State of Oregon
Department of Environmental Quality

SOUTHERN WILLAMETTE VALLEY 2002 GROUNDWATER STUDY

Final Report

May 2003

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Groundwater Quality Protection Program
Western Region

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Southern Willamette Valley 2002 Groundwater Study

ABSTRACT

During the Spring and Summer of 2002, The Oregon Department of Environmental Quality (DEQ) Groundwater Protection Program studied the current magnitude and extent of non-point source pollution of shallow groundwater in the Southern Willamette Valley. The Southern Willamette Valley is considered by DEQ to be a priority area for groundwater assessment and protection for several reasons, including: the severity and extent of nonpoint source groundwater contamination that has been documented in previous studies; the vulnerability of shallow groundwater to impacts from the overlying land uses; the expectation that the population growth in this area will rapidly expand; and that residents in the unincorporated areas of the Southern Willamette Valley will rely on groundwater as their primary drinking water supply. Water-supply data indicate that more than 80% of the groundwater used in the Willamette Valley is pumped from the shallow sand and gravel aquifer.

DEQ previously conducted a nitrate groundwater study of the Southern Willamette Valley in 2000-2001. That study confirmed and supplemented data previously collected by DEQ and other agencies characterizing the nitrate contamination of the in shallow groundwater in the alluvial aquifers. Shallow groundwater, defined as less than 75 feet below ground surface for the purposes of this study, was targeted for sampling as this is the resource most likely affected by anthropogenic activities.

The 2002 Southern Willamette Valley study focused on the resampling of wells from the SWV 2000-2001 study with nitrate values greater than 7.0 mg/l. The 2002 study included analyzing well water samples for nitrate, phosphate, iron, manganese, arsenic, lead, bacteria, pesticides, caffeine and other water quality parameters. Nitrate values were fairly consistent with previously reported levels. Fifteen (15) different pesticides were detected in the groundwater of the study area; most were detected at very low concentrations.

DEQ will use the results of this and previous evaluations to consider groundwater protection strategies, including the potential designation of Groundwater Management Area(s) or Area(s) of Groundwater Concern in the Valley, consistent with the State Statutes ORS 468B.150-188. If such a declaration is realized, then there will be a need to appoint a Lead Agency to develop a groundwater management plan with input from a Groundwater Management Committee comprised of local stakeholders. The primary goals of such management plans include the development and implementation of best management practices to lessen future groundwater contamination and the determination of appropriate means for current protection of public health and the groundwater resource.

I. INTRODUCTION

This report describes the work completed by the Department of Environmental Quality (DEQ) Groundwater Protection Program during the Spring and Summer of 2002 to study the current magnitude and extent of non-point groundwater pollution of shallow groundwater in the Southern Willamette Valley. The Southern Willamette Valley is considered by DEQ to be a priority area for groundwater assessment and protection for several reasons: including: the severity and extent of nitrate nonpoint source groundwater contamination documented by previous studies; the vulnerability of shallow groundwater to impacts from the overlying land uses; the expectation that the population growth in is area will continue to rapidly expand, and that residents in the unincorporated areas of this study area will rely on groundwater as their primary drinking water supply. The timing of this study was ideal as planning for future groundwater quality protection strategies resulting from the data allowed for integration and networking with other ongoing high-priority water quality improvement efforts in the Willamette Valley (i.e., Total Maximum Daily Loads [TMDLs] and the 1010 plans). The location of the Southern Willamette Valley is shown on Figure 1.

The goal of DEQ's Groundwater Program is to ensure that Oregon's groundwater is protected as a resource for all present and future beneficial uses. The protection strategy begins with monitoring and assessment to identify groundwater quality problems. Where nonpoint sources of groundwater contamination are identified, a Lead Agency to develop the Action Plan will be appointed and a groundwater management committees comprised of local stakeholders formed to advise State Agencies developing the groundwater management plan on local elements of the plan. Public education, research and demonstration projects are established to increase public awareness. These plans include development and implementation of best management practices to address groundwater contamination and protection.

When groundwater is contaminated from non-point sources at levels that exceed 70% of a Maximum Measurable Level [MML; OAR 340-40-90] for nitrate, or 50% of a MML for other parameters, DEQ is authorized to declare a "Groundwater Management Area." MMLs are generally equivalent to EPA's Maximum Contaminant Level (MCL) for public drinking water supply systems. The MML for nitrate is 10 milligrams per liter (mg/L). Once such a declaration is made, responsible agencies and local communities will work together to develop an Action Plan with a focus on the restoration of the groundwater quality. Through the development of an Action Plan, State government can play a key role in helping local governments, residents, and other stakeholders increase their awareness of groundwater quality concerns and mobilize them to take actions leading to groundwater protection and restoration of the water quality of this valuable resource.

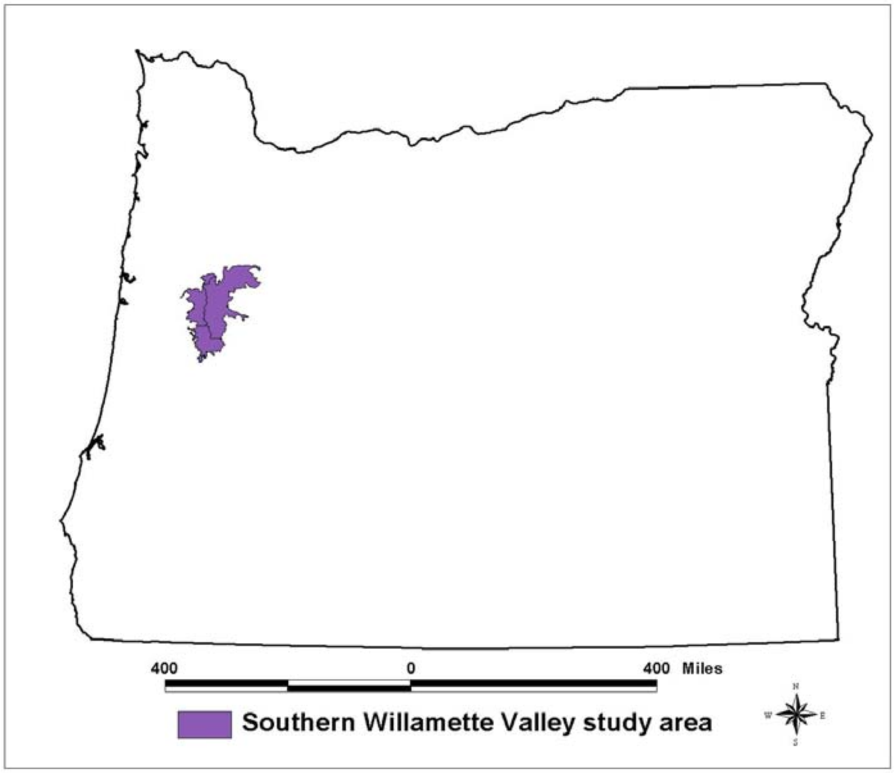

Figure 1

Locale of the Study Area

II. PURPOSE AND SCOPE OF THE STUDY

The purpose of this study was to supplement and confirm the nitrate results of the SWV 2000-2001 groundwater study, to evaluate the general groundwater geochemistry, and to assess overall pesticide levels in some of the shallow alluvial aquifers of the Southern Willamette Valley (SWV). Shallow groundwater, defined for the purpose of this study as less than 75 feet below the ground surface, in the alluvium has been the target of the recent studies because water-supply data indicate that more than 80% of the groundwater used in the Willamette Valley is pumped from this shallow alluvium (Hinkle, 1997). The unconfined shallow groundwater is assumed to be the groundwater resource most likely affected by anthropogenic activities.

