WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

The Aquifer Vulnerability Project

Nooksack Pilot Study Report

June 1999

Publication No. 99-10

The Aquifer Vulnerability Project

Nooksack Pilot Study Report

Prepared by:
Laurie Morgan

Washington State Department of Ecology
Water Quality Program
Watershed Management Section
PO Box 47600
Olympia, WA 98504-7600

June 1999
Publication No. 99-10

Printed on Recycled Paper

For additional copies of this document contact:

Department of Ecology
Publications Distribution Center
P.O. Box 47600
Olympia, WA 98504-7600

Telephone: (360) 407-7472

Table Of Contents

List of Figures

LIST OF TABLES

Acknowledgements

We gratefully acknowledge the help of the following people in completing this report:

Lee Faulconer, Washington State Department of Agriculture, and Interagency Ground Water Committee, Aquifer Vulnerability Subcommittee Chair; Steve Saunders, Diane Dent-White, Kirk Cook, Mary Shaleen-Hansen, Melanie Kimsey, Dave Garland, David Misko, Annie Phillips, Kim RattlingTail Homan, Denis Erickson, John Tooley, Pat Holm, Ed Bentley, Ed Young, Charles Haworth, and Ed Alberto, Washington State Department of Ecology; Jim Ebbert, Stephanie Leisle, U.S.G.S.; Dan Francis, David Jennings, Ginny Stern, Washington State Department of Health; Scott Downey, EPA Region 10.

Disclaimer

The computer representation of data and maps has been compiled by the Washington State Department of Ecology Aquifer Vulnerability Project from sources which have supplied data or information that has not been verified by the Washington State Department of Ecology Aquifer Vulnerability Project. This data is offered here as a general representation only, and is not to be used for commercial purposes without verification by an independent professional qualified to verify such data or information. The Washington State Department of Ecology does not guarantee the accuracy, completeness,or timeliness of the information shown, and shall not be liable for any loss or injury resulting from reliance upon the information shown.

Preface

Aquifer vulnerability has been a topic of national concern for more than a decade. During this time, technology advancements have made the difficult process of analyzing data regarding aquifer vulnerability increasingly easier. More potential ground water pollution sources can now be located on a map using computer software. The ground water quality data collected by various agencies can be collated into a database and plotted on a map. The aquifers that are close to the ground surface without any overlying protective layers can be identified, along with soils that allow contaminants to easily pass through to ground water.

Thus it is possible to identify where ground water is most likely to be at risk. And, with more and more data automation, this information can be updated more easily than was ever possible before.

The Aquifer Vulnerability Project examined the Nooksack basin for ground water quality concerns across data sources, across Ecology programs, and across agencies. The data sources included thus far are the U.S. Geological Survey, the Washington State Department of Health, the Washington State Department of Ecology, and the National Resource Conservation Service. These sources were used because they are available statewide. Local information should be added into the knowledge base framework.

As agencies move towards a coordinated, organized method of cooperation, information that pertains to ground water will be much easier to obtain and use. Examples of progress in this area include steps the US Environmental Protection Agency, the US Geological Survey, the Department of Health and the Department of Ecology have taken to organize and automate their agency data, and make the data resource generally available.

Finally, it must be said that it is not enough for individual agencies to independently make data available. A concerted interagency effort is needed to guide how ground water data and knowledge can be used together for the public good. Public decisions about ground water protection that rely on data from various sources deserve to be guided by an organized, understandable framework that provides context, interpretation, and appropriate use guidelines. The agencies who generate the data and information are in the best position to guide users and provide context and meaning to the data. The Aquifer Vulnerability Project therefore recommends that a standard operating framework for ground water data and information be developed by the Interagency Ground Water Committee.

Abstract

The Aquifer Vulnerability Project piloted an approach to analyzing stresses on ground water quality in the Nooksack basin, located in Whatcom County, Washington. Ground water data was obtained from the Washington State Department of Health (DOH), the Washington State Department of Ecology, the National Resource Conservation Service, and the U.S. Geological Survey (USGS).

Data used for this report include potential ground water contamination sources, ground water quality sampling history, surficial aquifer characteristics, and soil properties. ArcView™, a Geographic Information System software program, was used to plot and analyze the data.

The surficial aquifers in the Nooksack basin are especially vulnerable to ground water contamination. The ground water quality sampling history clearly shows past ground water contamination from volatile organic compounds and nitrates. The contamination of the aquifer by pesticides has also been an ongoing concern.

The sampling history in this area of the USGS, DOH, and Ecology are available in a Microsoft Access™ database for the period of record up to 1997. The facilities that

Ecology regulates are plotted on maps, and can be updated through the Ecology Facility/Site database. The soils data help identify areas where recharge occurs most readily, and where soil properties that affect chemical fate and transport (such as organic matter content) are located. And the surficial aquifer characterization (Tooley, Erickson, 1997) provides valuable information about where the aquifer is located, the depth to water, and ground water flow direction.

Spatial analysis was used to compare where potential ground water pollution sources are located over the surficial aquifer and soils allowing ready infiltration. Spatial analysis was also used to query for dairies within a specified radius of an historic nitrate exceedence. A simple overlay query can be used to determine which facilities that Ecology regulates lie within a wellhead protection zone. And having the historical sampling record from USGS, DOH, and Ecology allows a comparison of the story each data set tells about ground water quality in the basin, especially with respect to nitrates.

Recommendations include suggestions for improvements in agency coordination, tracking of potential contamination sources (especially nonpoint), data interpretation guidelines, and development of hydrogeological information for the state. The report also discusses information about the data that the user should be aware of.

Executive Summary

The purpose of the Aquifer Vulnerability Project is to establish a methodology for determining areas of the state of Washington that are at risk for ground water pollution because of sensitive physical settings and the presence of potential ground water contamination sources.

Aquifer vulnerability analysis looks at where ground water pollution has been detected, where potential ground water pollution sources are located, and where these potential sources are located over sensitive physical conditions, such as shallow unconfined aquifers and soils that readily allow infiltration.

Data for the Aquifer Vulnerability Project was compiled in three Water Quality Management Areas (Figure 1) to support the Watershed Scoping process. The Nooksack Watershed was chosen for this report as a pilot area to complete the analysis because of sufficient existing data resources.

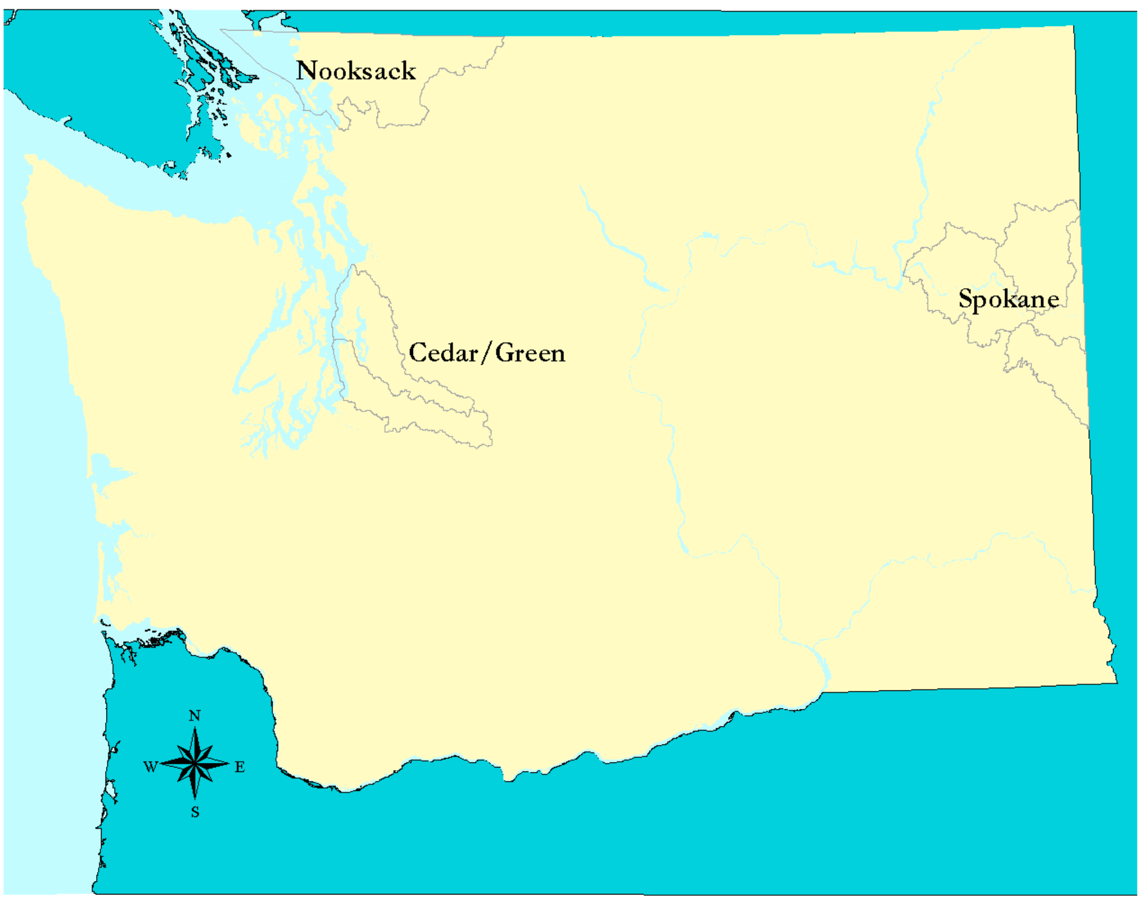


Figure 1: Aquifer Vulnerability Project Water Quality Management Areas

The Nooksack Watershed is located in Whatcom County, Washington. Ground water in the Nooksack resides largely in glacial deposits between the Cascade Mountains and the

Puget Sound. The hydrogeology of the watershed consists of unconfined shallow water table aquifers and deeper confined aquifers. More than half of all the wells considered in this report are completed in shallow ground water less than 100 feet deep, with most of these less than 50 feet deep

The combination of shallow unconfined ground water, tapped by the majority of wells, together with recharge directly from the ground surface, makes the Nooksack Basin particularly vulnerable to ground water pollution.

Ground water quality data for this report derives from sampling done by the United States Geological Survey (USGS), the Washington State Department of Health (DOH), and the Washington State Department of Ecology Environmental Assement Program, formerly the Environmental Investigations and Laboratory Section (EILS).

Surficial hydrogeology is incorporated from the Nooksack Watershed Surficial Aquifer Characterization (Tooley, Erickson, 1996), which also includes soils data provided by the National Resource Conservation Service (NRCS).

Potential contaminant source data is derived from Ecology's Facility/Site database, the Ecology Toxic Clean-up Program Site Information System (SIS) database, the Ecology Hazardous Waste Information Management System (HWIMSY) database, and the Ecology Water Quality Program Water Quality Permit Life Cycle System (WPLCS).

The results of the Aquifer Vulnerability Project spatial analysis show areas where anthropogenic impacts have occurred to ground water, and where there is a risk of further impacts from potential sources (Appendix E).

The Aquifer Vulnerability Project demonstrates how data from various sources can be combined to describe conditions and identify ground water quality stressors in a watershed. An automated process that links ground water quality data analysis for a basin to the data sources themselves should be established to provide an ongoing, up-to-date view that supports and helps refine regulatory activities.

Physical Setting

The Nooksack watershed occupies a large part of Whatcom County and consists of floodplains, low hills, valleys, and mountainous areas. The watershed is bounded on the north by the Canadian border, the east by the Skagit Range of the Cascades, the south by the Skagit river basin, and on the west by the Georgia Straits (Figure 2).

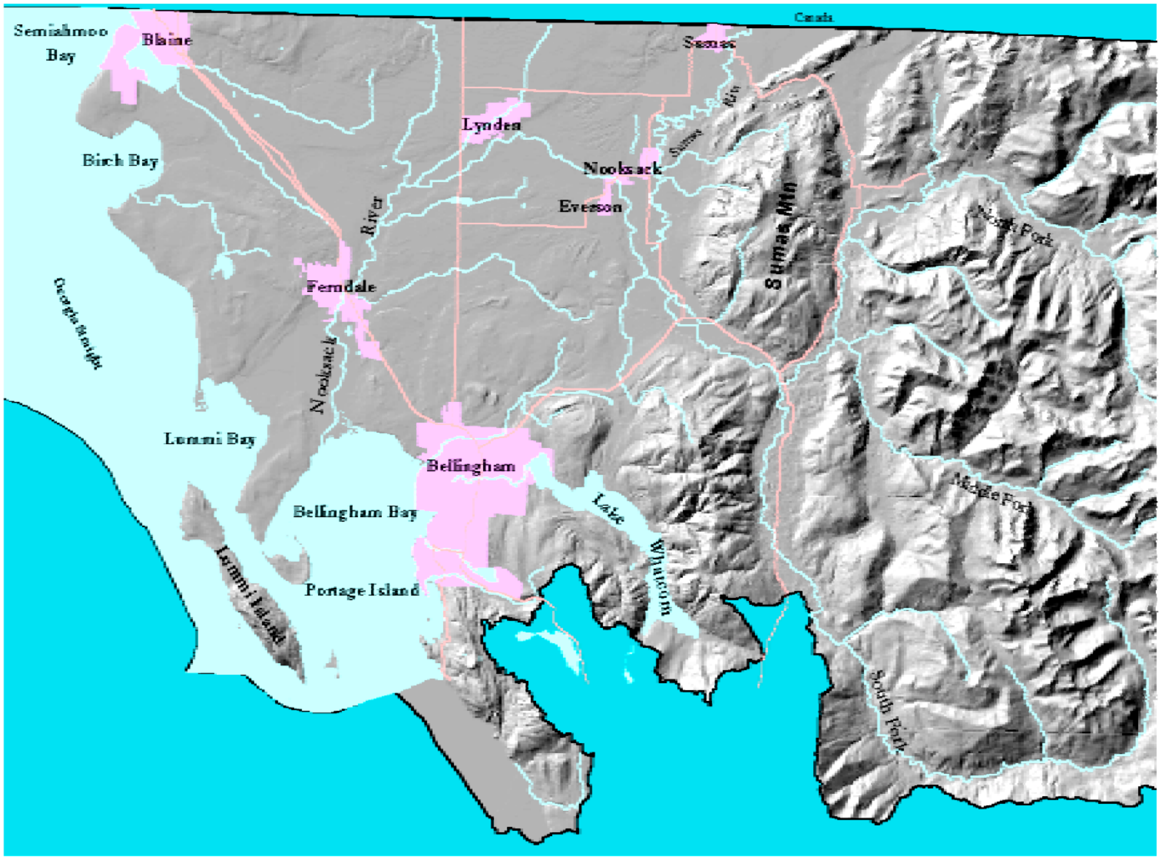


Figure 2: The Western Nooksack Watershed

Surficial Hydrogeology

Aquifers are particularly susceptible to contamination when they are shallow and unconfined. In order to define shallow unconfined aquifers in the Nooksack, Denis Erickson and John Tooley completed the Nooksack Watershed Surficial Aquifer Characterization (Erickson, Tooley, 1997).

Erickson and Tooley delineated the following surficial aquifers: Sumas-Blaine, Upper Valley, and Discontinuous. Figure 3 shows the areal extent of these units, along with areas where a surficial aquifer is not present.

The main aquifer, the Sumas-Blaine aquifer, is also called the Abbotsford-Sumas aquifer, because it extends into an area of Canada where the town of Abbotsford is located. The Abbotsford-Sumas Aquifer International Task Force has produced an Interim Status Report about the aquifer that includes hydrogeology, land use, health concerns, data sources, and education and outreach (Abbotsford-Sumas International Task Force, 1993).

In addition, the USGS is producing a report called the LENS study (after the towns in the study area of Lynden, Everson, Nooksack, Sumas), in cooperation with Whatcom County Planning Department under a Centennial Clean Water Grant administered by the Department of Ecology. The LENS study focuses on hydrogeology of the Abbotsford-Sumas aquifer and nitrates (Cox, Kahle, 1993).

The hydrogeological system of the Nooksack is dominated by glacial deposits and alluvial reworking of these deposits. The two main river systems are the Sumas and Nooksack. The main aquifer is the Abbotsford-Sumas Aquifer, which lies in the north central part of Whatcom County, and consists largely of the highly permeable Sumas Outwash deposits. These deposits rest in most places on older deposits of less permeable glaciomarine silt and bedrock (Cox, Kahle, 1993).

Following are descriptions of the aquifers from the Nooksack Watershed Surficial Aquifer Characterization report (Tooley, Erickson, 1997):

> The Sumas-Blaine Aquifer occupies an area of about 150 square miles between the towns of Sumas, Blaine, Ferndale, and the Nooksack River floodplain. The aquifer consists of glacial outwash and alluvial deposits. The water table is typically less than 10 feet.
>
> The Upper Valley Aquifers are located along the North, Middle, and South Forks of the Nooksack River. These aquifers consist of interlayered gravel, sand, silt, and clay deposited on the river valley floor. They are flanked along the valley walls by glacio-fluvial and outwash terrace deposits.
>
> The local discontinuous surficial aquifers are found at various locations in the western half of the Nooksack watershed. The largest of these are south of Ferndale, east of Blaine, across the bay southwest of Blaine, and east of Sumas. These aquifers are usually thin and not a major source of water. The lateral boundaries are based solely on parent associations of soils, due to lack of sufficient well data.

Table 1: Number of Wells with Given Depths in Feet from DOH, EILS and USGS Data

Data Source	<= 50	50 to 100	> 100	Total
DOH*	124	57	94	275
EILS	27	0	0	27
USGS	81	13	1	94

*Only includes DOH wells for which a location was available.

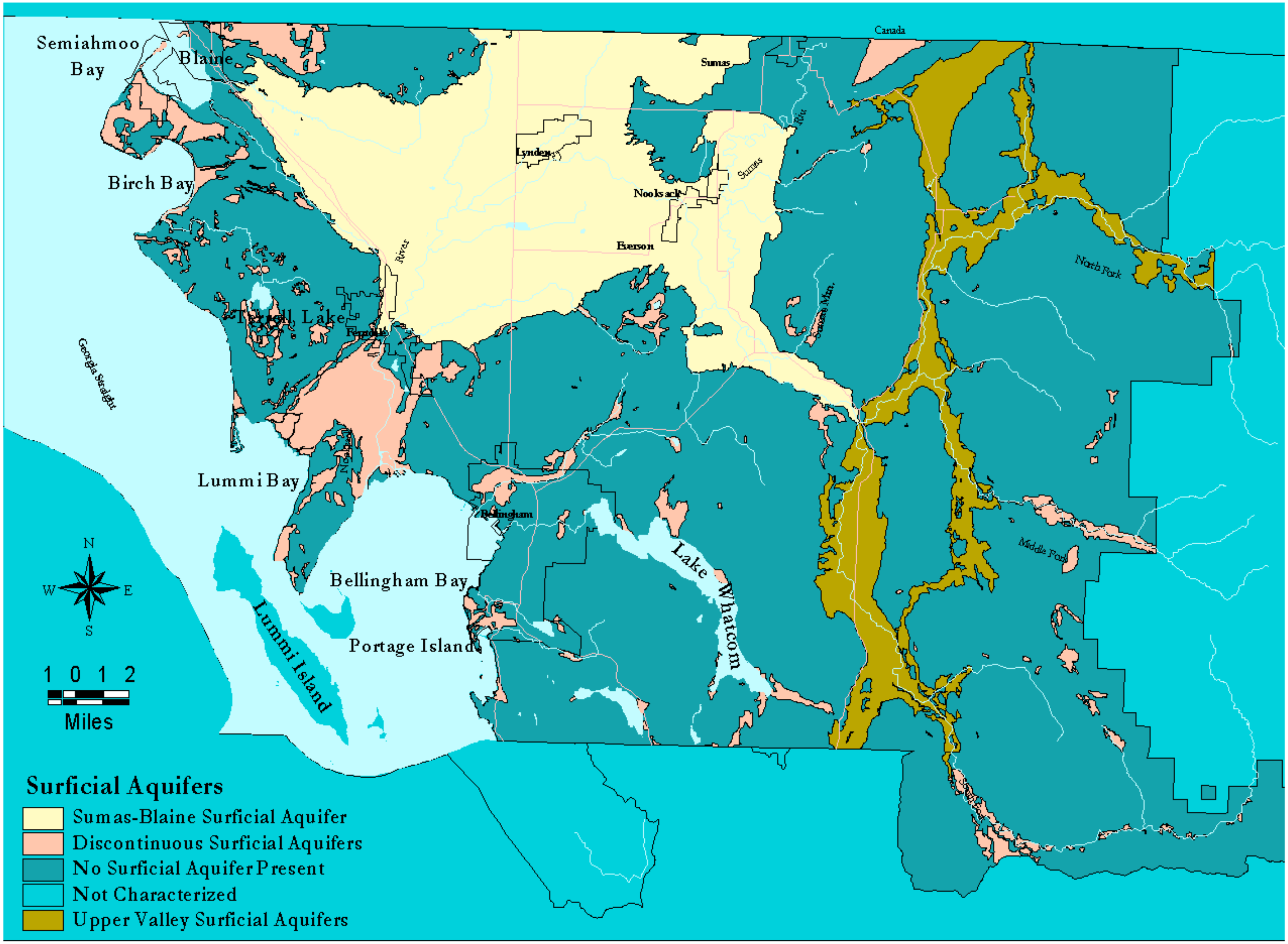


Figure 3: Nooksack Surficial Aquifers

Soils

Soils properties that are important in determining aquifer vulnerability relate to how well recharge can pass through the surface soils to the vadose zone and ultimately to the aquifer, and how the chemistry of the soils react with contaminants carried by the recharge. These soil properties are available from the NRCS database for county soil survey data, and have been made available to Ecology for the Nooksack watershed for the Surficial Aquifer Characterization.

Tooley and Erickson (1997) provide the following list of soil properties as important in an aquifer vulnerability analysis, due to their effect on recharge capacity and chemical fate and transport:

- Surface soil texture
- Soil permeability rate, inches per hour
- Water-table depth at the seasonal high water table
- Hydrologic group
- Soil drainage
- Minimum organic content, percent by weight
- Soil pH
- Cation exchange capacity
- Soil texture class
- Clay content, percent < 2 mm
- Unified soil classification
- Depth of upper boundary of the cemented pan, inches
- Cemented pan thickness

Appendix A contains ArcView plots of most of the above-listed soil properties. The plots of soils data clearly delineate parent associations of soils, especially the peat bogs, fluvial deposits/reworkings of glacial deposits, and some glacial features.

Soil characteristics affect recharge capability and contaminant chemical fate. Soil pH, organic matter content, cation exchange capacity, and clay content are soil properties that affect chemical fate. Hydrologic group, soil drainage, soil texture, and soil permeability affect the amount of recharge that passes through the soils, instead of running off.

Ground Water Quality

Ground water quality data from DOH, EILS, and USGS was obtained in 1997 for all sampling for the period of record. This data was loaded into an Access Database, and location coordinates were linked from GIS coverages to the data.

A series of plots of ground water concentration of arsenic, BTEX (benzene, toluene, ethylbenzene, xylene), volatile organic compounds, nitrates, and synthetic organic compounds were produced from this data and are presented in Appendix B. The plots show the maximum found at the well for the entire period of record up to the ending date, and ***therefore do not show existing water quality at a well now.*** The objective of these plots is to show where detections of ground water pollutants have occurred in the past, because those locations are vulnerable to ongoing stresses from human activities.

A list of parameters and a statistical summary of sampling results (maximum, minimum, average, standard deviation, number of times sampled) is in Appendix C.

The following tables describe the number of wells sampled and the number of samplings. The heading entitled "Number of Well Sample Visits" counts the unique combinations of well ID and sample date to count the number of samplings. Department of Health groundwater sampling locations without x-y coordinates are not included.

Table 2: Number of Wells Sampled by Agency in Whatcom County

Data Source	Period of Record	Number of Wells Sampled	Number of Well Sample Visits
DOH	11/75 to 3/97	444	1834
EILS	8/88 to 5/89	27	43
EILS*	1997	250	250
USGS	8/47 to 8/96	519	1028

*1997 Nitrate Sampling by Denis Erickson, EILS Program, Ecology

Table 3: DOH, EILS, and USGS Well Sample Visits by Year

Data Source	Year	Number of Well Sample Visits	Data Source	Year	Number of Well Sample Visits
DOH	1975	17	USGS	1948	4
DOH	1977	5	USGS	1949	2
DOH	1978	5	USGS	1956	7
DOH	1979	7	USGS	1958	1
DOH	1980	3	USGS	1959	2
DOH	1981	12	USGS	1960	19
DOH	1982	32	USGS	1962	4
DOH	1983	22	USGS	1965	1
DOH	1984	31	USGS	1966	2
DOH	1985	34	USGS	1967	1
DOH	1986	21	USGS	1968	55
DOH	1987	32	USGS	1969	2
DOH	1988	46	USGS	1970	2
DOH	1989	54	USGS	1971	58
DOH	1990	46	USGS	1972	80
DOH	1991	116	USGS	1973	14
DOH	1992	109	USGS	1974	10
DOH	1993	151	USGS	1978	38
DOH	1994	137	USGS	1981	7
DOH	1995	123	USGS	1990	309
DOH	1996	80	USGS	1991	313
DOH	1997	1	USGS	1992	2
EILS	1988	28	USGS	1993	3
EILS	1989	15	USGS	1994	36
*EILS	1997	250	USGS	1995	51
USGS	1947	1	USGS	1996	4

Department of Health groundwater sampling locations without x-y coordinates are not included. *EILS 1997 nitrate sampling round.

Table 4: Ground Water Quality Summary

Parameter Class	Lab Qualifier	DOH	EILS*	USGS	Total
Arsenic	D	40	1	6	47
	LT	147		16	163
	ND	10	1		11
	B		4		4
BTEX	D	3			3
	LT			17	17
	ND	135			135
Nitrates	D	180	(237*) 26	281	487
(See Note 10)	LT	61		108	169
	ND	10	(13*) 1		11
VOC/SOC	D	4	12	6	22
	E			2	2
	LT			29	29
	ND	144	15		159

Notes:

1. *EILS 1997 nitrate sampling round counts are in parentheses.
2. DOH: Washington State Department of Health
3. EILS: Washington State Department of Ecology, Environmental Investigations and Laboratory Section.
4. USGS: United States Geological Survey
5. BTEX: Benzene, Toluene, Ethylbenzene, and Xylene. This data is a subset of the VOC/SOC data.
6. VOC/SOC: Volatile/Synthetic Organic Compounds
7. D - Detect; E – Estimate; LT – Less Than; ND - Non-Detect; B – Compound Detected in Method Blank; NA – Not Analyzed.
8. DOH data only includes those wells that have an xy location.
9. Wells with multiple lab qualifiers (D, ND, etc.) are counted in the following order: D, E, LT, ND, B. Hence, a well with nine ND's and one D, would be counted once as a D. A well with a LT and a ND would be counted once under LT. ND's are a count of wells that have never had any D, E, or LT sample results. This makes sense if you are most interested in where pollutants have been detected, and where they have not been detected, though sampled.
10. Whether nitrates are detected or not is not so significant compared to whether the concentration in ground water is likely to approach or exceed 10 Mg/L, the health standard. See Table 5.

Table 5: Summary of Maximum Nitrate Detects per Well, Mg/L

Data Source	>= 0 and <= 5	> 5 and <= 10	> 10	Total
DOH	128	32	20	180
EILS	10	7	9	26
EILS[2]	144	41	53	250
USGS	188	50	43	281
Total	470	130	125	737

1. See Notes 1, 2, 3, 7, and 8 under Table 4.
2. EILS sampling round by Denis Erickson in 1997.

Potential Ground Water Pollution Sources

The Department of Ecology regulates potential ground water pollution sources according to a framework of laws and regulations that have come into existence over time to address different problems.

The following is a list of types of activities and regulated facilities:

Hazardous Waste and Toxics Reduction Program
Hazardous Waste Generators
Hazardous Waste Treatment, Storage, or Disposal Facilities
RCRA Corrective Action or Closure Sites

Toxics Clean-up Program
Toxic Clean-up Sites
Leaking Underground Storage Tanks

Solid Waste Program
Solid Waste Landfills

Water Quality Program
Animal Manure Waste
Municipal Waste
Food Processing Waste
Septic Tanks (>14,500 gallons per day flow design)
Underground Injection Control
Sand and Gravel
Agricultural Processing Waste
Water Treatment Plant Waste

These facility locations are contained in the Ecology Facility/Site Database. ArcView maps of these facility locations by category are contained in Appendix D.

Nonpoint Sources

Nonpoint sources of ground water pollution typically include applications of pesticides and fertilizer, septic waste, land application of municipal or animal waste, and stormwater infiltration.

Geographical data for nonpoint sources is more difficult to obtain than data for point sources. Land use may have such designations as urban, forest, or agricultural (Appendix D - Figure 38), but the crops grown, the amount of fertilizers and pesticides applied, and the location of applications is difficult to obtain.

Septic system locations are not available for many Washington counties, including Whatcom County. Some counties have septic system locations mapped to land parcel information.

Locations of Confined Animal Feeding Operations (CAFO's), such as beef cattle, poultry, and hog lots, are not easily available yet. However, for dairies, a cooperative effort by several agencies produced the statewide dairy GIS cover in 1995, updated in 1996. These are locations of dairies obtained by address matching, and so there are probable and known inaccuracies, and the locations do not necessarily correspond to where dairy waste is being applied. A 1997 updated dairy cover for the Nooksack has been made available.

The locational information provided, along with an estimate of number of cows based on raw milk production, is valuable for providing an overview of dairies in the watershed. It is easy to see, for example (Appendix D - Figure 37), that the dairies are mostly located over the Sumas-Blaine Surficial Aquifer, where there are known persistent elevated nitrates in ground water above health limits.

Agricultural applications of pesticide and fertilizer are exempt from Water Quality regulations unless the application results in the transport of a regulated substance below the root zone (Washington Administrative Code, WAC 173-200-010 (3)(a)). The Model Toxics Control Act (MTCA) exempts application of pesticides and fertilizers on food crops, providing all applicable laws and regulations are followed (Revised Code of Washington, RCW 70.105D.040 (3) (d). After a discharge has proceeded below the root zone, it is regulated under the Ground Water Quality Standards, unless there is a cleanup action under MTCA at the site (WAC 173-200-010 (3)(c)).

Septic waste is regulated according to flow design in gallons per day (WAC 246-272-03001).

Table 6: Authorities for Regulating Septic Systems Based on Flow Design in Gallons per Day

WA Dept. of Ecology	WA Dept. of Health	Local Health Departments
>14,500	3,500 to 14,500	<= 3,500

Septic system density and local soil, vadose, and ground water conditions determine if a ground water impact is likely to occur.

Land application is regulated by Ecology’s Water Quality Program under the State Waste to Ground Discharge permit. Land application site locations are currently recorded as a point (not an area) in the WPLCS database and in Ecology’s Facility/Site database.

Storm water infiltration is regulated under the Underground Injection Control Program, which is delegated to the Department of Ecology by the US Environmental Protection Agency (EPA). Dry wells are typical stormwater infiltration conduits. Underground Injection Control (UIC) wells can be located to the nearest township, range, section, quarter-quarter, as soon as the UIC database is updated.

Aquifer Vulnerability Analysis

Known Impacts

Aquifer vulnerability assessments seek to determine both where the physical setting is conducive to contamination of ground water, and where potential contaminant loading exists. Detections of anthropogenic chemicals at wells are evidence that human activity at the land surface has resulted in ground water contamination.

The figures in Appendix B show where human activities have resulted in chemical breakthrough to ground water in terms of where contaminants have been detected at a well.

In Whatcom County, it is abundantly evident from the ground water sampling data from the USGS, DOH, and EILS (Appendix B), as well as data from toxic cleanup sites (Appendix D), that there have been ongoing anthropogenic stresses on the Sumas-Blaine Aquifer (Appendix E, Figure 42). Ground water pollutants detected in wells include volatile organic compounds, pesticides, nitrates, petroleum hydrocarbons, and priority pollutant metals. Arsenic, a naturally occurring toxic compound, has been detected in wells also.

Toxic clean-up sites that are confirmed or suspected ground water pollution sources are spread throughout the watershed (Appendix D).

Potential ground water pollution point sources tracked in Ecology’s Facility/Site database tend to cluster around Bellingham, Blaine, Ferndale, Lynden, Sumas, and Nooksack, with a few clustered sources outside of these areas (Appendix D, Figure 36).

Multiple nonpoint sources, such as fertilizers, septic systems, land application of waste, and dairy discharge are probable causes of the ongoing nitrate contamination of the Sumas-Blaine surficial aquifer. However, dairies located over the Sumas-Blaine aquifer (Appendix D, Figure 37) seems to be the major nitrate source (Erickson, 1998).

Spatial Analysis

Aquifer vulnerability analysis must consist of a thorough understanding of a watershed's hydrogeological systems, surface conditions, potential contaminant sources, and state of ground water quality, taken together. Spatial comparison can then be used to examine the relationship between potential contaminant sources, physical conditions and known ground water problems.

The following are examples of spatial analysis of aquifer vulnerability data. The figures themselves are presented in Appendix E, and are the result of using ArcView and the ArcView Spatial Analyst extension to spatially query the data described in this report:

- Figure 39: Potential ground water pollution sources that overlie a surficial aquifer and soils that are classified as Hydrologic Group A or B (through which recharge infiltrates more easily than soils that are classified Hydrologic Group C or D).

- Figure 41: Potential ground water pollution sources that are within wellhead protection zones, with Critical Aquifer Recharge Areas shown (CARA's).

- Figure 42: Where ground water stresses exist for volatile organic compounds, nitrates, and pesticides as shown by previous detections in ground water samples, or the presence of a clean-up site.

- Figure 43: Lynden, Everson, Nooksack, Sumas (LENS) area close-up of where ground water stresses exist for volatile organic compounds, nitrates, and pesticides as shown by previous detections in ground water samples, or the presence of a clean-up site.

- Figure 44: Ground Water Management Areas, Wellhead Protection Zones, and Potential Ground Water Pollution Sources.

- Figure 45: Dairies within 2 miles of a well with an historical maximum nitrate level of 10 Mg/L or more.

Aquifer vulnerability analysis also reveals information gaps. For example, while regulating dairies is critical for decreasing nitrate loading to ground water, other potential sources that also contribute to nitrate loading should be addressed, but we do not have enough spatial information about these other potential sources.

Potential sources not currently mapped in GIS in the Nooksack include fertilizer application areas and septic system locations. It has also been suggested (Erickson, 1998) that converting land use to raspberry farms in Whatcom County may have a significant effect on nitrate loading, but we do not have maps of raspberry farm locations, nor an estimate of the nitrate loading effects of raspberry farms. Therefore, it is difficult to assess the effect of these potential sources on the nitrate problem in the Nooksack. The evaluation of the effectiveness of regulatory/outreach activities is made more difficult by not being able to track potential contributions to the problem.

Data Discussion

The following is a discussion of information the user needs to be aware of, with regard to the data used in this report.

The ground water quality data has been compiled from sampling done for varied purposes. This means that the story the data has to tell is highly dependant on the sampling designs. The extent of where contaminants are found in ground water depends on where the sample locations were chosen, and what parameters were found depends on what parameters were sampled for.

The detection limit is not included in the supporting databases for this project, nor are they considered in the report. The detection limit could be used in screening data for whether the lab result of ‘not detected’ was reasonable. As detection limits become lower over time, compounds are detected in ground water, where previously they would have been reported as ‘not detected’.

DOH, EILS and USGS may have sampled some of the same wells, but since they have different location methods, the wells that overlap would appear more than once, if they were to be included on the same plot. The overlap cannot be resolved until each well is identified with a unique well identifier, and each agency cross-references the unique well identifier with data in its database. This is not an impediment to aquifer vulnerability analysis, since we are interested in locating areas where ground water pollution from man-made sources has occurred, and an offset on the scale of interest does not visibly change the result. At a very close scale, the least accurate locations would be the DOH wells, since they are located at the center of the quarter-quarter, section, township and range reported for each well. It could therefore appear on a map that a well is in a lake or Puget Sound, when their actual location is on-shore.

