DEQ Water Quality Division

2008 Annual Progress Report For the Lower Umatilla Basin Groundwater Management Area

September 29, 2009

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Department of Environmental Quality

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1.0 INTRODUCTION

This report describes the progress made towards implementation of the Lower Umatilla Basin Groundwater Management Area Action Plan during the year 2008. This report was prepared by the Oregon Department of Environmental Quality (DEQ) using information provided by the affected and interested parties involved in the Lower Umatilla Basin Groundwater Management Area. It should be noted that many of the parties contributing to this document are also doing other activities that are protective of groundwater both within and outside the GWMA. However, these "other activities" are not mentioned in this document because they are not directly applicable to implementation of the Action Plan.

Previous progress reports have included information on the establishment of the Lower Umatilla Basin Groundwater Management Area, important facts about nitrate, the goals of the Action Plan, and ways to measure success of the Action Plan. This information is not reiterated in this report. Previous progress reports (as well as other LUB GWMA documents) are available at http://www.deq.state.or.us/wq/groundwater/lubgwma.htm Only activities conducted in 2008 are discussed in this document.

2.0 EDUCATION / OUTREACH ASPECTS OF ACTION PLAN IMPLEMENTATION

This section of the report includes information on the educational / outreach activities conducted in 2008 as part of the Action Plan implementation, general cataloging of information, printed material available, information sources, and future needs in education / outreach. Previously completed activities are described in previous progress reports.

2.1 Educational / Outreach Activities Conducted

Umatilla County SWCD Efforts

The Umatilla County SWCD's Clean Water Neighborhood Coordinator worked with the LUB GWMA Irrigated Agriculture Sub-Committee to help implement the BMP survey.

The SWCD has been meeting with small acre landowners providing information on irrigation practices, manure and pasture management. All this information is kept on file at the SWCD's Hermiston office.

The SWCD conducted nitrate/septic tank surveys in Westland Estates area west of Hermiston due to contamination of nitrate to public well water that supplied 22 homes. The SWCD was unable to get any funding to help homeowners install their own well. The SWCD worked with the Greater Eastern Oregon Development Corporation, the Oregon Watershed Enhancement Board, and USDA Rural Development to find funding for well development, but could not identify any loans available. The SWCD took an active role in trying to help homeowners with well water problems with four meetings: January 16th, January 22nd, March 15th, and March 21st, 2008

The SWCD, through its' website http://www.umatillacountyswcd.com/, is maintaining a location for news about events and meetings of interest in Umatilla County and links to other newsletters and websites. Monthly, this information is sent out electronically as "Umatilla County SWCD e-NOTES" to a growing number of recipients. Updates to groundwater information and programs will be regularly included. The periodic newsletter sent out both electronically and hard copy gives an accounting of events that the SWCD participates in and provides information about current programs.

The SWCD aired Public Service Announcements to promote participation in workshops such as the Horse Management Workshop.

Round Table Discussions

The Umatilla County SWCD continued using a round table discussion format for its public outreach forums. The round table discussion format is more informal than the traditional "speaker and audience" format. Audiences

typically find the format allows greater interaction with presenters, and provides more opportunities for attendees to ask questions pertinent to their water quality concerns.

The SWCD held two round table workshops to educate homeowners. To advertise the events, the SWCD did a saturation mailing to 12,956 rural residents with postcards. In addition, nitrate flyers were put in all the area newspapers, and public service announcements were aired on the radio.

These workshops included discussions on septic system care, well health, pasture management, and water testing. Other topics covered by professions were potential health risk for infants, resale value of property, and potential loss of public drinking water.

One round table workshop was held on June 17, 2008 at the Blue Mountain Community College Hermiston campus. Eleven presenters discussed water quality issues with 16 people.

One round table workshop was held on June 18, 2008 at the McNary Fire Station in Umatilla. Nine presenters discussed water quality issues with 12 people.

County Fair

The Umatilla County SWCD attended the Umatilla County Fair to promote a Horse Management Workshop.

Clean Water Neighborhood and PURE

With the assistance of funding through DEQ and OWEB, the Umatilla County SWCD Resource Assistance for Rural Environments (RARE) participant worked on developing the "Clean Water Neighborhood" project and assisted with creating PURE (Preserving Umatilla's Natural Resources through Education). These programs are vehicles for education and financial assistance in the LUB GWMA. The effort is designed to affect groundwater quality beginning with the individual landowner by making them aware of activities that may be contributing to pollution, then assisting in addressing these activities. The Clean Water Neighborhood program begins education through fairs, radio, newsletters, and chamber of commerce membership. It then moves to workshops and on to individual landowner contacts. Obtaining sufficient funds to fully implement the project is difficult. Using grant monies, the Umatilla County SWCD opened a satellite office within the Hermiston Irrigation District for the Clean Water Neighborhood outreach program and hired Teresa Walchli as the Clean Water Neighborhood Coordinator.

It is envisioned that the Clean Water Neighborhood project include the following tasks:

- Identify interested persons/neighborhood to host neighborhood meetings to provide the rural residential community with information and alternatives on how to manage their property while protecting groundwater quality.
- Facilitate organization, discussion and presentations for neighborhood meetings
- Compile a "toolkit" of available resource materials and contact information to bring to the neighborhood meetings. The toolkit of information available through the CWN will grow and evolve as needed.
- Provide outreach to organizations such as 4H, FAA, and Scouts to raise awareness of water quality issues.
- Produce a newsletter to report updated information and highlight accomplishments
- Follow up with neighborhood groups to assess progress of implementation
- Identify and reward individuals that have met their goals
- Organize informal workshops to provide information to larger audiences
- Offer workshops for realtors on groundwater quality concerns

The Preserving Umatilla's Resources through Education (PURE) program will be used to support an organized outreach effort to present a consistent message about groundwater protection and other relevant natural resource issues. Activities would include:

- Development and distribution of workbooks and informational packets

- Development and presentation of educational displays and demonstration models
- Organization and presentation of workshops about relevant natural resource topics such as small acreage management, pasture management, and horse management
- Organization of annual seminars presenting updated information about precision agriculture and other relevant topics
- Participation in school related events such as Watershed Field Days, Outdoor School and classroom presentations

The PURE program assisted with an Oregon Association of Conservation Districts poster contest incorporated into classroom learning.