DEQ's 2002 investigation was an expansion of the previous SWV study. Of the 476 wells sampled during the 2000-2001 study, 100 wells had nitrate values greater than 7.0 milligrams per liter (mg/L). These 100 wells were targeted for the expanded analyses program of the 2002 study. In addition to nitrate, pesticides and the collection of field parameters there was a decision to include other water quality parameters to allow for an increased understanding of the study site geochemistry. Bacteria samples were collected and analyzed courtesy of Oregon State University Extension Service.

III. DESCRIPTION OF THE SOUTHERN WILLAMETTE VALLEY

Location of the Southern Willamette Valley Study Area

The study area includes the lowlands of the southern portion of the Willamette Valley, extending from Eugene to Albany in Lane, Linn, and Benton Counties (see Figure 2). Areas inside the urban growth boundaries of Eugene, Corvallis, Albany, and Lebanon are excluded because of this study's emphasis on groundwater quality issues affecting non-regulated rural water supplies. The boundary of the study area approximately coincides with the limits of unconfined aquifers within the Southern Willamette Valley, known to include a shallow sensitive aquifer. It is bounded on the east by the Cascade Range, to the west by the Oregon Coast Range, to the north by the Salem Hills, and to the south by the city of Eugene's urban growth boundary. The study area encompasses approximately 780 square miles.

Land Uses

Land uses in the study area are predominantly agricultural, including a diversity of crops (field crops, such as grains, hay, mint and hops; seed crops such as grass and vegetable seeds; and vegetable fruit, nut, and nursery crops) and pasture. Many of these crops are irrigated. Commercial livestock production occurs in the study area, including 33 confined animal feeding operations (CAFOs) permitted by the Oregon Department of Agriculture. Non-agricultural uses include rural residential, commercial, industrial, and natural habitat enhancement. A complete description of the land uses and the other groundwater quality studies conducted in this area is contained in the Southern Willamette Valley Groundwater 2000-2001 Assessment, Final Report (DEQ, 2003.)

Hydrogeology

Previous work in the Willamette Valley conducted by the US Geological Survey (USGS) and the Water Resources Department (WRD) has defined five regional hydrogeologic units. These regional units are (1) the Basement Confining unit, (2) the Columbia River Basalt unit, (3) the Willamette Confining unit [not shown as it underlies various units and does not surface in the study area], (4) the Willamette Aquifer [depicted as the Older and Younger Upper Sedimentary Unit], and (5) the Willamette Silt unit (see Figure 3).

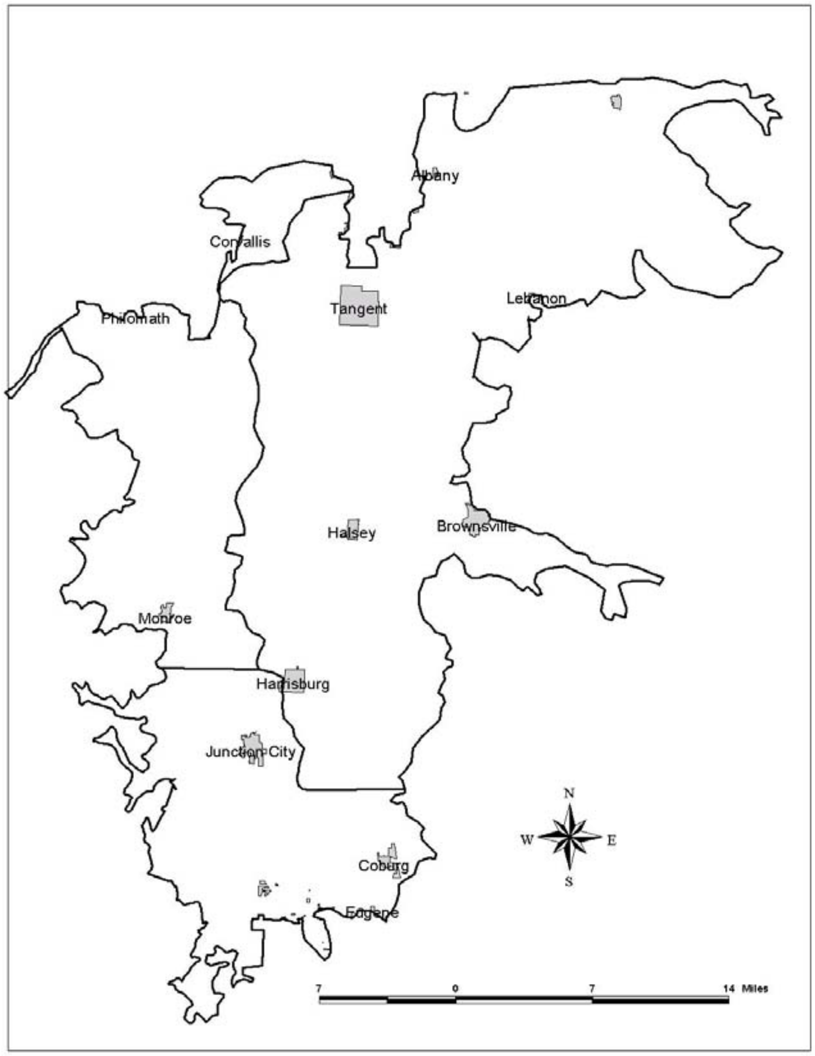

Figure 2

Location of the Southern Willamette Valley Study Area

The highlands of this study area are chiefly comprised of marine volcanic and sedimentary rocks of the Coast Range to the west and of the volcanic rocks of the Cascades to the east. The alluvial deposits in the valley are a heterogeneous combination of materials, ranging from clay to gravel. The character and distribution of the unconsolidated deposits in the lowlands exert substantial control on current topography, soil characteristics, and groundwater properties. The extent and thickness of major Quaternary-age deposits control a majority of the regional groundwater systems within the Willamette River Basin.