The data compilation for this report was completed, for the most part, in 1997. Since then, more sampling has probably taken place. Some of the businesses shown as potential ground water contamination sources may have gone out of business, and others may have arrived. The volume and kind of potential contaminants changes constantly. A data compilation such as this one is a snapshot of conditions at a point in time. The difference for this study, however, is that with continually developing technology, we have an opportunity to establish data links that regularly update this information. The user should keep the time element in mind, however, when examining the data in this report.

For example, Figure 45, Appendix E, shows dairies located within two miles of an historic nitrate concentration of 10 Mg/L or greater. This does not necessarily mean that dairies in proximity to these wells caused the impact, although it is possible that some of them could have. It does mean, however, that dairies in such a sensitive impacted area need to be managed carefully to avoid further impacts.

The Department of Health data samples are not straightforward to interpret. Samples may be from wells, wells in well fields, well fields, or springs. Samples may be taken before or after treatment, at the source, or at the tap. One should avoid using metals data from samples taken at the tap, due to influence from water system piping, for example. In this report, Department of Health metals are not included in the anthropogenic ground water quality stress analysis, although some priority pollutant metals from EILS and USGS sampling are.

As noted previously, tracking of all potential ground water pollution sources is not complete, particularly with regard to nonpoint sources. Potentially hazardous materials that are used but do not generate a waste are also not included. However, there exists a potential to spill material wherever it is used.

Potential ground water pollution sources that are not tracked in the Facility/Site database include agricultural/non-agricultural fertilizer/pesticide application areas, septic systems, dairies, other animal operations, and underground injection control wells (dry wells).

Of these, there is a GIS cover for dairies (1996), and one for land use (1970's) which includes general categories of urban and agricultural land use.   Also, the Washington State Gap Analysis produced a GIS cover from satellite images that includes land use. There is also an updated (1992) land use map for the Puget Sound region, but it does not extend to Whatcom County.

The statewide dairy layer compiled in 1995 and updated in 1996 has errors and omissions. The locations are based on address matching, which may be the office, and not necessarily the farm. This information is being updated as dairy inspections proceed, which will improve the data. For the Nooksack, there is already an updated 1997 dairy layer.

There is a tracking database for UIC's, with locations to township, range, section, quarter-quarter in the process of being upgraded. A pilot UIC GIS cover that locates UIC wells in the center of the quarter-quarter was completed by the Aquifer Vulnerability Project. The process should be re-run after the UIC database upgrade.

Regulatory Roles

Entities with an interest in controlling ground water pollution include local government; private persons; citizen groups; EPA; Washington Department of Ecology Toxic Clean-up Program, Hazardous Waste Program, Water Quality Program, Industrial Section (a cross-program permitting unit), and the State Environmental Protection Act (SEPA) unit; the Washington Department of Agriculture; Whatcom County Planning Department, and Whatcom County Health Department. The USGS is not a regulatory agency, but is extremely important in the advancement of knowledge about ground water resources in the State of Washington. Similarly, the NRCS, Washington Cooperative Extension, and Washington universities have advisory and educational roles.

Ground Water Management Areas provide a structure for various interests to work on ground water issues together.

Ecology's Bellingham Field Office carries out regulatory activities in the Nooksack Watershed, and coordinates with local, county, state, and federal entities.

In addition, the Abbotsford-Sumas International Task Force meets to discuss the nitrate in ground water problem, and includes representatives from state, local, federal, and Canadian government.

The Conservation Districts have a supportive and educational role to promote agricultural Best Management Practices (BMP's) that lessen pollution. Ecology has an agreement with the Conservation Districts that refers agricultural operators whose activities are harming human health or the environment to Ecology when they fail to cooperate with the Conservation District.

The Washington State Department of Health (DOH) is responsible for implementing the Safe Drinking Water Act, which includes source water protection. Through the DOH Wellhead Protection Program, Wellhead Protection Zones are delineated by water purveyors. Wellhead contaminant inventories completed by water purveyors within the wellhead protection zones include activities regulated by federal, state, or local government. If there is a ground water contaminant problem at a well, well purveyors or well owners must turn to regulatory authorities to mitigate the problem. Therefore, a coordinated approach to ground water quality in a geographical area is extremely important to prevent ground water drinking water source contamination.

Conclusions

The ground water quality data presented in this report gives a history of sampling in the basin for DOH, EILS, and USGS. Combining ground water quality data sets enables the determination of who has sampled, what they have sampled for, what was found, and where the sampling points are located.

Potential ground water contamination source data gives an eagle's eye view of the basin from the standpoint of potential or existing stresses on ground water quality.

The surficial hydrogeology characterization and soils data allows for determining where sensitive natural physical conditions contribute to ground water quality stresses, given a pollution source.

The analysis of these three data sets together provides a more comprehensive picture of aquifer vulnerability that considers both pollution sources and the natural physical setting.

Recommendations

The agencies responsible for the data used in this report should enter into a cooperative effort to make the compilation of the data for any given Washington state watershed or county available in an easy form for ground water stress/aquifer vulnerability analysis.

The agencies should provide interpretation guidelines for the data and information they produce that could be used in such analysis.

The agencies should also play an active role in examining the data and analyses, and providing interpretive information and suggestions, especially since the roles played by each agency are interactive with the others with respect to ground water.

Specifically, a concerted cooperative effort to provide hydrogeological characterization for the state of Washington should be made. Already, the Department of Natural Resources has produced GIS covers for the geology of some areas of the state, and is working on more. The USGS has produced hydrogeological data, information, and analyses as part of the National Water Quality Assessment (NAWQA) studies in the Puget Sound Region and the Columbia Basin, the Regional Aquifer System Analysis (RASA) in the same areas, and cooperative studies in several counties. Local government and Ground Water Management Areas have also done hydrogeological studies. Moreover, Ecology has done studies in several areas of the state. This information needs to be compiled and reconciled so that a statewide coverage of important hydrogeological attributes of the state can be produced.

An ambient monitoring program for ground water is needed. Efforts to produce hydrogeological characterization for the state, and a sense of sampling history and potential ground water contamination stresses would aid in planning such an effort.

Ecology should set up direct links to Ecology databases that provide data and information for ground water stress/aquifer vulnerability analysis. These include Ecology's Hazardous Waste Information Management System (HWIMSY), Water Quality Permit Life Cycle System (WPLCS), and the Toxic Cleanup Program Site Information System (SIS).

The Standard Industrial Code (SIC) could be used to estimate the chemicals of concern associated with a regulated site in Ecology's Facility/Site database.

Programming support is needed to provide consistent structure and documentation to the analysis databases, to set up the aforementioned links, and to help make both the data and the analysis products available through the Internet. Programming support would help ensure that the data used in analysis of ground water stresses would be continually updated, by providing set links to data sources, so that the best and most recent data is used in making decisions.

Other data from local Ground Water Management Areas or from grant funded activities should be incorporated into this analysis. This would be easier if the local data could be submitted to Ecology in a form that is compatible with the Environmental Information Management System (EIM), currently in development and use at Ecology.

Detection limits should be included in the supporting databases and future reports, along with other information about wells and samples that may be recommended by the Aquifer Vulnerability Subcommittee of the Interagency Ground Water Committee and other interested parties as a result of review of this report.

Regulatory data should be used in conjunction with environmental data. Thus, you could compare the location of facilities that are out of compliance with areas that have already been impacted by pollutants, and with areas that are sensitive to discharges.

Aquifer vulnerability data should be used to support local ground water strategies to achieve the most valuable results for the efforts made to protect ground water resources.

Aquifer vulnerability data may be used to help identify where potential sources of ground water contamination should be tightly controlled, and where inspections and clean-ups should be targeted to relieve ground water quality stresses. Permits for discharge or locating a potential source in such an area should be appropriately conditioned or restricted.

Regulatory, educational, and outreach resources assigned to ground water protection should be prioritized by threat to ground water as a drinking water source. If a wellhead is threatened by contaminant loading, those sources should be identified and regulated until they cease to pollute ground water.

Where ground water proves to be a significant contributor, analysis and control of pollutant loading sources to ground water that contributes to lake or stream water quality impairment should be done in conjunction with surface water pollution loading estimates.

Evaluation of the effect of multiple loading sources over an aquifer should be used to inform the regulatory process.

Nitrate loading sources such as fertilizer applications, septic tank loading, and animal operations should be tracked where there is known nitrate contamination of ground water that is a threat to public health.

Pesticide loading sources, both agricultural and non-agricultural, should be tracked where there is known pesticide contamination of ground water. The reporting system that now exists makes it difficult to know what chemicals are applied to land, where, and how much. There needs to be a better regulatory mechanism for tracking pesticide use, and for controlling pesticide applications in areas where pesticides in ground water have been detected.

All chemical ingredients in pesticides should be clearly labeled, including so-called "inert" ingredients.

Areas where pesticides have migrated below the root zone, and which therefore are not exempt from regulation, need to be addressed in accordance with the ground water quality standards and the Model Toxics Control Act, as appropriate.

Areas where fertilization of crops results in the migration of nitrates below the root zone similarly need to be addressed in accordance with the ground water quality standards.

Plumes of toxic contaminants in ground water, or soil contamination that could pollute ground water at toxic clean-up sites should be mapped and kept updated. The pollutants, extent of contamination, and general level of concentrations should be included, along with a summary about the pollution problem and clean-up plans.

Coordination between the Department of Ecology and Department of Health needs to be vigorous in the area of source water protection/wellhead protection. While well purveyors are inventorying potential contaminant sources within wellhead protection zones, Ecology has regulatory responsibility for these potential sources. This potentially builds expectations on the part of well purveyors and the public that Ecology will protect their drinking water supply by strictly regulating potential contaminant sources. A local/state/federal coordinated prioritization process is needed.

It would be extremely useful to obtain a detailed report from the Department of Health that describes the strengths and weaknesses of public water supply well data.

Multiple locations for the same well from different databases should be resolved through an ongoing commitment to tag wells with a unique well identifier. The unique well identifier should be cross-referenced to existing data in each database to the extent possible. A fund to encourage well tagging whenever a sampling is done at a well would make it easier to have materials and training available when opportunities to tag wells occur.

Training of Ecology ground water staff to make use of aquifer vulnerability databases and GIS covers would increase the usefulness of the project.

An Aquifer Vulnerability Project budget for training, travel, conferences, and material acquisition (especially publications, programming support, and certain software upgrades) should be funded.

References

Abbotsford-Sumas Aquifer International Task Force, 1993. Interim Status Report.

Cox, S. and S. Kahle, 1993. Hydrology and Water Quality in Lowland Glacial Aquifers of Whatcom County, Washington and British Columbia, Canada. Draft US Geological Survey Water-Resources Investigations Report in LENS Groundwater Study by Whatcom County, Final Report, December 15, 1993.

Erickson, D., 1998. Sumas-Blaine Surficial Aquifer Nitrate Characterization. Washington State Department of Ecology Report No. 98-310, 27 p. and appendices.

Tooley, J.E. and D. Erickson, 1997. Nooksack Watershed Surficial Aquifer Characterization. Washington State Department of Ecology Report No. 96-311, 12 p.

Appendix A

National Resource Conservation Service Soils Data With Importance for Aquifer Vulnerability

