Technical Memorandum
Review of Existing Groundwater Nitrate Studies

Task 3 – Walla Walla Water Quality Assessment

Draft Report

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1.0 Introduction

In much of Eastern Washington, the volume of available and accessible groundwater is a primary factor of consideration when evaluating watershed health. Aquifer levels impact water availability as well as the costs associated with accessing groundwater resources. However, even when sufficient volume of groundwater is available, the beneficial use of such water can be limited by water quality impairment such as high nitrate levels.

During the Level 2 Assessment scoping phase, the Walla Walla Water Quality Subcommittee worked with the Department of Ecology and the consultants to identify potential options for water quality study. One of the proposals was to focus on a review of nitrate levels in ground water to identify any potential areas susceptible to long-term contamination to drinking water supplies, and to suggest possible mitigation options. As a result, the analysis of the extent of nitrate contamination in Water Resource Inventory Area (WRIA) 32, identification of areas at high risk, and potential nitrate reduction strategies provided in this document will be incorporated into the larger WRIA 32 watershed plan currently under development.

The primary concern about the impact of nitrate (NO_3) in the environment is leaching into ground water. This concern largely results from the potential for health effects that may result from humans and ruminant animals drinking contaminated ground water.

Nitrate in drinking water at high enough concentrations can cause acute human health problems such as methemoglobanemia ("blue baby syndrome") and similar health issues in livestock. Standards for nitrate in public drinking water supplies have been set at 10 mg/L as nitrate (NO_3). The Washington State Department of Ecology has "trigger" level of 2 mg/L nitrate as an indication of potential concern. Elevated nitrates can also be indicative of other groundwater contaminants such as microorganisms or pesticides.

Elevated nitrate levels in groundwater can indicate contamination from septic systems, sewage lines, or from commercial practices such as pesticide application, fertilizer application and food processing. Common nonpoint sources of elevated nitrate concentrations in ground water include: (1) high-density animal operations where manure is generated and land-applied at rates in excess of crop nutrient requirements; and (2) row-crop agriculture where fertilizer used to supplement crop needs can leach into groundwater. Nitrate that moves below the crop root zone can potentially leach into ground water. Generally, water and dissolved nitrate percolate below the root zone and through the intermediate vadose zone to an aquifer. From there, these waters can recharge deeper aquifers or discharge to streams or water bodies, raising nitrate levels in the aquifers and/or surface waters to which the aquifer is connected. Nitrate is removed from ground water solution generally through plant uptake or denitrification. However, once nitrate has leached into ground water, the dissolved nitrate can travel through sediments and rock with little attenuation other than dilution, because nitrate is not sorbed by soil particles.

To support development of water quality enhancement strategies in the WRIA 32 watershed plan, this document reviews existing data regarding nitrate levels in groundwater of WRIA 32, analyzes the extent of nitrate contamination in WRIA 32, identifies areas at high risk for increased nitrate levels in the future, and provides potential nitrate reduction strategies.

2.0 Data Availability

The following agencies were contacted in an attempt to locate all known nitrate data for WRIA 32:

- United States Geological Survey
- United States Department of Agriculture – Natural Resource Conservation Service
- Environmental Protection Agency (Region 10)
- Washington State Department of Ecology
- Washington State Department of Health
- Washington State University: Extension
- Washington State University: Geology & Environmental Science Departments
- Walla Walla County Health Department
- Columbia County Health Department

Despite a large volume of information available for surface water quality, groundwater quality data for the area is limited. The majority of available information in WRIA 32 is centered near the City of Walla Walla. Analysis of nitrate levels in WRIA 32 presented in this document relied primarily upon the following sources:

- Walla Walla/College Place Pre-Groundwater Management Plan (EES, 1995)
- Pesticide Residues in the Walla Walla Surficial Aquifer (Ecology, 1995)
- Water Quality Characteristics of the Columbia Plateau Regional Aquifer System in Parts of Washington, Oregon and Idaho (USGS/Steinkampf, 1989)

In addition to these sources, the Washington State Department of Health maintains water quality sampling results for public water system wells and individual private wells are tested by county health departments upon request. However, the data is not readily available, and privacy issues exist regarding the private wells. Walla Walla County Health Department well testing data is currently being compiled into a GIS database by the Walla Walla County Planning Department. When available (anticipated in August, 2003), this information can be used to identify locations within Walla Walla County that have reported high nitrate levels. Any new information can be incorporated into the forthcoming Walla Walla Basin Watershed Plan.