Sustainable Agriculture Seminar

A seminar on sustainable agriculture was held at the Pendleton Convention Center on October 16, 2008. The seminar featured 10 exhibitor booths, 13 presenters, and 80 attendees.

Umatilla County Efforts

Examples of specific Umatilla County policies to address the educational aspect of the Action Plan implementation include:

1. Umatilla County will maintain a library of materials and contacts regarding BMPs to prevent water contamination.
2. Umatilla County may require video viewing or training regarding septic system maintenance as a condition of development approval.
3. Umatilla County may require video viewing or training regarding proper well placement, construction, and maintenance as a condition of development approval.
4. Umatilla County shall coordinate with other concerned entities to develop an outreach program regarding proper well and septic system maintenance, livestock containment, and lawn fertilization and irrigation.
5. Umatilla County will coordinate with the LUB GWMA committee in establishing an educational program regarding water contamination within the western portion of the County.

Public Schools and Civic Groups

In 2008, the Umatilla SWCD participated in the 6th grade Outdoor School giving presentations on water quality testing and environmental protection using the Enviroscape® model.

In 2008, DEQ personnel participated in several Outdoor School programs with fifth and six graders from Stanfield, Hermiston, Echo, Arlington, Condon, Heppner, and Sherman County to demonstrate ways to prevent pollution of groundwater and surface water by using a groundwater model and an Enviroscape® model. It is estimated that 400 Eastern Oregon kids were exposed to the concepts of groundwater and surface water protection through Outdoor School programs in 2008.

Hermiston OSU Extension faculty continue to discuss recommended practices to reduce nitrogen loading to the groundwater at Hermiston High School, local civic groups and to local Cub Scout Packs.

Morrow County Land Use Findings of Fact

All Findings of Fact for land use actions in Morrow County requiring a public hearing now identify if the subject property is located within the LUB GWMA and provide contacts for the applicant/landowner to obtain additional information.

Morrow County Water Use Committee

Morrow County established a Water Use Committee with one of its focuses being water quality. The Intergovernmental Agreement (signed by Morrow County, Morrow County cities and towns, the Port of Morrow, and the local irrigation district) specifically identifies the existence of the LUB GWMA. While this committee is

not currently active, there will be future need for county-wide discussion concerning water quantity and quality. This committee is a natural starting point for those discussions.

Farm Fair

The Umatilla County SWCD attended Farm Fair and conducted surveys on irrigation management practices. DEQ gave two presentations on the status of the LUB GWMA at the 2008 Umatilla County Farm Fair.

Water Wells

On a regular basis, Oregon Water Resources Department (WRD) staff answers questions from the public and well contractors on well construction issues. When a new or recently constructed well is found to be commingling water, the well is repaired or abandoned. When people contact the WRD staff with water quality problems, well construction and well placement are investigated as the possible cause of the problem. WRD staff educates the public on how poor well construction can lead to poor water quality.

On the second Monday of every quarter, the WRD gives its test for new water well drillers. Upon request, special tutoring sessions are offered to individuals wishing to take the test. In these sessions, the State well construction rules and statutes are discussed. Heavy focus is placed on well location, sealing depth, areas of known nitrate contamination, alternative well construction methods, under reamer systems, and telescoping casing methods of construction. In addition to the new driller education, WRD staff works with SWCD and other agencies on workshops for realtors and other interested public. Some of the topics covered in these workshops include basic well construction, sand point wells, well location, well abandonment, and water rights.

Confined Animal Feeding Operations (CAFOs)

ODA occasionally receives requests from CAFOs to assess the adequacy of their groundwater protection measures. When requested, ODA visits the site and provides recommendations. In addition, ODA Technical Staff review scientific literature on a regular basis to keep up to date on CAFO issues.

In cases where non-permitted CAFOs land-apply wastes, ODA offers educational reviews designed to assist operators in identifying potential pollution pathways associated with waste application. The CAFO program requires development and implementation of an Agricultural Waste Management Plan. Through this process, appropriate BMPs are identified that are protective of both surface and groundwaters of the state.

LUB Citizens Advisory Committee Activities

The LUB Advisory committee met twice in early 2008. They met primarily to review and comment on the drafts of the *Second Four-year Evaluation of Action Plan Success and 2005/2006 Annual Progress Report.*

ODA met or teleconferenced three times during May, June and July to discuss and refine the response to DEQ related to future obligations for defining, implementing and reporting Best Management Practices for irrigated agriculture. ODA prepared a GIS database and maps to account for the different land uses in the GWMA. This includes irrigated commercial agriculture, residential agriculture, water reuse, and CAFOs. Further refinement of the maps to separate permanent pastures from cropland will help define the area with highest fertilizer usage.

In August 2008, the Irrigated Agriculture Committee was reorganized and met to bring new members up to date and discuss needs for measuring success of BMPs. ODA staff met with the co-chairs of the Irrigated Ag Committee, DEQ and OSU several times from August through November to review a very useful BMP document from Michigan State U. and develop a grower survey to gauge implementation of BMPs for water and nutrient management. An update of LUB data and activities was presented at the Hermiston Farm Fair in December and growers were asked to participate in completing irrigation and nutrient management surveys. SWCD staff took the lead in gathering surveys and assisting growers in filling them out.

The CAFO Committee was reorganized and met on 9/16/08 to bring the new members up to speed on the LUB GWMA process and progress.

The Education Committee, led by the SWCD, met to plan education activities for the coming year.