ArcView Plots by Laurie Morgan
July 1998

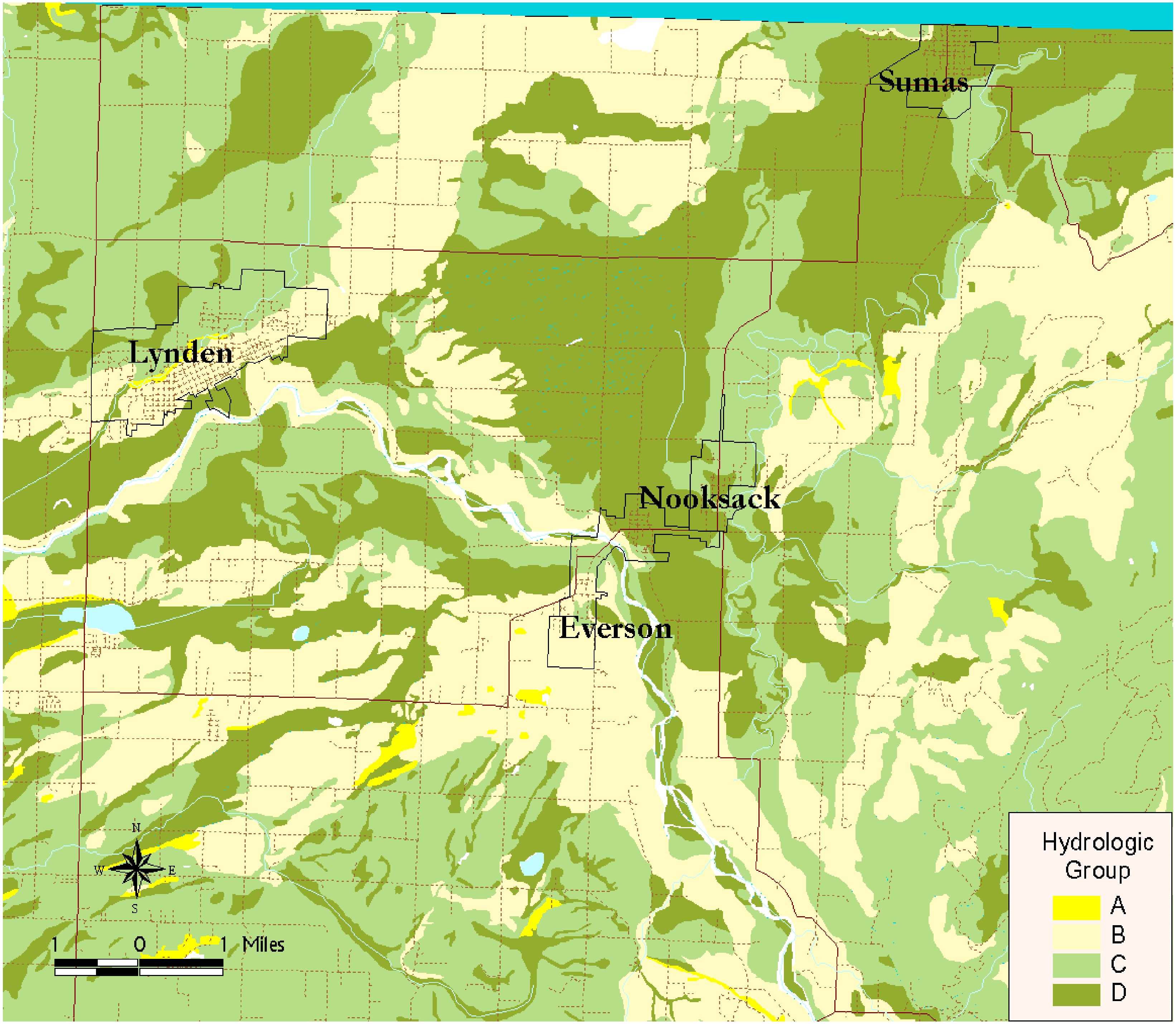


Figure 4: Hydrologic Groups

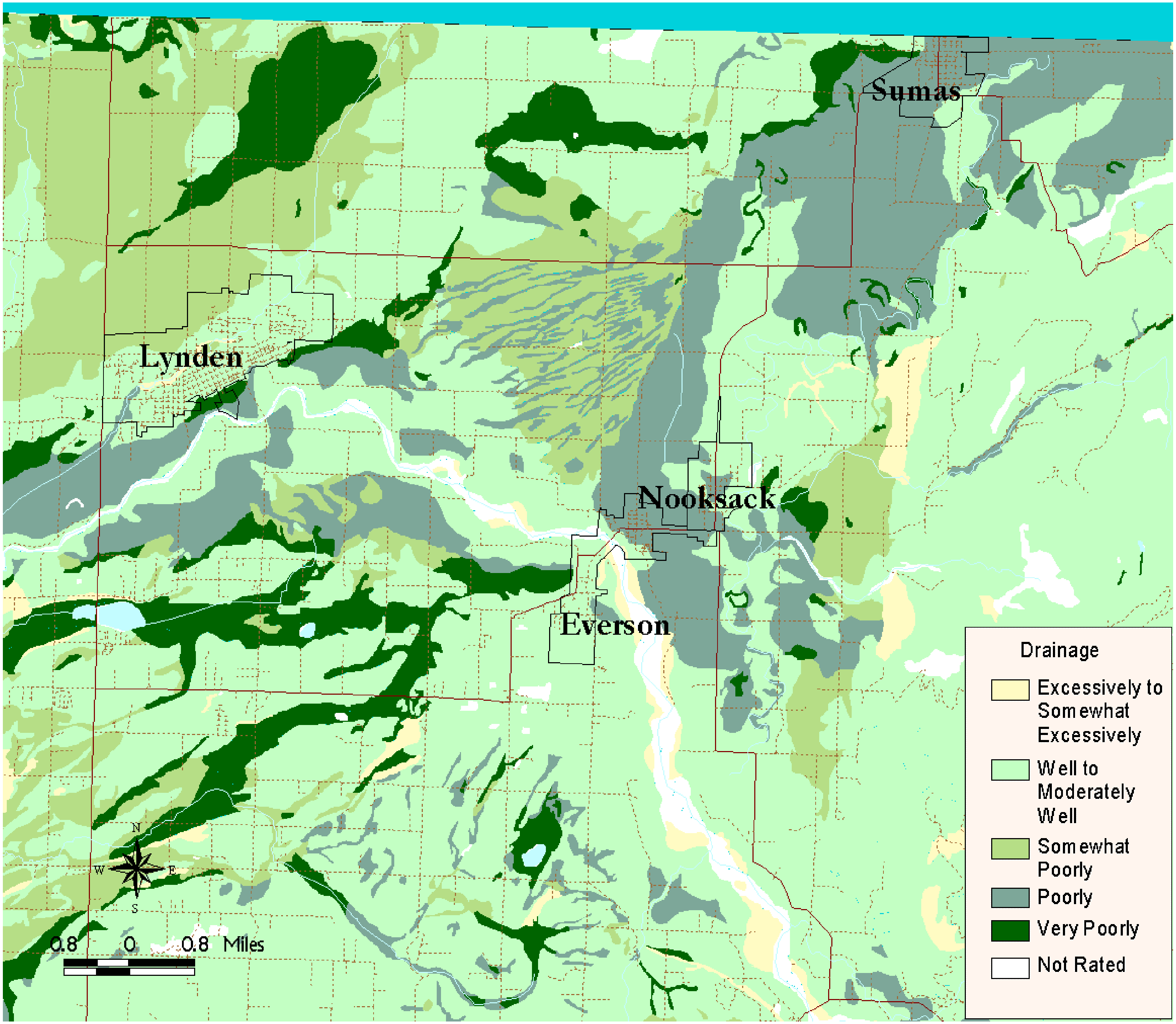


Figure 5: Soil Drainage

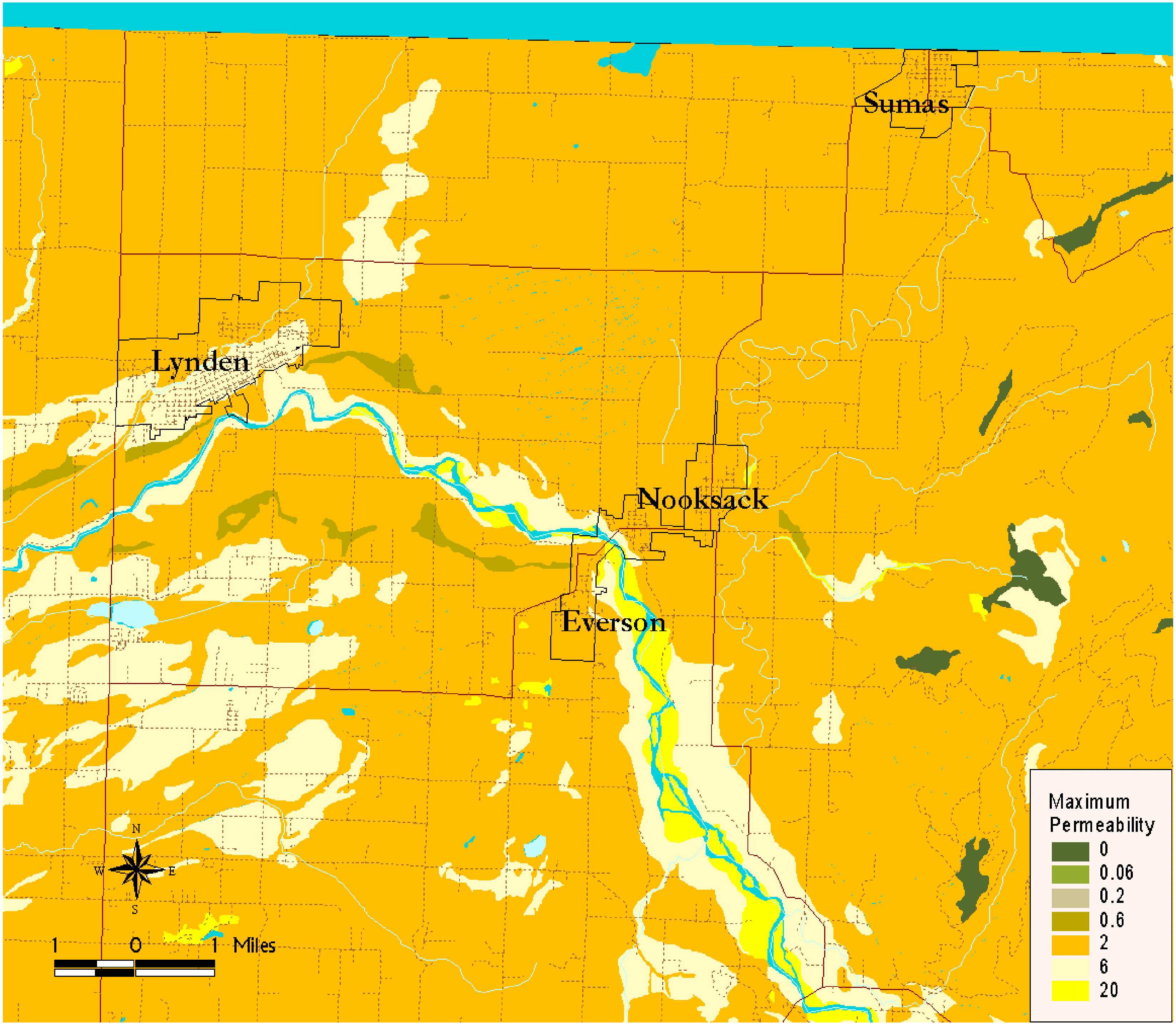


Figure 6: Maximum Soil Permeability

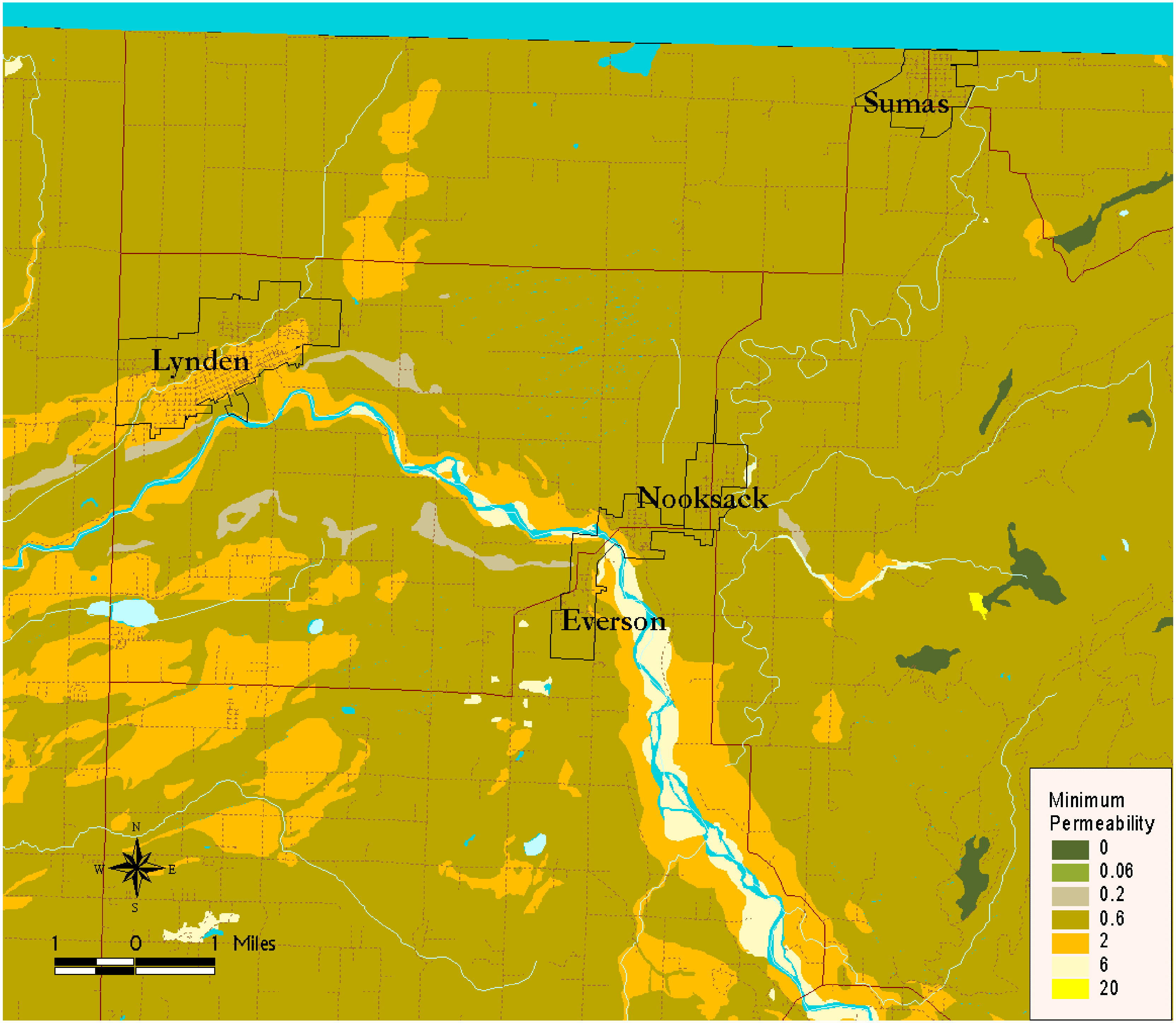


Figure 7: Minimum Permeability

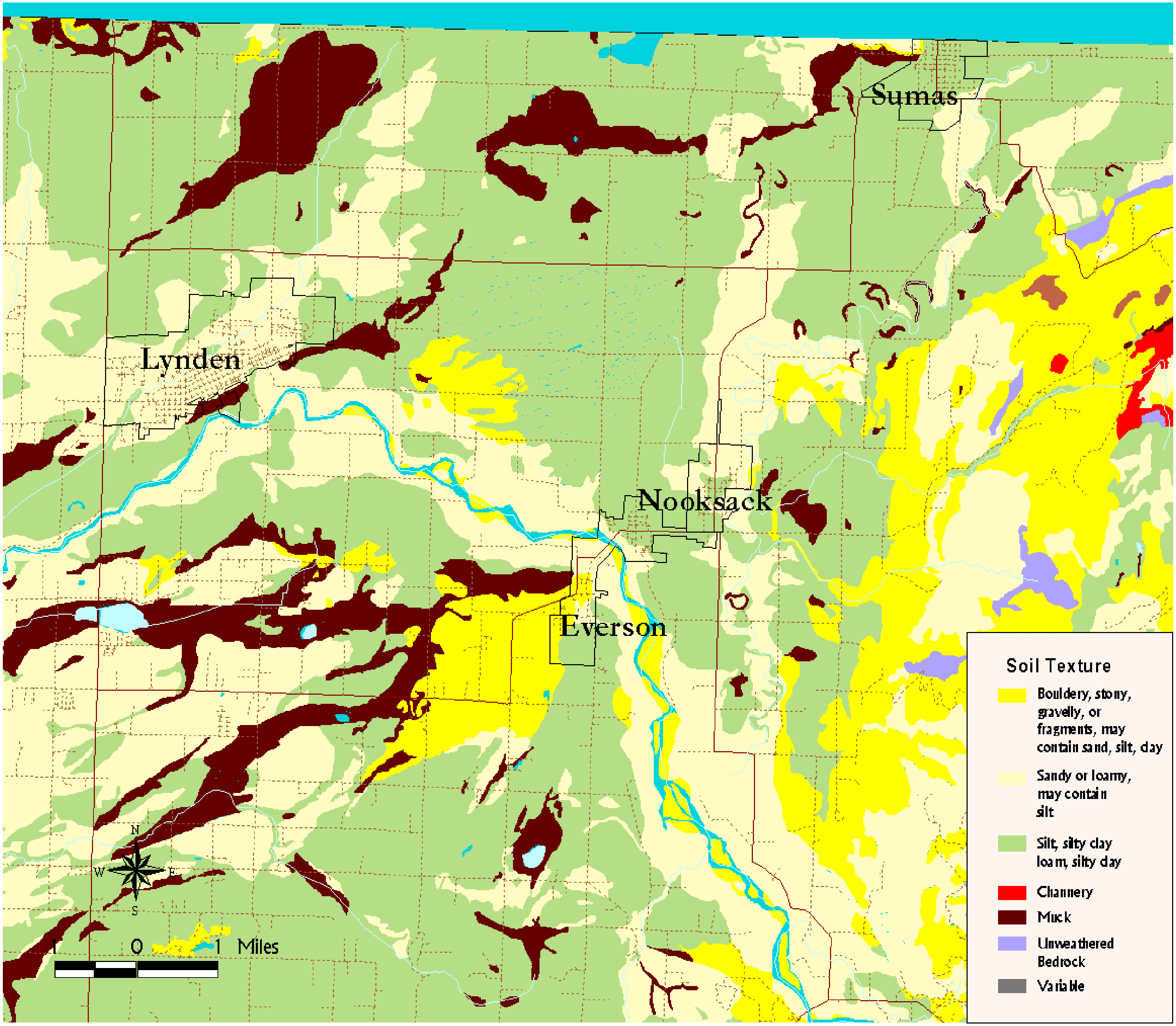


Figure 8: Soil Texture Class

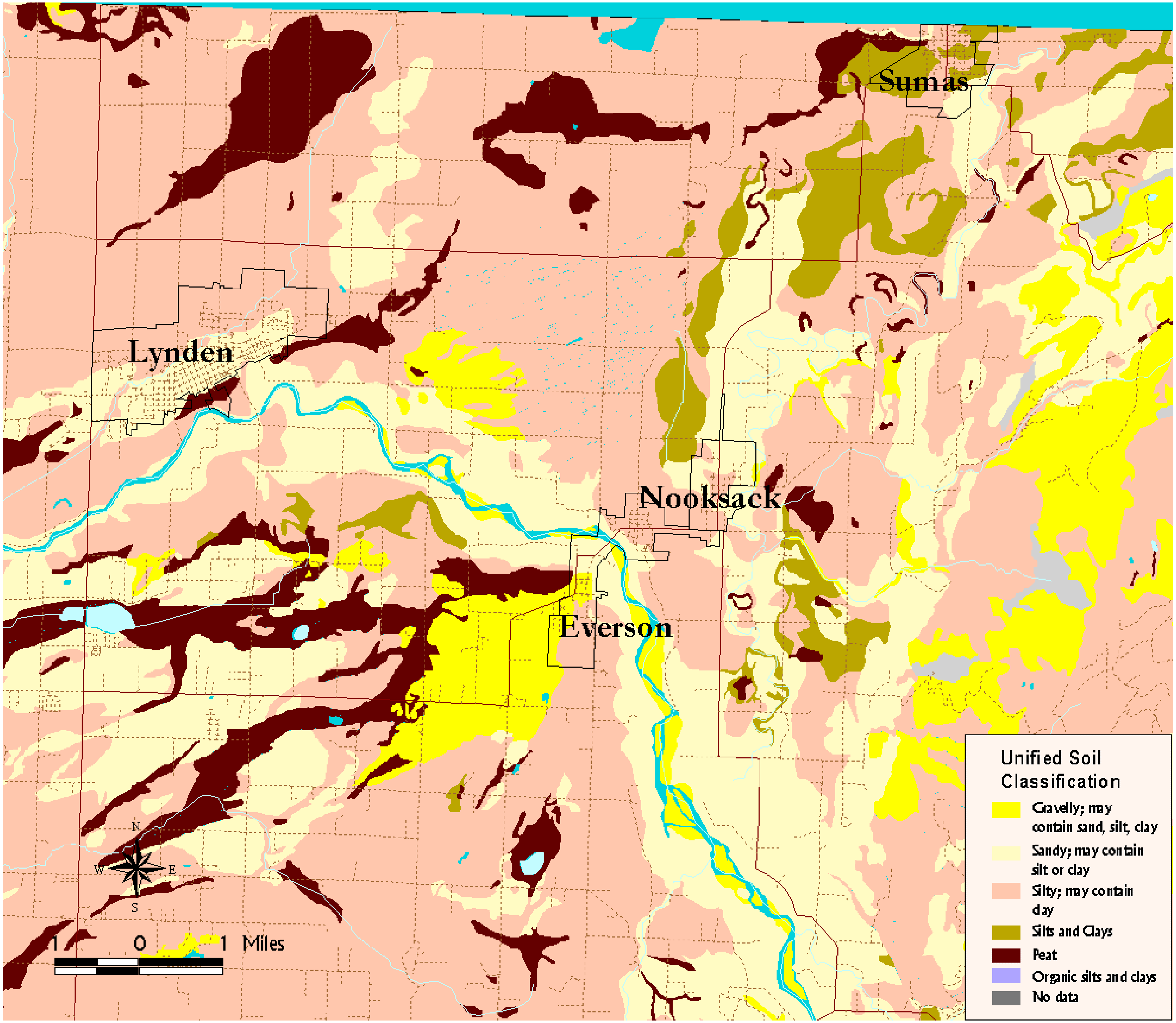


Figure 9: Unified Soil Classification

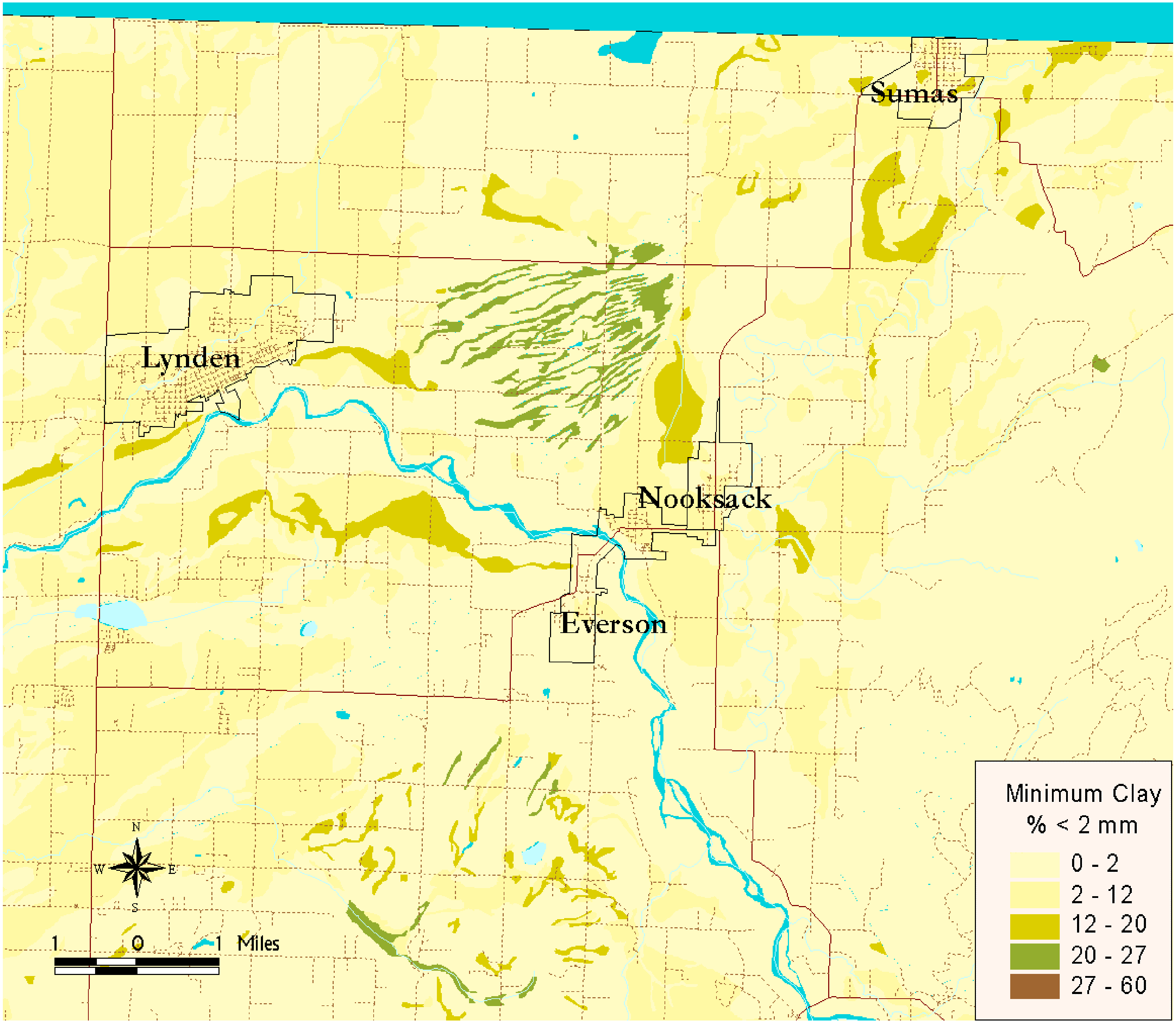


Figure 10: Minimum Clay, Percent < 2 mm

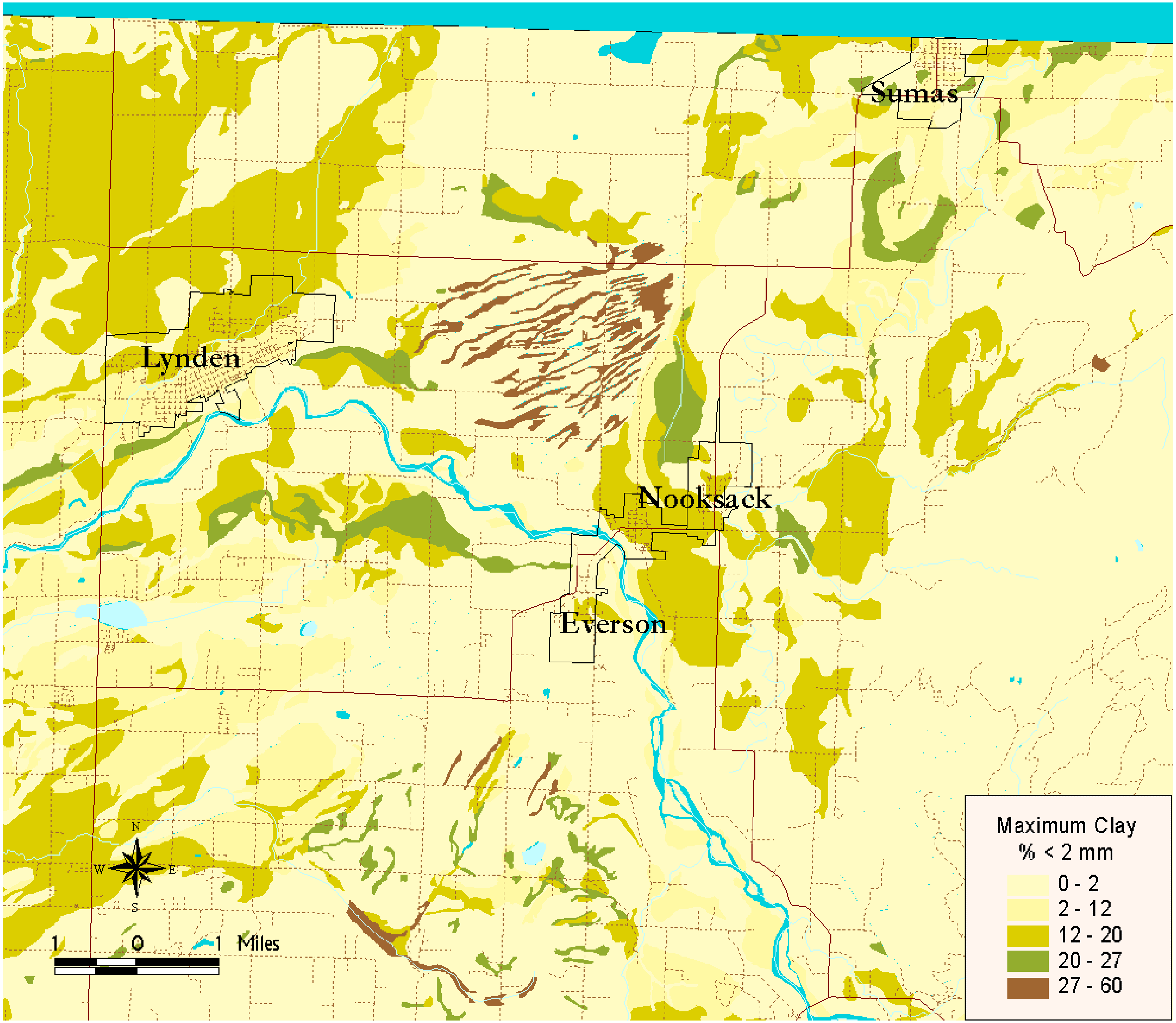


Figure 11: Maximum Clay, Percent < 2 mm

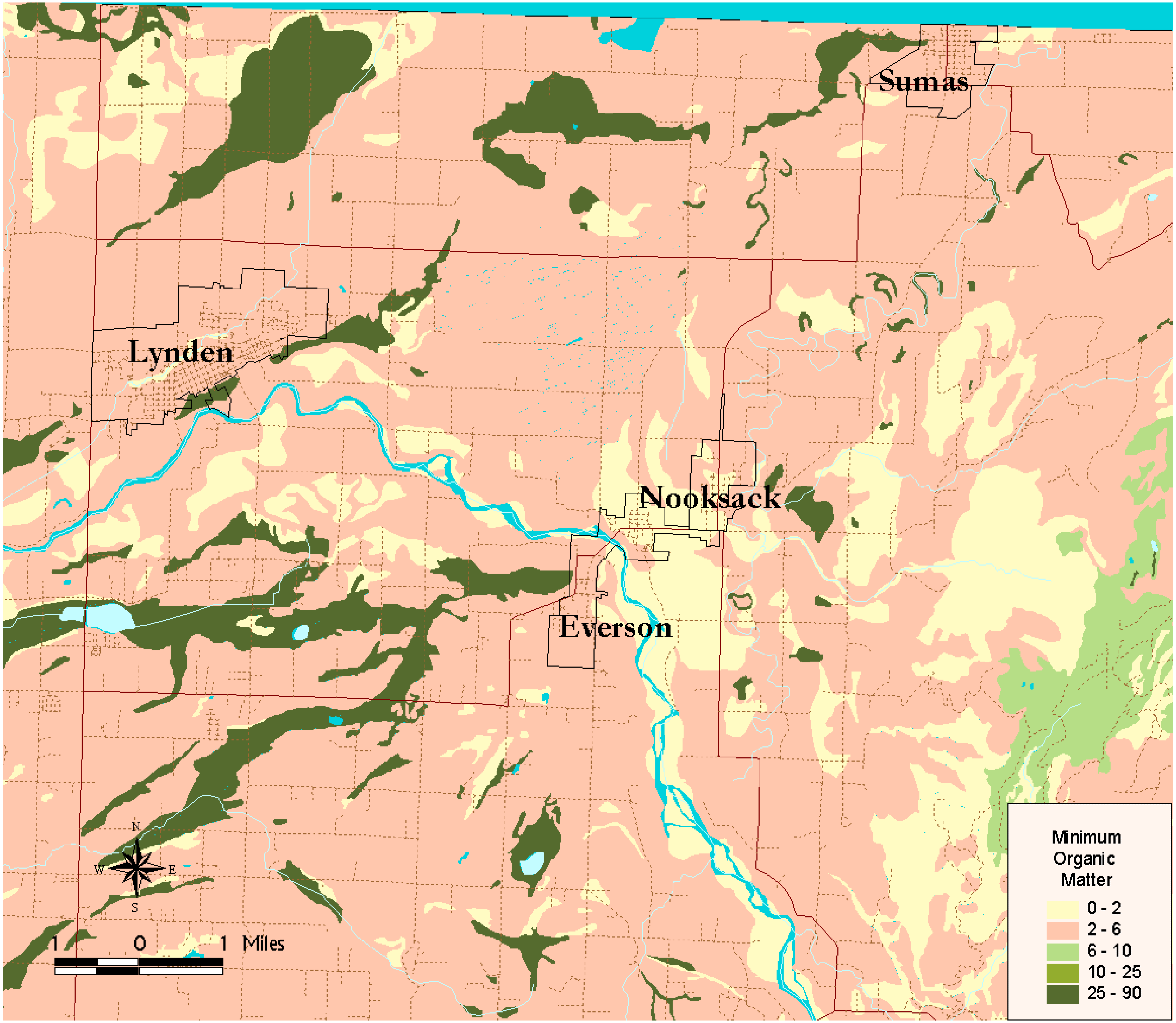


Figure 12: Minimum Organic Matter Content

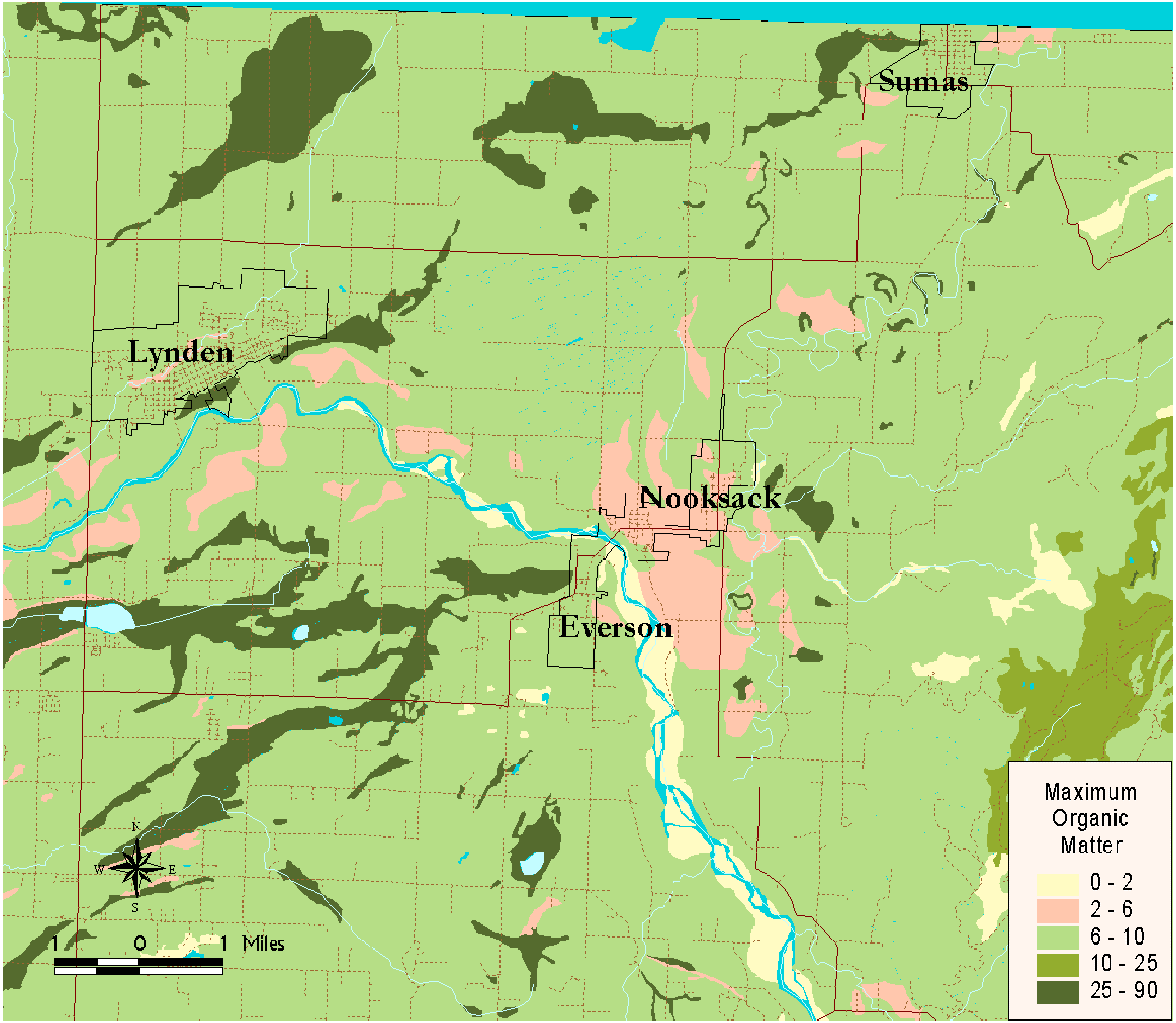


Figure 13: Maximum Organic Content

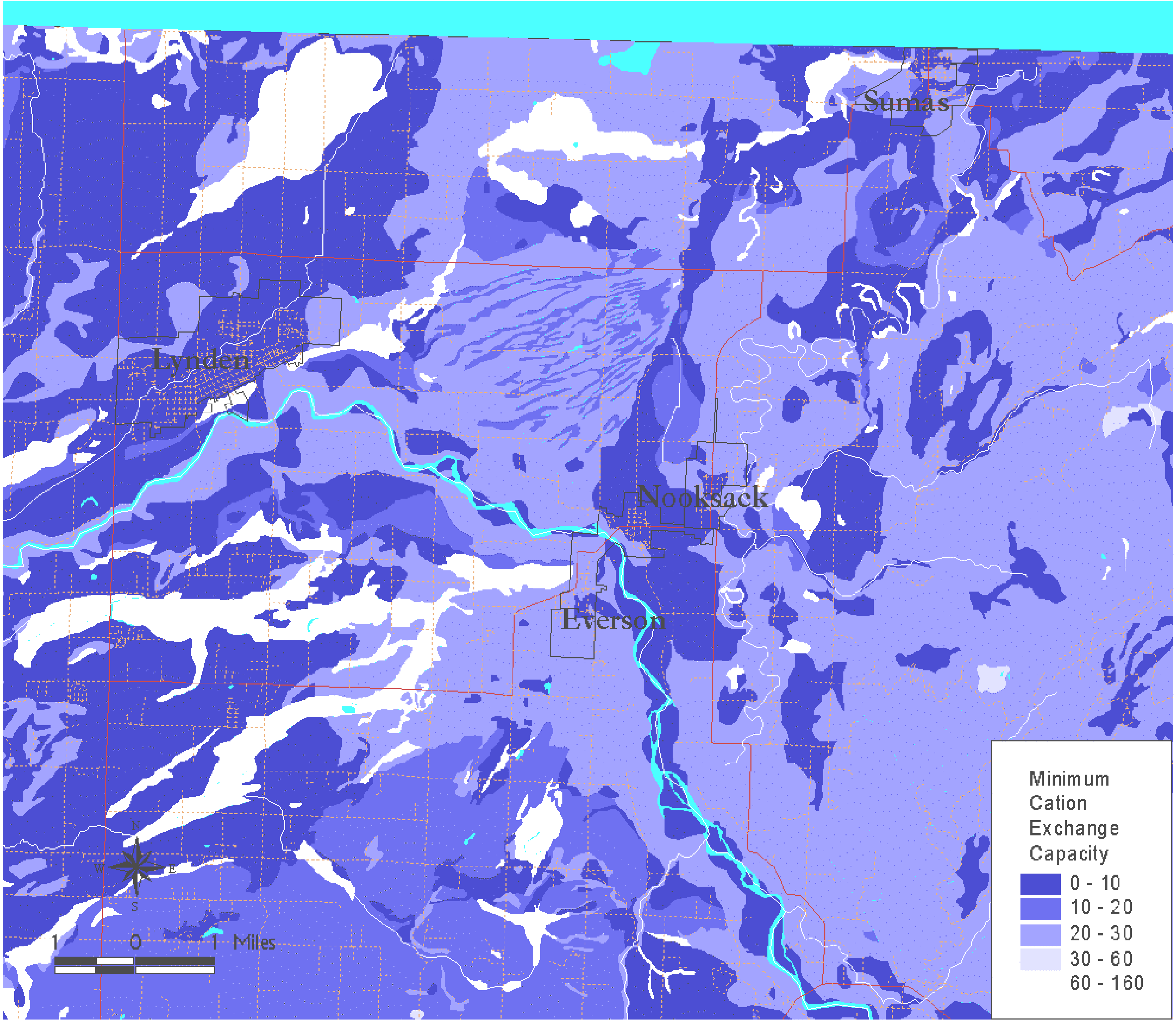


Figure 14: Minimum Cation Exchange Capacity

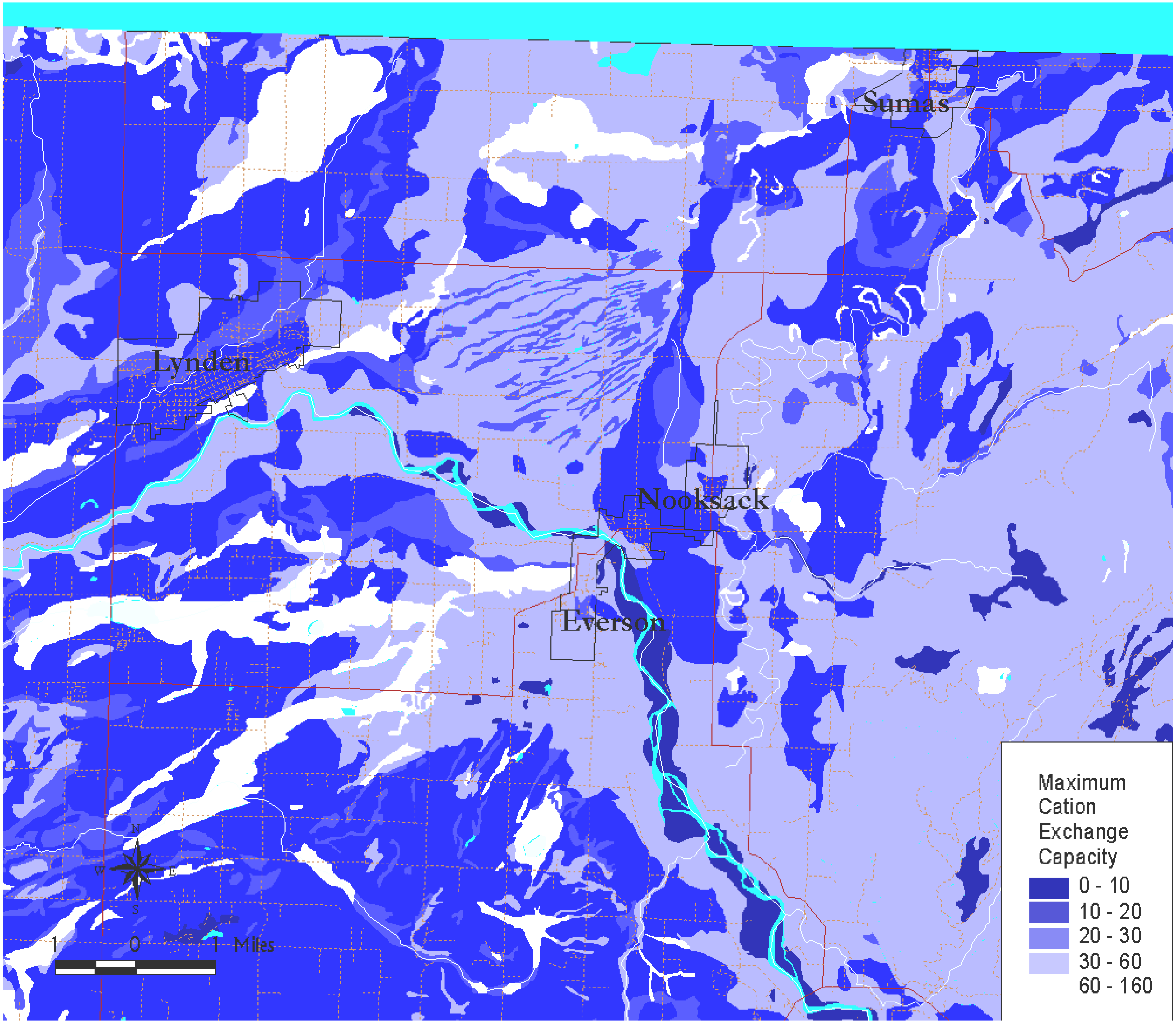


Figure 15: Maximum Cation Exchange Capacity

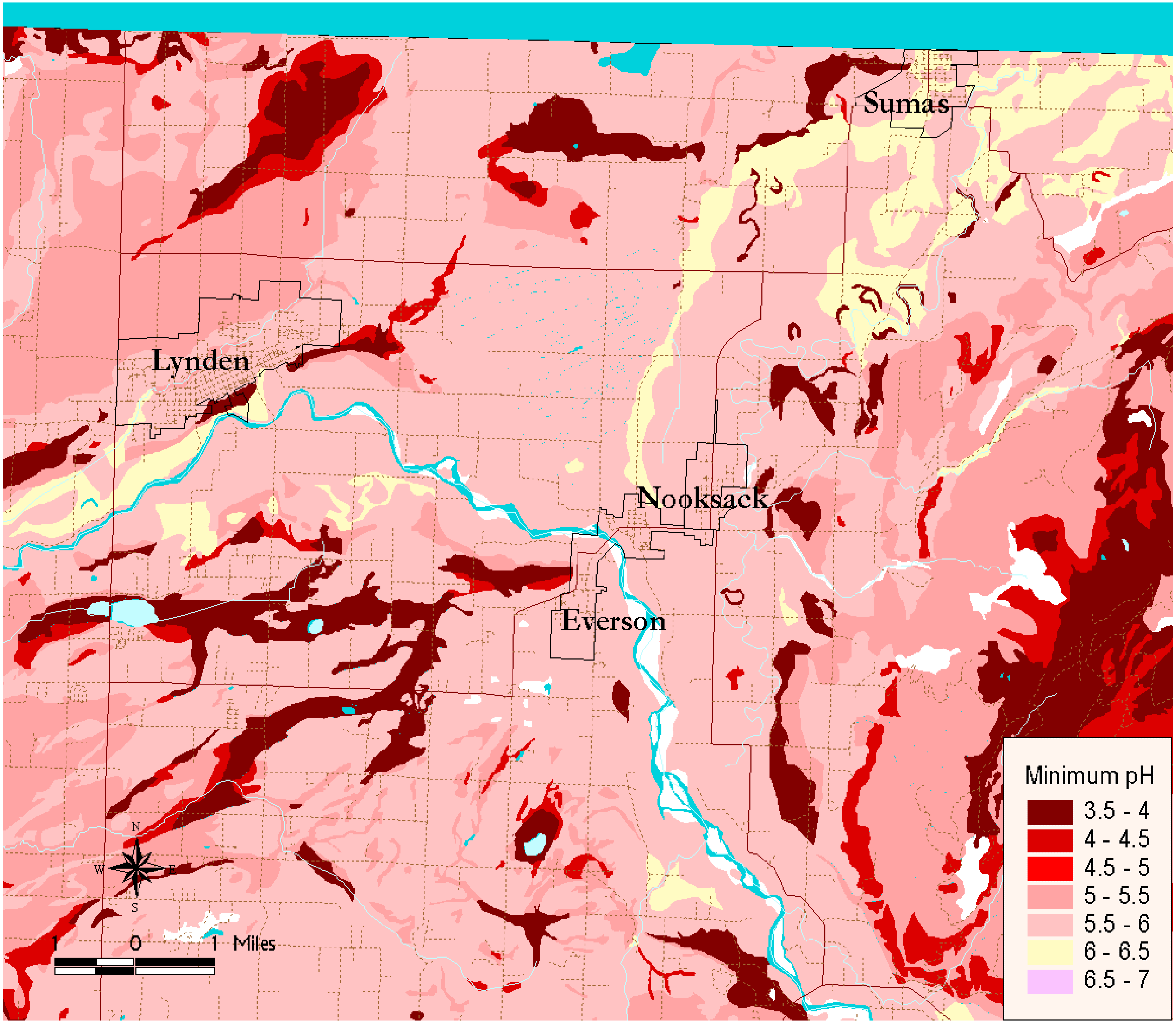


Figure 16: Minimum pH

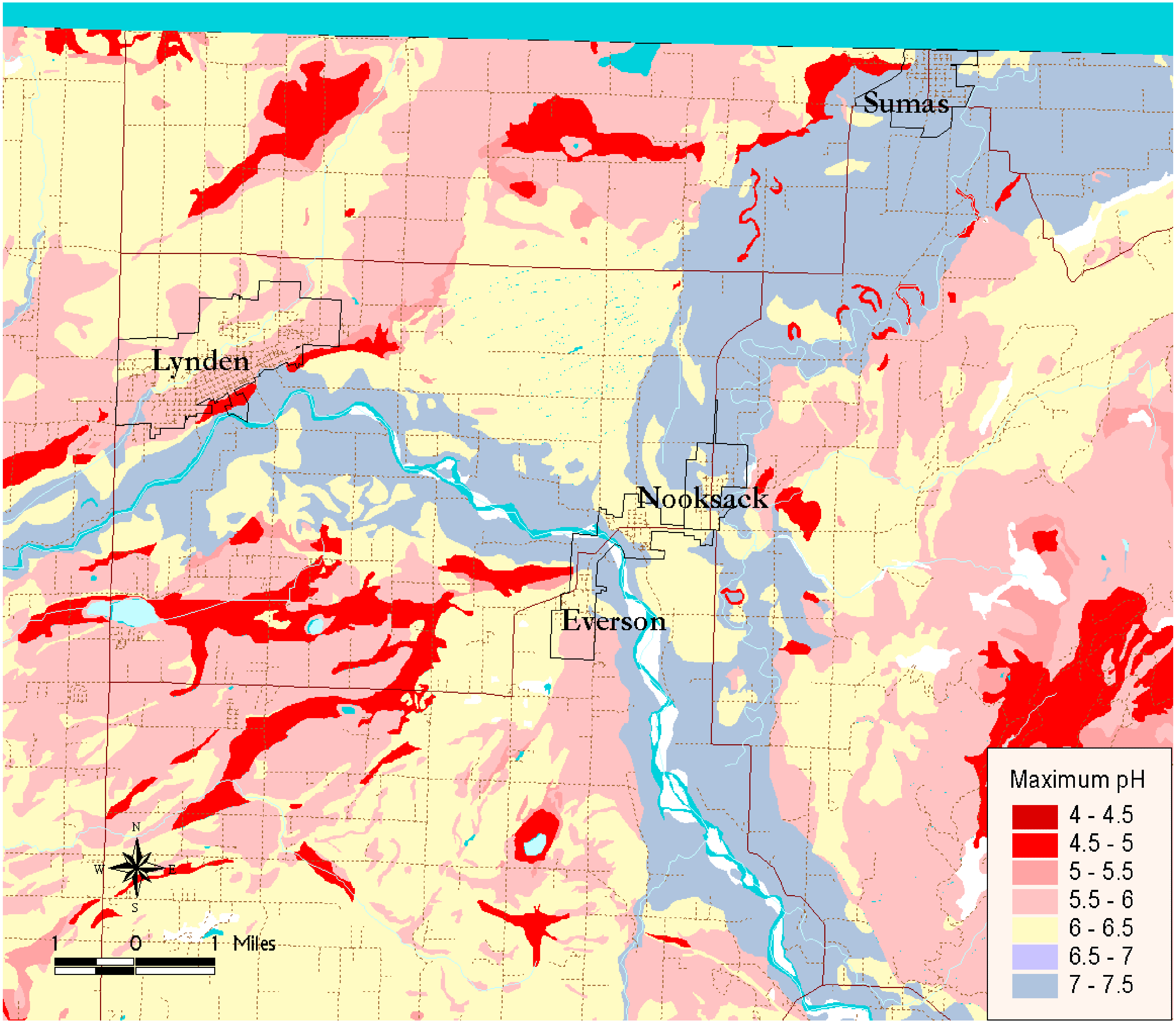


Figure 17: Maximum pH

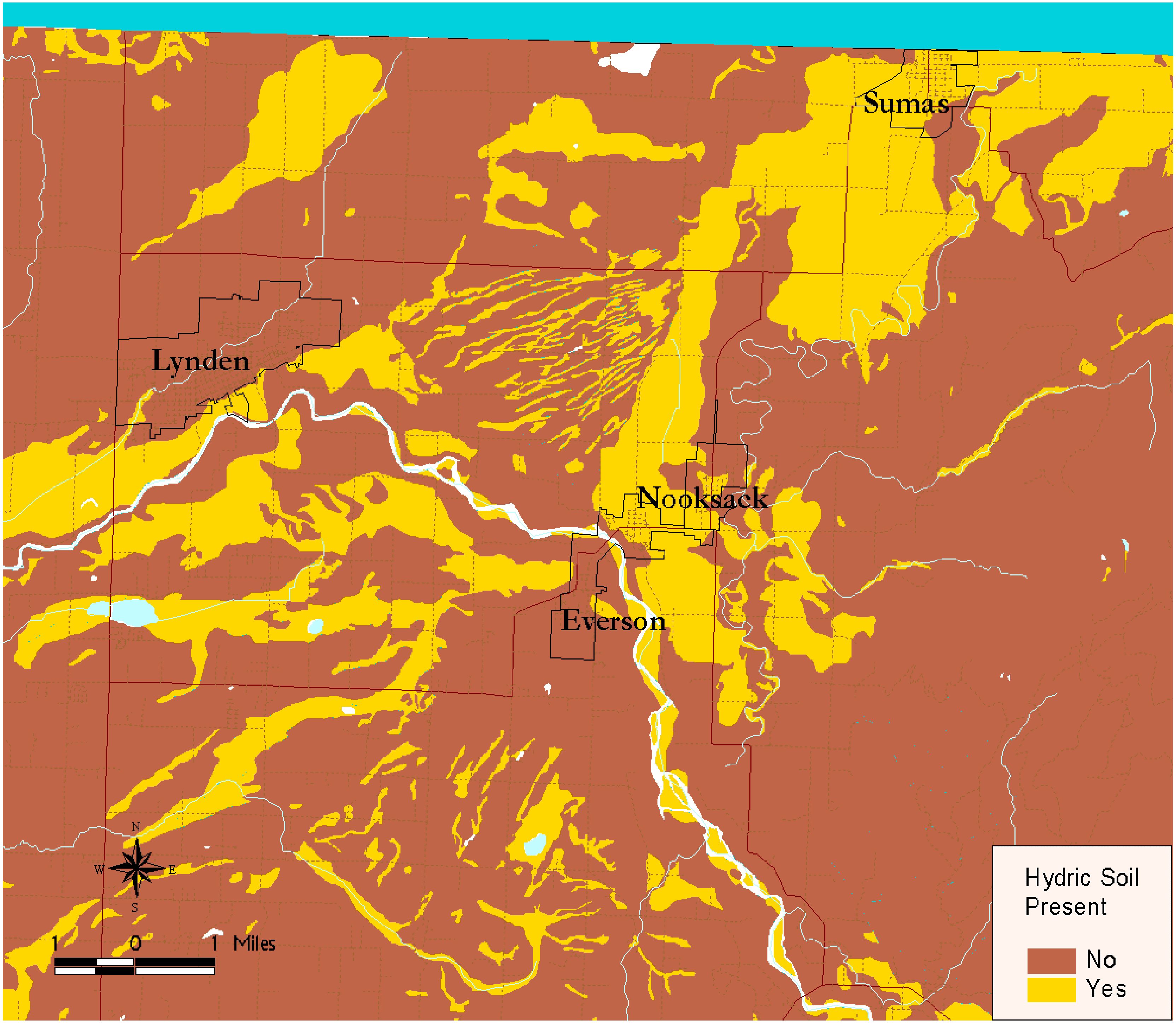


Figure 18: Hydric Soils

Appendix B

Ground Water Quality Data
Washington State Department of Health
U.S. Geological Survey
Department of Ecology Environmental Investigations Program

ArcView Plots by Laurie Morgan
July 1998

Data contained in this appendix was compiled for this project in 1997. The following dates are the period of record:

The period of record for USGS samples is from 6/71 to 8/96. The period of record for DOH samples is from 11/77 to 12/96. The period of record of Ecology EILS samples is from 8/88 to 12/96, with the addition of a round of nitrate sampling completed in 1997.