3.0 General Nitrate Levels

The basalt aquifer system is ubiquitous beneath WRIA 32, consisting of three primary aquifer units from oldest (deep) to youngest (shallow): Grande Ronde, Wanapum, and the Saddle Mountains. The Walla Walla River Basin is underlain by two geologically distinct aquifers. The confined basalt aquifer underlies the entire basin and can be up to 3,000 feet thick. The basalt aquifer is split into three distinct units: the Grande Ronde, Wanapum and Saddle Mountains. The Grande Ronde, the oldest and thickest of the three units, underlies all of WRIA 32. The Wanapum unit overlies the Grande Ronde unit but is thinner and less extensive in area, extending beneath the western three-quarters of the WRIA. The Saddle Mountains unit is the youngest basalt formation in the area, overlying the Wanapum unit in the southern and far western portion of the WRIA. The unconfined gravel aquifer underlies a much smaller area than any of the three basalt units, extending from City of Walla Walla west along the Walla Walla River. The groundwater table in the gravel aquifer is shallow and goes to stream level in some areas. Recharge to the gravel aquifer occurs from precipitation infiltration, recharge from streams, ditches and canals, and to a lesser degree from upward recharge from the basalt aquifer. Additional description of the subsurface hydrogeology is included in the WRIA 32 Level 1 Assessment (EES 2002).

3.1 Nitrate Levels by Aquifer

Generally, nitrate concentrations decrease with greater depth and age of the aquifer unit (Exhibit 1). Within the Walla Walla Watershed, this equates to highest concentrations of nitrates in the gravel aquifer, lower concentrations in the Saddle Mountains, and Wanapum basalt aquifers, and lowest concentrations in the Grande Ronde aquifers (Exhibit 2). Sufficient well testing data to facilitate detailed analysis of nitrate concentrations in most of the WRIA is not available. However, a study of groundwater quality in the greater Columbia Basin was published in 1989 by the United States Geological Survey (Steinkampf, 1989). This study included 824 samples (350 wells) from 1982-1985: 283 from the Grande Ronde Unit, 410 from the Wanapum, and 131 from the Saddle Mountains Unit. Most wells samples were irrigation or municipal wells and each drew from a single basalt unit. Although exact locations of the sampling were not presented in the report, the full extent of each aquifer was tested with the exception of the crest of the Blue Mountains. Thus, because these three aquifer units extend well beyond the borders of WRIA 32, data used in calculating average nitrate concentrations for each aquifer unit likely includes data points gathered from outside of the WRIA. Average nitrate concentration in the full extent of the Saddle Mountains unit is approximately 4.8 mg/L, 2.9 mg/L in the Wanapum, and 0.96 in the Grande Ronde (Steinkampf, 1989). While the highest nitrate concentrations in the Wanapum unit are partially located within WRIA 32, the area of the Saddle Mountains Unit that is located within WRIA 32 contains nitrate concentrations below 2 mg/L on average (Steinkampf, 1989). Areas of the Saddle Mountains Unit with the highest nitrate levels are northwest of WRIA 32 (see Steinkampf, 1989).