Re-use Water Consortium Meetings

The Water Reuse Committee met several times. They met to look at the monitoring data from the food processing wastewater application sites and to respond to the DEQ statements in the draft Four-Year Evaluation report.

KOHU lawn and garden show

Every Friday morning from March through October, OSU Extension faculty (Don and Phil) host a radio program focused on home lawn and garden care. They address issues including pest management, nutrient management, and irrigation water management. The focus of the program is for homeowners to manage their lawns and gardens in both environmentally and productive manner.

2.2 General Cataloging of Information

The Umatilla County SWCD's Hermiston office is the home of their Clean Water Neighborhood Project. The Clean Water Neighborhood Coordinator maintains a water quality library that includes handouts from workshops, as well as information available to the public on the computer library. The Clean Water Neighborhood office created a list of "who to contact" for workshop attendees.

2.3 General Implementing Strategy

The Umatilla County SWCD develops strategies to address water quality through newspaper articles, visual surveys, letters and individual interviews to encourage adoption of BMPs that will enhance water quality.

The CWN Education Committee will assist the Coordinator in defining specific areas within the LUB GWMA to focus outreach efforts.

Previous surveys suggest the general public has a lack of concern about nitrates in groundwater. The SWCD is involved in assisting 22 Westland Estate homeowners who are losing their public drinking water well access due to high nitrates and other issues. More residents need to know they can be affected.

2.4 Printed Material

The SWCD maintains brochures and handouts designed for workshops for the public and continues to gather hard copies of information pertaining to groundwater, conservation of natural resources, and important water quality concerns. However, the SWCD now commonly recommends internet sites that contain far more information. The SWCD web site http://www.umatillacountyswcd.com/ contains lots of conservation information along with some water quality information.

The Morrow County Planning Department regularly distributes written materials about groundwater quality, OSU Home-A-Syst information, etc. to landowners. The distribution of this groundwater quality information is made a condition of approval of many land use permits, including subdivisions and partitions in residential zones.

The following handouts are available in the Morrow County Planning Department and are provided upon request to local homeowners.

Water Handouts:

- LUB GWMA DEQ Fact Sheet
- Small Acre Conservation Toolbox
- Managing Small Acreage Horse Farms
- Disposal of Chlorinated Water
- Rural Domestic Water Supply and Conserving Water
- Keeping Your Well Water Well
- 12 Simple Things You Can Do To Protect Your Well Water

- Drinking Water and Health
- Source water Collaborative: Advice Worth Drinking

Sewer Handouts:

- So…now you own a septic system
- The care and feeding of your septic system
- Groundwater protection and your septic system
- Interim Septage Storage Tanks
- Septic Tank Additives
- Septic System Management Landscaping and other Activities on Your Property
- Septic Systems & Stream Crossings Test Pit Preparation
- Septic Tank Maintenance (DEQ)
- Septic Tank Maintenance (OSU)
- Why Do Septic Systems Fail?
- Procedures and Criteria for Installing New Septic System

Home-A-Syst Handouts

- Worksheet 1: Drinking Water Condition
- Fact Sheet 1: Improving Drinking Water Well Condition
- Worksheet 2: Pesticide Storage and Handling
- Fact Sheet 2: Improving Pesticide Storage and Handling
- Worksheet 3: Fertilizer Storage and Handling
- Fact Sheet 3: Improving Fertilizer Storage and Handling
- Worksheet 4: Petroleum Product Storage
- Fact Sheet 4: Improving Petroleum Product Storage
- Worksheet 5: Hazardous Waste Management
- Fact Sheet 5: Improving Hazardous Waste Management
- Worksheet 6: Household Wastewater Treatment
- Fact Sheet 6: Improving Household Wastewater Treatment
- Worksheet 7: Livestock Waste Storage
- Fact Sheet 7: Improving Livestock Waste Storage
- Worksheet 8: Livestock Yards Management
- Fact Sheet 8: Improving Livestock Yards Management
- Worksheet 9: Milking Center Wastewater Handling
- Fact Sheet 9: Improving Milking Center Wastewater Handling
- Worksheet 10: Site Evaluation
- Worksheet 11: Overall Homestead Assessment

Forest Facts (from OSU)

- Forests and Drinking Water
- Landslides
- Reforestation
- Planting Tree Buffers
- Earthquakes
- Disposing of Woody Material
- Thinning
- Mechanical Fuels Reduction
- Pruning
- Carbon Storage in Forests

Also available upon request is the "Living with Umatilla and Morrow County Natural Resources" manual. In addition, a general disclaimer about the impact a proposed development may have on groundwater quality is included in almost every "Finding of Fact" report for land use actions.

Examples of specific Morrow County policies to address the educational aspect of the Action Plan implementation include:

1. Morrow County maintains a library of materials regarding BMPs to prevent water contamination.
2. Morrow County coordinates with the LUB GWMA committee in establishing an educational program regarding water contamination.

Living with Umatilla and Morrow County Natural Resources

In 2006, a manual was prepared that describes the natural resources of the Lower Umatilla Basin with emphasis on the fragile nature of the ecosystem and actions people can take to minimize their impact on the natural resources. The LUB GWMA is discussed in this booklet. This manual is designed to help the residents of Umatilla and Morrow Counties learn more about the natural resources of the region; as well as the benefits and issues associated with these resources. It includes contact and informational resources readers can utilize and success stories to get readers thinking about how they might better manage their little piece of the world. The booklet was prepared through the cooperation of the Morrow SWCD, Blue Mountain Resource Conservation & Development Council, EPA, Morrow County Planning Department, Umatilla County Planning Department, DEQ, and the Umatilla County Commissioners. It is available from the Columbia Blue Mt. Resource Conservation and Development office and can be requested by calling 541/278-8049, ext. 140.