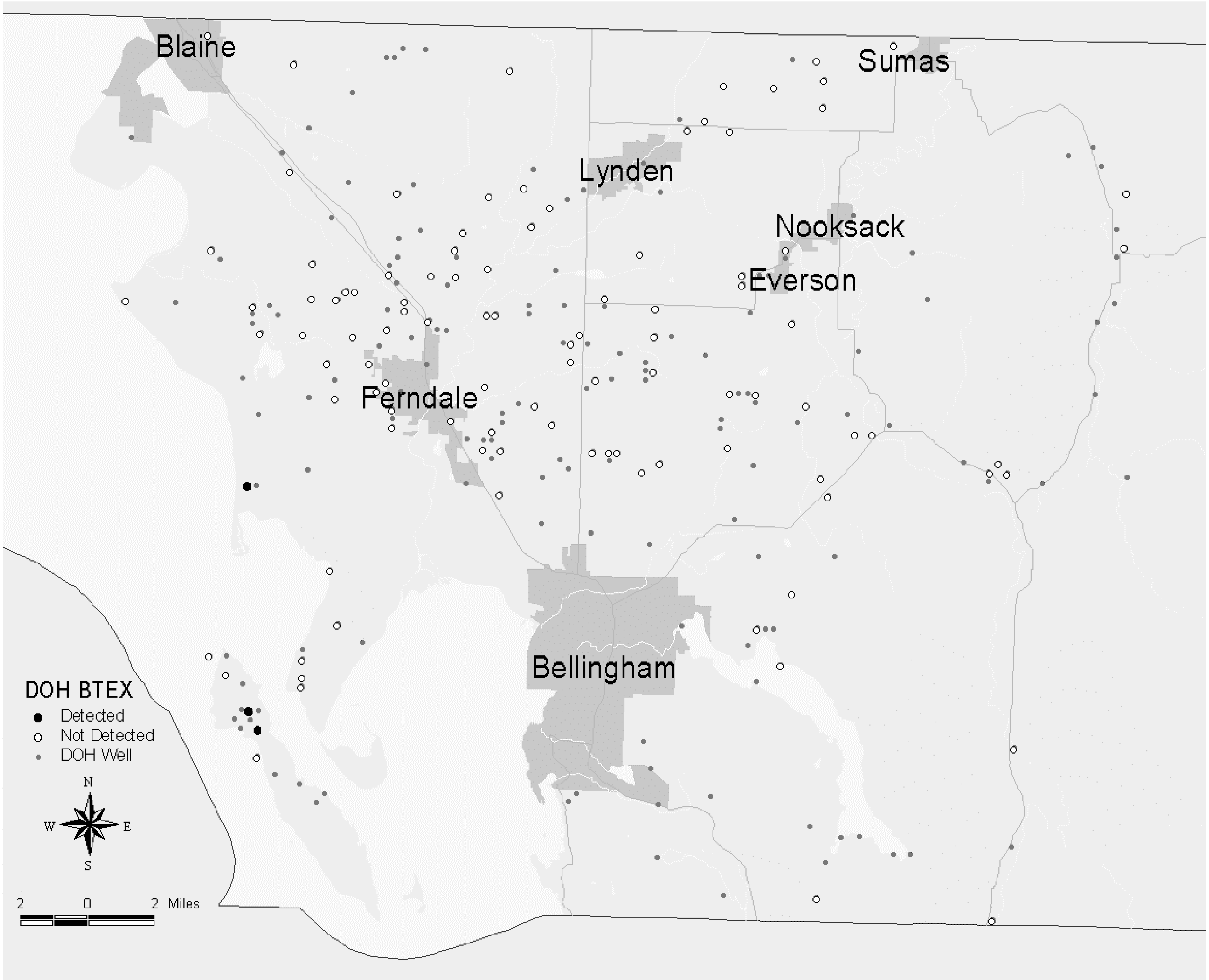


Figure 19: Public Water Supply Wells – Benzene, Toluene, Ethylbenzene, Xylene

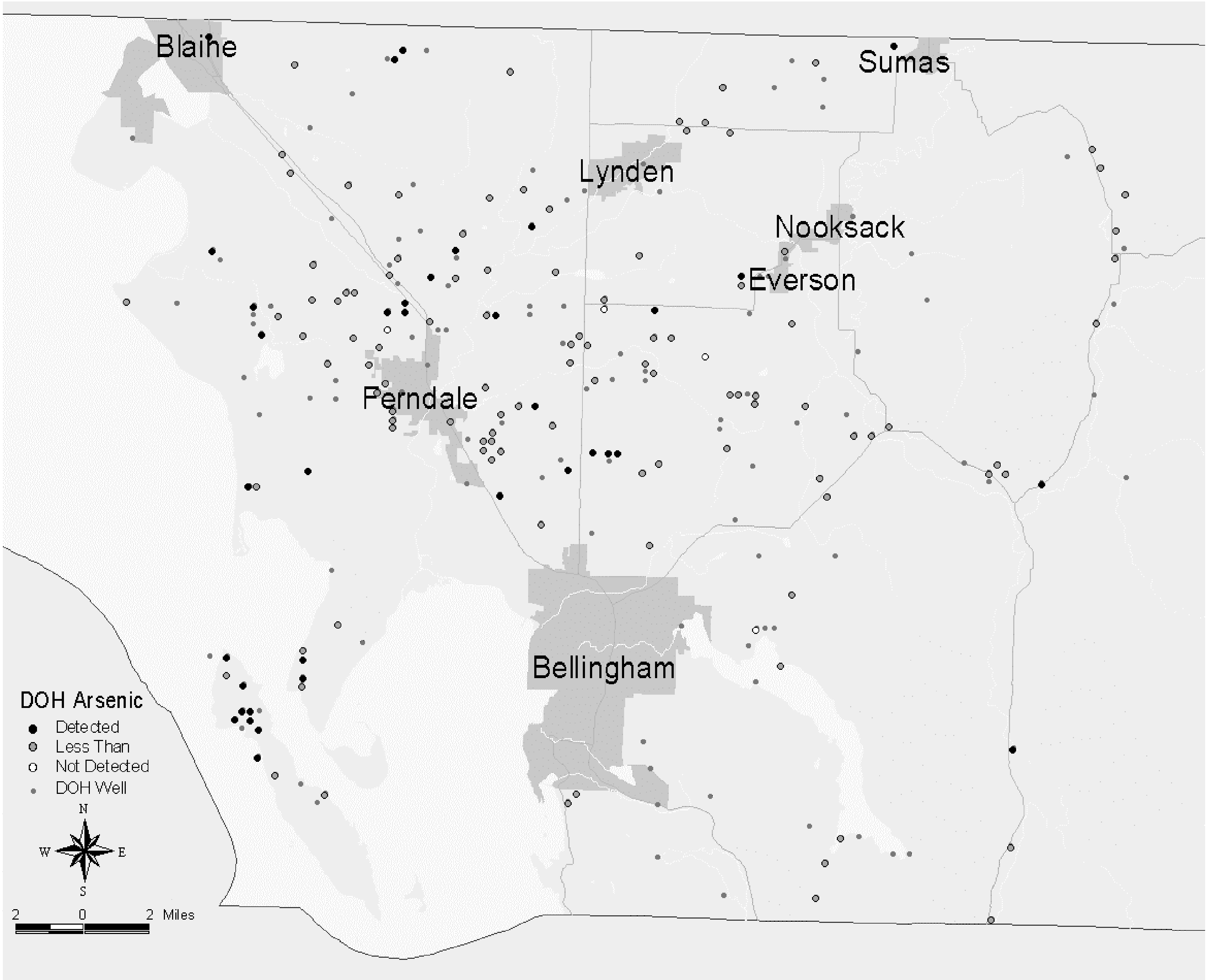


Figure 20: Public Water Supply Wells – Arsenic

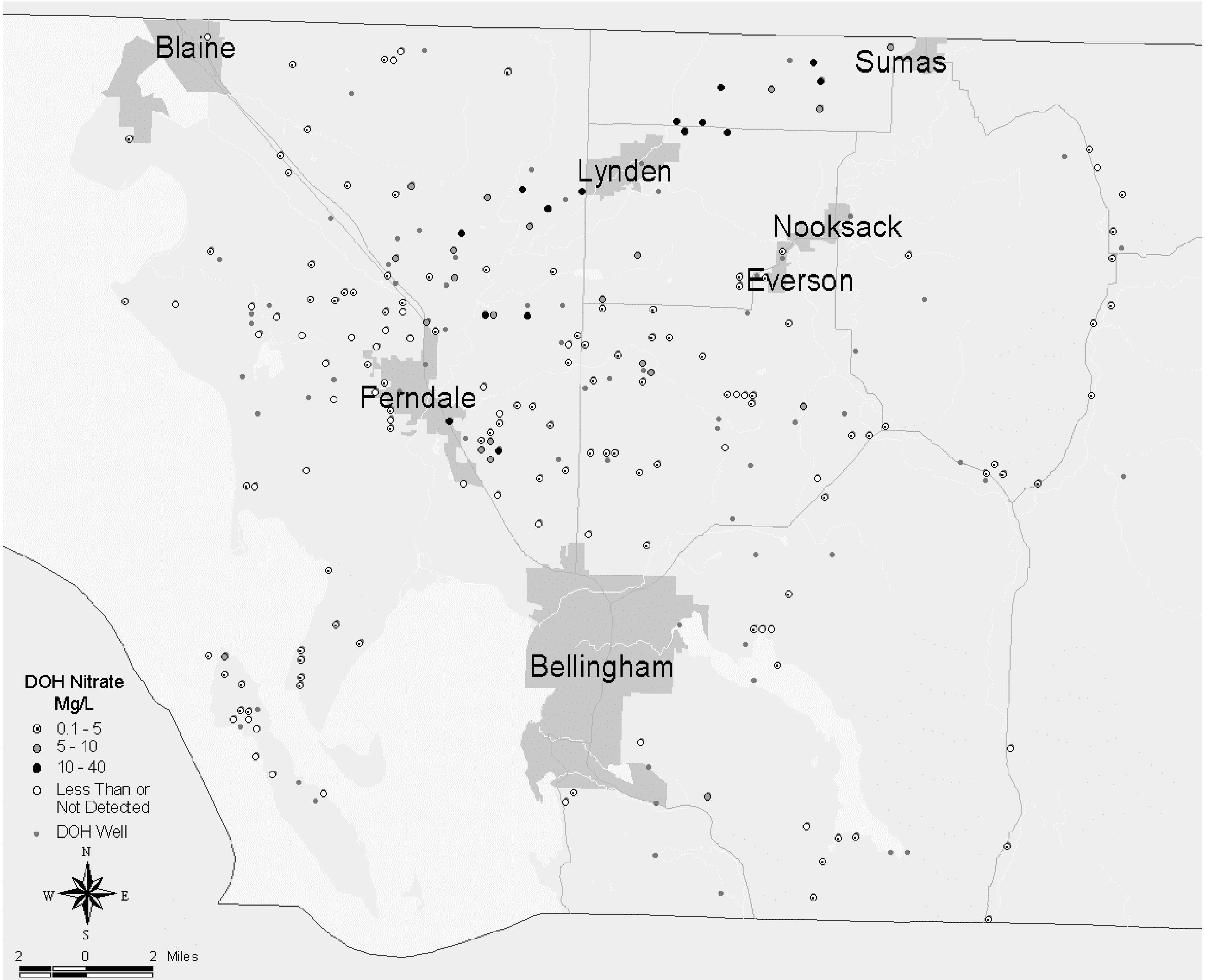


Figure 21: Public Water Supply Wells – Nitrates

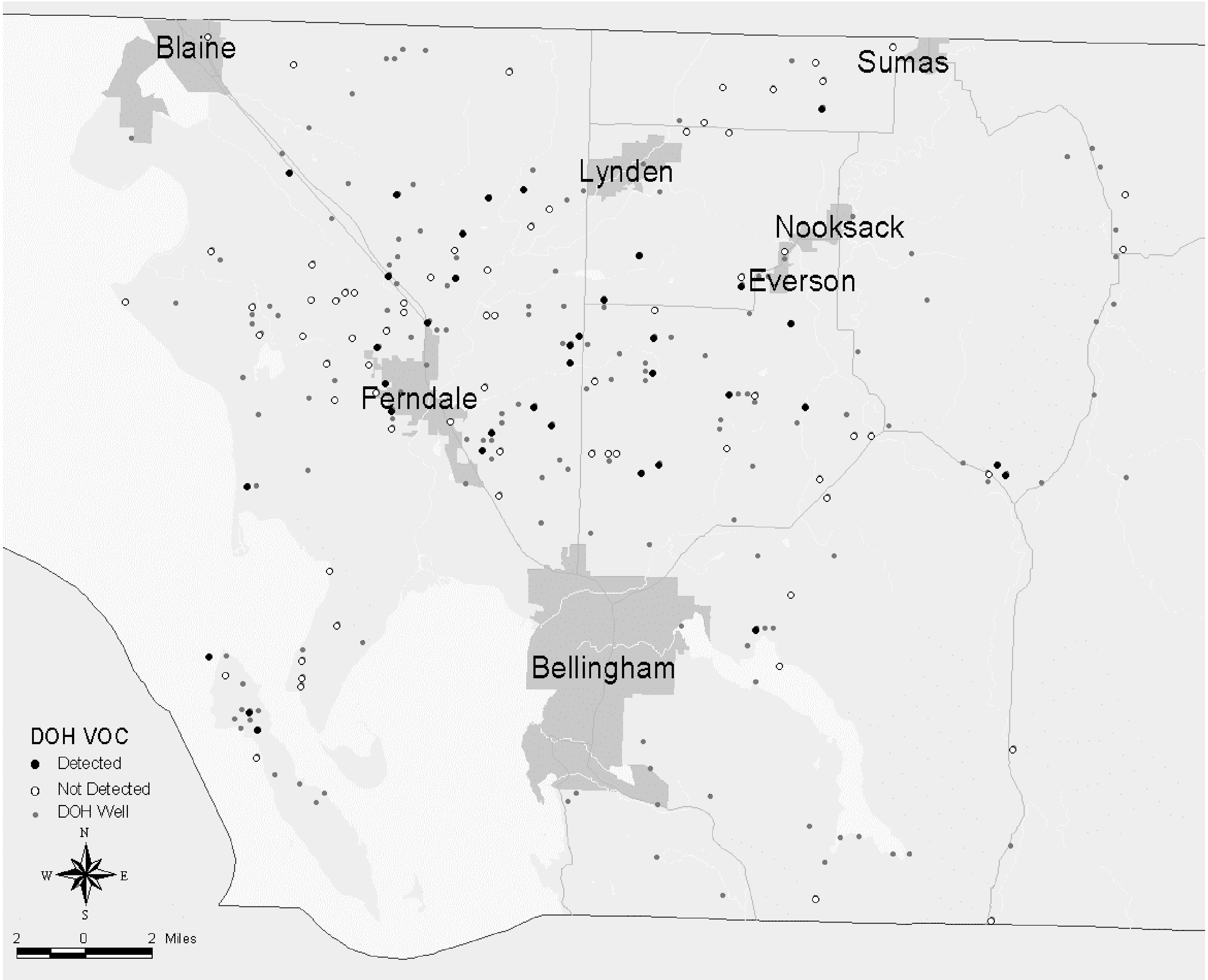


Figure 22: Public Water Supply Wells – Volatile Organic Compounds

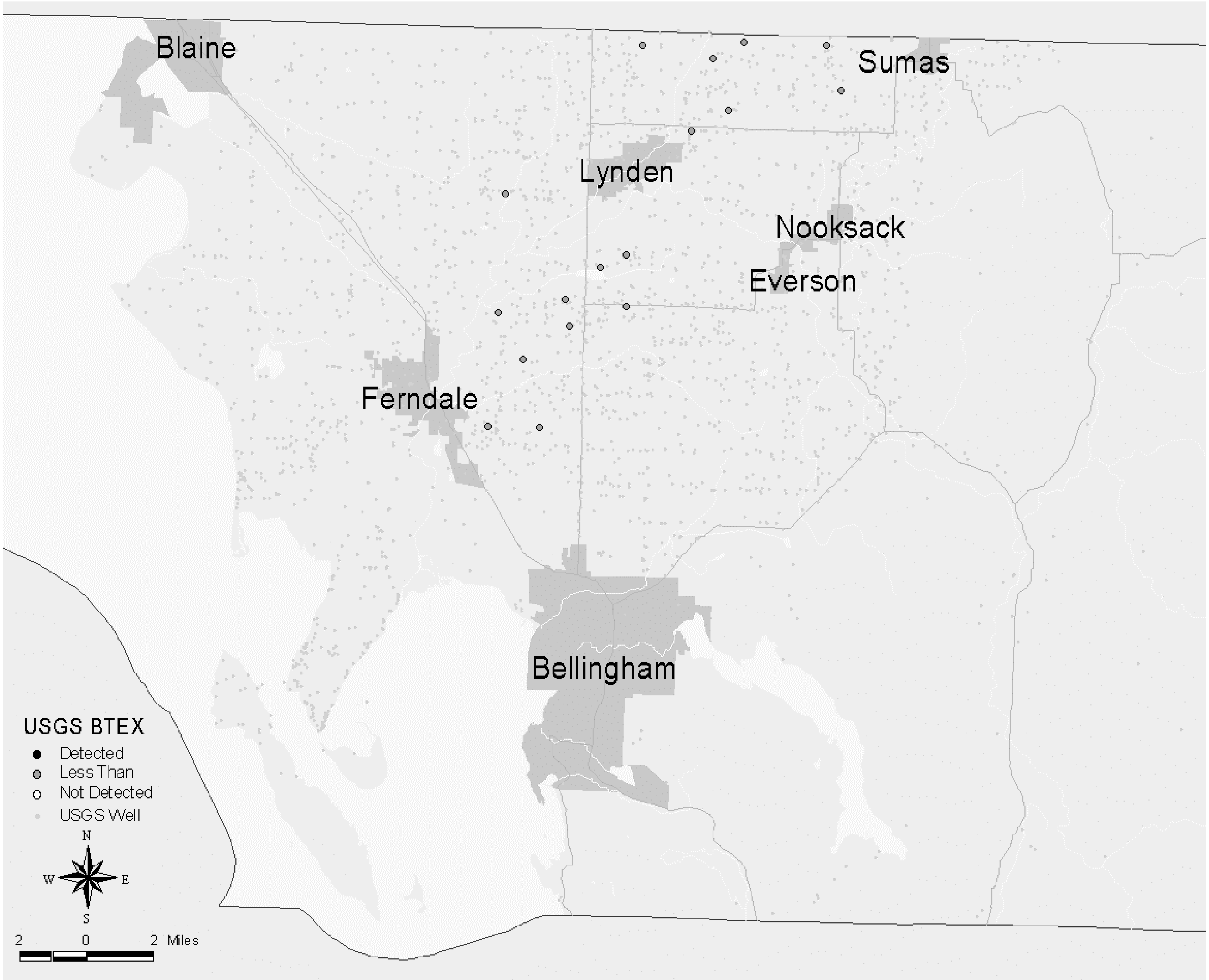


Figure 23: USGS Wells – Benzene, Ethylbenzene, Toluene, Xylene

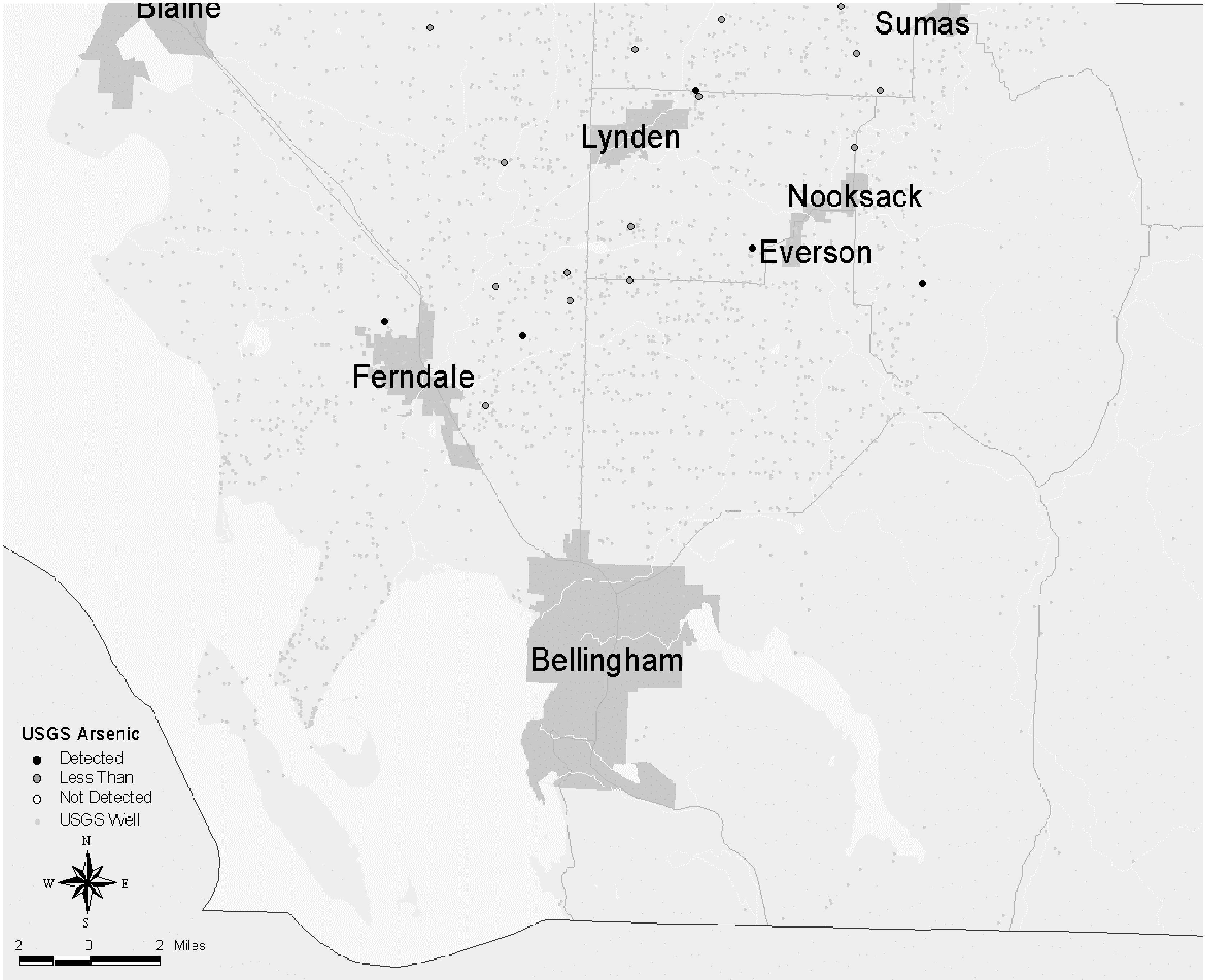


Figure 24: USGS Wells – Arsenic

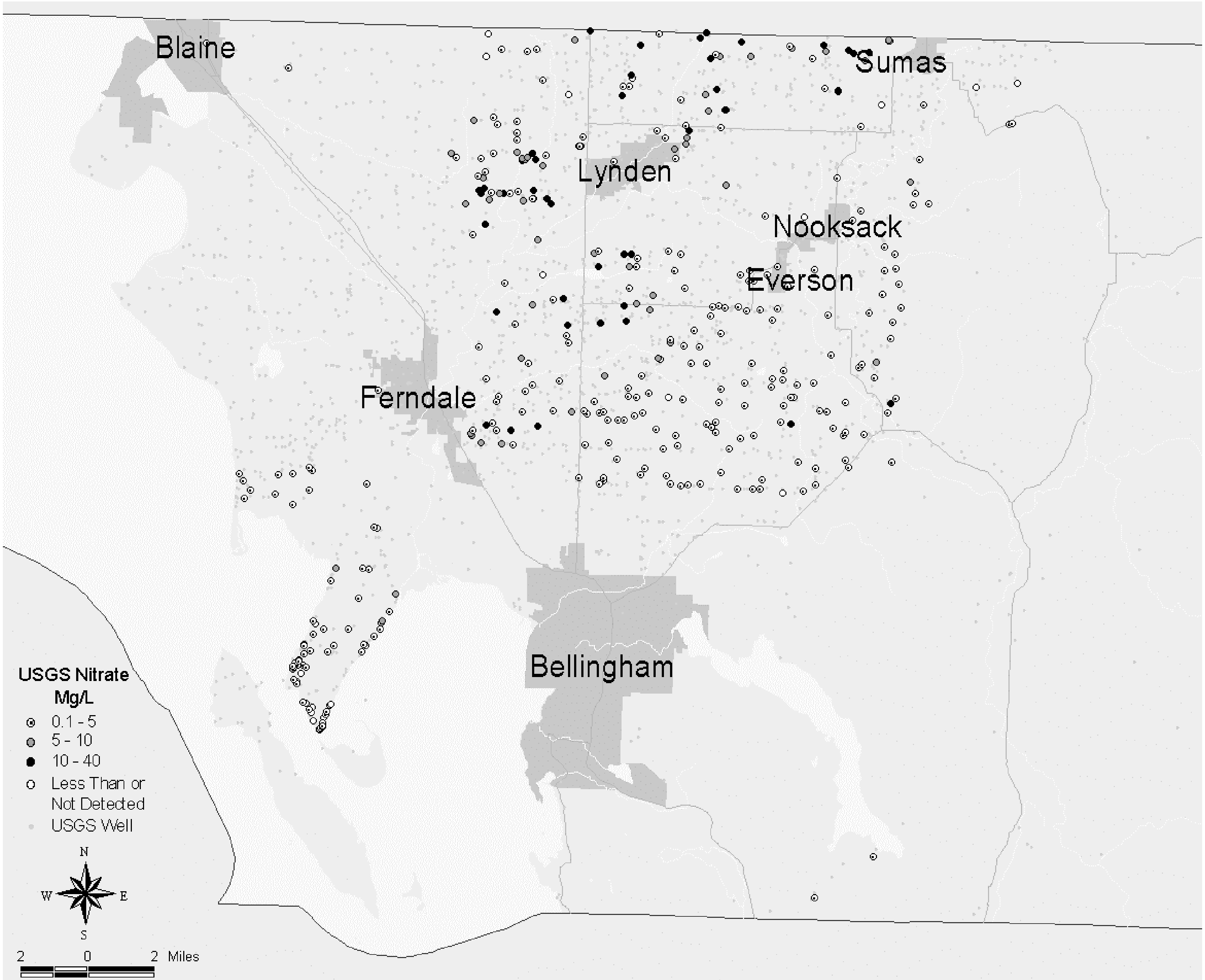


Figure 25: USGS Wells – Nitrates

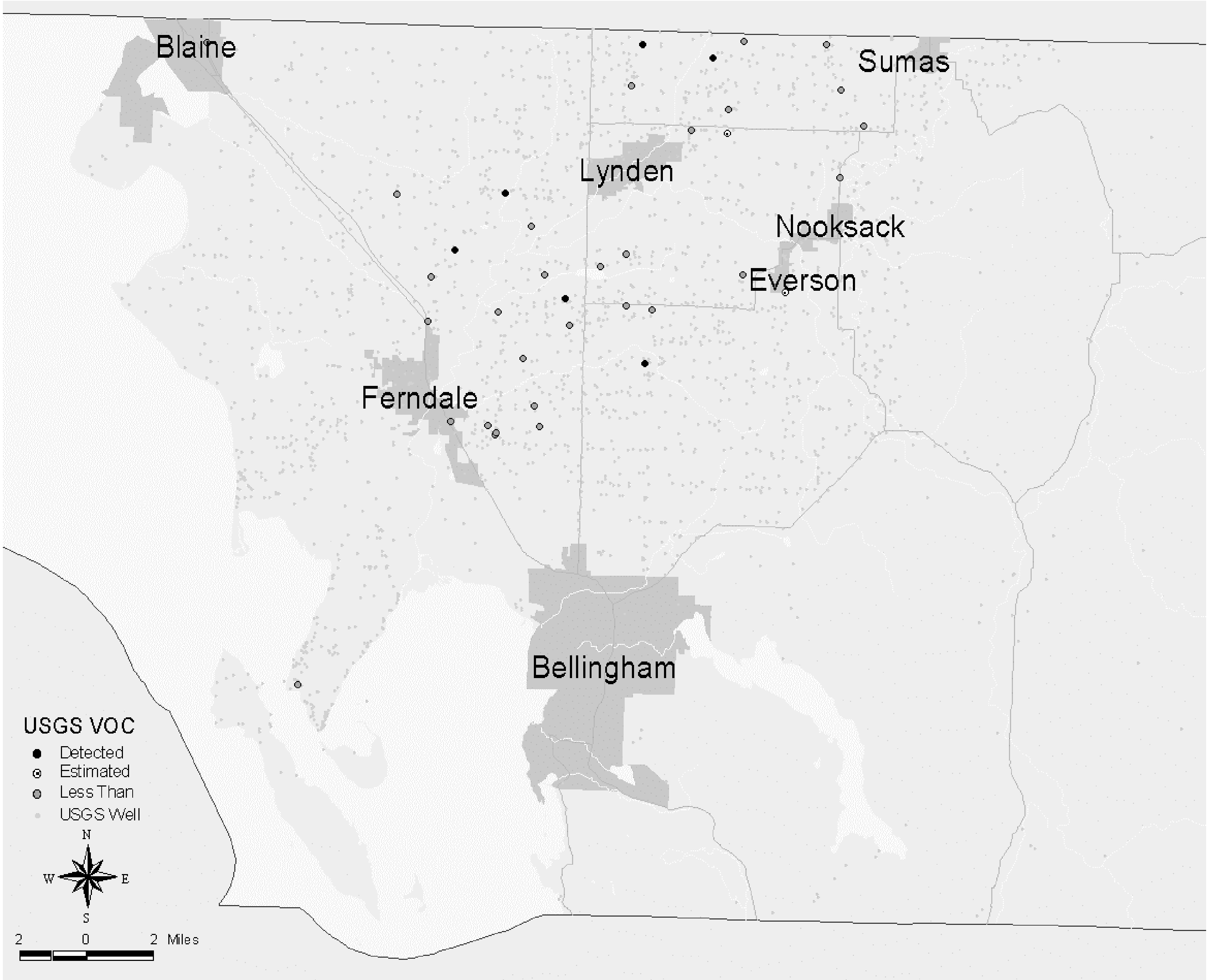


Figure 26: USGS Wells – Volatile and Semi-Volatile Organic Compounds

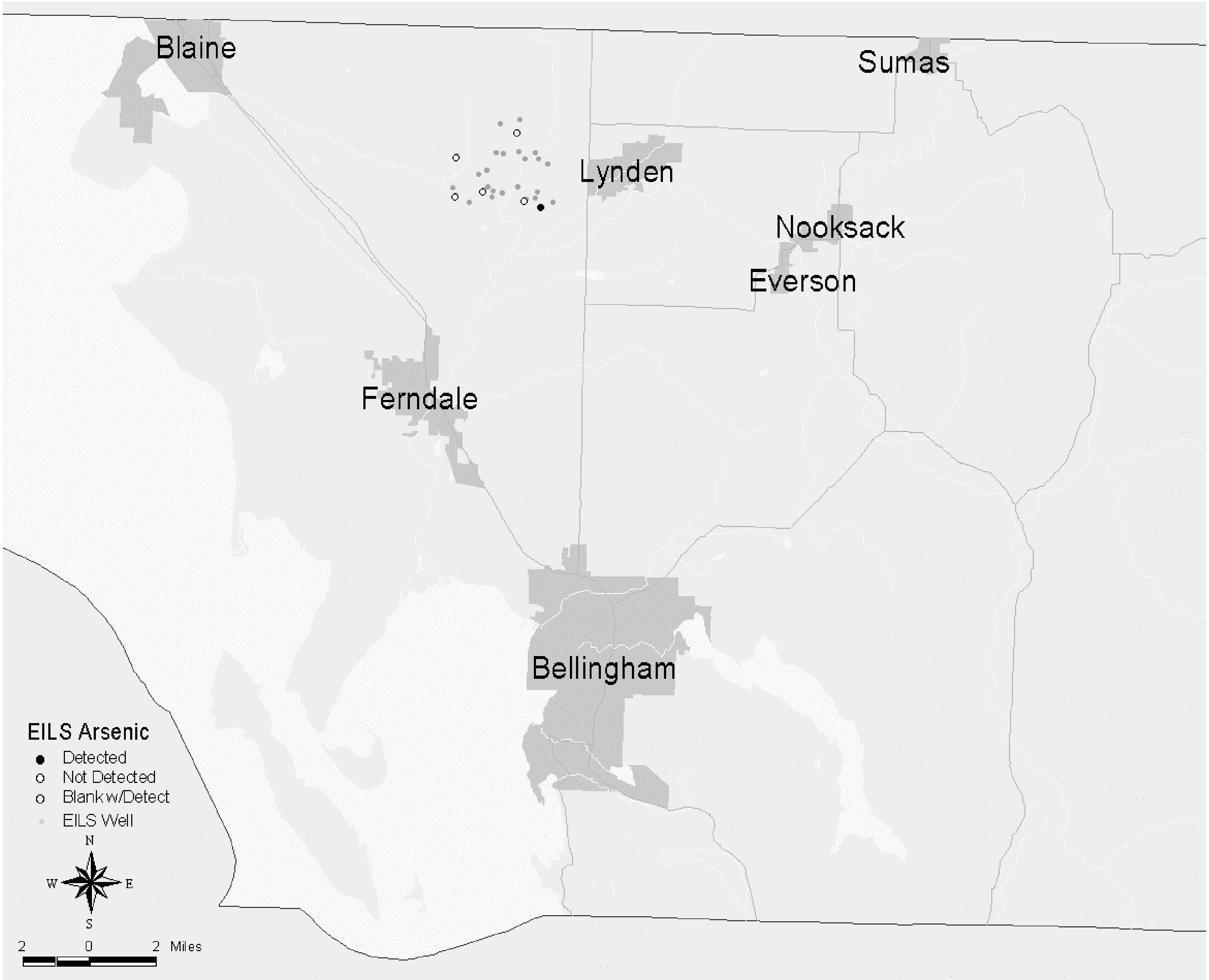


Figure 27: Ecology EILS Wells – Arsenic

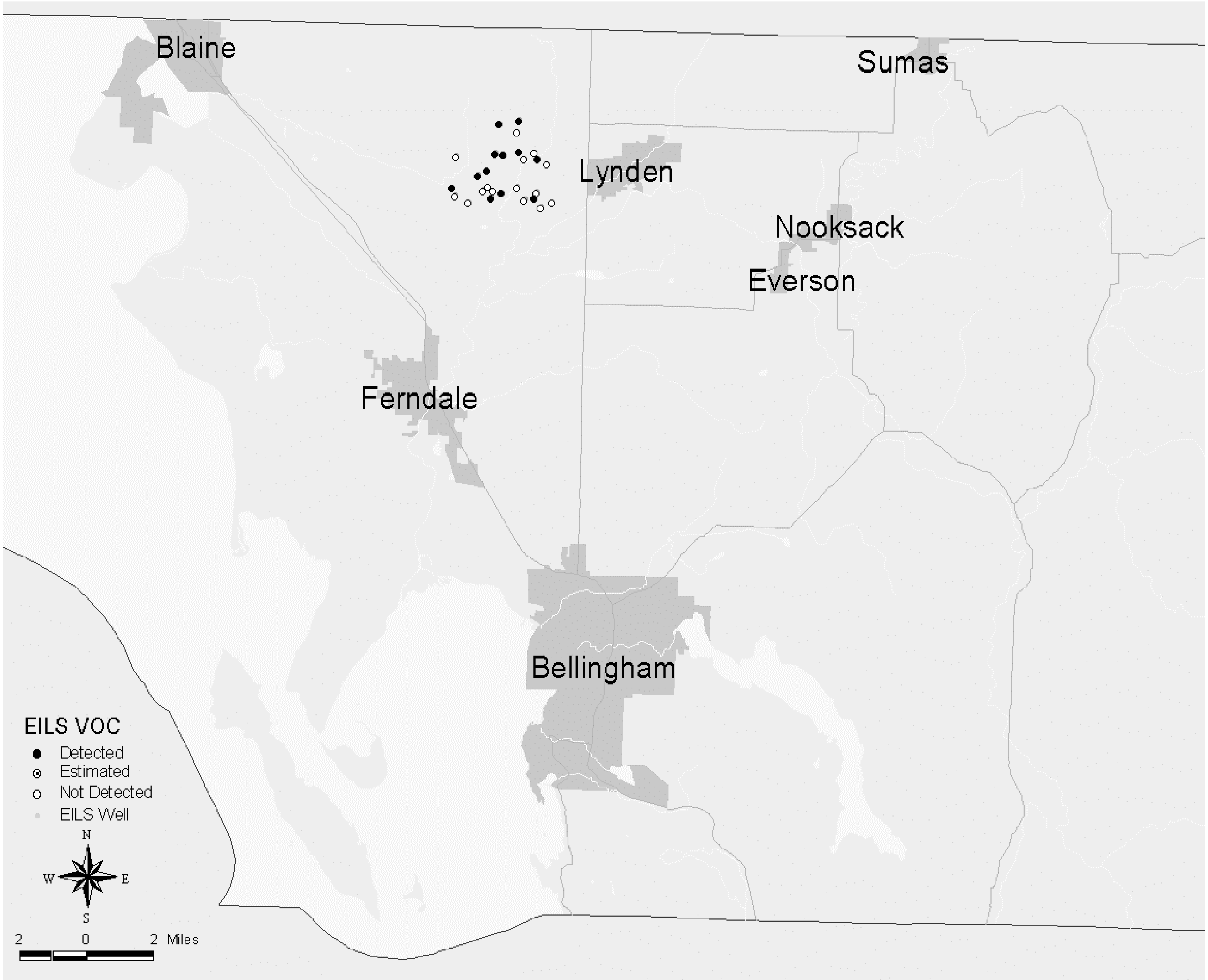


Figure 28: Ecology EILS Wells - Volatile and Semi-Volatile Organic Compounds

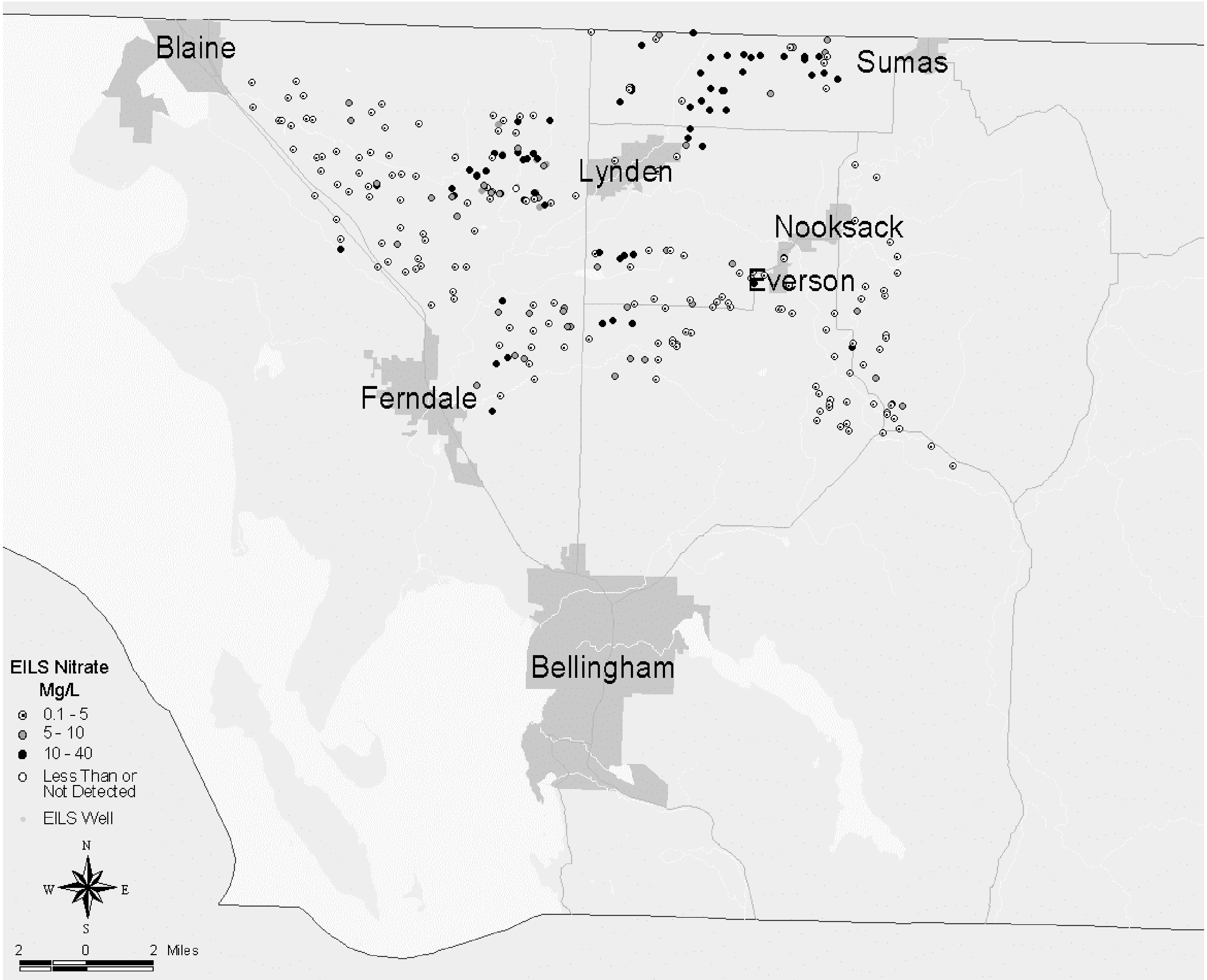


Figure 29: Ecology EILS Wells – Nitrates (Includes 1997 Sampling)