The majority of available data is from the Walla Walla / College Place urban area. Localized well tests conducted as part of the Walla Walla/College Place Pre-Groundwater Management Plan (EES, 1995) reflect the trend of increasing nitrate levels in shallower aquifers. Sampling for this study occurred from three wells in the gravel (shallow) aquifer and three from a basalt (deep) aquifer unit (see Table 3-1). For wells tested in the basalt aquifer, the farthest upgradient was City of Walla Walla Well No. 7, while the farthest downgradient was the Frost Ranch Deep Well. For gravel aquifer wells, the farthest upgradient was the Ruther Well, and the Frost Ranch Shallow Well was the farthest downgradient. Nitrate values provided in Table 3-1 were derived from single samples taken during spring of 1994. Wells drawing from the gravel aquifer resulted in nitrate levels of 0.2-5.2 mg/L, while the basalt wells tested showed nitrate levels below detection limits.

Table 3-1
Nitrate Concentrations in Selected Wells: City of Walla Walla Area

Well	Aquifer	Well Location				Nitrate Concentration (mg/L)
		Township	Range	Section	¼-¼	
City of Walla Walla Well No. 7	Basalt	7N	36E	7	NW NW	0.0
Walla Walla College Dairy Farm Well	Basalt	7N	35E	33	NE SW	0.0
Frost Ranch Well (deep)	Basalt	6N	34E	7	SE SE	0.0
Ruther Well	Gravel	7N	36E	34	NW NW	0.3
Klicker Well	Gravel	6N	35E	4	NE NW	5.2
Frost Ranch Well (shallow)	Gravel	6N	34E	7	SE SW	2.0

Source: EES, 1995

3.2 Nitrate Levels above MCL

Elevated nitrate levels above its Maximum Contaminant Level (MCL: 10 mg/L as N) in WRIA 32 are most frequently observed in the far western portion of the WRIA, near Burbank, that is out of the planning area (Mike Steward, DOH, pers. comm. 6/18/03). However, nitrate levels above the MCL have been observed within the planning area, primarily in the gravel aquifer near the City of Walla Walla. Nitrate levels exceeding the MCL were detected during sampling that occurred during 1989 (205J study summarized in EES, 1995) and 1993-1994 (Ecology, 1995). These sampling results are summarized on Exhibit 4. Elevated nitrate levels in the 1989 sampling were detected primarily along the southern edge of the City of Walla Walla near the confluence of Yellowhawk and Garrison Creeks. Approximately 16% of the 1989 study sections exceeded the MCL of 10 mg/L, while 37% of the study sections exceeded 5 mg/L. Wells in the same vicinity that draw water from the basalt aquifer, however, showed nitrate concentrations less than 0.5 mg/L (EES, 1995); again reflecting the trend of decreasing nitrate concentrations with depth. The 1993-1994 sampling demonstrated a similar spatial pattern wherein the wells that exceeded the MCL (22%) were clustered around the Yellowhawk/Cottonwood Creeks confluence, with additional MCL exceedances occurring near the Mill Creek/Walla Walla River confluence (see Exhibit 4).

4.0 Areas of Focus

Elevated nitrate concentrations represent a significant groundwater quality concern in those areas where groundwater meets a significant proportion of groundwater needs. The potential sources of groundwater contamination vary, but can include excessive fertilizer application to fields and lawns, livestock waste, and septic systems.

With dependence of rural residents upon groundwater supplies for drinking water, rural (unsewered) residential development can represent a significant threat to groundwater quality with the use of septic systems. As such, regions of the watershed with rural residential development pressure represent additional areas of focus to protect high quality groundwater from further degradation. Private septic systems have been identified as a potential source of significant nitrate inputs to groundwater near the City of Walla Walla (EES, 1995). As such, those areas along the south and west sides of the City of Walla Walla represent areas of focus given that nitrate contamination has already occurred due to intensive land use activities, including agriculture and rural residential development. As identified in the WRIA 32 Implementation Area Outlines, regions with rural residential development pressure include the following: Titus Creek near Bennington Lake, Mill Creek near 7 Mile Road, near the confluence of the North Fork and South Fork Touchet River, near the confluence of North Fork Touchet and Robinson Creek, near the confluence of Wolf Fork and Robinson Creek, surrounding the upper Coppei Creek forks, and surrounding upper Dry Creek. Special attention should be provided to these areas to help ensure that additional residential development does not lead to groundwater degradation.