A Consumer's Guide to Water Well Construction, Maintenance, and Abandonment

The Oregon Water Resources Department updated the Consumer's Guide to Water Well Construction, Maintenance, and Abandonment in August 2006 and is currently working on another update. The document includes information on common well construction questions such as proper set back requirements, well abandonment, drilling your own well, and other well topics. This pamphlet is handed out to anyone inquiring about wells. This pamphlet is also made available to other agencies for their uses in dealing with the public. Individuals with Internet access can obtain a copy at www.wrd.state.or.us under the publication link.

Other Educational Printed Material

The following educational materials were randomly available at the Umatilla County SWCD. Most of these materials are now available online.

Tips on Land & Water Management for Small Acreages in Oregon
Blue Thumb Pamphlet, Water Conservation Tips
Basic Guide for Lawn Maintenance (Pendleton Public Works Pamphlet)
Home*A*Syst pamphlet and worksheets 1-11
Farm*A*Syst overview booklet titled "Twelve simple things you can do to protect well water"
Home*A*Syst pamphlet titled "Why do septic systems fail?"
Groundwater: Pollute or Preserve? It's Your Choice (OSU Extension Circular 1343)
LUB Groundwater Action Plan
Oregon Groundwater Community Involvement Program
"I Love Water" pamphlet
Living with Umatilla/Morrow County Natural Resources
Tips on Land and Water for Small Acreage in Oregon
Oregon – Soil and Water Conservation District
OSU's Soil Sampling for Home Garden and Small Acreages
OSU's Soil Test Interpretation Guide
USDA's Watershed Health – Harmony, A Partnership with a Healthy Land

USDA's ABC of Rotational Grazing – Pastures
USDA's Managing your land for horse health and water quality
USDA's Managing mud and manure
USDA's Composting Horse Manure and Farm Waste
USDA's The composting companion
USDA's Building a compost pile
USDA's How to Compost and use horse manure
USDA's Manure management in small farm livestock operations
USDA's Managing pastures
USDA's Composting – An alternative for livestock manure management and disposal of dead animals
Umatilla County SWCD – Fact Sheet on Estimating Soil Moisture by Feed and Appearance
Water Quality and Agriculture in Oregon – SB1010
Planning and Managing Irrigation
Soil Nutrient Management
Weed Booklets
Fencing Information Toolkits
Pasture Toolkits
Composting Toolkits
Information Books – Horse and Conservation on Your Land
Oregon Small Acreage Conservation
Small Acreage Fact Sheets #1 Protecting Your Watershed
#4 Protecting Stream banks from Erosion
#5 Managing Streamside Area with Buffers
#6 Managing Pasture in Eastern Oregon
#9 Managing Stock Water in Pastures and Streamside Areas
#12 Fertilizing for Profit
#14 Planning and installing irrigation
#18 Before You Buy: Wells, Septic Systems and a Healthy Home site
#19 After You Buy: Wells, Septic Systems and a Healthy Home site

2.5 Information Sources

The following table contains contact information for various topics related to the GWMA.

Topic	Contact	Organization	Telephone #
Irrigated Agriculture BMP Implementation	Bev Kopperud Janet Greenup Don Horneck Loren Unruh	Umatilla County SWCD Morrow County SWCD OSU Extension NRCS	(541) 276-8131 (541) 676-5452 (541) 567-8321 (541) 278-8049
Health effects of nitrate and/or how to remove nitrate from your drinking water	Drinking Water Section	Oregon Health Division	(503) 731-4010
Protecting groundwater quality while developing property	Carla McLane Tamra Mabbott	Morrow Co. Planning Umatilla Co. Planning	(541) 922-4624 (541) 278-6246
Groundwater quality protection guidelines related to lawn and garden maintenance	Bev Kopperud Don Horneck	Umatilla County SWCD OSU Extension	(541) 276-8131 (541) 567-8321
Groundwater quality protection guidelines related to well construction and maintenance		Oregon Water Resources Department	(541) 278-5456
Groundwater quality protection guidelines related to animal density	Eric Moeggenberg	Oregon Department of Agriculture	(541) 617-0055
DEQ's bi-monthly monitoring well	Phil Richerson	Oregon Department of	(541) 278-4604

network		Environmental Quality	
Properly siting, installing, and maintaining a septic system	Bernie Duffy or Bob Marshall	Oregon Department of Environmental Quality	(541) 276-4063

2.6 Future Needs in Education / Outreach

The following items have been identified that would assist in the education and outreach aspects of Action Plan implementation:

- Complete a Rural Residential Survey at the end of 2009.
- Translate additional educational materials into Spanish and make them available to the Spanish-speaking population within the GWMA.
- Continue to pursue funding to implement the Clean Water Neighborhood and PURE projects.

3.0 DETERMINATION AND IMPLEMENTATION OF BMPS

This section of the report includes discussions of various research projects conducted in 2008 for determining BMPs relevant to the Lower Umatilla Basin.

3.1 Research into BMP Determination

Research into BMPs has occurred on several levels since declaration of the GWMA. Previous research is described in previous progress reports.

No research regarding BMP determination for irrigated agriculture, septic systems in rural residential development, CAFOs or the land application of food processing process water was conducted in the LUB GWMA in 2008.

3.2 BMP Implementation

BMP implementation has occurred on several levels since declaration of the LUB GWMA. Previous examples of BMP implementation are described in previous progress reports.

Nutrient Management

ODA continues to work with some of the permitted CAFOs in the LUB GWMA that also grow crops by reviewing their annual soil testing data. They then point out areas where excess nitrogen is present in the soil and require that this be accounted for agronomically in the next season's (or winter) crop.

Irrigation Management – Companies like IRZ Consulting and Simplot Soilbuilders continue to play an important role in implementing irrigation management in the LUB.

IRZ's irrigation management service includes soil moisture monitoring, an on-line source of daily crop water use and evapotranspiration reports, the use of aerial infrared photography, the development of comprehensive water conservation plans, and irrigation scheduling software. The Northwest Irrigation Network is available to commercial growers and the community as a whole.