Appendix C: ***Ground Water Quality Data Tables***

Table 7: Washington State Department of Health Sampled Parameters

Department of Health groundwater sampling locations without x-y coordinates are not included.
Lab Qualifiers: NA – Not Analyzed; ND – Not Detected; D – Detected; LT – Less Than; GT – Greater Than

Data Source	Parameter Number	Parameter Name	Lab Qualifier	Number of Samples	Maximum Result	Minimum Result	Average Result	Standard Deviation	Units
DOH	0062	1,1 DICHLOROPROPENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0072	1,1,1,2-TETRACHLOROETHANE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0047	1,1,1-TRICHLOROETHANE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0080	1,1,2,2 - TETRACHLOROETHANE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0067	1,1,2-TRICHLOROETHANE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0058	1,1-DICHLOROETHANE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0046	1,1-DICHLOROETHYLENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0050	1,2,0 DICHLOROETHANE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0098	1,2,3 - TRICHLOROBENZENE	ND	286	0	0	0.00	0.00E+00	ug/L
DOH	0079	1,2,3-TRICHLOROPROPANE	D	1	0.7	0.7	0.70		ug/L
DOH	0079	1,2,3-TRICHLOROPROPANE	ND	290	0	0	0.00	0.00E+00	ug/L
DOH	0091	1,2,4, - TRIMETHYLBENZENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0095	1,2,4-TRICHLOROBENZENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0063	1,2-DICHLOROPROPANE	D	8	3.5	0.4	1.73	1.24E+00	ug/L
DOH	0063	1,2-DICHLOROPROPANE	ND	287	0	0	0.00	0.00E+00	ug/L
DOH	0154	1,3 - DICHLOROPROPENE	ND	11	0	0	0.00	0.00E+00	ug/L
DOH	0089	1,3,5, TRIMETHYLBENZENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0070	1,3-DICHLOROPROPANE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0059	2,2 DICHLOROPROPANE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0112	ANTIMONY	LT	65	0.02	0.002	0.01	4.22E-03	mg/L
DOH	0112	ANTIMONY	ND	11	0	0	0.00	0.00E+00	mg/L
DOH	0004	ARSENIC	D	62	0.37	0	0.04	6.80E-02	mg/L
DOH	0004	ARSENIC	LT	394	0.025	0.001	0.01	1.91E-03	mg/L
DOH	0004	ARSENIC	ND	27	0	0	0.00	0.00E+00	mg/L
DOH	0115	ASBESTOS	D	2	0	0	0.00	0.00E+00	MFL
DOH	0115	ASBESTOS	LT	1	0.191	0.191	0.19		MFL
DOH	0005	BARIUM	D	89	1.2	0	0.08	1.48E-01	mg/L
DOH	0005	BARIUM	LT	361	1	0.01	0.20	1.05E-01	mg/L
DOH	0005	BARIUM	ND	17	0	0	0.00	0.00E+00	mg/L
DOH	0049	BENZENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0110	BERYLLIUM	D	2	0.0006	0.0006	0.00	0.00E+00	mg/L
DOH	0110	BERYLLIUM	LT	63	0.02	0.0005	0.00	2.69E-03	mg/L

Data Source	Parameter Number	Parameter Name	Lab Qualifier	Number of Samples	Maximum Result	Minimum Result	Average Result	Standard Deviation	Units
DOH	0110	BERYLLIUM	ND	10	0	0	0.00	0.00E+00	mg/L
DOH	0078	BROMOBENZENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0086	BROMOCHLOROMETHANE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0028	BROMODICHLOROMETHANE	D	35	19.4	0.7	4.55	4.58E+00	ug/L
DOH	0028	BROMODICHLOROMETHANE	ND	258	0	0	0.00	0.00E+00	ug/L
DOH	0030	BROMOFORM	D	15	17.4	0.6	4.07	5.21E+00	ug/L
DOH	0030	BROMOFORM	ND	273	0	0	0.00	0.00E+00	ug/L
DOH	0054	BROMOMETHANE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0006	CADMIUM	D	36	0.009	0	0.00	2.05E-03	mg/L
DOH	0006	CADMIUM	LT	393	0.01	0	0.00	7.91E-04	mg/L
DOH	0006	CADMIUM	ND	34	0	0	0.00	0.00E+00	mg/L
DOH	0048	CARBON TETRACHLORIDE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0021	CHLORIDE	D	425	1301	0	74.61	1.38E+02	mg/L
DOH	0021	CHLORIDE	LT	101	20	1	6.40	3.38E+00	mg/L
DOH	0021	CHLORIDE	ND	3	0	0	0.00	0.00E+00	mg/L
DOH	0071	CHLOROBENZENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0156	CHLORODIBROMOMETHANE	D	18	16.8	0.5	3.12	5.02E+00	mg/L
DOH	0156	CHLORODIBROMOMETHANE	ND	48	0	0	0.00	0.00E+00	mg/L
DOH	0055	CHLOROETHANE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0027	CHLOROFORM	D	42	74.6	0.5	13.47	2.18E+01	ug/L
DOH	0027	CHLOROFORM	ND	246	0	0	0.00	0.00E+00	ug/L
DOH	0053	CHLOROMETHANE	D	5	3.2	0.7	1.40	1.02E+00	ug/L
DOH	0053	CHLOROMETHANE	ND	286	0	0	0.00	0.00E+00	ug/L
DOH	0007	CHROMIUM	D	29	0.05	0	0.01	1.15E-02	mg/L
DOH	0007	CHROMIUM	LT	405	0.05	0.001	0.01	3.09E-03	mg/L
DOH	0007	CHROMIUM	ND	33	0	0	0.00	0.00E+00	mg/L
DOH	0060	CIS-1,2-DICHLOROETHYLENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0065	CIS-1,3-DICHLOROPROPENE	ND	286	0	0	0.00	0.00E+00	ug/L
DOH	0018	COLOR	D	167	530	0	11.95	4.12E+01	Color Units
DOH	0018	COLOR	GT	9	15	5	8.33	4.33E+00	Color Units
DOH	0018	COLOR	LT	282	10	0.1	5.03	7.26E-01	Color Units
DOH	0018	COLOR	ND	14	0	0	0.00	0.00E+00	Color Units
DOH	0016	CONDUCTIVITY	D	502	1750	0	327.80	2.30E+02	umhos/cm
DOH	0023	COPPER	D	32	0.3	0	0.06	8.76E-02	mg/L
DOH	0023	COPPER	LT	150	0.3	0.005	0.13	8.49E-02	mg/L
DOH	0023	COPPER	ND	32	0	0	0.00	0.00E+00	mg/L

Data Source	Parameter Number	Parameter Name	Lab Qualifier	Number of Samples	Maximum Result	Minimum Result	Average Result	Standard Deviation	Units
DOH	0116	CYANIDE	D	4	0.03	0.01	0.02	9.45E-03	mg/L
DOH	0116	CYANIDE	LT	54	0.1	0.005	0.04	3.86E-02	mg/L
DOH	0116	CYANIDE	ND	10	0	0	0.00	0.00E+00	mg/L
DOH	0103	DBCP (TOTAL)	ND	11	0	0	0.00	0.00E+00	ug/L
DOH	0029	DIBROMOCHLOROMETHANE	D	28	13.7	0.5	2.49	3.32E+00	ug/L
DOH	0029	DIBROMOCHLOROMETHANE	ND	232	0	0	0.00	0.00E+00	ug/L
DOH	0064	DIBROMOMETHANE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0158	DICHLOROBENZENE	ND	11	0	0	0.00	0.00E+00	ug/L
DOH	0104	DICHLORODIFLUOROMETHANE	ND	264	0	0	0.00	0.00E+00	pci/L
DOH	0162	DICHLORODIFLUOROMETHANE	ND	27	0	0	0.00	0.00E+00	ug/L
DOH	0102	EDB (ETHYLENE DIBROMIDE)	ND	11	0	0	0.00	0.00E+00	ug/L
DOH	0073	ETHYLBENZENE	D	1	0.5	0.5	0.50		ug/L
DOH	0073	ETHYLBENZENE	ND	290	0	0	0.00	0.00E+00	ug/L
DOH	0254	FLUORENE	D	3	4.2	0.9	2.23	1.74E+00	ug/L
DOH	0254	FLUORENE	ND	228	0	0	0.00	0.00E+00	ug/L
DOH	0019	FLUORIDE	D	128	1.5	0	0.32	2.09E-01	mg/L
DOH	0019	FLUORIDE	LT	309	0.5	0.1	0.21	5.81E-02	mg/L
DOH	0019	FLUORIDE	ND	29	0	0	0.00	0.00E+00	mg/L
DOH	0163	FLUOROTRICHLOROMETHANE	ND	14	0	0	0.00	0.00E+00	ug/L
DOH	0015	HARDNESS	D	457	432	0	93.16	5.88E+01	mg/L
DOH	0015	HARDNESS	LT	9	54	5	16.44	1.46E+01	mg/L
DOH	0097	HEXACHLOROBUTADIENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0008	IRON	D	277	41.1	0	0.72	3.02E+00	mg/L
DOH	0008	IRON	LT	214	0.18	0.01	0.07	3.13E-02	mg/L
DOH	0008	IRON	ND	9	0	0	0.00	0.00E+00	mg/L
DOH	0087	ISOPROPYLBENZENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0009	LEAD	D	73	0.16	0	0.01	2.32E-02	mg/L
DOH	0009	LEAD	LT	373	0.01	0.0005	0.01	3.78E-03	mg/L
DOH	0009	LEAD	ND	30	0	0	0.00	0.00E+00	mg/L
DOH	0074	M/P XYLENES (MCL FOR TOTAL)	D	2	1.7	0.5	1.10	8.49E-01	ug/L
DOH	0074	M/P XYLENES (MCL FOR TOTAL)	ND	285	0	0	0.00	0.00E+00	ug/L
DOH	0010	MANGANESE	D	347	232	0	0.78	1.25E+01	mg/L
DOH	0010	MANGANESE	LT	156	0.07	0.0002	0.01	8.94E-03	mg/L
DOH	0010	MANGANESE	ND	10	0	0	0.00	0.00E+00	mg/L
DOH	0083	M-DICHLOROBENZENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0011	MERCURY	D	90	0.0082	0	0.00	8.49E-04	mg/L

Data Source	Parameter Number	Parameter Name	Lab Qualifier	Number of Samples	Maximum Result	Minimum Result	Average Result	Standard Deviation	Units
DOH	0011	MERCURY	LT	343	0.005	0.0001	0.00	4.55E-04	mg/L
DOH	0011	MERCURY	ND	33	0	0	0.00	0.00E+00	mg/L
DOH	0056	METHYLENE CHLORIDE (DICHLOROME)	ND	60	0	0	0.00	0.00E+00	ug/L
DOH	0159	MONOCHLOROBENZENE	ND	11	0	0	0.00	0.00E+00	ug/L
DOH	0094	N - BUTYLBENZENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0096	NAPHTHALENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0111	NICKEL	D	1	0.038	0.038	0.04		mg/L
DOH	0111	NICKEL	LT	62	0.04	0.001	0.01	1.18E-02	mg/L
DOH	0111	NICKEL	ND	10	0	0	0.00	0.00E+00	mg/L
DOH	0020	NITRATE-N	D	484	39.5	0	4.67	5.21E+00	mg/L
DOH	0020	NITRATE-N	LT	204	6.2	0.1	0.38	4.79E-01	mg/L
DOH	0020	NITRATE-N	ND	42	0	0	0.00	0.00E+00	mg/L
DOH	0114	NITRITE-N	D	10	0.5	0	0.07	1.54E-01	mg/L
DOH	0114	NITRITE-N	LT	87	5	0.05	0.56	5.22E-01	mg/L
DOH	0114	NITRITE-N	ND	20	0	0	0.00	0.00E+00	mg/L
DOH	0088	N-PROPYLBENZENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0081	O-CHLOROTOLUENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0084	O-DICHLOROBENZENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0075	O-XYLENE (MCL FOR TOTAL)	D	1	0.7	0.7	0.70		ug/L
DOH	0075	O-XYLENE (MCL FOR TOTAL)	ND	286	0	0	0.00	0.00E+00	ug/L
DOH	0082	P-CHLOROTOLUENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0052	P-DICHLOROBENZENE	D	2	1	1	1.00	0.00E+00	ug/L
DOH	0052	P-DICHLOROBENZENE	ND	289	0	0	0.00	0.00E+00	ug/L
DOH	0093	P-ISOPROPYLTOLUENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0092	SEC - BUTYLBENZENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0012	SELENIUM	D	30	0.015	0	0.01	3.27E-03	mg/L
DOH	0012	SELENIUM	LT	404	0.205	0.001	0.01	1.00E-02	mg/L
DOH	0012	SELENIUM	ND	31	0	0	0.00	0.00E+00	mg/L
DOH	0013	SILVER	D	22	0.01	0	0.00	3.26E-03	mg/L
DOH	0013	SILVER	LT	409	0.02	0.001	0.01	3.84E-03	mg/L
DOH	0013	SILVER	ND	34	0	0	0.00	0.00E+00	mg/L
DOH	0014	SODIUM	D	395	325	0	45.37	5.81E+01	mg/L
DOH	0014	SODIUM	LT	63	10	0.005	5.90	2.39E+00	mg/L
DOH	0014	SODIUM	ND	1	0	0	0.00		mg/L
DOH	0076	STYRENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0022	SULFATE	D	104	167	0	23.54	2.19E+01	mg/L

Data Source	Parameter Number	Parameter Name	Lab Qualifier	Number of Samples	Maximum Result	Minimum Result	Average Result	Standard Deviation	Units
DOH	0022	SULFATE	LT	28	29	5	12.36	8.46E+00	mg/L
DOH	0057	T-1,2-DICHLOROETHYLENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0026	TDS-TOTAL DISSOLVED SOLIDS	D	66	1070	0	289.50	2.75E+02	mg/L
DOH	0026	TDS-TOTAL DISSOLVED SOLIDS	LT	3	680	108	463.33	3.10E+02	mg/L
DOH	0026	TDS-TOTAL DISSOLVED SOLIDS	ND	2	0	0	0.00	0.00E+00	mg/L
DOH	0090	TERT-BUTYLBENZENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0068	TETRACHLOROETHYLENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0113	THALLIUM	LT	65	0.002	0.001	0.00	1.74E-04	mg/L
DOH	0113	THALLIUM	ND	10	0	0	0.00	0.00E+00	mg/L
DOH	0066	TOLUENE	D	3	1.1	0.96	1.01	8.08E-02	ug/L
DOH	0066	TOLUENE	ND	288	0	0	0.00	0.00E+00	ug/L
DOH	0161	TOTAL NITRATE/NITRITE	ND	2	0	0	0.00	0.00E+00	ug/L
DOH	0031	TOTAL TRIHALOMETHANE	D	1	77.5	77.5	77.50		ug/L
DOH	0031	TOTAL TRIHALOMETHANE	ND	35	0	0	0.00	0.00E+00	ug/L
DOH	0160	TOTAL XYLENES	ND	36	0	0	0.00	0.00E+00	ug/L
DOH	0069	TRANS-1,3-DICHLOROPROPENE	ND	286	0	0	0.00	0.00E+00	ug/L
DOH	0051	TRICHLOROETHYLENE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0085	TRICHLOROFLUOROMETHANE	D	1	1.9	1.9	1.90		ug/L
DOH	0085	TRICHLOROFLUOROMETHANE	ND	287	0	0	0.00	0.00E+00	ug/L
DOH	0017	TURBIDITY	D	465	123.3	0	1.74	8.14E+00	NTU
DOH	0017	TURBIDITY	LT	11	1	0.1	0.36	2.91E-01	NTU
DOH	0017	TURBIDITY	ND	1	0	0	0.00		NTU
DOH	0045	VINYL CHLORIDE	ND	291	0	0	0.00	0.00E+00	ug/L
DOH	0024	ZINC	D	32	8	0	0.39	1.42E+00	mg/L
DOH	0024	ZINC	LT	153	0.3	0	0.14	8.30E-02	mg/L
DOH	0024	ZINC	ND	30	0	0	0.00	0.00E+00	mg/L

Table 8: Washington Department of Ecology EILS Program Sampled Parameters

Does not include 1997 Nitrate data.
Lab Qualifiers: D – Detect; J – Estimated; U – Not Detected; B – Analyte found in method blank

Data Source	Parameter Number	Parameter Name	Lab Qualifier	Number of Samples	Maximum Result	Minimum Result	Average Result	Standard Deviation	Units
EILS	9612	1,2-Dibromo-3-Chloropropane (Dbcp)	D	1	0.36	0.36	0.36		ug/l
EILS	9612	1,2-Dibromo-3-Chloropropane (Dbcp)	J	3	0.3	0.3	0.30	6.08E-09	ug/l
EILS	9612	1,2-Dibromo-3-Chloropropane (Dbcp)	U	32	0.01	0.01	0.01	3.55E-10	ug/l
EILS	7887	1,2-Dichloropropane	D	18	24	0.3	7.08	6.73E+00	ug/l
EILS	7887	1,2-Dichloropropane	J	2	0.4	0.4	0.40	0.00E+00	ug/l
EILS	7887	1,2-Dichloropropane	U	21	0.2	0.1	0.20	2.18E-02	ug/l
EILS	9376	2,4,5-T	U	29	0.2	0.2	0.20	2.96E-09	ug/l
EILS	9372	2,4,5-Tp (Silvex)	U	29	0.2	0.2	0.20	2.96E-09	ug/l
EILS	9475	2,4-D	U	29	0.5	0.5	0.50	0.00E+00	ug/l
EILS	9482	2,4-Db	U	29	2	2	2.00	0.00E+00	ug/l
EILS	5136	3,5-Dichlorobenzoic	U	29	0.6	0.6	0.60	8.37E-09	ug/l
EILS	1000	4-Nitrophenol	U	29	5	5	5.00	0.00E+00	ug/l
EILS	7600	5-Hydroxydicamba	U	29	0.2	0.2	0.20	2.96E-09	ug/l
EILS	6247	Acifluorfen (Blazer)	U	29	0.2	0.2	0.20	2.96E-09	ug/l
EILS	1597	Alachlor	U	34	1	1	1.00	0.00E+00	ug/l
EILS	1160	Aldicarb	U	29	1.5	1.5	1.50	0.00E+00	ug/l
EILS	1646	Aldicarb Sulfone	U	29	1	1	1.00	0.00E+00	ug/l
EILS	1646	Aldicarb Sulfoxide	U	29	1	1	1.00	0.00E+00	ug/l
EILS	8341	Ametryn	U	34	0.3	0.3	0.30	8.72E-09	ug/l
EILS	7440	Arsenic	B	4	0.67	0.2	0.35	2.21E-01	ug/l
EILS	7440	Arsenic	D	3	1.7	1.59	1.65	5.51E-02	ug/l
EILS	7440	Arsenic	U	1	0.2	0.2	0.20		ug/l
EILS	1912	Atrazine	U	34	0.3	0.2	0.20	1.72E-02	ug/l
EILS	1142	Baygon (Propoxur)	U	32	5	1.1	1.47	1.15E+00	ug/l
EILS	2505	Bentazon	U	29	0.5	0.5	0.50	0.00E+00	ug/l
EILS	ALK-	Bicarbonate alkalinity as CaCO3	D	8	47	8	34.88	1.25E+01	mg/l
EILS	3144	Bromacil	U	34	2.2	2.2	2.20	5.69E-08	ug/l
EILS	7440	Cadmium	D	4	0.36	0.2	0.29	6.63E-02	ug/l
EILS	7440	Cadmium	U	4	0.2	0.2	0.20	0.00E+00	ug/l
EILS	7440	Calcium	D	8	29.3	15.1	20.80	5.76E+00	mg/l
EILS	1563	Carbofuran	J	1	2.4	2.4	2.40		ug/l

Data Source	Parameter Number	Parameter Name	Lab Qualifier	Number of Samples	Maximum Result	Minimum Result	Average Result	Standard Deviation	Units
EILS	1563	Carbofuran	U	31	2	0.5	0.65	4.50E-01	ug/l
EILS	ALK-	Carbonate alkalinity as CaCO3	U	8	1	1	1.00	0.00E+00	mg/l
EILS	5234	Carboxin	U	34	1	1	1.00	0.00E+00	ug/l
EILS	1339	Chloramben	U	29	0.5	0.5	0.50	0.00E+00	ug/l
EILS	CL	Chloride	D	8	25	10	15.88	4.45E+00	mg/l
EILS	7440	Chromium	U	8	5	5	5.00	0.00E+00	ug/l
EILS	7440	Copper	D	7	77.5	5.7	17.67	2.64E+01	ug/l
EILS	7440	Copper	U	1	5	5	5.00		ug/l
EILS	2172	Cyanazine	U	29	0.8	0.8	0.80	1.18E-08	ug/l
EILS	1134	Cycloate	U	34	0.4	0.4	0.40	7.12E-09	ug/l
EILS	1861	Dacthal (DCPA)	U	29	0.2	0.2	0.20	2.96E-09	ug/l
EILS	7599	Dalapon (Dpa)	U	29	5	5	5.00	0.00E+00	ug/l
EILS	1918	Dicamba II	U	29	0.2	0.2	0.20	2.96E-09	ug/l
EILS	1203	Dichloroprop	U	29	0.5	0.5	0.50	0.00E+00	ug/l
EILS	8885	Dinoseb	U	29	2.5	2.5	2.50	0.00E+00	ug/l
EILS	9575	Diphenamid	U	34	0.4	0.4	0.40	7.12E-09	ug/l
EILS	3305	Diuron	U	29	0.5	0.5	0.50	0.00E+00	ug/l
EILS	1069	EDB (Ethylene Dibromide)	D	2	2.95	0.02	1.49	2.07E+00	ug/l
EILS	1069	EDB (Ethylene Dibromide)	J	3	1.72	1.5	1.58	1.22E-01	ug/l
EILS	1069	EDB (Ethylene Dibromide)	U	31	0.01	0.01	0.01	3.46E-10	ug/l
EILS	2222	Fenamiphos	U	34	0.3	0.3	0.30	8.72E-09	ug/l
EILS	5123	Hexazinone	U	34	0.3	0.3	0.30	8.72E-09	ug/l
EILS	7439	Iron, total	D	4	8.19	0.011	2.08	4.07E+00	mg/l
EILS	7439	Iron, total	U	4	0.01	0.01	0.01	0.00E+00	mg/l
EILS	7439	Lead	D	3	50	5.4	21.77	2.46E+01	ug/l
EILS	7439	Lead	U	9	5	1	3.22	2.11E+00	ug/l
EILS	7439	Magnesium	D	8	12.7	4.48	6.53	3.03E+00	mg/l
EILS	7439	Manganese	D	3	0.34	0.01	0.13	1.82E-01	mg/l
EILS	7439	Manganese	U	5	0.01	0.01	0.01	1.47E-10	mg/l
EILS	7439	Mercury	U	8	0.08	0.08	0.08	9.96E-10	ug/l
EILS	1675	Methomyl	U	29	0.5	0.5	0.50	0.00E+00	ug/l
EILS	5121	Metolachlor	U	34	1.5	1.5	1.50	0.00E+00	ug/l
EILS	2108	Metribuzin	U	34	0.4	0.4	0.40	7.12E-09	ug/l
EILS	7440	Nickel	U	8	10	10	10.00	0.00E+00	ug/l
EILS	NO2/	Nitrate+Nitrite-N, Total	D	42	24.45	0.28	8.45	5.55E+00	mg/l
EILS	NO2/	Nitrate+Nitrite-N, Total	U	1	0.01	0.01	0.01		mg/l

Data Source	Parameter Number	Parameter Name	Lab Qualifier	Number of Samples	Maximum Result	Minimum Result	Average Result	Standard Deviation	Units
EILS	2313	Oxamyl (Vydate)	U	29	0.6	0.6	0.60	8.37E-09	ug/l
EILS	8786	Pentachlorophenol	U	29	0.2	0.2	0.20	2.96E-09	ug/l
EILS	7723	Phosphorus-P, dissolved and total	D	32	0.058	0.001	0.01	1.34E-02	mg/l
EILS	7723	Phosphorus-P, dissolved and total	U	11	0.01	0.01	0.01	2.18E-10	mg/l
EILS	1918	Picloram	U	29	1	1	1.00	0.00E+00	ug/l
EILS	7440	Potassium	D	43	17.1	0.36	2.97	4.12E+00	mg/l
EILS	1610	Prometon (Pramitol 5p)	D	6	6	0.5	1.65	2.14E+00	ug/l
EILS	1610	Prometon (Pramitol 5p)	U	28	0.3	0.3	0.30	6.13E-09	ug/l
EILS	1394	Propazine	U	34	0.2	0.2	0.20	3.56E-09	ug/l
EILS	1224	Propham	U	29	0.5	0.5	0.50	0.00E+00	ug/l
EILS	7782	Selenium	B	1	2.2	2.2	2.20		ug/l
EILS	7782	Selenium	U	7	1	1	1.00	0.00E+00	ug/l
EILS	1223	Simazine	U	34	0.8	0.5	0.76	1.08E-01	ug/l
EILS	7440	Sodium	D	8	18	4.3	11.31	5.47E+00	mg/l
EILS	SO4	Sulfate	D	8	86	7.7	25.84	2.52E+01	mg/l
EILS	3401	Tebuthiuron	U	34	0.4	0.4	0.40	7.12E-09	ug/l
EILS	5902	Terbacil	U	34	3.5	3.5	3.50	0.00E+00	ug/l
EILS	TDS	Total dissolved solids	D	43	720	80	182.91	9.52E+01	mg/l
EILS	TOC	Total organic carbon	D	43	13	1.3	4.27	1.98E+00	mg/l
EILS	TOH	Total organic halides	D	36	54	5	17.25	1.21E+01	ug/l
EILS	TOH	Total organic halides	U	6	5	5	5.00	0.00E+00	ug/l
EILS	7440	Zinc	D	8	78.8	5	23.96	2.59E+01	ug/l

Table 9: United States Geological Survey Sampled Parameters

Data Source	Para-meter Number	Parameter Name	Lab Quali-fier	Number of Samples	Maximum Result	Minimum Result	Average Result	Standard Deviation	Units
USGS	7756	1,1,1,2-TETRACHLORO	LT	29	0.2	0.05	0.18	5.26E-02	UG/L
USGS	3451	1,1,2,2-TETRACHLOROETHANE	LT	29	0.2	0.1	0.19	3.51E-02	UG/L
USGS	7716	1,1-DICHLOROPROP	LT	29	0.2	0.05	0.18	5.26E-02	UG/L
USGS	7761	1,2,3-TRICHLORO	LT	4	0.2	0.2	0.20	0.00E+00	UG/L
USGS	3455	1,2,4-TRICHLOROBENZENE	LT	4	0.2	0.2	0.20	0.00E+00	UG/L
USGS	3210	1,2-DICHLOROETHANE	LT	29	0.2	0.05	0.18	5.26E-02	UG/L
USGS	7765	1,2DIBROMOETHANE	D	2	0.3	0.3	0.30	0.00E+00	UG/L
USGS	7765	1,2DIBROMOETHANE	LT	27	0.2	0.1	0.19	3.62E-02	UG/L

Data Source	Para- meter Number	Parameter Name	Lab Quali- fier	Number of Samples	Maximum Result	Minimum Result	Average Result	Standard Deviation	Units
USGS	4561	1,2DICHLETHENE,W	LT	25	0.2	0.2	0.20	0.00E+00	UG/L
USGS	3456	1,3-DICHLOROBENZENE	LT	29	0.2	0.05	0.18	5.26E-02	UG/L
USGS	7717	1,3DICHLPROPANE	D	2	0.2	0.2	0.20	0.00E+00	UG/L
USGS	7717	1,3DICHLPROPANE	LT	27	0.2	0.05	0.18	5.43E-02	UG/L
USGS	3457	1,4-DICHLOROBENZENE	LT	29	0.2	0.05	0.18	5.26E-02	UG/L
USGS	4929	1-NAPHTHOL FLTRD	LT	6	0.007	0.007	0.01	8.50E-11	UG/L
USGS	7744	1-NAPHTHOL, WHOLE	LT	2	0.5	0.5	0.50	0.00E+00	UG/L
USGS	7744	123TRICHLPROPANE	D	2	1.4	1.2	1.30	1.41E-01	UG/L
USGS	7744	123TRICHLPROPANE	LT	27	0.2	0.2	0.20	0.00E+00	UG/L
USGS	7722	124-TRIMETHYLBEN	E	2	0.01	0.01	0.01	0.00E+00	UG/L
USGS	7722	124-TRIMETHYLBEN	LT	2	0.05	0.05	0.05	0.00E+00	UG/L
USGS	7722	135-TRIMETHYL BE	LT	4	0.05	0.05	0.05	0.00E+00	UG/L
USGS	7717	2,2-DICHLOROPROP	LT	29	0.2	0.05	0.18	5.26E-02	UG/L
USGS	3974	2,4,5-T DISSOLVED	LT	6	0.035	0.035	0.04	0.00E+00	UG/L
USGS	3973	2,4-D DISSOLVED	LT	5	0.035	0.035	0.04	0.00E+00	UG/L
USGS	3874	2,4-DB FLTRD	LT	6	0.035	0.035	0.04	0.00E+00	UG/L
USGS	7354	2-BUTENE T-1,4-D	LT	4	5	5	5.00	0.00E+00	UG/L
USGS	7710	2-HEXANONE,TOTAL	LT	4	5	5	5.00	0.00E+00	UG/L
USGS	8266	26DIETHYLANILINE	LT	19	0.003	0.003	0.00	7.12E-11	UG/L
USGS	8258	3-HYDRX. CARBOFU	LT	2	0.5	0.5	0.50	0.00E+00	UG/L
USGS	4930	3HYDRXYCARBOFURA	LT	6	0.014	0.014	0.01	1.70E-10	UG/L
USGS	7705	ACETATE, VINYL	LT	4	5	5	5.00	0.00E+00	UG/L
USGS	4926	ACETOCHLOR FLTRD	LT	6	0.002	0.002	0.00	3.01E-11	UG/L
USGS	8155	ACETONE,TOTAL	LT	4	5	5	5.00	0.00E+00	UG/L
USGS	4931	ACIFLUORFEN FLTR	LT	6	0.035	0.035	0.04	0.00E+00	UG/L
USGS	3421	ACROLEIN TOTAL	LT	4	2	2	2.00	0.00E+00	UG/L
USGS	3421	ACRYLONITRILE TOTAL	LT	4	2	2	2.00	0.00E+00	UG/L
USGS	4634	ALACHLOR, DISSOLVED	LT	19	0.002	0.002	0.00	5.63E-11	UG/L
USGS	7782	ALACHLOR, TOT RE	LT	24	0.2	0.1	0.12	4.15E-02	UG/L
USGS	8261	ALDICARB	LT	2	0.5	0.5	0.50	0.00E+00	UG/L
USGS	4931	ALDICARB FLTRD	LT	6	0.016	0.016	0.02	2.40E-10	UG/L
USGS	4931	ALDICARB SULFONE	LT	6	0.016	0.016	0.02	2.40E-10	UG/L
USGS	8258	ALDICARB SULFONE	LT	2	0.5	0.5	0.50	0.00E+00	UG/L
USGS	8258	ALDICARB SULFOXI	LT	2	0.5	0.5	0.50	0.00E+00	UG/L
USGS	4931	ALDICARB SULFOXI	LT	6	0.035	0.021	0.02	5.72E-03	UG/L
USGS	9041	ALKALINITY	D	147	605	9.2	115.99	1.08E+02	MG/L AS CAC

