columbia	N	28	NO3, 1296, <MCL
01313	CULBERTSON'S MOBILODGE	Columbia	N	24	ND
01391	INGLIS WATER CO-OP	Columbia	N	39	ND
01411	DIKESIDE MOORAGE	Columbia	N	30	ND
01423	PARADISE MOORAGE	Columbia	N	90	ND
01433	GREEN'S POINT WATER SYSTEM	Columbia	N	26	ND
01474	WESTLAND WATER ASSOCIATION	Columbia	N	24	ND
01482	HILAND WATER COMPANY	Columbia	N	30	ND
05079	LITTLE JACK FALLS ROAD WTR SYS	Columbia	N	18	ND

05114	DEER ISLAND HEIGHTS TRAILER PK	Columbia	N	63	ND
05121	SUNVIEW MOBILE HOME PARK	Columbia	N	11	ND
05129	RIVERVIEW LODGE - TILLAMOOK CO.	Tillamook	N	24	NO3, 0295-1196, <MCL
05138	WOODSON WATER ASSOCIATION	Columbia	N	23	NO3, 1299, <MCL
05248	WEST RAINIER WATER ASSOCIATION	Columbia	N	45	ND
05284	BOULDER RIDGE MOBILE HOME PARK	Columbia	N	18	ND
05453	USFS CASTLE ROCK CAMPGROUND	Tillamook	N	20	ND
05471	JONES WATER SYSTEM	Columbia	N	15	ND
05513	POWERS WATER SYSTEM	Columbia	N	10	ND
05519	ODOT HD CLATSKANIE MAINTENANCE	Columbia	N	12	ND
05521	ODF/WL CEDAR CREEK HATCHERY	Tillamook	N	15	ND
05530	GRAMADA TERRACE	Columbia	N	14	ND
05535	ELDERBERRY LODGE WATER ASSOC.	Clatsop	N	24	ND
05609	MALARKEY RANCH INN	Columbia	N	15	NO3, 0697-1100, <MCL
05635	BARNSTORMER, THE	Columbia	N	25	ND
05639	SAUVIE COVE R.V. PARK	Columbia	N	40	ND
05645	GANN COOPERATIVE WATER SYSTEM	Tillamook	N	16	ND
05659	ROLLING COURT	Columbia	N	14	ND
05660	ROUNDHOUSE LANE MOBILE PARK	Columbia	N	20	NO3, 1294, <MCL
05678	ODF/WL NEHALEM FISH HATCHERY	Clatsop	N	24	ND
05728	SANDLAKE COUNTRY INN	Tillamook	N	12	ND
05763	THISTLE HILL WATER CO-OP	Columbia	N	20	ND
05830	SHORTLIDGE WATER SYSTEM	Tillamook	N	20	ND
05848	VINEMAPLE ACRES W.S.	Clatsop	N	20	ND
05853	FERNVIEW MOBILE HOME COURT #1	Columbia	N	24	ND
05872	WALKER WATER SYSTEM	Columbia	N	15	ND
05904	VALLEY OF THE MOON	Columbia	N	26	ND
05942	EAGLE'S VIEW BED & BREAKFAST	Tillamook	N	10	ND
05952	RIVERVIEW HOME SITES	Clatsop	N	14	ND
06009	NORTH GATE CITY CHURCH	Columbia	N	10	ND
06039	WILLAMETTE IND.-NORTH COAST	Clatsop	N	20	ND
06040	LAURELWOOD W.S. (WELL)	Columbia	N	24	NO3, 1199, <MCL
06064	MILORIS WATER DISTRICT	Columbia	N	18	ND