Simplot Soilbuilder's irrigation scheduling and crop water management services utilize crop ET rates, plant water uptake within the root zone and moisture movement through the soil profile.

Irrigation Conversions

The Umatilla County SWCD continues to apply for funding to convert small acreage farms from flood irrigation to a more efficient sprinkler or drip systems. These applications reportedly don't rank very high due to difficulty quantifying environmental benefits. However, the SWCD was successful in completing the L-line conversion and applied for another grant for the I-line in 2008.

EQIP Projects

The Environmental Quality Incentives Program (EQIP) provides a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land. The program is guided by a local working group who defines funding criteria dependant on the area of interest for funding improvement projects. The program is implemented by NRCS.

In 2008, EQIP cost share dollars funded $938,091 in Umatilla County and $495,348 in Morrow County.

Giddings Probe - OSU Extension Service provides maintenance and one-on-one training for a Giddings Probe used for deep soil sampling. The Giddings Probe is used for deep soil sampling. This is of particular value following high nitrogen use, shallow rooted crops. Sampling after crops such as potatoes and onions to depths beyond two feet is difficult with hand probes. The Giddings probe was acquired to allow deeper sampling: to four

feet, six feet, or even deeper (samples have been collected from nine feet where soil depth allows). The concept is to measure the amount of residual nitrogen, particularly in the three to five feet zone that might still be pulled back up and utilized by a "sponge crop" such as cereal, grass seed, or sudan grass. Although alfalfa leaves some residual nitrogen itself, this is generally deposited in the surface two feet and its deeper rooting habit (even to depths of six to seven feet) can be an effective way to move nitrogen back to the surface where it can then be removed with the harvested crop. This concept was very successfully used by a local grower when they were utilizing high nitrogen hog waste from their lagoon and is now being used by another grower utilizing municipal sludge. An area-wide deep sampling study conducted by an OSU Master's student identified additional "hot spots" of nitrogen deposition such as swales.

The Giddings Probe was checked out for 79 days for sampling in Umatilla and Morrow Counties in 2008.

Implementation of Recommended Management Practices – In addition to the specific goals specified for 2009 (discussed in Section 5.0), the Action Plan also lists several recommended practices for the irrigated agriculture community (Section VI, items A.2.c.1.a through p).

Federal programs provide incentive payments and technical assistance for adoption of acceptable systems. The SWCD and OSU Extension actively promote adoption of BMPs for protection of groundwater. However, growers are not required to report any of their activities.

Analysis of the enrollment statistics for the USDA's Conservation Security Program reflects, to a large extent, the adoption of practices that meet at least the minimum NRCS standards for soil and water quality. Keep in mind that payment limitations prevent enrollment of all cropland in the basin though the same BMPs are likely used on many more acres.

CAFOs

Educational reviews were (and still are) offered by ODA to assist operators in identifying potential pollution pathways associated with waste application. The CAFO operator identifies and adopts BMPs through the Animal Waste Management Planning process. ODA reviews Animal Waste Management Plans (AWMPs) that are submitted as part of a CAFO's National Pollutant Discharge Elimination System (NPDES) permit.

An amendment to the Morrow County Zoning Ordinance that restricted the number of animals on property zoned Rural Residential, Suburban Residential, and Farm Residential in 1998. Since adoption of the animal density requirements, several actions have been taken by the Morrow County Code Enforcement Officer to enforce those regulations. While there continue to be a few violations, often by the same landowners, general overall compliance has been achieved. Code enforcement actions will continue as necessary and needed. Umatilla County has similar ordinances.

Rural Residential

The City of Boardman includes groundwater protection and wellhead protection as integral parts of staff reports developed for land use decisions within the jurisdictional boundaries of the City, the Urban Growth Boundary, and the delineated Wellhead Protection Area. Although there is not a Wellhead Protection Ordinance, review of potential impacts of any development is accomplished through a process of staff review, Site Team review (bringing in other utilities and agencies for review), and Planning Commission approval (when use is not outright). These reviews allow for the assessment of groundwater and other environmental impacts to be addressed or mitigated prior to development. The City of Boardman does not allow new septic systems within the City limits.

The City of Boardman has developed a Municipal Sewer System Plan that includes a requirement for developers to extend sewers to new developments within City limits, and that prohibits new septic systems within 300 feet of the municipal sewer system.

During the subdivision and partitioning of land in the LUB GWMA, Morrow County Planning require the seller to notify the buyer(s) of the potential for elevated nitrate levels in groundwater and encourage regular testing of well water.

The Umatilla County SWCD is promoting BMP implementation through the Clean Water Neighborhood Program and articles in the East Oregonian.

Food Processor Process Water

Each of the food processors that land-apply water have a permit and an Operation, Monitoring, & Maintenance Plan (OM&M Plan) on file with DEQ. These documents detail various BMPs regarding nutrient management and water management, specific to their facility. An example of nutrient management that some facilities perform is post-harvest soil sampling (to help compare the amount of nitrogen applied to the amount of nitrogen removed). An example of water management that some facilities perform is soil moisture monitoring (to allow the control of deep percolation of process water).

3.3 Future Needs Regarding BMP Determination and Implementation

BMP research needs are discussed below. In accordance with the Action Plan, implementation of BMPs should be tracked to ensure that BMP implementation occurs. Currently this is not occurring in an organized fashion that will allow spatial analysis of BMP implementation relative to monitoring well nitrate concentrations. Tracking of BMP implementation in both time and space will allow evaluation of BMP effectiveness, and it will also allow success stories to be documented in a scientifically defensible manner.

Continued BMP development and implementation is also an important part of GWMA management. Since groundwater quality will change very slowly, performance of new and already existing BMPs should continue to be evaluated. Most BMPs have not been rigorously tested in a manner that ensures the target nitrate levels for groundwater will be achieved.