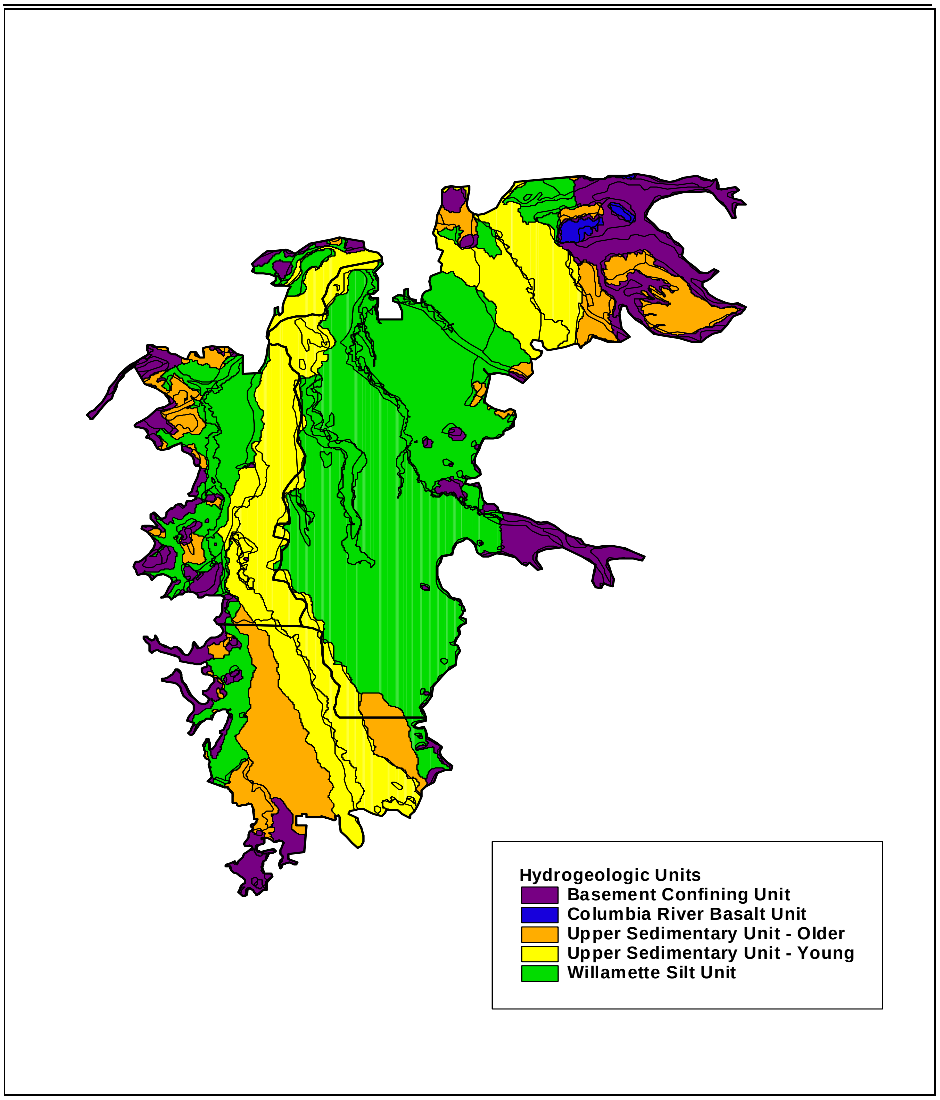

FIGURE 3

Southern Willamette Valley Hydrogeologic Units

The Upper Sedimentary Units, and especially the Younger member, contains the most important and productive aquifer in this study area. The combined Younger and Older members of the Upper Sedimentary Unit are referred to as the Willamette Aquifer. This aquifer is more permeable and susceptible to contamination than other basin deposits, such as the Willamette Silt.

In the study area, groundwater in the younger unit of the Willamette aquifer generally occurs under unconfined conditions. The overall groundwater flow direction of the shallow alluvial aquifers is towards the Willamette River. Groundwater in the close proximity of the Willamette River will tend to flow in the direction of the river drainage.

IV. STUDY DESIGN AND METHODS

Project Organization and Responsibilities

This groundwater assessment was undertaken as a DEQ Groundwater Program initiative, in consultation with Oregon State University Extension Service (OSU), Oregon Department of Human Services (DHS), and Oregon Water Resources Division (WRD). Responsibilities for all participants are detailed in the Appendices as Attachment A.

Selection of the Parameters

The 100 wells that had measured nitrate levels greater than 7.0 mg/L in the earlier SWV groundwater study were selected for the 2002 analyses. In addition to nitrate, pesticides and the collection of field parameters, sampling of well water was conducted for the analyses of: arsenic; lead; selenium; caffeine; chloride; sulfate; ammonia; total phosphate; and total kjeldahl nitrogen (TKN). Bacteria samples were collected and analyzed courtesy of Oregon State University Extension Service.

Nitrate was included in this study for the purpose of comparison to the earlier 2000-2001 values. It is known that nitrate in groundwater may originate from a number of point and non-point sources, including fertilizer, manure, septic systems, natural soil nitrogen, atmospheric deposition, land disposal of municipal waste, and fixation of atmospheric nitrogen.

Pesticides, which include herbicides, fungicides, insecticides and any associated metabolites, are frequently used in combination with fertilizers. An over-application of a pesticide on the land above the shallow alluvial aquifer may be eventually detected in the underlying shallow groundwater. Pesticides found in the groundwater may originate from a variety of non-point sources, such as applications to agricultural land, home lawn, private and public parks, golf courses, and road and ditch maintenance. As the pesticides studied in this project are all synthetic chemicals, background concentrations for these constituents should be below the method detection level, i.e., should not be detected.

Some parameters were selected to gain a better understanding of environmental indicators of the agricultural processes. Phosphate, total kjeldahl nitrogen and ammonia may be present due to fertilizer application or a result of decaying crop remnants. Several parameters were selected to give homeowners more information about the safety of their drinking water. Bacteria may be found in well water samples if the well is in close proximity to a septic leach field or if the well is poorly constructed or maintained. Lead may most likely be present in well water samples if there is lead solder in the pipes. Arsenic is most likely to be naturally present in deeper bedrock aquifers in the SWV; however USGS indicated that at a regional scale, well depth does not appear to be a useful indicator of arsenic levels (Hinkle & Polette, 1999). Caffeine was selected as a potential indicator of influences from septic systems.

The other parameters selected for this study were chosen to gather information to better characterize the geochemistry of the groundwater. The collection of data from a specific time period can allow for examining the relationships between the various parameters. This type of analysis could be very useful when evaluating the various sources of contamination and developing groundwater protection strategies.

Sampling Design

Groundwater samples were collected from the targeted wells over a three month period, from May to July 2002. DEQ staff re-established contact with the current owners of these study wells and requested permission to access the wells previously sampled. If the previous owner no longer resided at the known address for a targeted well, DEQ staff explored County records, web-sites such as Anywho.com, or contacted neighbors to determine the current owner and/or resident. The new owner was approached, and DEQ staff explained the project and sought their permission to resample the targeted well.

Several residents indicated they had installed new wells or deepened their existing wells based upon the SWV 2000-2001 sampling results. In these situations, both the new deep well and the older shallow well were scheduled for sampling, if both were accessible. Additional wells were included as DEQ's request to resample the all the original targeted wells was not always successful.

Two teams of two to three field staff collected samples for three consecutive days during the last week of each month. The wells selected for each months' sampling were based upon the response to DEQ requests for permission to sample. Sampling dates and times were scheduled with each resident, and a call to the homeowner was placed approximately 1 hour prior to the planned site visit to inform them the sampling crew would be arriving shortly. Complete details on this subject are presented in DEQ's Upper Willamette Basin Groundwater Assessment – Final Sampling and Analysis Plan, June 2002.