In addition, areas of irrigated agriculture represent areas of focus for monitoring nitrate levels. Over application of irrigation water can leach nitrates from the root zone before it can be completely utilized by plants, thus contributing to groundwater contamination (Pratt, 1984). Intensive irrigation in the vicinity of Walla Walla and in the northwest portion of the WRIA significantly increases the potential for leaching of nitrates from surface applications into the groundwater. Areas of focus for continued groundwater monitoring regarding existing elevated nitrates, or the potential for groundwater contamination, are summarized in Exhibit 5.

Groundwater quality is vital to the City of Walla Walla's aquifer storage and recharge (ASR) project. Because water cycled through the ASR project is used for drinking water, both the surface water used for injection and the groundwater with which the injected water mixes must both be of high quality. Based upon the limited data available, it does not appear that groundwater quality will be a limiting factor for this project. However, further ground water quality monitoring to characterize the potential capture zone area will be a necessary part of the ASR project.

5.0 Preliminary Nitrate Reduction Strategies

Given the diversity of uses in the areas of focus identified above, nitrate reduction strategies by necessity must address the variety of potential sources of nitrate inputs to groundwater. Nitrate reduction strategies focus primarily upon changes in best management practices that can decrease the rate at which nitrates enter the groundwater system.

General

- Enhance understanding of hydraulic connectivity for transmission between gravel & basalt aquifers to facilitate understanding of the potential to transfer water with high nitrate concentrations from the gravel to basalt aquifers.
- Expanded monitoring program to define areas of nitrates contamination and to begin characterization of any significant plumes or trends in these areas. This monitoring should focus specifically on areas of irrigated agriculture, Group A Public Water Systems that have shown elevated nitrates, and areas of intensive rural development pressures where the density of private wells and septic systems may increase.
- Develop data sharing system between DOH, County Health Departments, and County Planning Departments to facilitate placement of rural wells away from areas known to be high in nitrates.

Municipal/Urban

- Encourage urban lawn best management practices such as reducing fertilizer inputs, pet waste management, and composting yard waste.
- Evaluate potential contributions of Walla Walla Wastewater Treatment Plant effluent in areas of land application.
- Municipal well maintenance & proper sealing of abandoned wells to avoid potential for casing leaks.
- Evaluation of activities & enforcement of wellhead protection areas in municipal wellhead protection plans.