1. *BMP Implementation*

    a. *Develop and implement a survey of irrigated agriculture BMPs that are protective of groundwater quality.*

    One recurring LUB GWMA Action Plan goal is to gauge the degree to which BMPs that are protective of groundwater are being implemented. To date, the methods used to estimate the extent of BMP implementation in the LUB GWMA have varied from survey to survey. It would be beneficial to develop a method of systematically capturing the same BMP implementation information that allows periodic evaluation of the degree of BMP implementation. [Primary candidates for work are OSU Extension and the SWCDs].

    b. *Document BMP implementation on the GWMA scale in a system that allows spatial analysis (e.g., GIS).*

    It would be beneficial to track BMP implementation both temporally and spatially. This will allow quantification and documentation that action plan goals are being achieved and will also allow analysis of monitoring well water quality relative to BMP implementation. This provides the positive link between landowner activities and resultant water quality. It is anticipated that this is likely a very controversial and time-consuming task. Since privacy issues and perception of government priorities will be large drivers, those entities with higher credibility with the landowners will need to accomplish the work, and great pains will need to be taken to preserve landowner anonymity while still preserving scientific value. A very detailed work plan would be required for this item, but the results would be very valuable. [Primary candidates for work are OSU Ext, SWCDs, and OSU Geography (or other department with interest and GIS skill).]

c. Field scale BMP performance evaluations.

In some cases, it would be beneficial to perform evaluations of BMPs (both existing and experimental) at the field scale. Since the GWMA is highly variable, this process will provide case studies that show the viability of practices for production as well as environmental protection. Effectively, these studies will be demonstration projects and should have a strong outreach component. Proposed projects should have very well developed monitoring plans capable of documenting BMP performance. [Primary candidates for work are OSU Ext, Umatilla SWCD, OSU Bioresource Engineering, and OSU Crop and Soil Sciences.]

d. Revise some of the fertilizer guides and recommended BMPs.

Deficiencies were noted with various fertilizer guides. Several guides are approximately 20 years old, and they recommend rates and practices that are not consistent with present practices. On a case-by-case basis, fertilizer guides and BMP guidance documents should be revised. Plans to revise fertilizer guides should provide basic information that describes the deficiencies of the current document and the number of acres that will be affected by the revisions. Review and revision should also evaluate the environmental aspects of the document. Consideration should be given to adding a section giving environmental pointers (e.g., "To account for mineralization of nitrogen from organic sources, a mineralization N test can be used.", "Over-irrigation may result in leaching of nitrate.", etc.). [Primary candidates for work are OSU Ext and OSU Crop and Soil Sciences.]

e. Mineralization N test.

One particular BMP that should be evaluated is a mineralization N test. This test requires a digestion period (therefore, more lead time by the operator), but it provides information to the operator about how much nitrogen will become available to the plant during the growing season. A comparison of this test with other commonly used tests may encourage operators to use this test when applicable. This test may allow more accurate budgeting of nitrogen. [Primary candidates for work are OSU Ext and OSU Soil Sciences.]

f. Groundwater workshop for growers and certified crop advisors.

Reportedly, it is relatively difficult for certified crop advisors to satisfy their groundwater point's requirement due to a general low number of workshops that qualify. For this reason, groundwater workshops in both GWMAs should be well attended. Sponsoring these workshops allows DEQ and ODA to ensure that the content is consistent with the intent of the action plans and with groundwater protection in general. [Primary candidates for work are OSU Ext, DEQ and the SWCDs.]

g. Develop outreach material/strategy for small acreage growers and/or lawn and garden care.

Small acreage growers and homeowners occupy a relatively small percentage of the GWMA. In those areas with higher density of residences, the effect of their practices on groundwater may be appreciable. Historically, these people have been very difficult to communicate with in an effective and efficient manner. Grants designed to effectively communicate environmentally protective practices to this demographic should be encouraged. Innovative approaches may be necessary to draw in these portions of the LUB Community. [Primary candidates for work are OSU Ext and the Umatilla SWCD.]

4.0 GROUNDWATER QUALITY MONITORING

Results of DEQ's Bi-Monthly Monitoring

DEQ samples a network of 32 wells1 every other month for analysis of nitrate. The results of this monitoring are presented in Table 1. Table 1 includes results from the 66 sampling events conducted since adoption of the Action Plan. In addition, results from two additional sampling events are included in Table 1: the first bimonthly event (October 1991) and the synoptic event (July 1992) conducted during the investigation phase of the project.

It is important to note that the water quality discussion in this report involves only the data collected from the bi-monthly network and only since adoption of the Action Plan. The first regional trend analysis required by the Action Plan is scheduled for early 2010, and will include a more thorough evaluation of the bi-monthly well network data and likely an evaluation of additional groundwater quality data from the GWMA.

Table 1
Comparison of Nitrate Values (in ppm) from Selected Sampling Events
Lower Umatilla Basin Groundwater Management Area