Sample Collection Methods

Field sampling was conducted in accordance with DEQ's standard procedures (DEQ, 1993 a & b) and the Final Sampling and Analysis Plan (DEQ, 2002). Prior to sample collection, the depth to water in the well would be measured, if possible, and recorded. If the resident was present, they would be asked about recent water usage. An electronic water depth probe was used to gauge the depth to water levels. Additional ½" pipe plugs and 7/16" hexhead bolts, a ratchet and a small crescent wrench were available to remove the wellhead cover and replace any breakage that may occur during this procedure. Depth to water levels were not collected at wells when the resident was not present or if the well was inaccessible.

Wells were purged for approximately 5 minutes. Temperature, pH, and specific conductance were measured in the field and recorded on field data sheets and well site identification sheets (see the Appendices, Attachment B1 and B2). A GPS reading would be gathered, and recorded on these sheets with the preassigned site LASAR number. Pictures of wells and the surrounding area were taken as appropriate.

Samples for nitrate/nitrite, ammonia, phosphate and TKN were collected in 500 ml“R” poly containers, and acidified to a pH<2 with sulfuric acid. Metals were collected in 250 ml “TM” poly containers, and acidified to a pH<2 with nitric acid. Alkalinity samples were collected in a 1000 ml “P” poly container. Chloride and sulfate samples were field filtered with a 0.45 micron filter, and collected in 250 ml “DP” poly container. Bacteria samples were placed into sterilized 125 ml containers prepared by Department of Human Services Laboratory. Pesticides were placed in 2 liter amber glass containers. All samples were cooled on ice after collection and during transport to the appropriate laboratories.

V. RESULTS OF THE 2002 SAMPLING

Overview

Of the 100 wells sampled during the 2000-2001 Southern Willamette Valley (SWV) groundwater investigation, only 87 wells were included in the SWV 2002 study. There were many reasons why 13 of the original wells were not included in this sampling program. Some wells had been decommissioned and replaced with new wells; several well owners had moved and new owners could not be contacted; and at least one previous well owner was deceased and there was no clear new ownership of the well. Three owners declined further involvement in this study, and we were not able to get timely approval for sampling one well that provides drinking water to five families.

While designing the sampling program for the SWV 2002 study, two other relevant opportunities for nitrate and pesticide sampling materialized. The City of Coburg requested that DEQ help them in determining the extent of septic system impact to the groundwater in and near the town’s Urban Growth Boundary (UGB). The entire town of Coburg employs individual septic systems to treat residential and commercial wastewater. The associated impact from septic systems on groundwater would be best evaluated by nitrate analyses. As the City of Coburg is adjacent to an area of concern for the SWV project, this proved to be a timely request. Samples were collected in areas presumed to be upgradient and downgradient of the UGB, as well as two private wells inside the UGB.

The second relevant study that was ongoing during our sampling event was the Oregon State University Food Toxicology and Nutrition Lab (Fish Lab). In the spring of 2000, Oregon State University researchers began finding an unusually high rate of liver cancer in untreated ("control") fish. A number of other unusual effects were found in the fish, including high mortality, altered growth, kidney damage, anemia, and various physical deformities. Researchers involved with the Fish Lab Project requested we consider sampling a selected group of private wells in the area for nitrates and pesticides. As the Fish Lab study site was within the SWV study area, this request was considered reasonable.

In total, 100 wells were sampled for nitrates, total kjeldahl nitrogen, total phosphate and ammonia analyses. A total of 95 bacteria samples were collected from all sampling locations except the Monroe pitcher pump and 4 UGB wells. Pesticides and the other inorganic analyses were limited to the SWV wells (87), the new deep wells (2), the Fish Lab study wells (3) and one (1) UGB well. The analytical data is contained in the Appendices as Attachment C

Nitrate

The DEQ Laboratory performed all nitrate analyses using EPA Method 353.2, with a Reporting Level of 0.005 milligrams per liter (mg/L) as Nitrogen (N). The highest nitrate value was 27.8 mg/L. The following areas had 17 wells with nitrate levels greater than or equal to 15 mg/L:

Junction City	5
Coburg	6
Halsey	2
Monroe	3[#]
Scio	1

Table 1: Areas where nitrate levels were greater than or equal to 15 mg/l

31 wells had Nitrate values greater than or equal to 10 mg/L and less than 15 mg/L in the following areas:

Junction City	14
Coburg	10
Corvallis	3
Albany	1
Halsey	1
Monroe	1
Shedd	1

Table 2: Areas where nitrate levels were greater than or equal to 10 mg/l and less than 15 mg/l

52 wells had Nitrate values less than 10 mg/L in the following areas:

Junction City	15*
Coburg	17
Harrisburg	6
Corvallis	5*
Albany	3
Halsey	1
Monroe	2*
Shedd	3

Table 3: Areas where nitrate levels were less than 10 mg/l

* includes either a new deep well or a new pretreatment system
# includes an old pitcher pump as a new monitoring location

Bacteria

Total Coliform

This is a group of bacteria which is aerobic and facultative anaerobic, rod-shaped bacteria. These bacteria are found in the intestines of warm blooded animals and thus will be present in sewage, on and in soils, vegetation and some surface waters.

The total coliform group has been used for sometime as an "indicator organism". This indicator organism by itself is considered to cause no diseases in man or animals. However, by the presence of this organism indicates the likelihood of other pathogenic or disease-causing organisms, such as *E Coli*.

The Oregon Department of Human Services performed all total coliform analyses. The Presence/Absence analytical method was selected for this procedure. Samples from 29 wells indicated the presence of total coliform.

E Coli

E. coli is used as an indicator of fecal contamination, as *E. coli* is abundant in human and animal feces.

The Oregon Department of Human Services performed all *E Coli* analyses. The Presence/Absence analytical method was selected for this procedure. Samples from 4 wells indicated the presence of *E Coli*.

Pesticides

The Oregon Department of Agriculture Laboratory (ODA) performed all pesticide analyses by a method similar to the one utilized by USGS when conducting the assessment of pharmaceutical and personal care products in environmental (water) samples. DEQ identified 31 parameters of interest, and the ODA lab ensured they had standards for all of these parameters. Solid phase extractions were followed by a full GC/MS screening evaluation, which is able to detect over 300 pesticides. If additional pesticides were found during this screening, those pesticides were added to the list of parameters of interest. Two separate Gas Chromatograph/Mass Spectrometer analyses were then conducted for the Fraction A (Acidics) Pesticides and the Fraction B (Neutrals) Pesticides. The detailed analytical method for this procedure can be found in Appendix as Attachment D.

15 different pesticides were detected above their respective reporting limits. Reporting limits varied between 6.0 and 35 nanograms per liter (ng/L) or parts per trillion (ppt). The following is a summary of these detections.