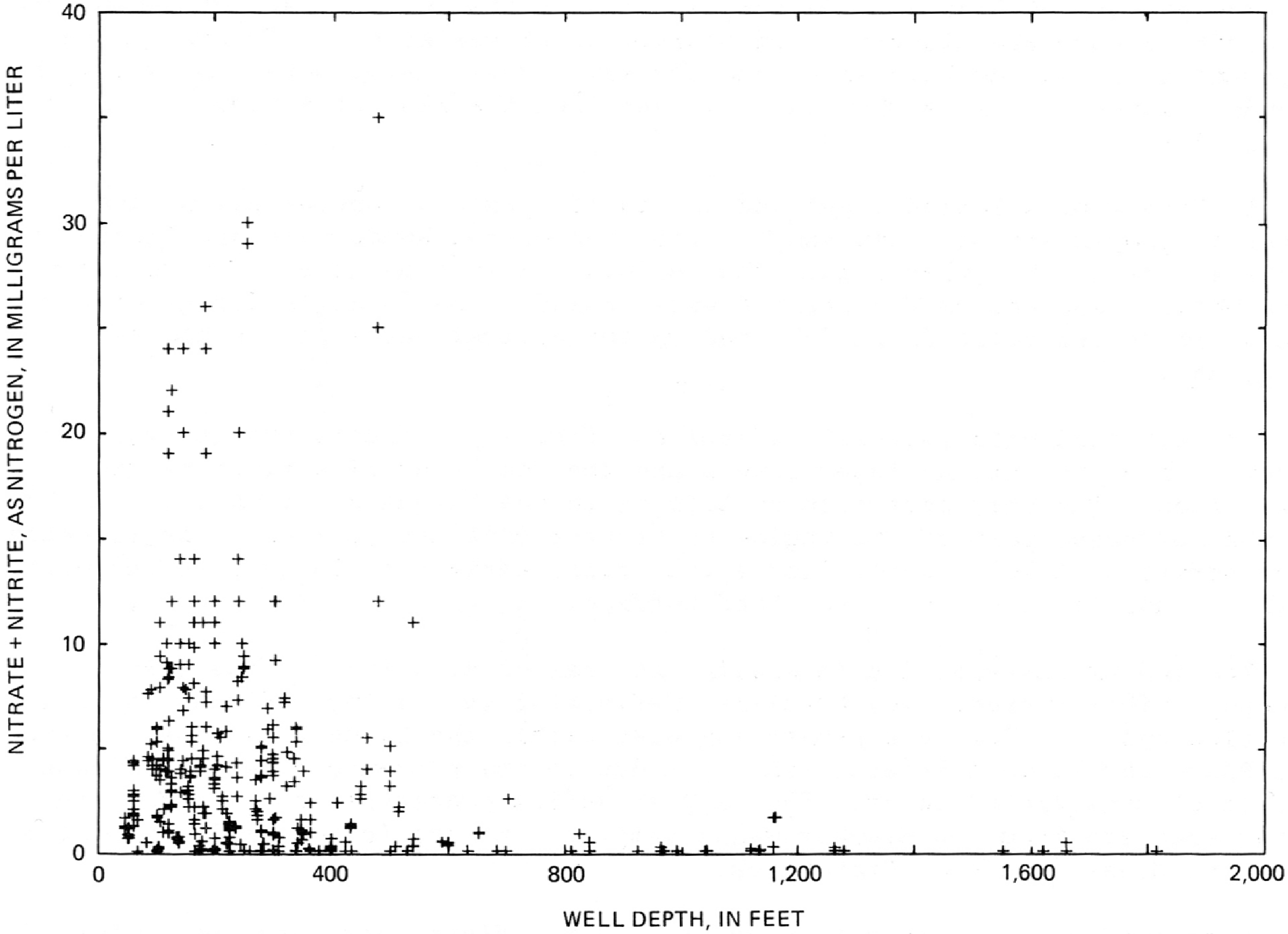
Rural Residential

- Encourage connection of new construction to municipal sewers wherever possible.
- Implement and/or enforce existing County zoning regulations in areas experiencing rural residential development pressure.

- Public education regarding maintenance of septic systems and fertilizer application.

Agricultural

- Support continued research on the relationship between fertilizer application/irrigation rates and crop needs (quantity and timing)
- Limit land application of manure to shallow-slope fields (e.g. less than 6%).
- Regular planting of crops such as alfalfa in feedlot areas to take-up excess nitrogen.



Source: USGS/Steinkampf, 1989

EXHIBIT 1

Walla Walla

Water Quality Assessment

Nitrate Concentrations (1982-1983)

June 2003

Economic and Engineering Services, Inc.