Alluvial Aquifer

Well ID	Oct-91 (1st bimonthly event)	Jul-92 (synoptic event)	Jan-98 (1st event after Action Plan adoption)	Mar-98	May-98	Jul-98	Sep-98	Nov-98	Jan-99	Mar-99	May-99	Jul-99	Sep-99	Nov-99
UMA033	10	7.6	6.6	7.1	6.5	7.2	6.9	7	7.1	7.51	6.63	7.03	7.28	6.98
UMA034	2.5	2	5	6.8	3.5	6.3	5.5	4.6	4.9	7.32	7.37	4.1	3.64	3.46
UMA038	1.6	3	3.9	4.2	4.4	4.9	4.6	3	3	2.74	4.09	3.19	3.75	3.00
UMA039	2.1	1.3	3.5	2.4	3.1	ns	3.6	4	4.3	2.92	2.06	3.92	4.11	4.19
UMA046	1.4	0.47	0.56	1.2	0.49	0.5	0.67	0.54	0.51	0.912	0.507	0.83	0.872	0.406
UMA048	1.8	1.2	1.8	1.8	1.7	1.9	1.8	1.9	1.7	1.78	1.72	1.69	2.02	2.12
UMA056	6.4	6.6	6.8	6.9	6.8	6.5	6.5	6.5	6.8	7.32	6.75	6.73	6.86	6.69
UMA058	13	23	16	21	15	11	19	17	11	18.1	11.1	10.2	15.2	11.2
UMA066	4.8	6.5	8.5	8.3	8.8	8.4	8.6	8.8	8.8	9.38	9.07	7.6	6.75	8.05
UMA084	14	10	14	9.5	12	16	15	14	13	6.66	6.21	7.4	11.8	10.9
UMA085	20	22	**29**	29	29	28	**31**	**31**	**31**	31.5	**33.3**	**31.0**	**33.4**	**33.0**
UMA088	11	12	14	14	14	15	17	15	15	14.7	15.4	16.3	16.5	16.4
UMA094	13	10	11	9.3	8.5	8.1	9.5	8.4	8.4	8.17	7.41	7.44	7.59	7.14
UMA096	**25**	**31**	28	**32**	**31**	**31**	29	27	30	31.5	32.4	29.1	25.5	22.5
UMA103	17	21	20	18	18	18	18	16	18	18.4	18.8	17.4	18.2	17.0
UMA109	2.5	1.9	4.7	5.6	5.4	4.8	3.9	2.8	3.9	5.62	4.51	3.49	3.31	3.53
UMA110	6.8	5.9	5.7	3.8	8.4	9.3	9.3	6.8	5	3.93	5.69	7.51	8.34	4.72
UMA112	5	4.6	2.7	6.9	2.8	3.1	3.3	2.9	3.2	3.77	3.35	3.67	3.73	3.98
UMA116	3.1	3	4.3	4	4	4.2	4.3	4.3	4.5	4.57	4.27	4.26	4.49	4.92
UMA119	6.6	6.8	15	18	11	8.5	3.5	9.6	15	20.5	17.9	8.28	7.66	14.3
UMA122	8.1	9.7	14	22	26	21	15	13	17	24.4	31.3	21.6	11.9	14
UMA133	21	17	29	32	30	29	28	29	30	29.6	26	18.1	15.8	25.4
UMA144	2.9	4.9	18	20	13	12	12	17	19	19.7	17.4	4.33	1.46	11.2
UMA156	13	10	24	24	19	16	16	23	28	**32**	8	17.8	19.8	21.5
UMA160	0.06	0.02	0.02	0.02	0.02	0.4	0.67	6	<0.02	<0.004	0.0062	0.0063	3.03	0.0052
UMA168	4.7	3.6	3.6	3.1	2.8	2.2	2.1	3.1	3.4	3.02	2.75	2.17	2.34	3.45
UMA180	0.14	0.7	1.3	1.7	1.6	2.2	2.7	ns	ns	3.99	4.12	5.00	5.41	ns
UMA185	0.13	0.11	0.14	0.13	0.15	0.15	0.15	0.12	0.14	0.135	0.138	0.139	0.143	0.143
UMA187	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.004	<0.004	<0.0050	<0.0050	<0.0050
UMA190	0.89	0.55	2.7	1.4	1.7	1.1	2.5	3.8	2.4	2.99	1.39	0.612	0.827	3.68
UMA191	0.37	0.87	0.9	1.4	1.2	1	1.2	0.73	0.87	1.22	1.14	0.909	1.15	0.793
UMA198	5.8	7.9	14	16	16	16	13	14	17	15.9	12	9.4	7.49	16.6
UMA201	12	11	17	17	18	20	19	21	21	20.4	21.4	20.7	19.4	23.7
Maximum per sampling event	**25**	**31**	**29**	**32**	**31**	**31**	**31**	**31**	**31**	**32**	**33.3**	**31.0**	**33.4**	**33.0**
Median per sampling event	5.0	6.2	6.7	7.0	7.6	8.1	6.7	7.0	7.8	7.3	6.7	6.9	6.8	7.0
Average per sampling event	7.2	7.7	10.2	10.9	10.1	10.1	9.8	10.4	11.1	11.6	10.1	8.8	8.7	9.8

Basalt Aquifer

Well ID	Oct-91 (1st bimonthly event)	Jul-92 (synoptic event)	Jan-98 (1st event after Action Plan adoption)	Mar-98	May-98	Jul-98	Sep-98	Nov-98	Jan-99	Mar-99	May-99	Jul-99	Sep-99	Nov-99
UMA028	2.2	2.2	5.3	5.1	6.3	6.7	7.7	7.8	7.8	8.36	8.87	9.23	9.01	9.56
UMA029	**37.0**	**31.0**	**49.0**	**43.0**	**51.0**	**36.0**	**41.0**	**39.0**	**41.0**	**43.3**	**42.4**	**47.0**	**46.5**	**46.3**
UMA047	2.5	2.6	3	3	3.2	3.1	3.1	3.0	3.0	3.16	3.07	3.1	3.17	3.06
UMA106	0.8	0.75	0.52	0.47	0.8	0.94	0.9	1.2	0.66	0.792	0.834	0.644	0.938	1.51
UMA164	2.8	2.9	3.6	3.6	3.8	3.8	ns	3.9	3.7	2.04	4.42	4.25	4.27	4.09
Maximum per sampling event	**37.0**	**31.0**	**49.0**	**43.0**	**51.0**	**36.0**	**41.0**	**39.0**	**41.0**	**43.3**	**42.4**	**47.0**	**46.5**	**46.3**
Median per sampling event	2.5	2.6	3.6	3.6	3.8	3.8	5.4	3.9	3.7	3.2	4.4	4.3	4.3	4.1
Average per sampling event	9.1	7.9	12.3	11.0	13.0	10.1	13.2	11.0	11.2	11.5	11.9	12.8	12.8	12.9

[1] The well network originally consisted of 38 wells. Some well owners have since decided to end their participation while other wells are no longer in use.