Data Source	Para-meter Number	Parameter Name	Lab Quali-fier	Number of Samples	Maximum Result	Minimum Result	Average Result	Standard Deviation	Units
USGS	9041	ALKALINITY	LT	1	1	1	1.00		MG/L AS CAC
USGS	3908	ALKALINITY,DIS,I	D	6	88	18	49.33	3.18E+01	MG/L AS CACO
USGS	0041	ALKALINITY,WH,FE	D	84	387	16	141.58	8.66E+01	MG/L AS CACO
USGS	0041	ALKALINITY,WH,IT	D	90	606	8	106.61	1.14E+02	MG/L AS CACO
USGS	3425	ALPHA BHC	LT	19	0.002	0.002	0.00	5.63E-11	UG/L
USGS	3479	ALUMINUM BM<63 D	D	3	8.3	7.5	7.80	4.36E-01	PERCENT
USGS	0110	ALUMINUM DISSOLVED	D	1	10	10	10.00		UG/L AS AL
USGS	0110	ALUMINUM DISSOLVED	LT	1	10	10	10.00		UG/L AS AL
USGS	0110	ALUMINUM TOTAL	D	4	1800	20	600.00	8.37E+02	UG/L AS AL
USGS	0110	ALUMINUM TOTAL	LT	3	10	10	10.00	0.00E+00	UG/L AS AL
USGS	8218	AMETRYNE	LT	24	0.1	0.1	0.10	1.27E-09	UG/L
USGS	3480	ARSENIC BM<63 DS	D	1	10	10	10.00		UG/G
USGS	3480	ARSENIC BM<63 DS	LT	2	10	10	10.00	0.00E+00	UG/G
USGS	0100	ARSENIC DISSOLVED	D	6	6	1	2.67	2.58E+00	UG/L AS AS
USGS	0100	ARSENIC DISSOLVED	LT	14	1	1	1.00	0.00E+00	UG/L AS AS
USGS	3963	ATRAZINE UNF REC	D	1	0.1	0.1	0.10		UG/L
USGS	3963	ATRAZINE UNF REC	LT	23	0.1	0.1	0.10	0.00E+00	UG/L
USGS	3963	ATRAZINE, DISSOLVED	D	1	0.024	0.024	0.02		UG/L
USGS	3963	ATRAZINE, DISSOLVED	E	1	0.003	0.003	0.00		UG/L
USGS	3963	ATRAZINE, DISSOLVED	LT	17	0.001	0.001	0.00	3.16E-11	UG/L
USGS	3480	BARIUM BM<63 DSL	D	3	550	530	540.00	1.00E+01	UG/G
USGS	0100	BARIUM DISSOLVED	D	27	1100	4	90.04	2.17E+02	UG/L AS BA
USGS	8267	BENFLURALIN FIL	LT	19	0.002	0.002	0.00	5.63E-11	UG/L
USGS	3871	BENTAZON, FLTRD	LT	6	0.014	0.014	0.01	1.70E-10	UG/L
USGS	7722	BENZENE 123TRIME	LT	4	0.05	0.05	0.05	0.00E+00	UG/L
USGS	3403	BENZENE, TOTAL	LT	29	0.2	0.05	0.18	5.26E-02	UG/L
USGS	3481	BERYLLIUM BM<63	D	3	1	1	1.00	0.00E+00	UG/G
USGS	0101	BERYLLIUM DISSOLVED	LT	7	1.5	0.5	0.64	3.78E-01	UG/L AS BE
USGS	0044	BICARBONATE,WH,F	D	84	470	20	171.50	1.04E+02	MG/L AS HCO3
USGS	0045	BICARBONATE,WH,I	D	90	715	10	126.64	1.31E+02	MG/L AS HCO3
USGS	3481	BISMUTH BM<63 DS	LT	3	10	10	10.00	0.00E+00	UG/G
USGS	0102	BORON DISSOLVED	D	51	890	10	91.57	1.79E+02	UG/L AS B
USGS	0102	BORON DISSOLVED	LT	16	10	10	10.00	0.00E+00	UG/L AS B
USGS	0402	BROMACIL DISS RE	LT	6	0.035	0.035	0.04	0.00E+00	UG/L
USGS	3023	BROMACIL xTR, xH	LT	5	0.2	0.2	0.20	3.33E-09	UG/L
USGS	7187	BROMIDE DISSOLVED	D	73	3.1	0.01	0.24	5.26E-01	MG/L AS BR

Data Source	Para-meter Number	Parameter Name	Lab Quali-fier	Number of Samples	Maximum Result	Minimum Result	Average Result	Standard Deviation	Units
USGS	7187	BROMIDE DISSOLVED	LT	8	0.01	0.01	0.01	1.24E-10	MG/L AS BR
USGS	8155	BROMOBENZENE WAT	LT	29	0.2	0.05	0.18	5.26E-02	UG/L
USGS	5000	BROMOETHENE	LT	4	0.1	0.1	0.10	0.00E+00	UG/L
USGS	3210	BROMOFORM TOTAL	LT	29	0.2	0.2	0.20	2.96E-09	UG/L
USGS	4931	BROMOXYNIL FLTRD	LT	6	0.035	0.035	0.04	0.00E+00	UG/L
USGS	3023	BUTACHLOR xTR xH	LT	5	0.1	0.1	0.10	1.67E-09	UG/L
USGS	0402	BUTYLATE DISS RE	LT	19	0.002	0.002	0.00	5.63E-11	UG/L
USGS	3023	BUTYLATE xTR, xH	LT	5	0.1	0.1	0.10	1.67E-09	UG/L
USGS	3482	CADMIUM BM<63 DS	LT	3	2	2	2.00	0.00E+00	UG/G
USGS	0102	CADMIUM DISSOLVED	D	2	3	1	2.00	1.41E+00	UG/L AS CD
USGS	0102	CADMIUM DISSOLVED	LT	25	3	1	1.08	4.00E-01	UG/L AS CD
USGS	3483	CALCIUM BM<63 DS	D	3	1.7	1.5	1.60	1.00E-01	PERCENT
USGS	0091	CALCIUM DISSOLVED	D	229	320	2	28.51	2.87E+01	MG/L AS CA
USGS	8268	CARBARYL FIL 0.7	LT	19	0.003	0.003	0.00	7.12E-11	UG/L
USGS	4931	CARBARYL FLTRD	LT	6	0.008	0.008	0.01	1.20E-10	UG/L
USGS	3975	CARBARYL UNFILT	LT	23	0.5	0.5	0.50	0.00E+00	UG/L
USGS	8261	CARBOFURAN	LT	2	0.5	0.5	0.50	0.00E+00	UG/L
USGS	8267	CARBOFURAN FIL .	LT	19	0.003	0.003	0.00	7.12E-11	UG/L
USGS	4930	CARBOFURAN FLTRD	LT	6	0.028	0.028	0.03	3.40E-10	UG/L
USGS	0040	CARBON DIOXIDE DISSOLVED	D	64	41	0.5	8.96	9.19E+00	MG/L AS CO2
USGS	7704	CARBON DISULFIDE	E	3	0.4	0.01	0.14	2.25E-01	UG/L
USGS	7704	CARBON DISULFIDE	LT	1	0.05	0.05	0.05		UG/L
USGS	0068	CARBON INORG. BO	LT	2	0.1	0.1	0.10	0.00E+00	GM/KG AS C
USGS	0068	CARBON ORGANIC DISSOLVED	D	81	39	0.2	1.96	5.14E+00	MG/L AS C
USGS	0068	CARBON ORGANIC TOTAL	D	3	48	1.6	18.23	2.58E+01	MG/L AS C
USGS	0069	CARBON TOTAL BOT	D	2	36	35	35.50	7.07E-01	GM/KG AS C
USGS	0044	CARBONATE,WH,FET	D	4	35	2	13.00	1.49E+01	MG/L AS CO3
USGS	0044	CARBONATE,WH,FET	ND	36	0	0	0.00	0.00E+00	MG/L AS CO3
USGS	0044	CARBONATE,WH,IT,	D	9	31	1	15.78	9.72E+00	MG/L AS CO3
USGS	0044	CARBONATE,WH,IT,	ND	74	0	0	0.00	0.00E+00	MG/L AS CO3
USGS	3210	CARBONTETRACHLORIDE	LT	29	0.2	0.05	0.18	5.26E-02	UG/L
USGS	3024	CARBOOIN xTR, xH	LT	5	0.2	0.2	0.20	3.33E-09	UG/L
USGS	3483	CERIUM BM<63 DSL	D	3	46	41	44.00	2.65E+00	UG/G
USGS	4930	CHLORAMBEN FLTRD	LT	6	0.011	0.011	0.01	1.70E-10	UG/L
USGS	0094	CHLORIDE DISSOLVED	D	895	9400	0.8	113.46	5.04E+02	MG/L AS CL
USGS	0094	CHLORIDE DISSOLVED	GT	1	6000	6000	6000.00		MG/L AS CL

Data Source	Para-meter Number	Parameter Name	Lab Quali-fier	Number of Samples	Maximum Result	Minimum Result	Average Result	Standard Deviation	Units
USGS	0094	CHLORIDE DISSOLVED	LT	1	0.1	0.1	0.10		MG/L AS CL
USGS	0094	CHLORIDE DISSOLVED	N	1	7.4	7.4	7.40		MG/L AS CL
USGS	3430	CHLOROBENZENE	E	1	0.004	0.004	0.00		UG/L
USGS	3430	CHLOROBENZENE	LT	28	0.2	0.05	0.18	4.72E-02	UG/L
USGS	3210	CHLORODIBROMOMETHANE	LT	29	0.2	0.1	0.19	3.51E-02	UG/L
USGS	3431	CHLOROETHANE	LT	29	0.2	0.1	0.19	3.51E-02	UG/L
USGS	3210	CHLOROFORM TOTAL	E	1	0.005	0.005	0.01		UG/L
USGS	3210	CHLOROFORM TOTAL	LT	28	0.2	0.05	0.18	4.72E-02	UG/L
USGS	4930	CHLOROTHALONIL F	LT	6	0.035	0.035	0.04	0.00E+00	UG/L
USGS	3893	CHLORPYRIFOS, DI	LT	19	0.004	0.004	0.00	1.13E-10	UG/L
USGS	3484	CHROMIUM BM<63 D	D	3	130	110	116.67	1.15E+01	UG/G
USGS	0103	CHROMIUM DISSOLVED	D	2	10	2	6.00	5.66E+00	UG/L AS CR
USGS	0103	CHROMIUM DISSOLVED	LT	32	30	1	8.53	1.19E+01	UG/L AS CR
USGS	7709	CIS1,2DICHL.ETHE	LT	4	0.05	0.05	0.05	0.00E+00	UG/L
USGS	3470	CIS1,3-DICHL.PROP	LT	29	0.2	0.1	0.19	3.51E-02	UG/L
USGS	4930	CLOPYRALID FLTRD	LT	6	0.05	0.05	0.05	9.62E-10	UG/L
USGS	3484	COBALT BM<63 DSL	D	3	22	17	19.67	2.52E+00	UG/G
USGS	0103	COBALT DISSOLVED	LT	7	9	3	3.86	2.27E+00	UG/L AS CO
USGS	3162	COLIFORM FECAL 0	D	1	5	5	5.00		COLS./100 ML
USGS	3162	COLIFORM FECAL 0	LT	76	1	1	1.00	0.00E+00	COLS./100 ML
USGS	3161	COLIFORM, FECAL	D	5	6	1	3.80	2.28E+00	COLS./100 ML
USGS	3161	COLIFORM, FECAL	LT	10	1	1	1.00	0.00E+00	COLS./100 ML
USGS	0008	COLOR	D	9	40	3	10.67	1.22E+01	PLATINUM-COB
USGS	0008	COLOR	ND	9	0	0	0.00	0.00E+00	PLATINUM-COB
USGS	3485	COPPER BM<63 DSL	D	3	31	27	28.67	2.08E+00	UG/G
USGS	0104	COPPER DISSOLVED	D	22	190	1	28.14	5.05E+01	UG/L AS CU
USGS	0104	COPPER DISSOLVED	LT	12	50	10	35.00	1.93E+01	UG/L AS CU
USGS	8175	CYANAZINE	LT	24	0.2	0.1	0.12	4.15E-02	UG/L
USGS	0404	CYANAZINE DISS R	LT	19	0.004	0.004	0.00	1.13E-10	UG/L
USGS	3025	CYCLOATE xTR, xH	LT	5	0.1	0.1	0.10	1.67E-09	UG/L
USGS	4930	DACTHAL MONO-ACI	LT	6	0.017	0.017	0.02	2.40E-10	UG/L
USGS	8268	DCPA FIL 0.7 REC	LT	19	0.002	0.002	0.00	5.63E-11	UG/L
USGS	7598	DE-ISOPR ATRAZINE	LT	5	0.2	0.2	0.20	3.33E-09	UG/L
USGS	0404	DEETHYL ATRAZINE	E	3	0.011	0.002	0.01	4.58E-03	UG/L
USGS	7598	DEETHYL ATRAZINE	LT	5	0.2	0.2	0.20	3.33E-09	UG/L
USGS	0404	DEETHYL ATRAZINE	LT	16	0.002	0.002	0.00	6.01E-11	UG/L

Data Source	Para-meter Number	Parameter Name	Lab Quali-fier	Number of Samples	Maximum Result	Minimum Result	Average Result	Standard Deviation	Units
USGS	7200	DEPTH OF HOLE IN	D	9	185	84	143.67	3.19E+01	FT
USGS	7200	DEPTH OF WELL IN	D	1041	625	7	81.65	6.82E+01	FT
USGS	7201	DEPTH TOP OF SAM	D	56	277	12	118.29	5.58E+01	FT
USGS	7200	DEPTH-BOT.WATER	D	16	200	16	100.88	6.34E+01	FT
USGS	7200	DEPTH-TOP-WATER	D	25	178	12	97.16	5.25E+01	FT
USGS	7200	DEPTH-TOP-WATER	GT	4	1	1	1.00	0.00E+00	FT
USGS	3826	DETERGENTS [MBAS]	D	50	0.19	0.01	0.07	5.07E-02	MG/L
USGS	3826	DETERGENTS [MBAS]	LT	2	0.01	0.01	0.01	0.00E+00	MG/L
USGS	3826	DETERGENTS [MBAS]	ND	12	0	0	0.00	0.00E+00	MG/L
USGS	3957	DIAZINON DISSOLVED	LT	19	0.002	0.002	0.00	5.63E-11	UG/L
USGS	8262	DIBROMOCHLOROPRO	LT	4	0.5	0.5	0.50	0.00E+00	UG/L
USGS	3021	DIBROMOMETHANE,W	LT	29	0.2	0.1	0.19	3.51E-02	UG/L
USGS	3844	DICAMBA FLTRD	LT	6	0.035	0.035	0.04	0.00E+00	UG/L
USGS	4930	DICHLOBENIL FLTR	LT	6	0.02	0.02	0.02	2.40E-10	UG/L
USGS	3210	DICHLOROBROMOMETHANE	LT	29	0.2	0.1	0.19	3.51E-02	UG/L
USGS	3466	DICHLORODIFLUOROMETHANE	LT	29	0.2	0.2	0.20	2.96E-09	UG/L
USGS	3449	DICHLOROETHANE 1	LT	29	0.2	0.05	0.18	5.26E-02	UG/L
USGS	3450	DICHLOROETHYLENE	LT	29	0.2	0.1	0.19	3.51E-02	UG/L
USGS	3454	DICHLOROPROPANE	D	4	5.6	1.6	3.90	2.02E+00	UG/L
USGS	3454	DICHLOROPROPANE	LT	25	0.2	0.05	0.18	5.61E-02	UG/L
USGS	4930	DICHLORPRO FLTRD	LT	6	0.032	0.032	0.03	4.81E-10	UG/L
USGS	3938	DIELDRIN DISSOLVED	LT	19	0.001	0.001	0.00	2.82E-11	UG/L
USGS	8157	DIISOPROPYLETHER	LT	4	0.1	0.1	0.10	0.00E+00	UG/L
USGS	4930	DINOSEB FLTRD	LT	6	0.035	0.035	0.04	0.00E+00	UG/L
USGS	3025	DIPHNAMDWTR,WHLR	LT	5	0.1	0.1	0.10	1.67E-09	UG/L
USGS	7030	DISSOLVED SOLIDS	D	176	5630	53	314.07	5.70E+02	MG/L
USGS	8267	DISULFOTON FIL .	LT	19	0.017	0.017	0.02	4.93E-10	UG/L
USGS	4930	DIURON FLTRD	LT	6	0.02	0.02	0.02	2.40E-10	UG/L
USGS	4929	DNOC FLTD	LT	6	0.035	0.035	0.04	0.00E+00	UG/L
USGS	7201	DPTH BOT. OF SAM	D	57	282	16	129.07	5.40E+01	FT
USGS	7200	ELEV.LSD [FT.AB.N]	D	1038	760	5	116.44	8.28E+01	FT NGVD
USGS	8266	EPTC FIL 0.7 REC	LT	19	0.002	0.002	0.00	5.63E-11	UG/L
USGS	4929	ESFENVALERATE FL	LT	6	0.019	0.019	0.02	0.00E+00	UG/L
USGS	8266	ETHALFLURALIN FI	LT	19	0.004	0.004	0.00	1.13E-10	UG/L
USGS	3439	ETHANE, HEXACHLOR	LT	4	0.05	0.05	0.05	0.00E+00	UG/L
USGS	8157	ETHER, ETHYL-	LT	4	0.1	0.1	0.10	0.00E+00	UG/L

Data Source	Para-meter Number	Parameter Name	Lab Quali-fier	Number of Samples	Maximum Result	Minimum Result	Average Result	Standard Deviation	Units
USGS	8267	ETHOPROP FIL 0.7	LT	19	0.003	0.003	0.00	7.12E-11	UG/L
USGS	3437	ETHYLBENZENE TOTAL	LT	29	0.2	0.05	0.18	5.26E-02	UG/L
USGS	3485	EUROPIUM BM<63 D	LT	3	2	2	2.00	0.00E+00	UG/G
USGS	3167	FECAL STRPT KF A	D	1	4	4	4.00		COLS./100 ML
USGS	3167	FECAL STRPT KF A	LT	68	1	1	1.00	0.00E+00	COLS./100 ML
USGS	4929	FENURON FLTRD	LT	6	0.013	0.013	0.01	1.70E-10	UG/L
USGS	3881	FLUOMETURON FLT	LT	6	0.035	0.035	0.04	0.00E+00	UG/L
USGS	0095	FLUORIDE DISSOLVED	D	129	1.1	0.1	0.24	1.69E-01	MG/L AS F
USGS	0095	FLUORIDE DISSOLVED	LT	68	0.1	0.1	0.10	5.58E-09	MG/L AS F
USGS	0095	FLUORIDE DISSOLVED	ND	5	0	0	0.00	0.00E+00	MG/L AS F
USGS	0409	FONOFOX DISS REC	LT	19	0.003	0.003	0.00	7.12E-11	UG/L
USGS	7765	FREON 113 UNF RE	LT	4	0.05	0.05	0.05	0.00E+00	UG/L
USGS	8160	FURAN, TETRAHYDR	D	1	1.1	1.1	1.10		UG/L
USGS	8160	FURAN, TETRAHYDR	LT	3	5	5	5.00	0.00E+00	UG/L
USGS	3486	GALLIUM BM<63 DS	D	3	18	17	17.33	5.77E-01	UG/G
USGS	3487	GOLD BM<63 DSL	LT	3	8	8	8.00	0.00E+00	UG/G
USGS	0090	HARDNESS TOTAL	D	239	2200	10	137.00	1.91E+02	MG/L AS CAO3
USGS	9590	HARDNESS, NONCAR	D	5	52	14	39.60	1.57E+01	MG/L AS CACO
USGS	9590	HARDNESS, NONCAR	ND	2	0	0	0.00	0.00E+00	MG/L AS CACO
USGS	3970	HEXACHLOROBUTA	LT	4	0.2	0.2	0.20	0.00E+00	UG/L
USGS	3026	HEXAZINONE, WHRE	LT	5	0.2	0.2	0.20	3.33E-09	UG/L
USGS	3487	HOLMIUM BM<63 DS	LT	3	4	4	4.00	0.00E+00	UG/G
USGS	3488	IRON BM<63 DSL	D	3	4.5	3.8	4.17	3.51E-01	PERCENT
USGS	0104	IRON DISSOLVED	D	171	79000	3	2122.29	7.65E+03	UG/L AS FE
USGS	0104	IRON DISSOLVED	LT	12	10	3	5.33	3.45E+00	UG/L AS FE
USGS	0104	IRON TOTAL	D	70	22000	10	945.86	3.04E+03	UG/L AS FE
USGS	0104	IRON TOTAL	LT	8	10	10	10.00	0.00E+00	UG/L AS FE
USGS	0104	IRON TOTAL	ND	1	0	0	0.00		UG/L AS FE
USGS	5000	ISODURENE	LT	4	0.05	0.05	0.05	0.00E+00	UG/L
USGS	7722	ISOPROPYL-BENZEN	LT	4	0.05	0.05	0.05	0.00E+00	UG/L
USGS	3488	LANTHANUM BM<63	D	3	20	20	20.00	0.00E+00	UG/G
USGS	3489	LEAD BM<63 DSL	D	3	17	14	15.33	1.53E+00	UG/G
USGS	0104	LEAD DISSOLVED	D	2	1	1	1.00	0.00E+00	UG/L AS PB
USGS	0104	LEAD DISSOLVED	LT	32	100	1	25.25	4.06E+01	UG/L AS PB
USGS	3934	LINDANE DISSOLVED	LT	19	0.004	0.004	0.00	1.13E-10	UG/L
USGS	8266	LINURON FIL 0.7	LT	19	0.002	0.002	0.00	5.63E-11	UG/L

Data Source	Para-meter Number	Parameter Name	Lab Quali-fier	Number of Samples	Maximum Result	Minimum Result	Average Result	Standard Deviation	Units
USGS	3847	LINURON FLTRD	LT	6	0.018	0.018	0.02	2.40E-10	UG/L
USGS	3489	LITHIUM BM<63 DS	D	3	25	23	23.67	1.15E+00	UG/G
USGS	0113	LITHIUM DISSOLVED	D	2	18	4	11.00	9.90E+00	UG/L AS LI
USGS	0113	LITHIUM DISSOLVED	LT	12	20	4	13.33	8.24E+00	UG/L AS LI
USGS	8579	M/P XYLENE UNFLT	LT	4	0.05	0.05	0.05	0.00E+00	UG/L
USGS	3490	MAGNESIUM BM<63	D	3	1.3	1	1.17	1.53E-01	PERCENT
USGS	0092	MAGNESIUM DISSOLVED	D	229	350	0.24	16.08	3.15E+01	MG/L AS MG
USGS	3953	MALATHION DISSOLVED	LT	19	0.005	0.005	0.01	0.00E+00	UG/L
USGS	3490	MANGANESE BM<63	D	3	1300	580	900.00	3.67E+02	UG/G
USGS	0105	MANGANESE DISSOLVED	D	136	3500	1	159.88	4.18E+02	UG/L AS MN
USGS	0105	MANGANESE DISSOLVED	LT	12	1	1	1.00	0.00E+00	UG/L AS MN
USGS	0105	MANGANESE TOTAL	D	19	700	3	104.37	1.84E+02	UG/L AS MN
USGS	0105	MANGANESE TOTAL	LT	8	50	10	37.50	1.75E+01	UG/L AS MN
USGS	0105	MANGANESE TOTAL	ND	2	0	0	0.00	0.00E+00	UG/L AS MN
USGS	3848	MCP FLTRD	LT	6	0.035	0.035	0.04	0.00E+00	UG/L
USGS	3848	MCPA FLTRD	LT	6	0.05	0.05	0.05	9.62E-10	UG/L
USGS	3491	MERCURY BM<63 DS	ND	3	0	0	0.00	0.00E+00	UG/G
USGS	7189	MERCURY DISSOLVED	D	1	0.1	0.1	0.10		UG/L AS HG
USGS	7189	MERCURY DISSOLVED	LT	19	0.1	0.1	0.10	0.00E+00	UG/L AS HG
USGS	8159	METH.ETHYL KETON	LT	4	5	5	5.00	0.00E+00	UG/L
USGS	7813	METH.ISOBU.KETON	LT	4	5	5	5.00	0.00E+00	UG/L
USGS	7357	METHACRYLATE, ET	LT	4	1	1	1.00	0.00E+00	UG/L
USGS	8159	METHACRYLATE, ME	LT	4	1	1	1.00	0.00E+00	UG/L
USGS	8159	METHACRYLONITRIL	LT	4	2	2	2.00	0.00E+00	UG/L
USGS	7729	METHANE BROMOCHL	LT	4	0.1	0.1	0.10	0.00E+00	UG/L
USGS	3850	METHIOCARB FLTRD	LT	6	0.026	0.026	0.03	3.40E-10	UG/L
USGS	3028	METHIOCARB WTR W	LT	2	0.5	0.5	0.50	0.00E+00	UG/L
USGS	4929	METHOMYL FLTRD	LT	6	0.017	0.017	0.02	2.40E-10	UG/L
USGS	3905	METHOMYL TOTAL	LT	23	0.5	0.5	0.50	0.00E+00	UG/L
USGS	4999	METHYL ACRYLATE	LT	4	2	2	2.00	0.00E+00	UG/L
USGS	8268	METHYL AZINPHOS	LT	19	0.001	0.001	0.00	2.82E-11	UG/L
USGS	7742	METHYL IODIDE	E	2	0.009	0.008	0.01	7.07E-04	UG/L
USGS	7742	METHYL IODIDE	LT	2	0.05	0.05	0.05	0.00E+00	UG/L
USGS	8266	METHYL PARATHION	LT	19	0.006	0.006	0.01	1.42E-10	UG/L
USGS	3441	METHYLBROMIDE TOTAL	LT	29	0.2	0.1	0.19	3.51E-02	UG/L
USGS	3441	METHYLCHLORIDE,TOTAL	E	2	0.02	0.01	0.02	7.07E-03	UG/L

Data Source	Para-meter Number	Parameter Name	Lab Quali-fier	Number of Samples	Maximum Result	Minimum Result	Average Result	Standard Deviation	Units
USGS	3441	METHYLCHLORIDE,TOTAL	LT	27	0.2	0.2	0.20	0.00E+00	UG/L
USGS	3442	METHYLENECHLORIDE	E	2	0.02	0.02	0.02	0.00E+00	UG/L
USGS	3442	METHYLENECHLORIDE	LT	27	0.2	0.1	0.19	2.67E-02	UG/L
USGS	8261	METOLACHLOR	LT	24	0.2	0.1	0.12	4.15E-02	UG/L
USGS	3941	METOLACHLOR,WAT.	LT	19	0.002	0.002	0.00	5.63E-11	UG/L
USGS	8261	METRIBUZIN	LT	24	0.1	0.1	0.10	1.27E-09	UG/L
USGS	8263	METRIBUZIN,WAT.D	LT	19	0.004	0.004	0.00	1.13E-10	UG/L
USGS	8267	MOLINATE FIL 0.7	LT	19	0.004	0.004	0.00	1.13E-10	UG/L
USGS	0106	MOLYBDENUM DISSOLVED	D	2	40	20	30.00	1.41E+01	UG/L AS MO
USGS	0106	MOLYBDENUM DISSOLVED	LT	5	30	10	14.00	8.94E+00	UG/L AS MO
USGS	7803	MTBE	LT	4	0.1	0.1	0.10	0.00E+00	UG/L
USGS	7185	N, NITRATE TOTAL	D	18	55	0.1	7.28	1.41E+01	MG/L AS NO3
USGS	7185	N, NITRATE TOTAL	ND	4	0	0	0.00	0.00E+00	MG/L AS NO3
USGS	7734	N-BUTYL-BENZENE	LT	4	0.05	0.05	0.05	0.00E+00	UG/L
USGS	7722	N-PROPYL-BENZENE	LT	4	0.05	0.05	0.05	0.00E+00	UG/L
USGS	3469	NAPHTHALENE TOTAL	LT	4	0.2	0.2	0.20	0.00E+00	UG/L
USGS	8268	NAPROPAMIDE FIL	LT	19	0.003	0.003	0.00	7.12E-11	UG/L
USGS	4929	NEBURON FLTRD	LT	6	0.015	0.015	0.02	0.00E+00	UG/L
USGS	0106	NICKEL DISSOLVED	LT	8	50	10	17.50	1.49E+01	UG/L AS NI
USGS	0062	NITRO AMN & ORG	D	86	63	0.2	1.73	7.66E+00	MG/L AS N
USGS	0062	NITRO AMN & ORG	LT	30	0.2	0.2	0.20	2.86E-09	MG/L AS N
USGS	0062	NITRO AMN & ORG	ND	3	0	0	0.00	0.00E+00	MG/L AS N
USGS	8208	NITROGEN 15/14 R	D	20	12.5	1.5	6.53	2.96E+00	RATIO PER MI
USGS	0062	NITROGEN AMM+ORG	D	82	50	0.2	1.65	6.74E+00	MG/L AS N
USGS	0062	NITROGEN AMM+ORG	LT	33	0.2	0.2	0.20	3.67E-09	MG/L AS N
USGS	0061	NITROGEN AMMONIA	D	173	46	0.01	0.61	4.33E+00	MG/L AS N
USGS	0060	NITROGEN AMMONIA	D	82	63	0.01	1.38	7.84E+00	MG/L AS N
USGS	0061	NITROGEN AMMONIA	LT	58	0.01	0.01	0.01	2.59E-10	MG/L AS N
USGS	0060	NITROGEN AMMONIA	LT	37	0.01	0.01	0.01	4.08E-10	MG/L AS N
USGS	0062	NITROGEN NITRATE	D	529	260	0.01	5.76	1.23E+01	MG/L AS N
USGS	0062	NITROGEN NITRATE	LT	3	0.1	0.1	0.10	0.00E+00	MG/L AS N
USGS	0061	NITROGEN,NITRITE	D	18	0.05	0.01	0.02	1.27E-02	MG/L AS N
USGS	0061	NITROGEN,NITRITE	D	82	0.24	0.01	0.03	4.07E-02	MG/L AS N
USGS	0061	NITROGEN,NITRITE	LT	101	0.01	0.01	0.01	4.45E-10	MG/L AS N
USGS	0061	NITROGEN,NITRITE	LT	213	0.01	0.01	0.01	4.65E-10	MG/L AS N
USGS	0063	NO2 + NO3 DISSOLVED	D	108	260	0.02	7.92	2.53E+01	MG/L AS N

Data Source	Para-meter Number	Parameter Name	Lab Quali-fier	Number of Samples	Maximum Result	Minimum Result	Average Result	Standard Deviation	Units
USGS	0063	NO2 + NO3 DISSOLVED	LT	58	0.1	0.05	0.05	1.28E-02	MG/L AS N
USGS	0063	NO2 + NO3 TOTAL	D	525	260	0.01	5.80	1.24E+01	MG/L AS N
USGS	0063	NO2 + NO3 TOTAL	LT	137	0.1	0.05	0.09	2.21E-02	MG/L AS N
USGS	0090	NONCARBONATE HARDNESS	D	41	2200	2	146.59	4.07E+02	MG/L AS CACO
USGS	0090	NONCARBONATE HARDNESS	ND	43	0	0	0.00	0.00E+00	MG/L AS CACO
USGS	4929	NORFLURAZON FLTR	LT	6	0.024	0.024	0.02	3.40E-10	UG/L
USGS	7727	O-CHLOROTOLUENE	E	1	0.006	0.006	0.01		UG/L
USGS	7727	O-CHLOROTOLUENE	LT	28	0.2	0.05	0.18	4.72E-02	UG/L
USGS	3453	O-DICHLORO-BENZENE	LT	29	0.2	0.05	0.18	5.26E-02	UG/L
USGS	4929	ORYZALIN FLTRD	LT	6	0.019	0.019	0.02	0.00E+00	UG/L
USGS	3886	OXAMYL FLTRD	LT	6	0.018	0.018	0.02	2.40E-10	UG/L
USGS	8261	OXYAMYL	LT	2	0.5	0.5	0.50	0.00E+00	UG/L
USGS	0030	OXYGEN DISSOLVED	D	120	12.9	0.1	3.53	3.18E+00	MG/L
USGS	0030	OXYGEN DISSOLVED	LT	3	2.7	0.1	0.97	1.50E+00	MG/L
USGS	0030	OXYGEN DISSOLVED	ND	20	0	0	0.00	0.00E+00	MG/L
USGS	3465	P,P' DDE DISSOLVED	E	1	0.003	0.003	0.00		UG/L
USGS	3465	P,P' DDE DISSOLVED	LT	18	0.006	0.006	0.01	1.30E-10	UG/L
USGS	7727	P-CHLORO-TOLUENE	LT	29	0.2	0.05	0.18	5.26E-02	UG/L
USGS	7735	P-ISOPROPYLTOLUENE	LT	4	0.05	0.05	0.05	0.00E+00	UG/L
USGS	3954	PARATHION DISSOLVED	LT	19	0.004	0.004	0.00	1.13E-10	UG/L
USGS	8266	PEBULATE FIL 0.7	LT	19	0.004	0.004	0.00	1.13E-10	UG/L
USGS	8268	PENDIMETHALIN F.	LT	19	0.004	0.004	0.00	1.13E-10	UG/L
USGS	8268	PERMETHRIN FIL .	LT	19	0.005	0.005	0.01	0.00E+00	UG/L
USGS	0040	PH, WH, FIELD	D	218	9.2	5.6	7.32	8.15E-01	STANDARD
USGS	0040	PH, WH, FIELD	ND	1	0	0	0.00		STANDARD
USGS	0040	PH, WH, LABORATORY	D	148	8.8	5.8	7.20	7.31E-01	STANDARD
USGS	8266	PHORATE FIL 0.7	LT	19	0.002	0.002	0.00	5.63E-11	UG/L
USGS	7050	PHOS ORTHO TOTAL AS P	D	116	2.2	0.01	0.35	5.94E-01	MG/L AS P
USGS	7050	PHOS ORTHO TOTAL AS P	LT	136	0.01	0.01	0.01	5.82E-10	MG/L AS P
USGS	0066	PHOSPHORUS DISSOLVED	D	1	0.02	0.02	0.02		MG/L AS P
USGS	0066	PHOSPHORUS DISSOLVED	LT	3	0.01	0.01	0.01	1.34E-10	MG/L AS P
USGS	0067	PHOSPHORUS ORTHO	D	34	3.3	0.01	0.48	8.68E-01	MG/L AS P
USGS	0067	PHOSPHORUS ORTHO	LT	68	0.01	0.01	0.01	2.21E-10	MG/L AS P
USGS	4929	PICLORAM FLTRD	LT	6	0.05	0.05	0.05	9.62E-10	UG/L
USGS	0093	POTASSIUM DISSOLVED	D	189	110	0.4	5.13	9.88E+00	MG/L AS K
USGS	8206	POTSSSIUM 40 DIS	D	7	4.5	0.6	2.19	1.41E+00	PCI/L AS K40

Data Source	Para-meter Number	Parameter Name	Lab Quali-fier	Number of Samples	Maximum Result	Minimum Result	Average Result	Standard Deviation	Units
USGS	4999	PREHNITENE	LT	4	0.05	0.05	0.05	0.00E+00	UG/L
USGS	0403	PROMETON DISS RE	D	1	0.21	0.21	0.21		UG/L
USGS	0403	PROMETON DISS RE	LT	18	0.018	0.018	0.02	3.01E-10	UG/L
USGS	3905	PROMETONE TOTAL	LT	24	0.2	0.1	0.12	4.15E-02	UG/L
USGS	3905	PROMETRYNE TOTAL	LT	24	0.1	0.1	0.10	1.27E-09	UG/L
USGS	8267	PRONAMIDE FIL .7	LT	19	0.003	0.003	0.00	7.12E-11	UG/L
USGS	0402	PROPACHLOR DISSOLVED	LT	19	0.007	0.007	0.01	2.25E-10	UG/L
USGS	3029	PROPACHLOR WTR W	LT	5	0.1	0.1	0.10	1.67E-09	UG/L
USGS	8267	PROPANIL FIL 0.7	LT	19	0.004	0.004	0.00	1.13E-10	UG/L
USGS	8268	PROPARGITE FIL .	LT	19	0.013	0.013	0.01	4.93E-10	UG/L
USGS	3902	PROPAZINE	LT	24	0.1	0.1	0.10	1.27E-09	UG/L
USGS	7810	PROPENE, 3-CHLOR	LT	4	0.1	0.1	0.10	0.00E+00	UG/L
USGS	4923	PROPHAM FLTRD	LT	6	0.035	0.035	0.04	0.00E+00	UG/L
USGS	3905	PROPHAM TOTAL	LT	23	0.5	0.5	0.50	0.00E+00	UG/L
USGS	3029	PROPOOUR, WTR WH	LT	2	0.5	0.5	0.50	0.00E+00	UG/L
USGS	3853	PROPOXUR FLTRD	LT	6	0.035	0.035	0.04	0.00E+00	UG/L
USGS	7200	PUMP PERIOD (MIN)	D	26	1655	10	647.42	5.17E+02	MIN
USGS	8230	RADON 222 TOTAL	D	4	390	110	227.50	1.36E+02	PCI/L
USGS	7600	RADON-222 PE	D	4	26	19	22.50	3.51E+00	PCI/L
USGS	7030	RESIDUE DIS 180C	D	75	13900	67	424.04	1.59E+03	MG/L
USGS	7735	SEC-BUTYL-BENZENE	LT	4	0.05	0.05	0.05	0.00E+00	UG/L
USGS	0114	SELENIUM DISSOLVED	D	1	1	1	1.00		UG/L AS SE
USGS	0114	SELENIUM DISSOLVED	LT	19	1	1	1.00	0.00E+00	UG/L AS SE
USGS	0095	SILICA DISSOLVED	D	187	53	1	22.17	9.67E+00	MG/L AS SIO2
USGS	0107	SILVER DISSOLVED	D	9	2	1	1.22	4.41E-01	UG/L AS AG
USGS	0107	SILVER DISSOLVED	LT	18	3	1	1.11	4.71E-01	UG/L AS AG
USGS	3976	SILVEX DISSOLVED	LT	6	0.021	0.021	0.02	0.00E+00	UG/L
USGS	0403	SIMAZINE DISS RE	LT	19	0.005	0.005	0.01	0.00E+00	UG/L
USGS	3905	SIMAZINE TOTAL U	LT	24	0.1	0.1	0.10	1.27E-09	UG/L
USGS	3905	SIMETRYNE TOTAL	LT	24	0.1	0.1	0.10	1.27E-09	UG/L
USGS	0093	SODIUM ADSORPTION RATIO	D	195	46	0.1	2.85	6.42E+00	RATIO
USGS	0093	SODIUM DISSOLVED	D	198	1800	3.2	66.36	1.88E+02	MG/L AS NA
USGS	0093	SODIUM, PERCENT	D	189	98	6	31.17	2.53E+01	PERCENT
USGS	9009	SPECIFIC CONDUCTIVITY	D	155	9950	72	509.73	9.17E+02	MICROSIEMENS
USGS	0009	SPECIFIC CONDUCTIVITY	D	780	40000	1	703.65	2.15E+03	US/CM @ 25C
USGS	0009	SPECIFIC CONDUCTIVITY	N	1	242	242	242.00		US/CM @ 25C