Bellevue Mount Vernon Olympia Portland Tri-Cities

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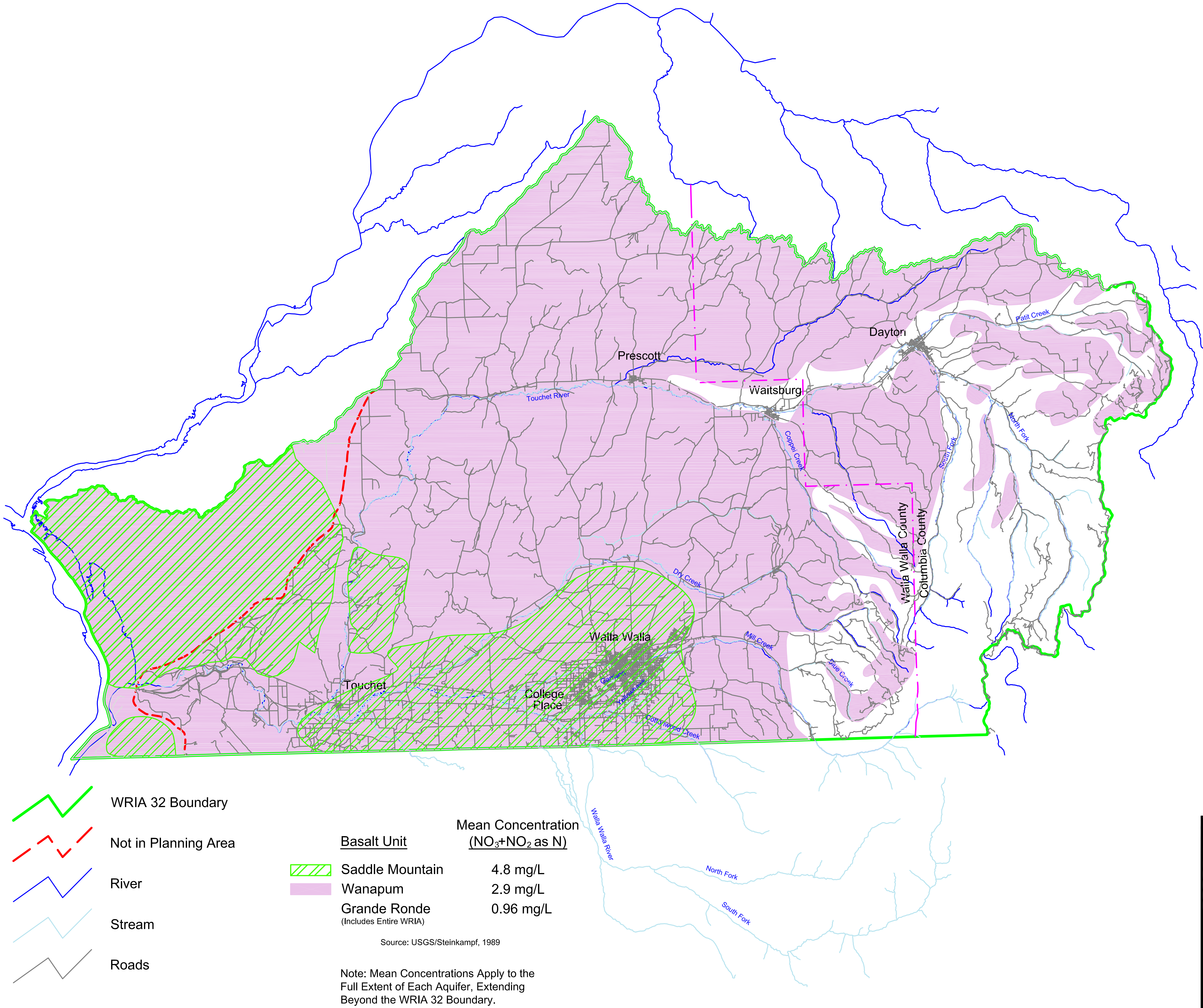

EXHIBIT 2

Walla Walla

Water Quality Assessment
Average Nitrate
Concentration by Aquifer

June 2003

Economic and Engineering Services, Inc.
Bellevue Mount Vernon Olympia Portland Tri-Cities