Atrazine and Desethyl Atrazine

By far the most widespread pesticides present were atrazine and its breakdown product desethyl-atrazine. Atrazine was reported to be present at 31 sampling locations, at concentrations ranging from 25-192 ng/L. Atrazine may have been present at 36 other locations at concentrations to low too quantify. The reporting limit for atrazine was 20 ng/L.

Desethyl-atrazine was reported to be present at 54 sampling locations, at concentrations ranging from 21 -776 ng/L. Desethyl-atrazine may have been present at 19 other locations at concentrations to low too quantify. The reporting limit for desethyl- atrazine was 13 ng/L.

Simazine

After atrazine and desethyl- atrazine, simazine was the next most frequently reported pesticide. Simazine was reported to be preset at 11 sampling locations, at concentrations ranging from 20 – 239 ng/L. There may have been simazine present at 9 other locations at concentrations to low too quantify. The reporting limit for simazine was 16 ng/L.

Terbacil

Terbacil was found to be present at 5 sampling locations, at concentrations ranging from 63 to 306 ng/L. Terbacil may have been present at two other locations at concentrations too low to quantify. The reporting limit for terbacil was 20 ng/L.

Bromacil

Bromacil was found to be present at 4 sampling locations, at concentrations ranging from 60 to 273 ng/L. Bromacil may have been present at three other locations at concentrations too low to quantify. The reporting limit for bromacil was 20 ng/L.

Malathion

Malathion was found to be present at 7 sampling locations, at concentrations ranging from 28 to 118 ng/L. Malathion may have been present at four other locations at concentrations too low to quantify. The reporting limit for malathion was 20 ng/L.

Bisphenol-A

Bisphenol-A (also know as 4,4-Isopropylidenediphenol) was found to be present at 10 sampling locations, at concentrations ranging from 619 to 1108 ng/L. The reporting limit for bisphenol-A was 20 ng/L.

Metribuzin

Metribuzin was found to be present at 4 sampling locations, at concentrations ranging from 56 to 240 ng/L. The reporting limit for metribuzin was 8.0 ng/L.

Other Pesticides

Seven other pesticides were reported to be present one or two times. Table 4 summarizes those results.

TABLE 4
Results for Infrequent Pesticide Detections

Parameter	Number of Detections	Concentrations	Method Reporting Limit
3,4-Dichloroaniline	2	38-156 ng/l	35
Clopyralid	1	160 ng/L	15
Diazinon	1	72 ng/L	18
Ethofumesate	1	28 ng/L	6
Metolachlor	2	26 -44 ng/L	17
p,p-DDT	1	12 ng/L	10
Picloram	1	120 ng/L	15

Other Inorganic Analyses

DEQ's laboratory analyzed the remainder of the parameters, which included the nutrients (phosphate, TKN and ammonia) metals and basic water quality anions and cations. These results are summarized in Table 5 and presented in full in the Appendices as Attachment C.

VI. DISCUSSION

Nitrate

Nitrate concentrations exceeding 2-3 mg/L generally indicate anthropogenic contributions of nitrate (Madison and Brunett, 1985). In the Southern Willamette Valley where nitrate concentrations are commonly reported to be less than 1 mg/L, it is likely that "background" (non-anthropogenic) concentrations of nitrate approach the method detection limit of 0.005 ppm. The health-based federal drinking water standard (MCL) for nitrate in public drinking water systems is 10 mg/L.

Nitrate values in 2002 were generally higher compared to the results of samples collected from the same wells in 2000-2001. Nitrate values for samples collected in 2002 were higher 74 % of the time; the greatest rise for a given well was an increase of 12.1 mg/L. The averaged nitrate increase for these wells was 2.82 mg/L. Nitrate values for 2002 samples decreased or remained the same 26% percent of the time. For these wells, nitrate levels were lower in 2002 by as much as 5.4 mg/L, with an averaged decrease of 1.2 mg/L

Overall, the nitrate concentrations for the SWV study wells resampled in 2002 remained above 7.0 mg/L. The successive sampling and analysis over a 1.5 year period of time (December 2000 to July 2002) provides supporting information that some portions of the shallow groundwater in the SWV Study area have sustained nitrate levels above the 7.0 mg/L criterion. This correlates well with the other nitrate studies of this area.

Many of the wells from the 2000-2001 SWV Study with nitrate values greater than 7.0 mg/L are located near the Willamette River. Thus, it follows that those 2002 SWV Study wells with evidence of persistent high nitrate values are also close to the Willamette River.

The Younger, Upper Sedimentary Unit of the Willamette Aquifer is illustrated in Figure 4 as the area mapped in yellow. This unit is the most productive aquifer in the study area and in the Southern Willamette Valley. Figure 4 also illustrates that the majority of the wells sampled for the SWV 2002 (73 of 87 wells) study are in or immediately adjacent to

TABLE 5

RESULTS FOR INORGANIC PARAMETERS

Parameter	Analytical Method	Reporting Limit	Units	Number of detections	Highest Detection	Lowest Detection	Average
Alkalinity	2320 B	1	mg/l as CaCO3	93	180	42	78.15
Aluminum	3120 B	0.05	mg/l	4	1.46	ND	0.07
Ammonia	4500-NH3 H	0.02	mg/L as N	18	0.14	ND	0.025
Arsenic	3120 B	0.01	mg/L	1	0.01	ND	NA
Calcium	3120 B	0.1	mg/L	93	87	0.2	28.1
Chloride	4500-Cl C	0.5	mg/L	93	190	2.3	15.65
Conductivity	2510 B	1	umhos/cm	101	921	188	329
Hardness	3120 B	0.7	mg/L	93	311	0.8	134
Iron	3120 B	0.05	mg/L	16	7.72	ND	0.201
Lead	3120 B	0.01	mg/L	4	0.052	ND	NA
Lithium	3120 B	0.015	mg/L	0	ND	ND	NA
Magnesium	3120 B	0.1	mg/L	93	36.2	0.16	15.68
Manganese	3120 B	0.005	mg/L	11	0.29	ND	0.011
Phosphate	4500-P E	0.01	mg/L as P	100	0.91	0.02	0.099
pH	150.2	0-14	SU	101	7.7	6.3	NA
Potassium	3120 B	0.5	mg/L	93	2.91	0.06	1.47
Selenium	3120 B	0.01	mg/L	0	ND	ND	NA
Sodium	3120 B	0.3	mg/L	93	70.1	6.4	13.65
Sulfate	300	0.2	mg/L	93	6.26	0.7	18.06
Total Kjeldahl Nitrogen	351.2	0.2	mg/L as N	4	0.4	0.2	NA

this highly productive unit. This unit surrounds or abuts the main stem of the Willamette River in the study area as seen in Figure

The lack of a significant thickness of an overlying protective material, such as the Willamette Silt, leaves the unconfined sand and gravel sedimentary aquifer extremely vulnerable to influences from land uses. It is apparent there may be some minimum thickness of Willamette Silt that could be effective in preventing high level impact of nitrate to shallow groundwater. Although there are at least 9 wells located in the Willamette Silt unit that are monitoring portions of an aquifer with nitrate levels above 7.0 mg/L, most of these wells are in areas where the Willamette Silt layer is likely relatively thin.