Data Source	Para-meter Number	Parameter Name	Lab Quali-fier	Number of Samples	Maximum Result	Minimum Result	Average Result	Standard Deviation	Units
USGS	0108	STRONTIUM DISSOLVED	D	12	1700	50	286.67	4.52E+02	UG/L AS SR
USGS	0108	STRONTIUM DISSOLVED	LT	2	50	50	50.00	0.00E+00	UG/L AS SR
USGS	7712	STYRENE, TOTAL	LT	29	0.2	0.05	0.18	5.26E-02	UG/L
USGS	0094	SULFATE DISSOLVED	D	189	620	0.2	22.21	4.81E+01	MG/L AS SO4
USGS	0094	SULFATE DISSOLVED	LT	13	1	0.1	0.38	4.32E-01	MG/L AS SO4
USGS	5000	T-BUTHYL ETHYL-E	LT	4	0.1	0.1	0.10	0.00E+00	UG/L
USGS	5000	T-PENTYL METHYLE	LT	4	0.1	0.1	0.10	0.00E+00	UG/L
USGS	8267	TEBUTHIURON FIL	LT	19	0.01	0.01	0.01	0.00E+00	UG/L
USGS	8266	TERBACIL FIL 0.7	LT	19	0.007	0.007	0.01	2.25E-10	UG/L
USGS	3031	TERBACIL WTR WHL	LT	5	0.2	0.2	0.20	3.33E-09	UG/L
USGS	8267	TERBUFOS FIL 0.7	LT	19	0.013	0.013	0.01	4.93E-10	UG/L
USGS	7735	TERT-BUTYL-BENZENE	LT	4	0.05	0.05	0.05	0.00E+00	UG/L
USGS	3447	TETRACHLOROETHYL	LT	29	0.2	0.05	0.18	5.26E-02	UG/L
USGS	8268	THIOBENCARB FIL	LT	19	0.002	0.002	0.00	5.63E-11	UG/L
USGS	7722	TOLUENE, O-ETHYL	LT	4	0.05	0.05	0.05	0.00E+00	UG/L
USGS	3401	TOLUENE, TOTAL	LT	29	0.2	0.05	0.18	5.26E-02	UG/L
USGS	7713	TOT. O-XYLENE (U	LT	4	0.05	0.05	0.05	0.00E+00	UG/L
USGS	3469	TR1,3-DICHL.PROP	LT	29	0.2	0.1	0.19	3.51E-02	UG/L
USGS	3454	TRANSDICH.ETHENE	LT	4	0.05	0.05	0.05	0.00E+00	UG/L
USGS	8267	TRIALLATE FIL .7	LT	19	0.001	0.001	0.00	2.82E-11	UG/L
USGS	3448	TRICH.FLUOR.METH	LT	29	0.2	0.1	0.19	3.51E-02	UG/L
USGS	3450	TRICHLOROETHANE	LT	29	0.2	0.05	0.18	5.26E-02	UG/L
USGS	3451	TRICHLOROETHANE	LT	29	0.2	0.1	0.19	3.51E-02	UG/L
USGS	3918	TRICHLOROETHYLENE	E	1	0.002	0.002	0.00		UG/L
USGS	3918	TRICHLOROETHYLENE	LT	28	0.2	0.05	0.18	4.72E-02	UG/L
USGS	4923	TRICLOPYR FLTRD	LT	6	0.05	0.05	0.05	9.62E-10	UG/L
USGS	8266	TRIFLURALIN FIL	LT	19	0.002	0.002	0.00	5.63E-11	UG/L
USGS	3903	TRIFLURALIN,TOT	LT	24	0.1	0.1	0.10	1.27E-09	UG/L
USGS	0108	VANADIUM DISSOLVED	LT	7	18	6	7.71	4.54E+00	UG/L AS V
USGS	3032	VERNOLATE, WHLRE	LT	5	0.1	0.1	0.10	1.67E-09	UG/L
USGS	3917	VINYLCHLORIDE	LT	29	0.2	0.1	0.19	3.51E-02	UG/L
USGS	0001	WATER TEMPERATURE	D	273	1032	5	14.64	6.18E+01	DEGREES
USGS	0001	WATER TEMPERATURE	ND	1	0	0	0.00		DEGREES
USGS	8155	XYLENE UNF REC	LT	25	0.2	0.2	0.20	0.00E+00	UG/L
USGS	0109	ZINC DISSOLVED	D	29	240	6	69.48	6.90E+01	UG/L AS ZN
USGS	0109	ZINC DISSOLVED	LT	5	10	3	8.60	3.13E+00	UG/L AS ZN

Appendix D: ***Potential Ground Water Pollution Sources***

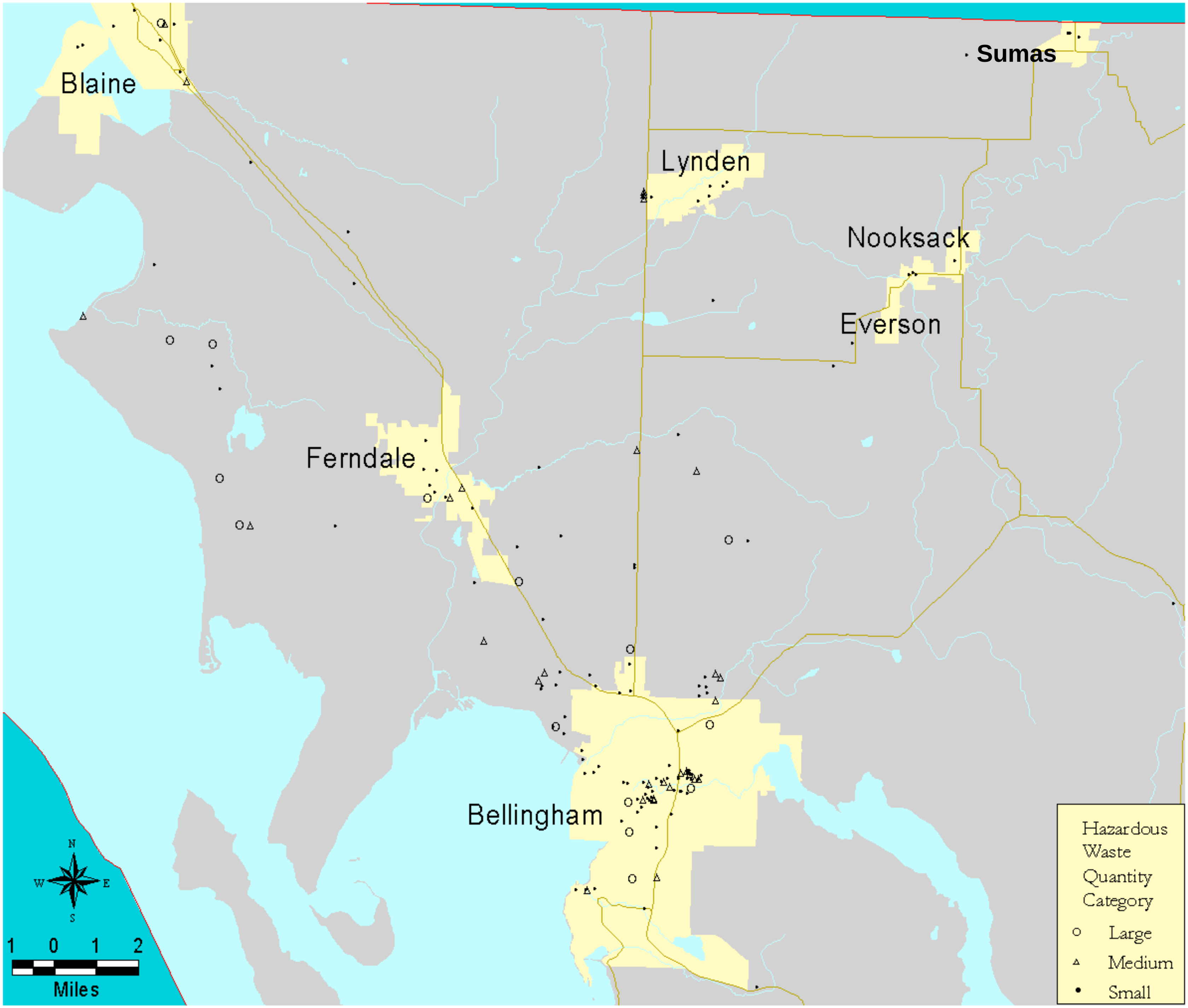


Figure 30: Hazardous Waste Generators by Quantity Generated

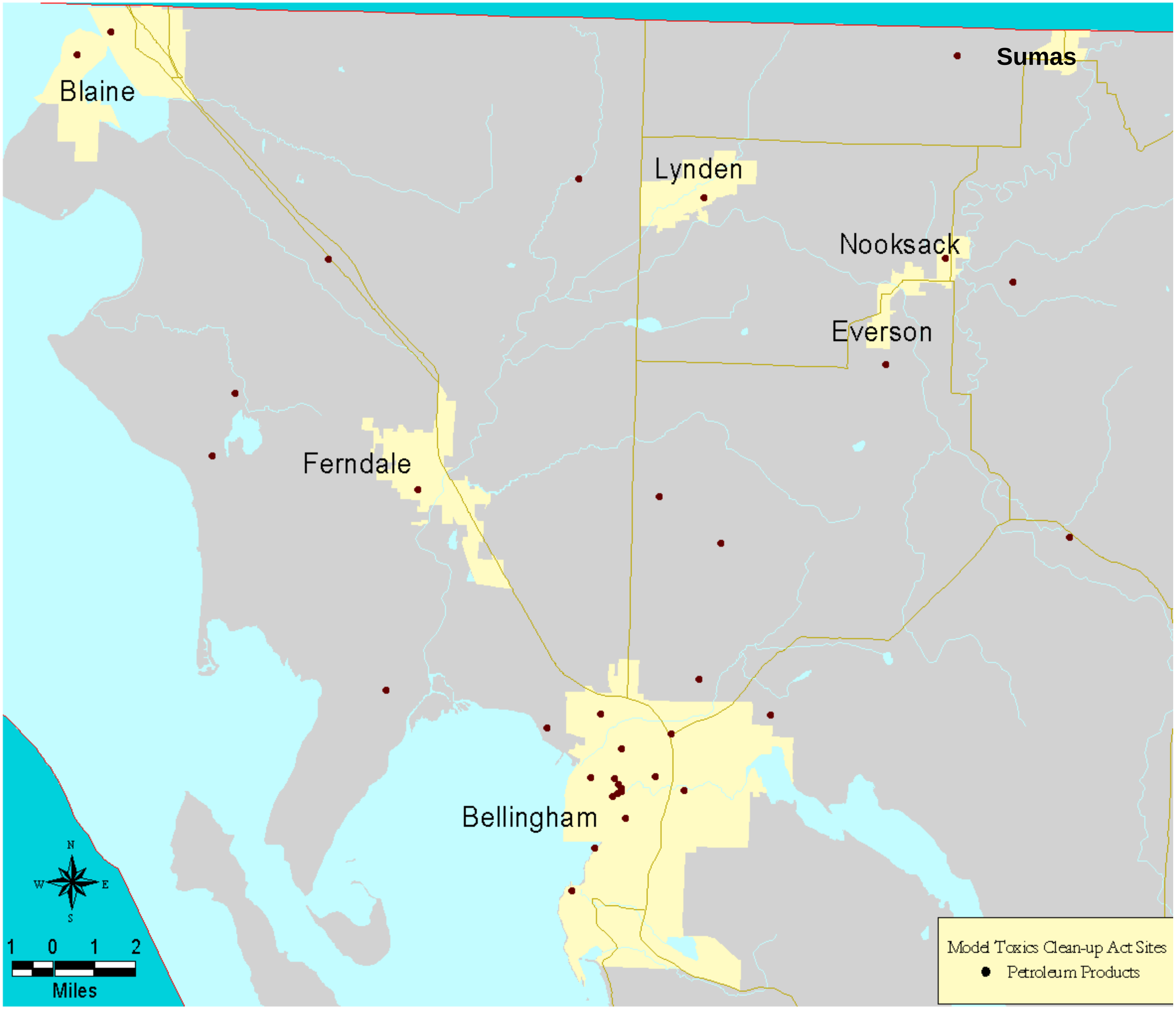


Figure 31: Toxic Clean-up Sites – Petroleum Products

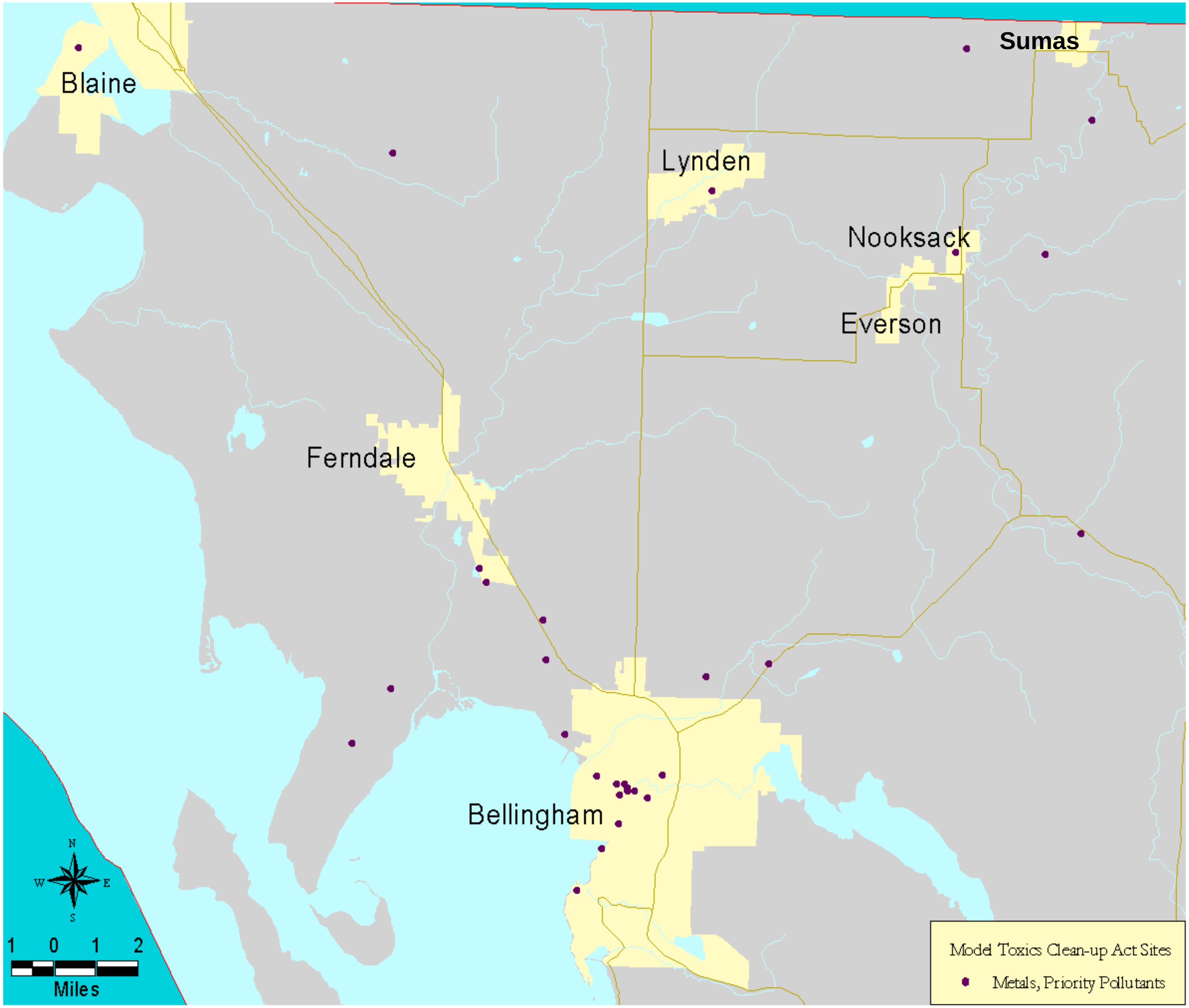


Figure 32: Toxic Clean-up Sites – Priority Pollutant Metals

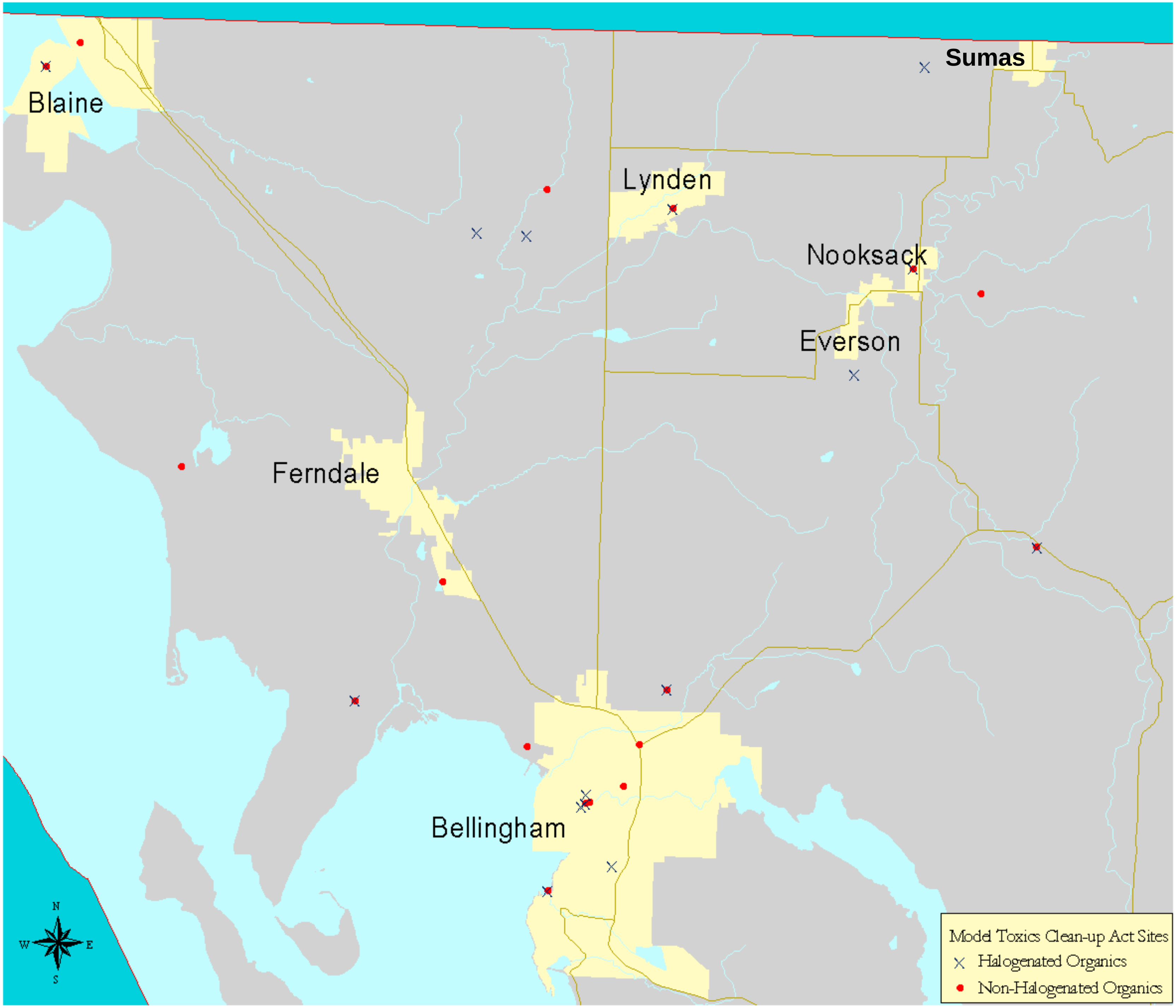


Figure 33: Toxic Clean-up Sites – Halogenated and Non-Halogenated Organics

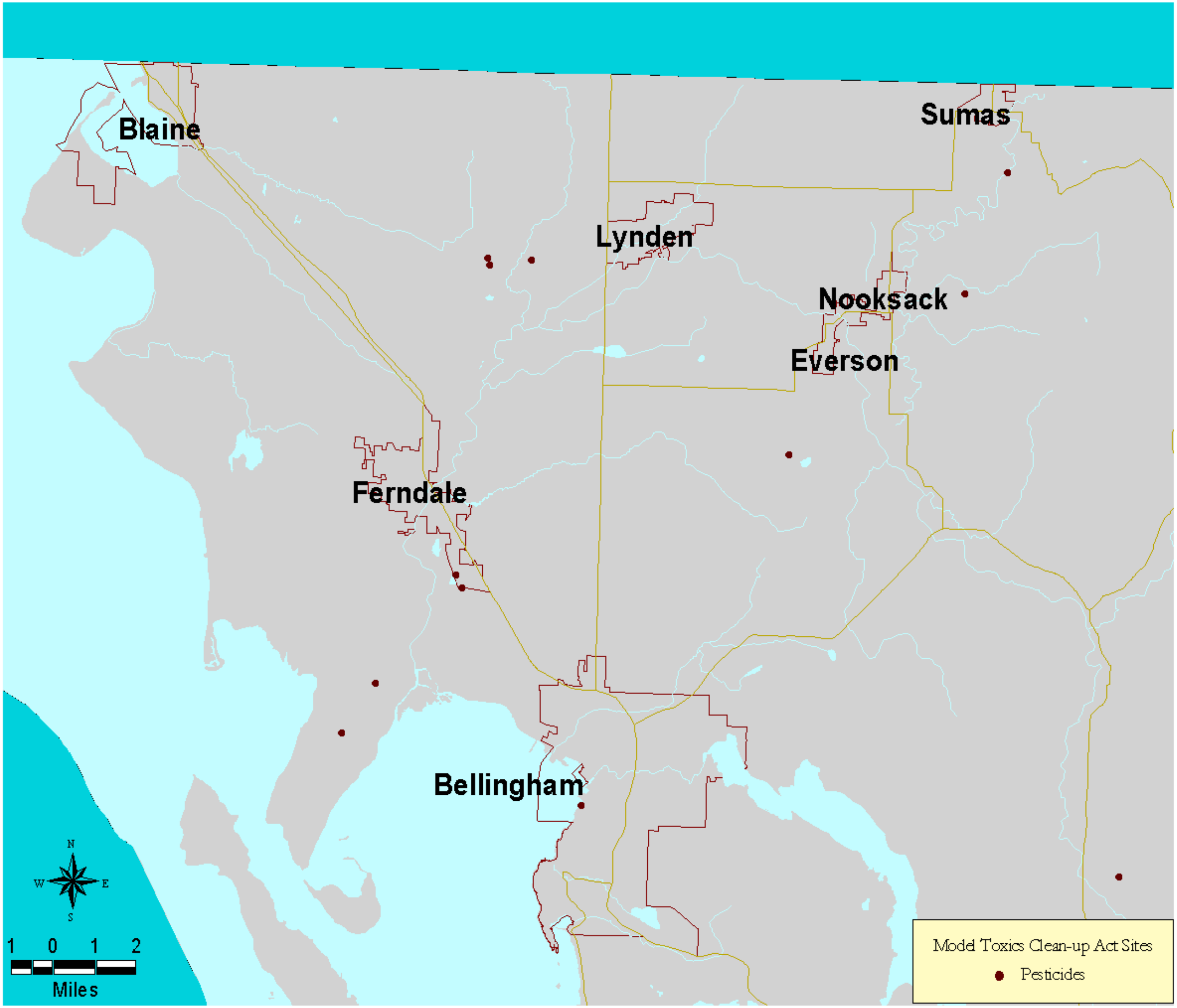


Figure 34: Toxic Clean-up Sites - Pesticides

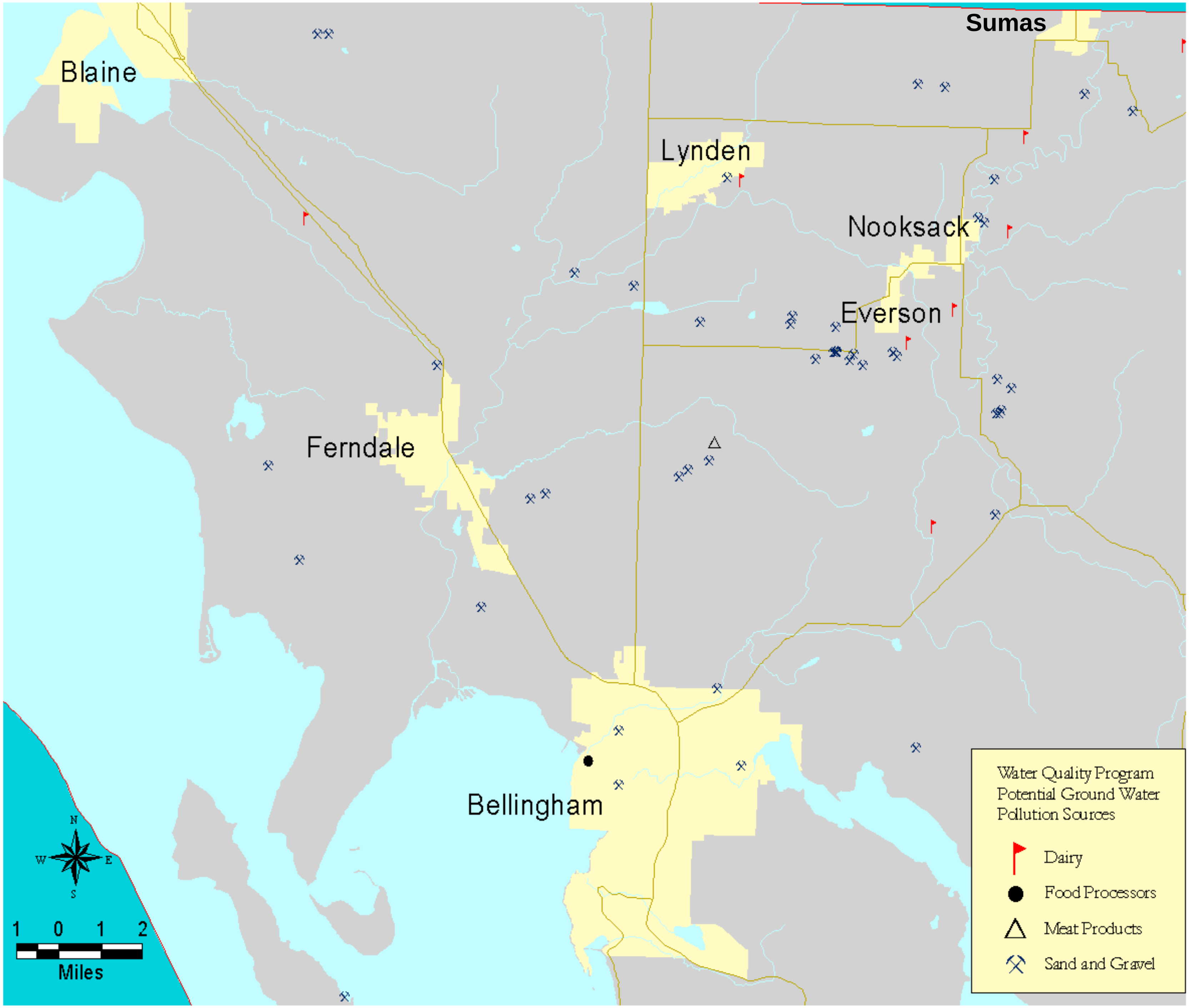


Figure 35: Water Quality State Waste Discharge to Ground or General Permit Facilities

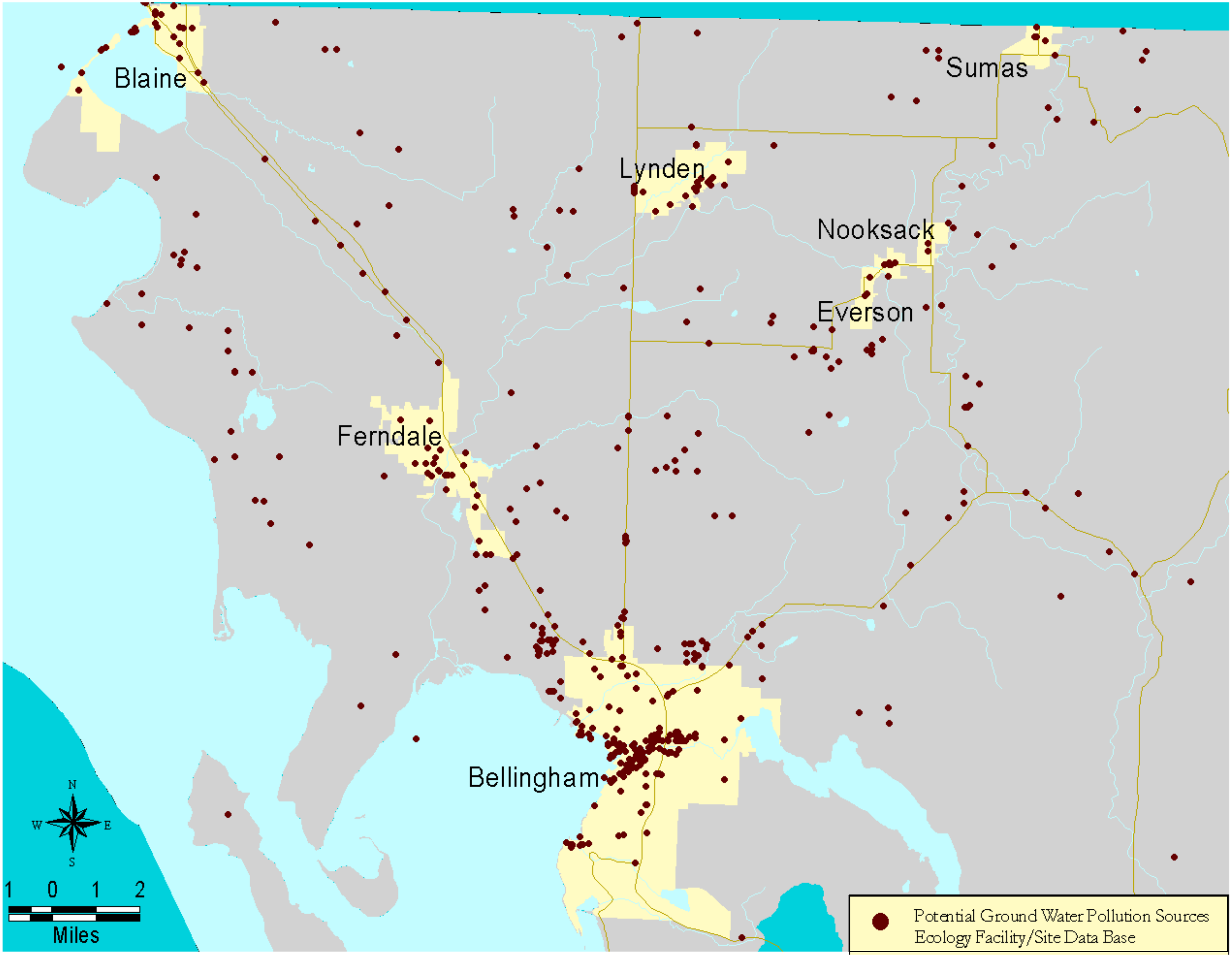


Figure 36: Potential Ground Water Pollution Sources from Ecology's Facility/Site Database