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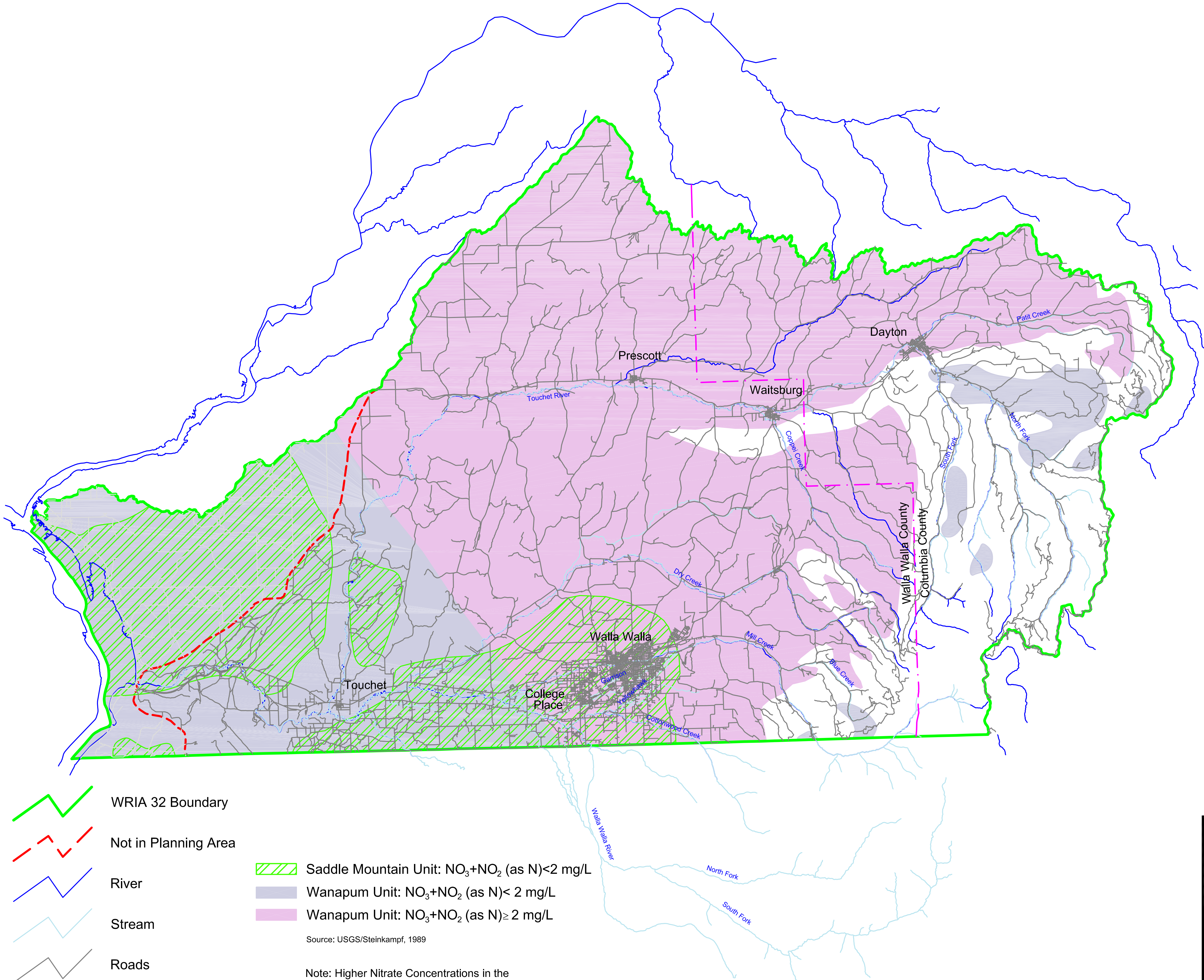

WRIA 32 Boundary

Not in Planning Area

River

Stream

Roads

Saddle Mountain Unit: NO_3+NO_2 (as N)<2 mg/L

Wanapum Unit: NO_3+NO_2 (as N)< 2 mg/L

Wanapum Unit: NO_3+NO_2 (as N)$\geq$ 2 mg/L

Source: USGS/Steinkampf, 1989

Note: Higher Nitrate Concentrations in the Saddle Mountain Unit are Found Northeast of WRIA 32.