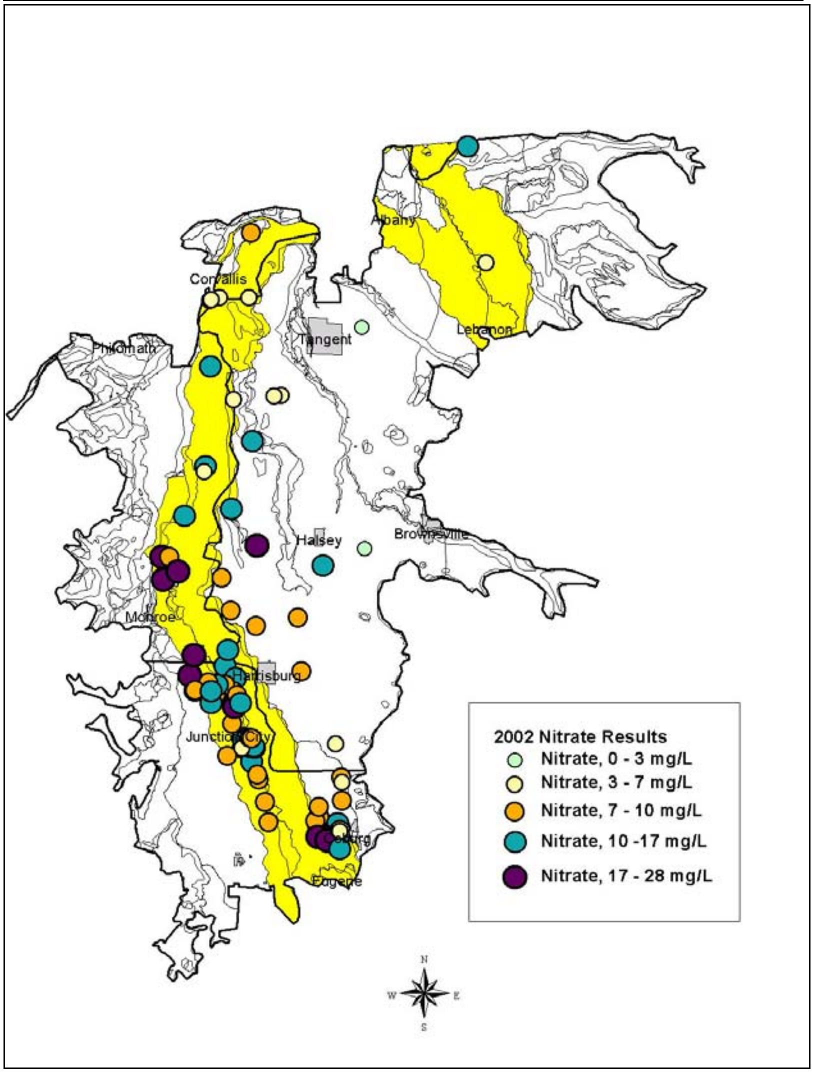

Figure 4

Nitrate results from the 2002 sampling event relative to the Upper Sedimentary Unit (Younger)

The Willamette Silt and its potential to degrade nitrate has been a focus of several recent Oregon State University (OSU) studies (Haggerty, 2001). In areas where the unconsolidated sedimentary aquifer is semi-confined and beneath the Willamette Silt unit, the Willamette Silt unit appears to protects groundwater quality. Nitrate does not appear to penetrate the Willamette Silt below a redox front (likely $Fe3+/Fe2+$ couple). The depth of the redox zone may vary and it is not precisely clear which other parameters may affect the rate of nitrate degradation.

The OSU nitrate studies occurred principally in the Northern Willamette Valley where the Willamette Silt layers are relatively thick; however the nitrate degradation phenomenon may likely happen in some areas of the Willamette Silt unit south of Salem. OSU plans to be studying the potential degradation of nitrate in the Southern Willamette Valley in the summer of 2003.

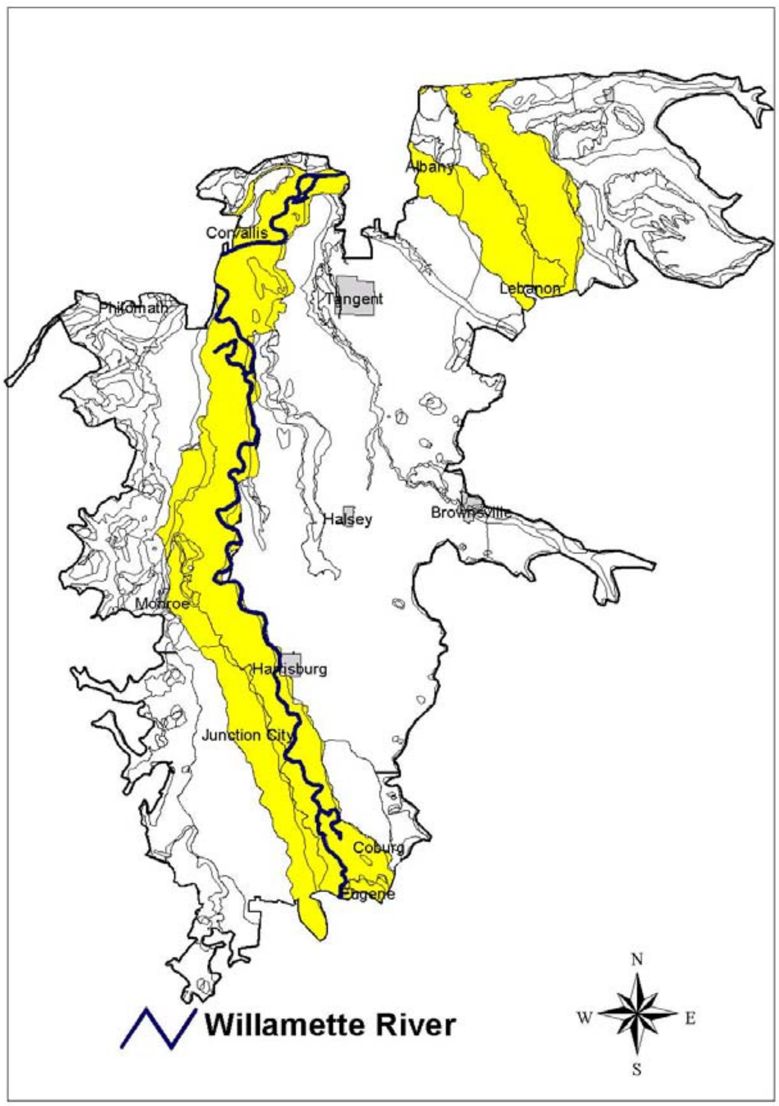

Figure 5

The main stem of the Willamette River relative to the Upper Sedimentary Unit (Younger)

Pesticides

Fifteen pesticides were reported at concentrations greater than Oregon Department of Agriculture Lab method reporting limit (MRL.) There were no exceedances of any health or public drinking water standards for any of the pesticides. Of the 15 pesticides detected in this study, there are two corresponding EPA Maximum Contaminant Levels (MCLs) established for public drinking water systems. Health based standards are available for 6 of the detected pesticides that do not have MCLs.