06084	MIAMI RIVER INN	Tillamook	N	6	ND
90187	COLUMBIA CO.PKS-SCAPPOOSE RV PARK	Columbia	N	25	ND
90401	MOUNTAIN VIEW MOTEL	Columbia	N	28	NO3, 0894-1195, <MCL>
90407	DISSTOP INN	Columbia	N	30	ND
90408	JAY DEE TAVERN	Columbia	N	40	ND
90409	WAY SIDE INN	Columbia	N	150	NO3, 1194-0995, <MCL
90413	ONEY'S RESTAURANT/LOUNGE	Clatsop	N	60	ND
90511	PGE TROJAN NUCLEAR PLANT	Columbia	Y	300	ND
90531	JEWELL HIGH/ELEMENTARY, SD #8	Clatsop	N	172	ND
90594	NESTUCCA UNION HIGH, SD 3	Tillamook	N	225	ND
90595	NESTUCCA VALLEY ELEMENTARY SCHOOL	Tillamook	N	300	ND
90629	COLUMBIA CO.PKS-SCAPONIA PARK	Columbia	N	20	ND
90631	BLM ALDER GLEN REC SITE	Tillamook	N	30	ND
90640	BLM FAN CREEK REC SITE	Tillamook	N	35	ND
90641	BLM DOVRE REC SITE	Tillamook	N	35	ND
90764	COLUMBIA CO.PKS-BIG EDDY PARK	Columbia	N	125	ND
90768	COLUMBIA CO.PKS-CAMP WILKERSON	Columbia	N	200	ND
90770	COLUMBIA CO.PKS-HUDSON/PARCHER PARK	Columbia	N	200	ND
90850	TILLAMOOK CO.PKS-KILCHIS PARK	Tillamook	N	10	ND
90918	CAMP MAGRUDER	Tillamook	N	125	ND
90921	BAY AIRE MOBILE HOME PARK	Tillamook	N	60	ND
90923	CAMPER COVE	Tillamook	N	25	ND
90933	101 CAMP TAVERN	Tillamook	N	85	ND
90935	ST. JOHN'S BACHELOR CLUB	Tillamook	N	60	ND
90939	TWIN ROCKS CONFERENCE ASSN.	Tillamook	N	300	ND
90941	WILSON RIVER FISHERMAN'S RV PK	Tillamook	N	100	ND
91007	OPRD BRADLEY STATE WAYSIDE	Clatsop	N	383	ND
91010	OPRD SADDLE MOUNTAIN STATE PK	Clatsop	N	150	ND
91069	OPRD CAPE MEARES STATE PARK	Tillamook	N	500	ND
91087	TILLAMOOK CO.PKS-TRASK	Tillamook	N	35	Fl, 0891-0798, <MCL>
91088	ODF BROWN'S CAMP FORREST PARK	Tillamook	N	40	ND
91090	ODF ELK CREEK CG	Tillamook	N	25	ND
91097	ODOT HD SUNSET REST AREA	Clatsop	N	500	ND

92087	CAMPS MERIWETHER/CLARK, BSA	Tillamook	N	700	ND
92088	CAMP COOPER, BSA	Tillamook	N	200	ND
92708	USFS SAND BEACH CG	Tillamook	N	100	ND
92709	USFS HEBO LAKE CAMPGROUND	Tillamook	N	16	ND
93427	COASTAL ST. HELENS CHEMICAL	Columbia	N	75	NO3, 0993-1297, <MCL
93694	ALSTON CORNERS-ASSEMBLY OF GOD	Columbia	N	130	ND
93722	RAINIER SCHOOL DISTRICT SD #13	Columbia	N	830	ND
93786	KOUNTRY JOYNT, THE	Columbia	N	50	ND
93791	VERNONIA GOLF CLUB	Columbia	N	100	ND
93792	SPAR TREE RESTAURANT	Columbia	N	50	ND
94110	HORIZON VIEW HILLS WATER SYS.	Tillamook	N	10	ND
94397	MIST GRADE ELEMENTARY, SD 47J	Columbia	N	42	ND
94481	CAMP 18	Clatsop	N	75	ND
94572	ALICE'S COUNTRY HOUSE	Tillamook	N	25	ND
94590	SUNNYSIDE CAFE & DELI	Columbia	N	43	Pb, 0292, >MCL
94687	NESKOWIN VALLEY SCHOOL	Tillamook	N	72	ND
94688	RED BARN FLEA MART/RV PARK	Tillamook	N	25	ND
94717	COLUMBIA RVR. PEOPLE'S UTILITY	Columbia	N	35	NO3, 1294-0501, <MCL>
94784	USFS CEDAR CREEK	Tillamook	N	20	ND
94882	OLYMPIC FOREST PRODUCTS	Columbia	N	60	ND
94945	GUIDE SHOP, THE	Tillamook	N	30	ND
94990	EXPRESS LANE ESPRESSO	Columbia	N	50	ND
95010	ODF NEHALEM FALLS CG	Tillamook	N	50	ND
95035	ORELLI'S	Columbia	N	25	NO3, 0898-0999, <MCL
95088	NANTUCKET SHORES	Tillamook	N	660	ND
95089	GENESIS SPORTS CENTER	Columbia	N	40	ND
95107	LEATHERS FUELS-SCAPPOOSE TEXACO	Columbia	N	200	ND
95119	USFS DERRICK ROAD HOST SITE	Tillamook	N	30	ND
TOTAL				49059	
NOTES:	PWS # = Public Water Supply Number				
	PWS Name = Public Water Supply Name				