EXHIBIT 3

Walla Walla

Water Quality Assessment
Average Nitrate Concentrations

June 2003

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Economic and Engineering Services, Inc.
Bellevue Mount Vernon Olympia Portland Tri-Cities

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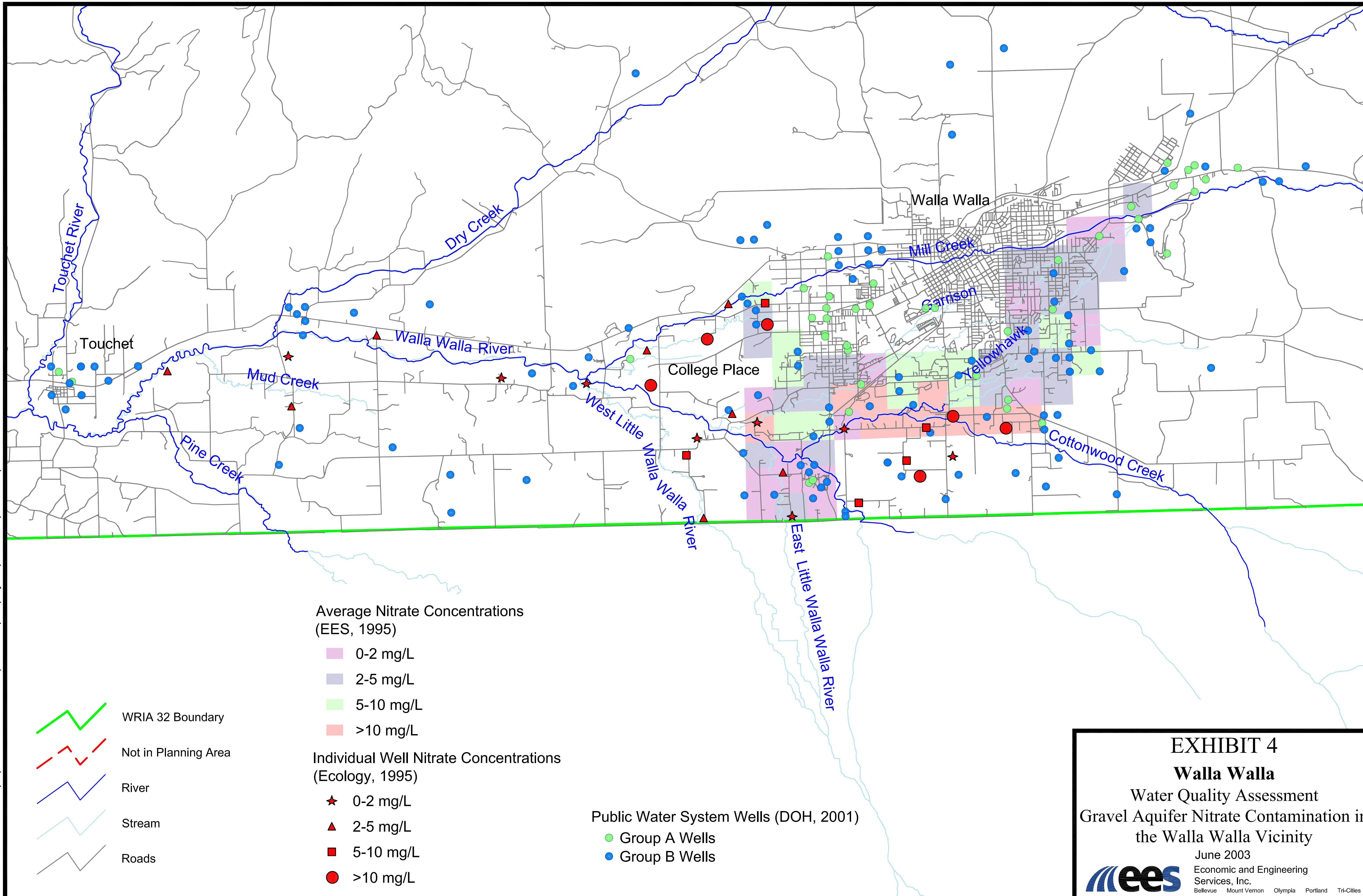

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Pratt, P.F. 1984. Nitrogen use and nitrate leaching in irrigated agriculture. In R.D. Hauck (ed.), Nitrogen in Crop Production (chap. 21). ASA. Madison, WI.

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