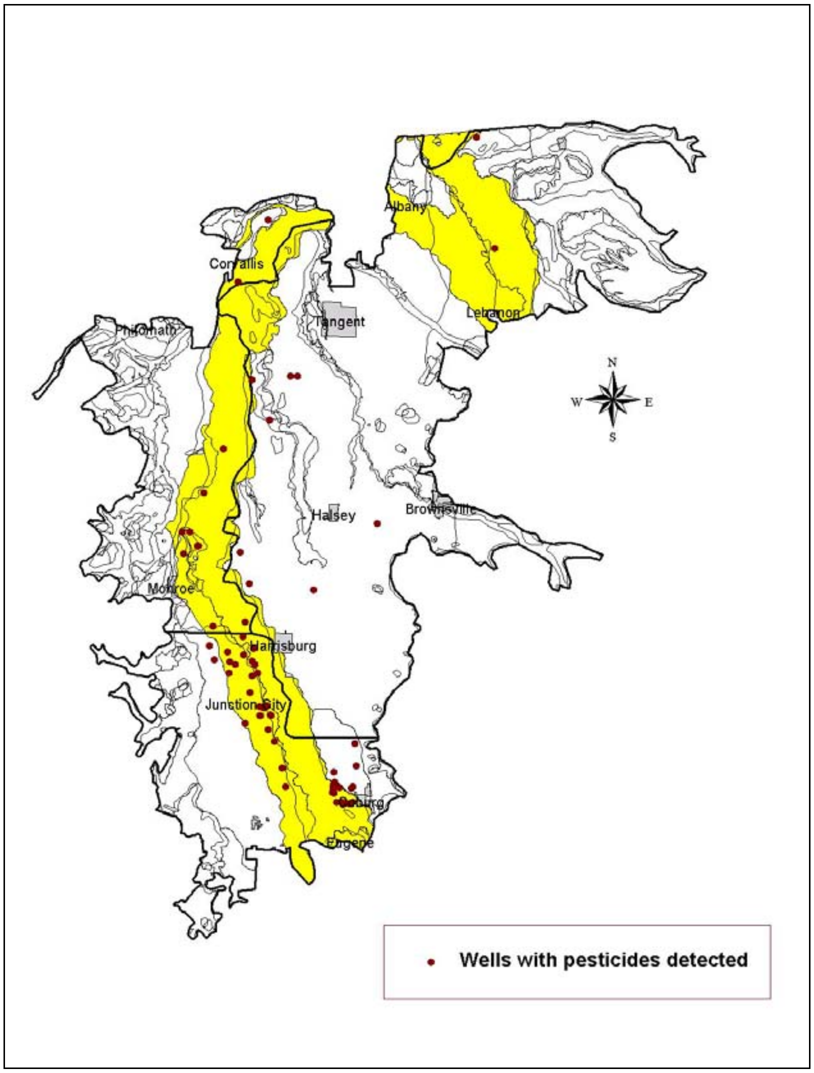

Figure 6

Locations where pesticides were detected in the 2002 sampling event, relative to the Upper Sedimentary Unit (Younger)

Most of the wells that had pesticide detections are located in or adjacent to the Upper Sedimentary Unit (Younger), the same location where many of the high nitrate values were noticed (see Figures 4 & 6). Samples for pesticides were collected from the 93 study wells that are disproportionately located in and near this sand and gravel unit, so the relative frequency of pesticide detections throughout the entire study area can not be evaluated. However, for the SWV study wells with nitrate greater than 7.0 mg/L, pesticides were detected 65% of the time.

Atrazine

The pesticide detected most frequently, atrazine, was never found at concentrations greater than 200 nanograms/Liter (ng/L), equivalent to 200 parts per trillion (ppt). EPA has determined that atrazine is a Class C substance, which is defined as a substance that is a possible human carcinogen, based on limited evidence of carcinogenicity in animals and the absence of such data in humans. The EPA atrazine MCL for public drinking water systems is 3 parts per billion (ppb).

Atrazine is a common herbicide used to control broadleaved and grassy weeds on agricultural fields, and near highways and railroads. After an application, atrazine could either be washed away from the soil by rainfall, or may seep through soil and enter the groundwater. Although the half-life of atrazine in surface water and wetlands may be relatively short (approximately 60-100 days) atrazine will persist for a significantly longer time in groundwater. Atrazine was the most frequently detected pesticide in public water systems, as reported in EPA' s November 1999 " A Review of Contaminant Occurrences in Public Drinking Water Supplies."

Atrazine was once one of the most heavily used pesticides in this study area. In the Southern Willamette Valley, the label for grass seed was withdrawn and grass-seed growers discontinued the use of atrazine sometime in the early 1990's 1. At the same time, atrazine use on SWV corn crops has decreased. Atrazine is still a viable product for grass seed fence rows and field borders.

Atrazine was detected in one-third (31 of 93) of the 2002 SWV sample locations. When USGS studied the shallow groundwater quality of the entire Willamette Basin (1993-1995), atrazine was found in 20 of the 69 groundwater samples, a 29% frequency.

Although detections of atrazine were similar between the USGS 1993-1995 study and this 2002 investigation, the ranges were quite different. USGS reported atrazine concentrations up to 890 ng/L, more than 4 times higher then the highest value found in the SWV 2002 study. This may be attributed to the different sampling locations (the entire Willamette Basin vs. the SWV), or may be the result of the decreased usage of this pesticide on the many grass fields in the study area.

Desethyl-atrazine

Although not a pesticide, desethyl-atrazine was present at higher concentrations than atrazine in all but four locations. Desethyl-atrazine was also the most frequently detected constituent measured by the pesticide analyses. Desethyl-atrazine is the primary breakdown product of atrazine. EPA does not have a MCL or health-based standard for desethyl-atrazine.

58% of the groundwater samples analyzed indicated the presence of desethyl-atrazine greater than the MRL; the highest concentration was 776 ng/L. This is in contrast to the range of concentrations reported by USGS of e4-e180 ng/L for desethyl-atrazine in their 1993-1995 groundwater study (e = estimated).

The ratio of atrazine to desethyl-atrazine ranged from 2.95 to 0.13 for those wells that had both constituents present. The median for this ratio was 0.40 and the average was 0.53. Although the USGS report did not provide ratios of atrazine to desethyl-atrazine, their report indicated that atrazine was detected 20 times, up to high value of 890 ng/L, while desethyl-atrazine was only detected 11 times with the highest value estimated to be 180 ng/L.

The dominance in frequency and quantity of the breakdown product may indicate that some of the atrazine, and thus some of the desethyl-atrazine, measured during the 2002 study may be more related to the historical usage of this product, rather than contemporary applications.

Simazine

Simazine was the third most frequently detected pesticide, present in 12 % of the samples. Simazine is also a Class C substance. The MCL for simazine is 4 ppt.