	SW ? = Is surface water mixed with groundwater?				
	Population = Population Served by PWS				
	Detections: ND = No Detections, TCE = Trichloroethylene, Dates shown as MMYY, <MCL> = detections below and above MCL, NO3 = Nitrate, Cd = Cadmium, Pb = Lead, VOCs = Volatile Organic Compounds, As = Arsenic, ~MCL = approximately equal to MCL, Hg = Mercury, 111-TCE = Trichloroethane.				

Table 3
Sample Results for DEQ Study
Clatsop Plains (Spring 1996)

Contaminant	# of Wells Found In	Mean (mg/L)	Max. (mg/L)	Detection Limit (mg/L)	Standard (mg/L)	# Wells over Standard
Nitrate	28	3.75	59	0.02	10	3
Bacteria*	13	25	290	4*	≤ 1	13
Lead	11	0.051	1.400	0.005	0.015 (ACTION LIMIT)	7
Arsenic	10	0.006	0.040	0.005	0.05	0
Copper	4	0.02	0.12	0.02	1.3 (ACTION LIMIT)	0
Chloroform	3	0.0003	0.0010	0.0005	0.100	0
Toluene	2	0.0002	0.0010	0.0005	1	0
Atrazine	1	0.0004	0.0390	0.0006	0.03	1
Cadmium	1	0.001	0.001	0.01	0.05	0
Barium	1	0.02	0.09	0.03	2	0
Chromium	1	0.02	0.03	0.03	0.1	0
Pentachlorophenol	1	0.0002	0.007	0.0001	0.001	1

*** NOTE:** Bacteria measured in colonies per 100 ml (CFU/0.1L). Detection limit = 4 CFU/0.1L.

Table 4
Resampling Results for DEQ Study
Clatsop Plains (Fall 1996)

Contaminant	# of Wells Found In	Mean (mg/L)	Max. (mg/L)	Detection Limit (mg/L)	Standard (mg/L)	# Wells over Standard
Nitrate	24	2	12	0.02	10	2
Bacteria*	25	93	1580	4*	≤ 1	25
Atrazine	1	0.0003	0.010	0.0001	0.003	1
Cadmium	1	0.001	0.003	0.001	0.005	0
Lead	1	0.003	0.007	0.005	0.015 (Action Limit)	0

*** NOTE:** Bacteria measured in colonies per 100 m/L (CFU/0.1L). Detection limit = 4 CFU/0.1L.

Table 5
Sampling Results for DEQ Study
Tillamook (Fall 1997)

Contaminant	# of Wells Found In	Mean (mg/L)	Max. (mg/L)	Detection Limit (mg/L)	Standard (mg/L)	# Wells over Standard
Nitrate	16	1.28	8.60	0.02	10	0
Antimony	18	0.0038	0.0069	0.0030	0.006	5
Bacteria*	1	12	280	2*	≤ 1	1
Barium	25	0.00713	0.05270	0.00010	2	0
Chromium	18	0.00118	0.00582	0.00020	0.1	0
Copper	24	0.03907	0.46500	0.00030	1.3	0
Nickel	24	0.00143	0.00643	0.00040	0.1	0

Table 6
Resampling Results for DEQ Study
Tillamook (Spring 1998)

NOTE: All measurements in mg/L, except bacteria in colonies/100 ml.

CONTAMINANT	# of Wells Found In	MAX. (mg/L)	DETECTION LIMIT (mg/L)	STANDARD (mg/L)	# of Wells over Standard
Antimony	1	0.0039	0.0030	0. 006	0
Barium	5	0.07190	0.00010	2	0
Cadmium	1	0.00013	0.00010	0.005	0
Chromium	4	0.00045	0.00020	0.1	0
Copper	5	0.52000	0.00030	1.3	0
Nickel	4	0.00182	0.00020	0.1	0
Lead	5	0.0221	0.0030	0.015	2
Bacteria	0	0	2	≤ 1	0
Ethylbenzene	1	0.0007	0.0005	0.7	0