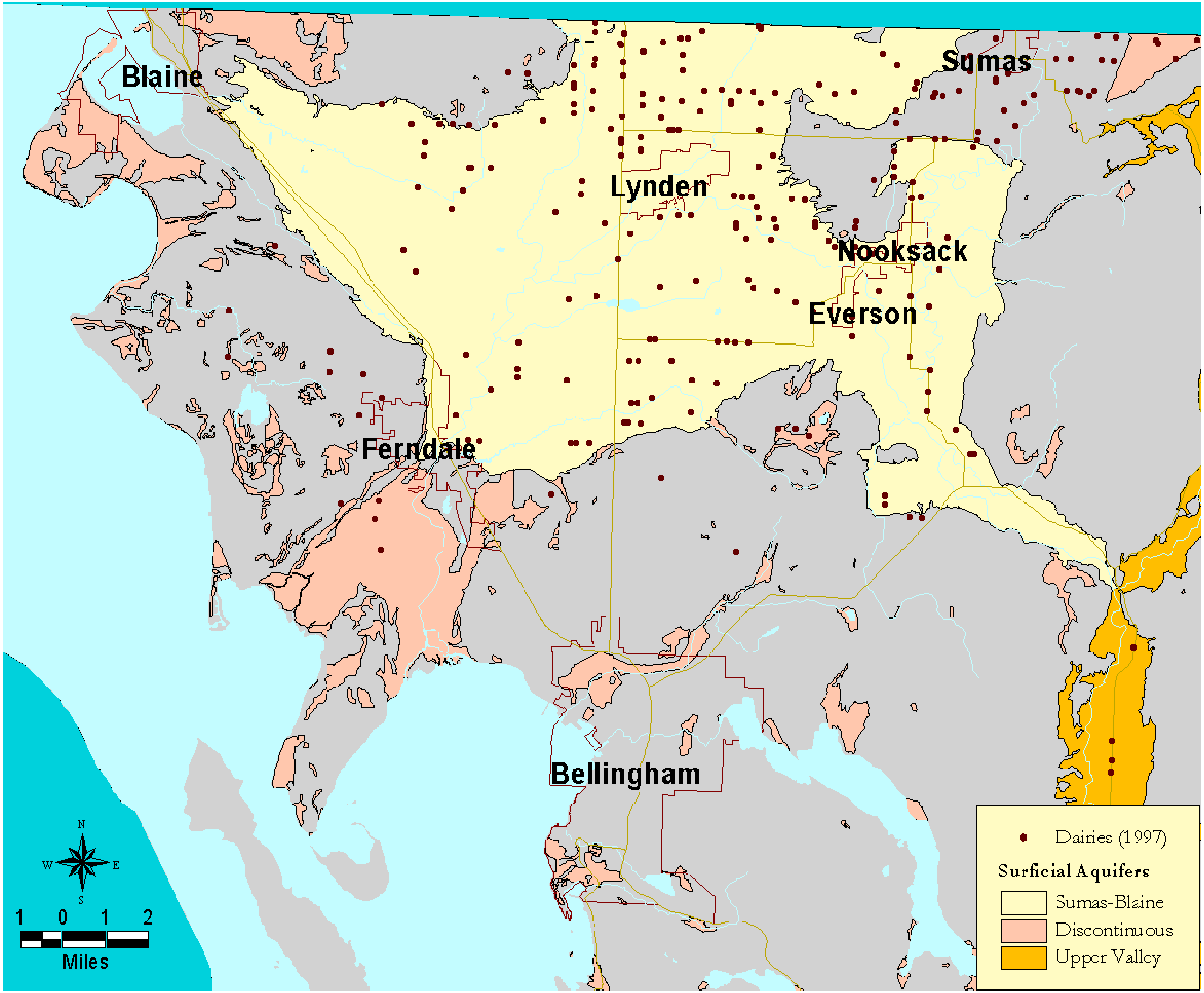


Figure 37: Dairies from the 1997 Data Compilation

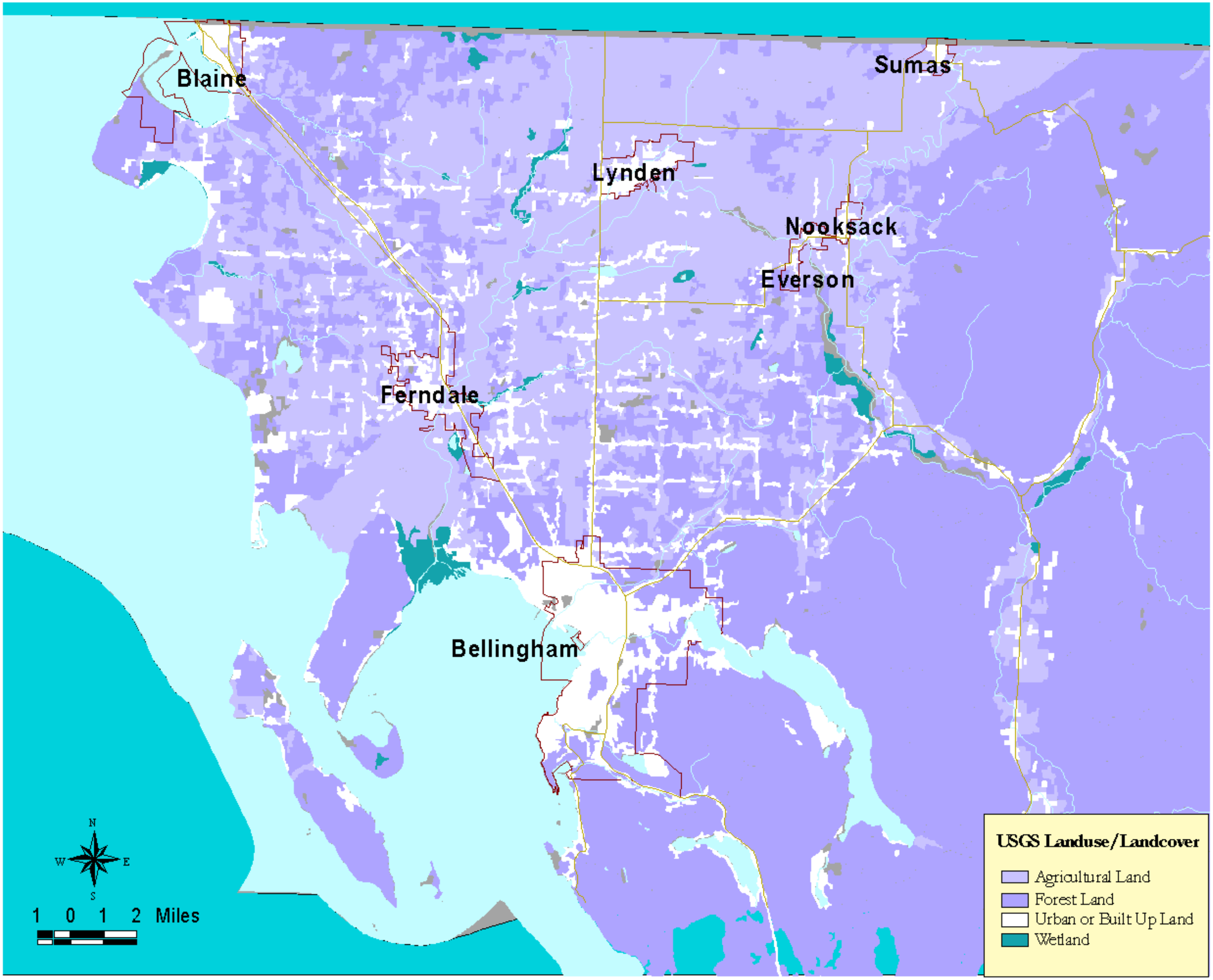
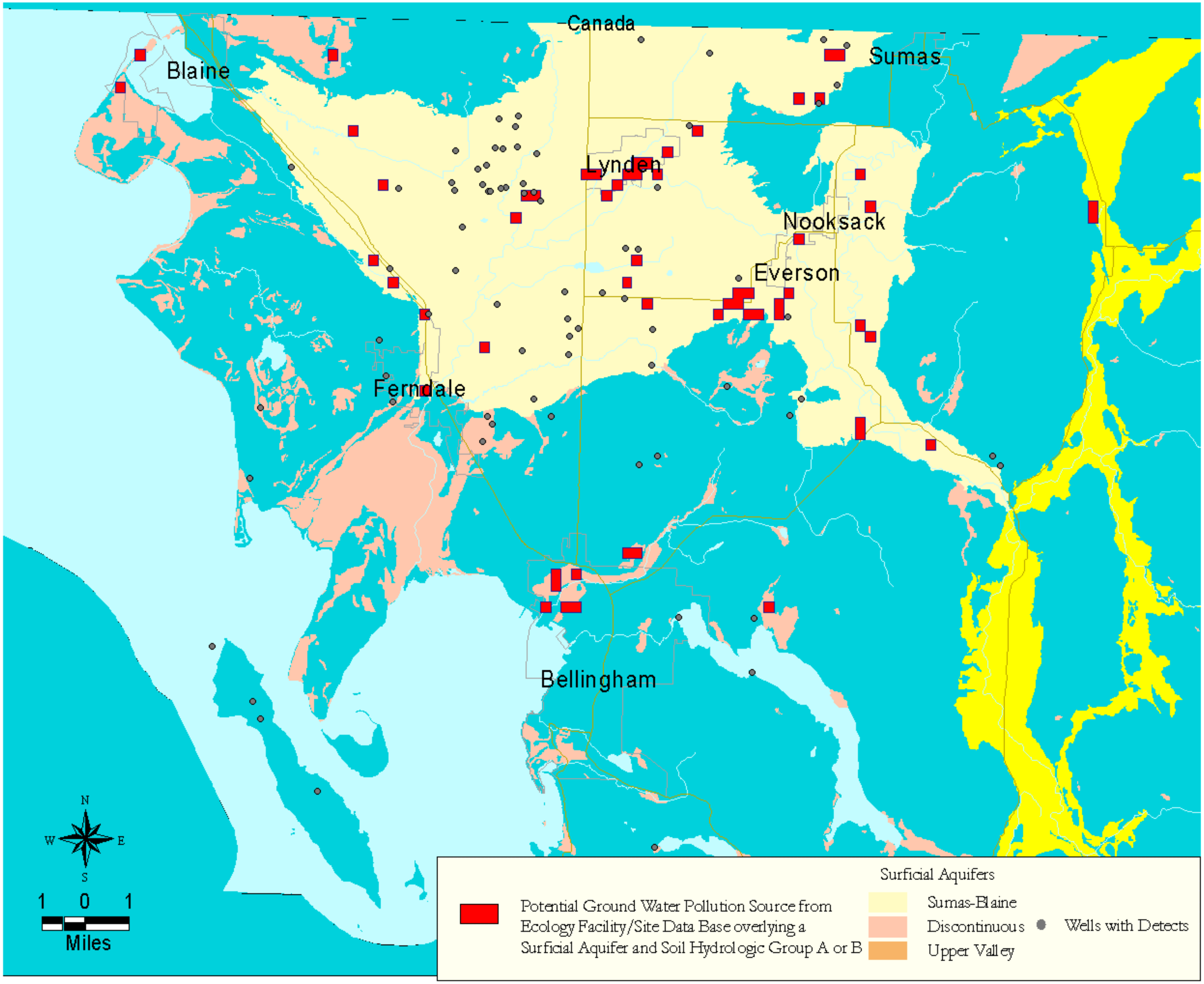


Figure 38: Land Use/Land Cover from 1970's USGS GIRAS

Appendix E: ***Aquifer Vulnerability Analysis***



E-1 **Figure 39: Potential Ground Water Pollution Point Sources Overlying a Surficial Aquifer and Soils Hydrologic Group A or B**

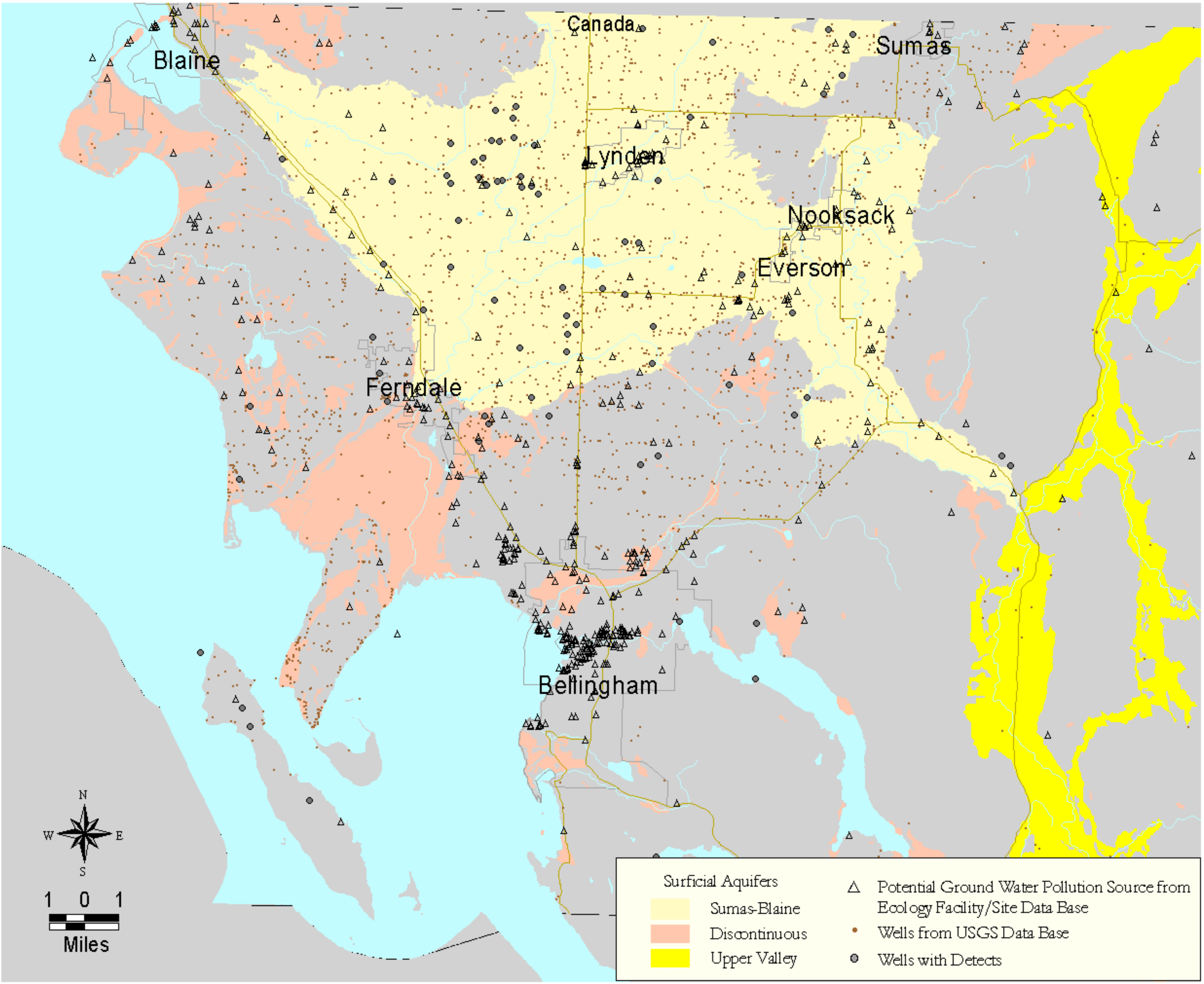


Figure 40: Potential Ground Water Pollution Sources, Surficial Aquifers, USGS Wells, and Detects

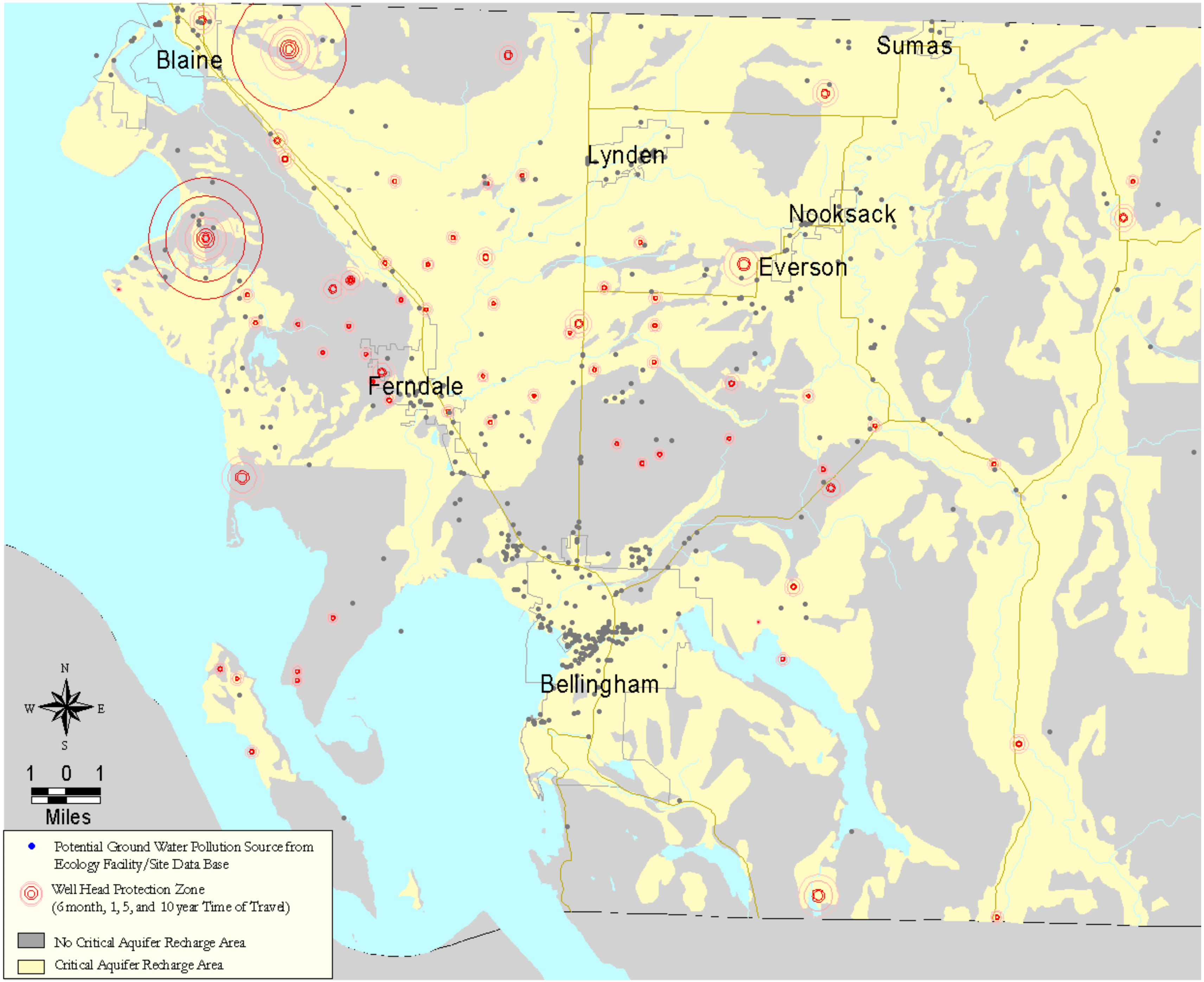


 Figure 41: Potential Ground Water Pollution Sources, Wellhead Protection Zones, and Critical Aquifer Recharge Areas

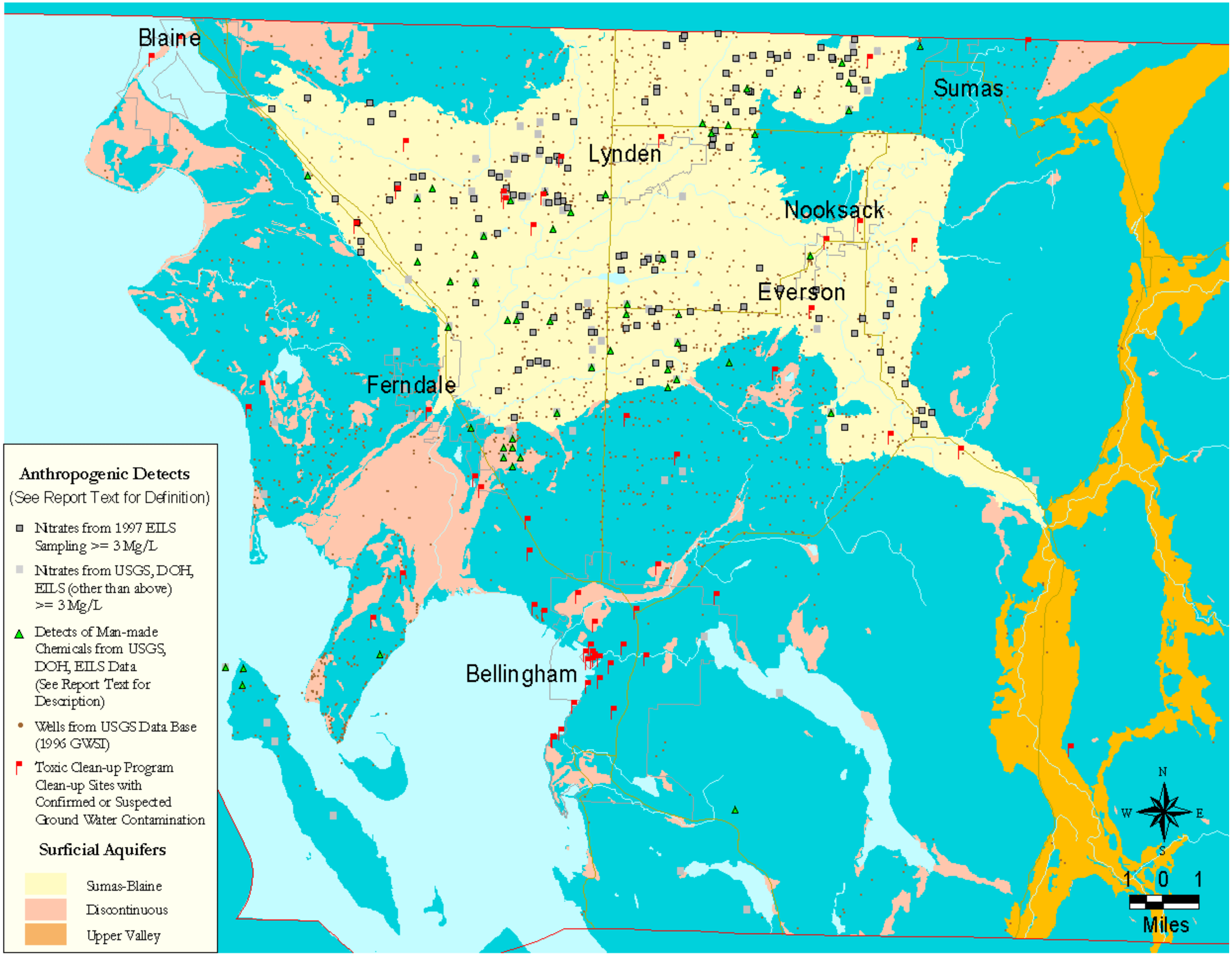


Figure 42: Anthropogenic Detects in USGS, DOH, EILS Wells and Clean-up Sites

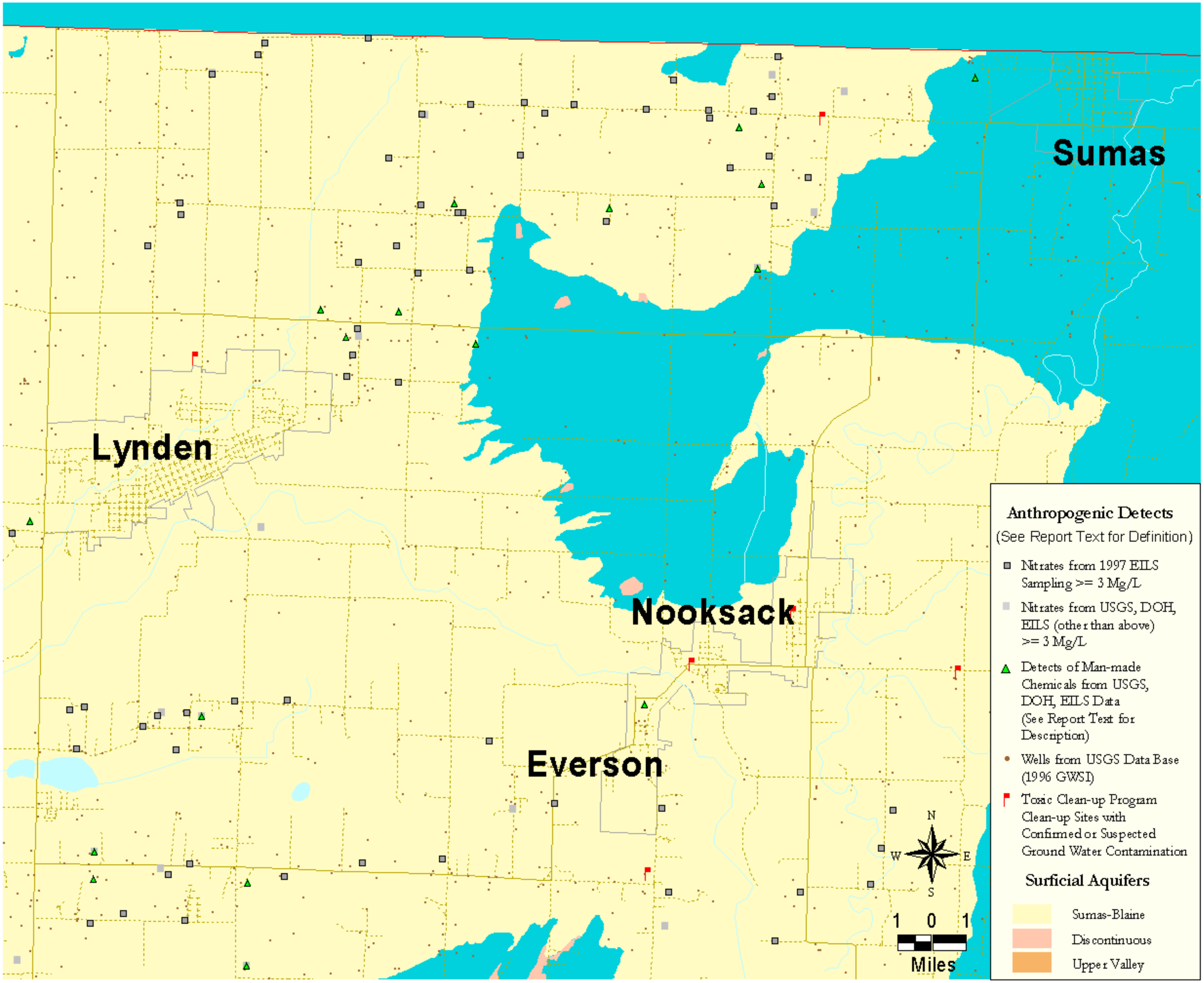


Figure 43: Anthropogenic Detects in USGS, DOH, EILS Wells and Clean-up Sites, Lynden-Everson-Nooksack-Sumas (LENS) Area

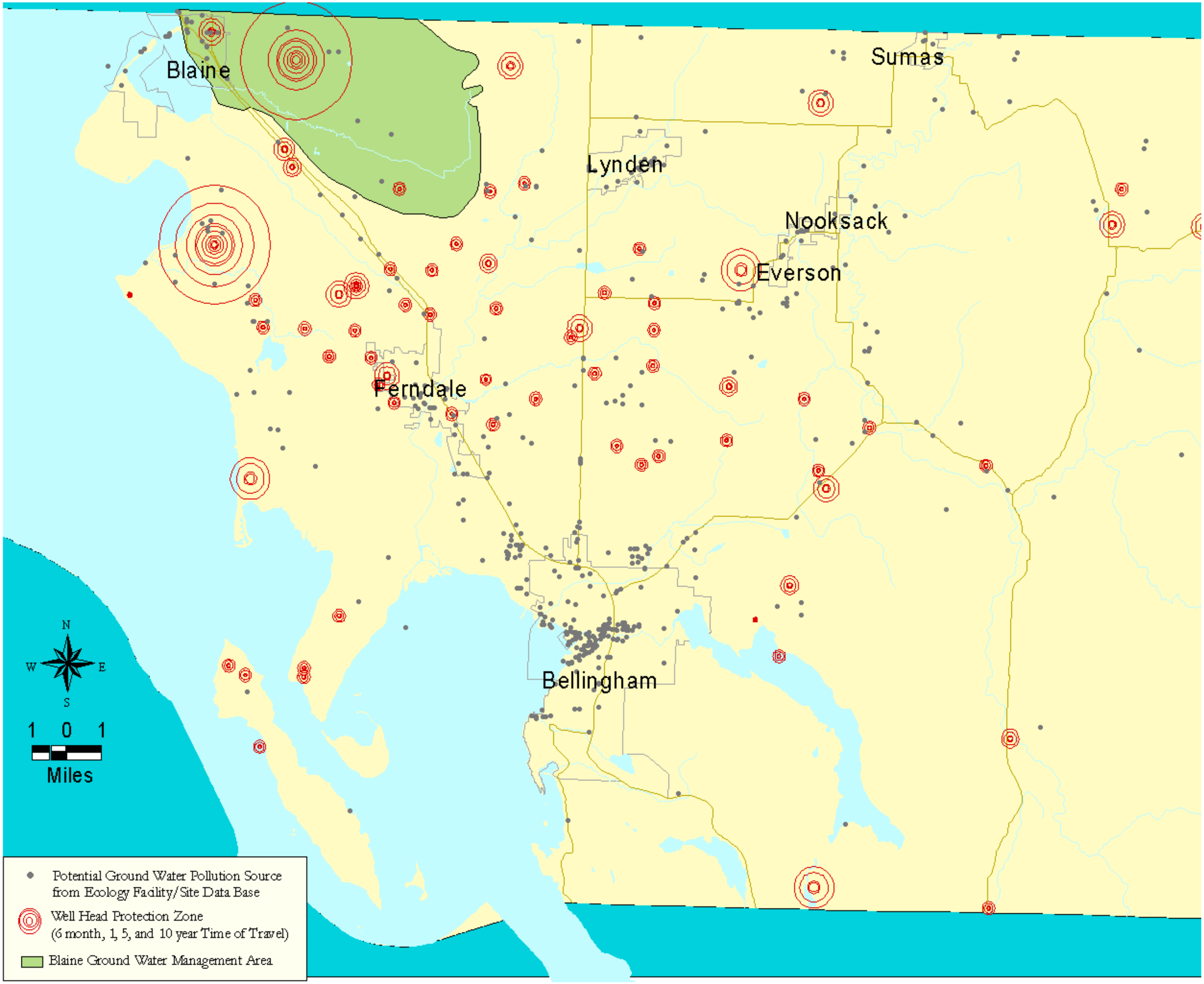


 Figure 44: Ground Water Management Areas, Wellhead Protection Zones, and Potential Ground Water Pollution Sources

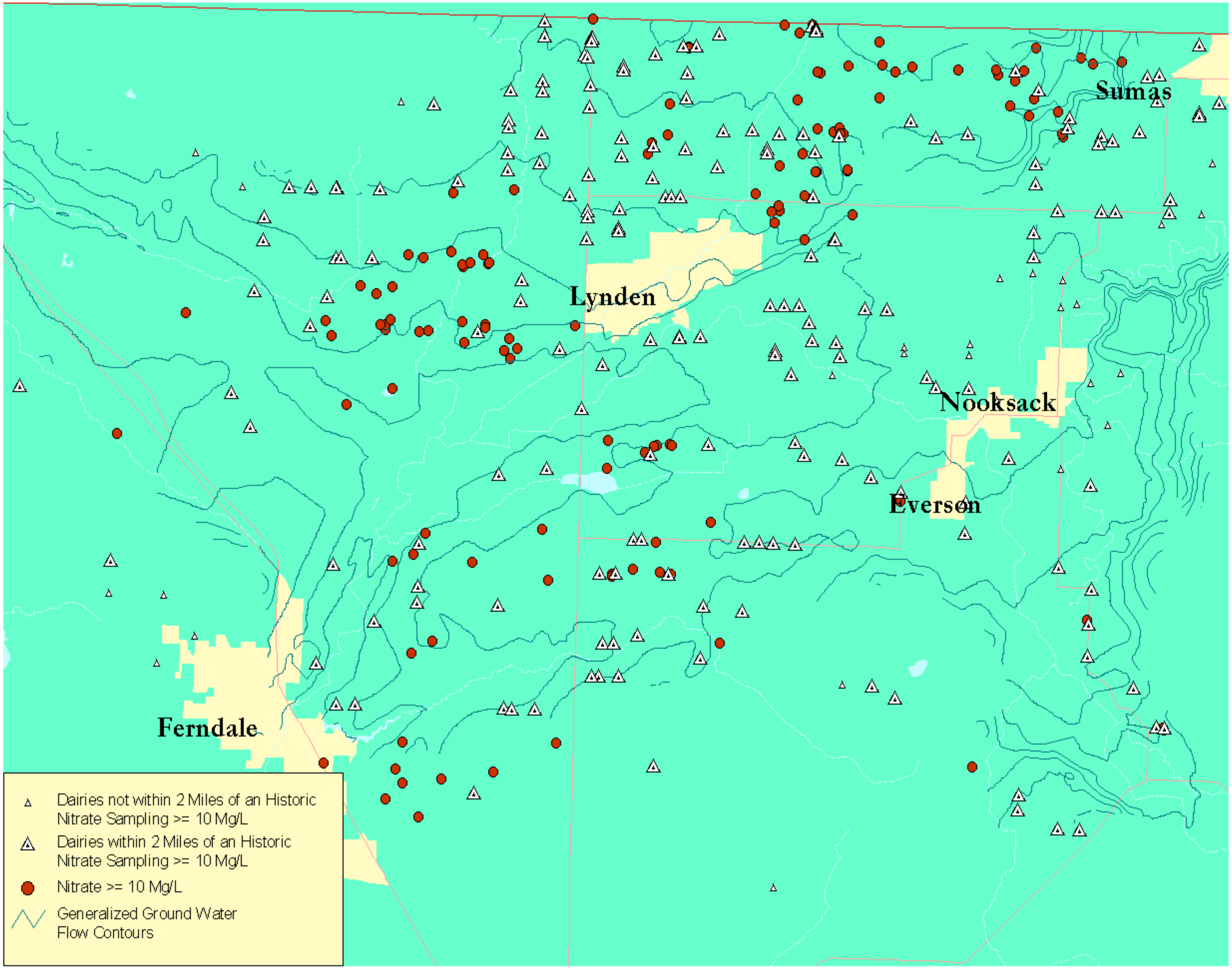


Figure 45: Dairies (1997) within 2 Miles of a Well with an Historic Maximum Nitrate Level Greater or Equal to 10 Mg/L

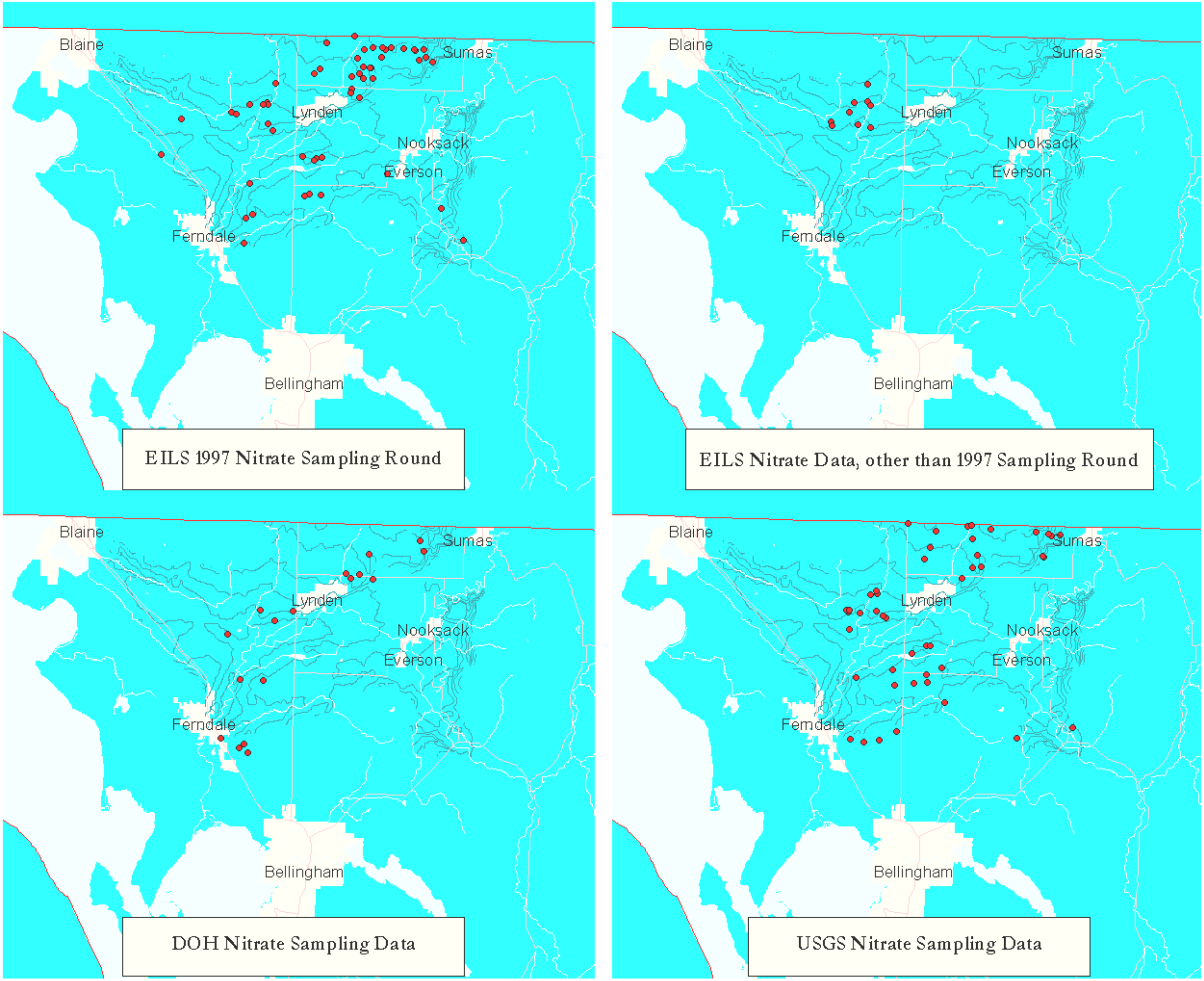


Figure 46: Nitrates Greater or Equal to 10 Mg/L by Data Source, with Generalized Ground Water Contours