Simazine is used to control broadleaved weeds and annual grasses in field, berries, nuts, vegetables, turfgrass, orchards, and vineyards. It has also been used for nonselective weed control in industrial areas at application rates higher than those recommended for agricultural purposes. Prior to 1992, simazine was also used to control submerged weeds and algae in farm ponds and fish hatcheries.

Simazine is somewhat persistent in the soil, and some residual simazine may be present in the soil even a year after the initial application. If simazine seeps into groundwater it can remain there for as much as several years.

In all but one instance in this study, simazine was detected along with atrazine and/or desethyl-atrazine (See Figure 7). The maximum concentration of simazine reported was 239 ng/L, and the average concentration for those samples that contained simazine was 83 ng/L. The 1993-1995 USGS study reported simazine present in 6% of their samples (4 of 69) and in concentrations ranging from 12-44 ng/L.

Other Pesticides

With the exception of malathion and bisphenol-A, the other pesticides were detected 5 or less times during the 2002 study. Malathion and bisphenol-A were detected up to 10 times, but their existence may be questionable.

Malathion and bisphenol-A were detected at the same locations, and only in one general portion of the study area (Junction City). All samples with these compounds were collected by the same sampling team, during the same sampling event (May) and used containers from the same box lot and sampled with the same equipment. Not all samples collected in May by this team reported malathion and/or bisphenol-A.

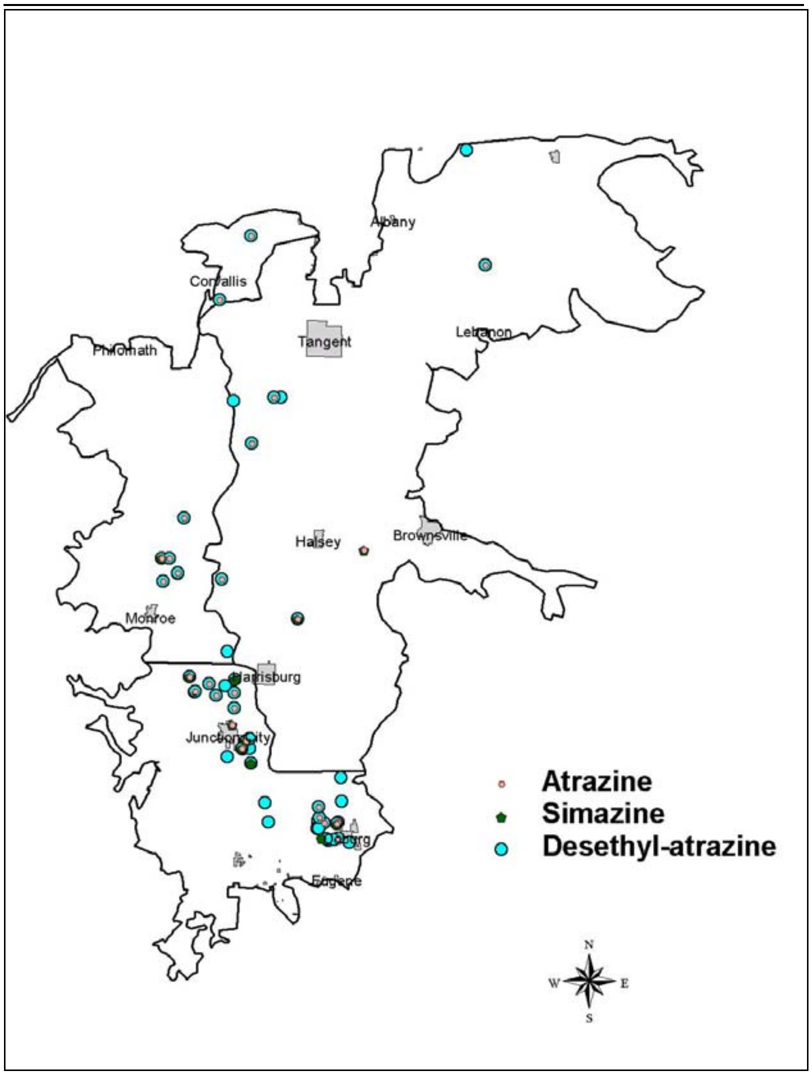

Figure 7

Locations of selected pesticide detections in the 2002 sampling event

Neither malathion nor bisphenol-A are expected to be present in study site groundwater. Malathion rapidly degrades in the environment, and bisphenol-A is a plasticizer which primarily has been detected in groundwater downgradient of landfills or other similar waste sites. There does not appear to be any identifiable laboratory contamination, and the field blanks do not help clarify this phenomenon. There is a chance that the samples or the sample containers became contaminated during the collection period, but this is speculation at this time. The results for malathion and bisphenol-A are suspect, and should be re-evaluated with the next pesticide sampling.

Caffeine

Caffeine was thought to be an appropriate indicator of groundwater impacts from septic systems due to the conservative nature of caffeine in wastewater and the environment. In addition, there is no widespread use of caffeine for agricultural purposes. Caffeine was only tentatively identified as present in one sample. The reporting limit for caffeine was 40 ng/L.

Caffeine may not have been detected during this study for many reasons: the groundwater near the study wells may not be impacted by septic systems; the homeowners may not drink caffeinated beverages; the reporting limit may have been too high; or the wells sampled may not have been downgradient of a septic system.

CONCLUSIONS

The nitrate data from this and previous Southern Willamette Valley studies provide documentation of a regional groundwater concern. Consistently, nitrate is present in the groundwater at concentrations greater than 7 mg/l. This effect is most noticeable in areas near the main stem of the Willamette River. This is also the same section that contains the most permeable and productive shallow aquifers of the area.

The pesticide data did not provide adequate information to characterize the entire study area. However, the results provided by the 2002 sampling allowed for reasoning that these compounds are not present at levels that are greater than EPA's advisory levels of MCLs. None of the pesticides detected during this study exceeded 50% of the MML, a criterion that must be met if pesticides are to be used as the tool for establishing a Groundwater Management Area.

The bacteria samples were qualitative, not quantitative, and did not provide overwhelming documentation of a widespread bacteria groundwater problem. It is more likely that few bacteria detections noted were due to localized situations.

The caffeine analyses were hopefully going to provide information of groundwater contamination due to septic systems releases. Unfortunately, there was almost no caffeine detected in any of the private water well samples. As was speculated in the previous chapter, there are many reasons why caffeine was not found in the samples. However, caffeine may still be an important compound when comparing chemical signatures of various sources. Future groundwater studies should continue the evaluation of the usefulness of caffeine as an indicator compound for septic system releases.

Only the nitrate data impart sufficient reason to declare a Groundwater Management Area for portions of the Southern Willamette Valley. A geological mapping undertaking should be completed to determine the appropriate boundaries of a future Groundwater Management Area. The focus for this mapping activity should include a detailed examination of the Upper Sedimentary Unit (both Younger and Older) and the thickness of the Willamette Silt to the east of the Willamette River. As some of the wells located in the Willamette Silt are associated with high nitrate values, there may be a minimum thickness of Willamette Silt that will act as a barrier to nitrate pollution of the groundwater.

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