Table 1
Comparison of Nitrate Values (in ppm) from Selected Sampling Events
Lower Umatilla Basin Groundwater Management Area

Alluvial Aquifer

Well ID	Jan-00	Mar-00	May-00	Jul-00	Sep-00	Nov-00	Jan-01	Mar-01	May-01	Jul-01	Sep-01	Nov-01
UMA033	7.03	6.97	6.47	6.56	6.83	6.72	6.8	6.82	6.73	6.84	6.88	6.98
UMA034	3.72	5.16	4.83	3.94	3.32	3.01	3.76	5.04	3.47	3.39	2.95	2.82
UMA038	2.08	2.04	2.51	1.28	2.24	1.09	2.38	3.51	1.69	0.983	2.96	4.23
UMA039	4.62	4.15	4.05	4.12	4.4	4.45	4.14	3.31	3.34	4.12	4.15	4.38
UMA046	0.459	0.782	0.474	0.533	0.776	0.473	0.485	0.512	0.473	0.429	0.61	0.512
UMA048	2.15	1.96	1.83	1.8	1.99	2.14	2.03	1.69	1.9	1.72	2.09	2.13
UMA056	6.46	7.02	4.56	6.76	6.41	6.33	6.31	6.22	5.74	3.87	5.18	6.55
UMA058	10.5	15.5	11	12.1	12.1	9.7	8.03	7.38	7.76	9.01	9.43	7.24
UMA066	8.76	9.1	8.18	6.7	7.5	8.07	8.55	8.63	9.21	8.82	8.01	8.48
UMA084	7.72	4.18	6.59	10.2	15.5	11.4	8.32	5.23	6.19	10.8	12.5	9.16
UMA085	**33.6**	**34.4**	**33.7**	**34.5**	**35.1**	35.0	**34.4**	**34**	**35.1**	**36.6**	**36.3**	**36.9**
UMA088	15.8	16.1	15.1	17.5	17.6	16.3	15.2	14.9	14.9	16.4	17.9	16.3
UMA094	7.15	6.99	6.49	6.56	7.42	7.04	6.57	6.17	6.32	6.78	7.09	6.98
UMA096	27.9	31.5	29.5	29.8	27.5	19.2	28.4	30.5	33.2	30.2	18.8	26.6
UMA103	20.8	21.7	20.9	22.4	22.5	20.7	21.6	20.5	19.3	19.4	18.7	20.1
UMA109	4.04	5.11	5.56	4.45	3.75	4.21	4.6	4.86	6.43	5.80	5.33	4.96
UMA110	3.81	4.39	6.13	7.26	8.27	5.69	5.72	5.27	3.22	4.45	5.5	3.48
UMA112	4.19	4.26	4.23	4.49	4.56	4.84	4.49	4.44	4.19	4.68	4.63	4.78
UMA116	5.08	4.98	4.25	4.3	4.85	4.89	4.38	3.99	4.56	4.49	4.26	4.18
UMA119	19	22.4	13.8	10.8	4.68	11.2	8.27	21.2	19.9	11.4	5.58	12.4
UMA122	19.4	17.8	20.9	34.4	24.4	22.2	25.9	25.2	30.8	32.2	23.5	26.1
UMA133	27.7	26.7	19.5	18.6	11.9	21.7	22.9	21.7	15.8	17.3	16.1	19.0
UMA144	15	17.6	12.4	10.5	9.69	10.5	13.6	16.2	11.6	10.0	9.36	9.88
UMA156	23.4	28.7	22.5	28.5	25.7	25.7	26.4	26.0	17.8	14.4	10	22.0
UMA160	<0.0050	0.0054	0.006	<0.0050	2.61	0.0071	<0.0050	<0.0050	0.0063	0.0077	0.151	9.67
UMA168	3.6	1.81	2.47	2.39	2.4	3.45	3.44	2.94	3	2.92	2.99	3.45
UMA180	ns	ns	5.18	5.07	4.5	3.29	3.19	3.36	5.53	8.56	7.32	4.37
UMA185	0.149	0.139	0.143	0.148	0.149	0.147	ns	0.140	ns	0.149	ns	0.149
UMA187	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	ns	<0.0050	0.0202	<0.0050	<0.0050	0.0059
UMA190	3.38	1.43	0.811	0.848	3.71	4.1	3.31	6.23	2.03	1.17	1.77	7.80
UMA191	0.679	0.958	2.22	1.7	1.13	1.14	1.1	1.27	3.14	1.37	0.954	1.00
UMA198	17.8	18.5	19.9	ns	ns	**41**	21	20.4	19	15.8	24.1	16.9
UMA201	25.01	24.3	22.4	23.4	25.1	29.4	24.8	23.8	21.7	24.5	23.2	21.2
Maximum per sampling event	**33.6**	**34.4**	**33.7**	**34.5**	**35.1**	**41**	**34.4**	**34**	**35.1**	**36.6**	**36.3**	**36.9**
Median per sampling event	7.1	7.0	6.3	6.6	6.4	6.5	6.7	6.2	6.3	6.8	6.9	7.0
Average per sampling event	11.0	11.2	10.0	10.7	10.0	10.8	11.0	11.0	10.1	10.0	9.6	10.0

Basalt Aquifer

Well ID	Jan-00	Mar-00	May-00	Jul-00	Sep-00	Nov-00	Jan-01	Mar-01	May-01	Jul-01	Sep-01	Nov-01
UMA028	10.9	10.4	9.49	10	10.4	12.5	**13.0**	**12.7**	12.3	10.3	9.38	11.7
UMA029	**47.8**	**46.7**	**44.1**	**43.4**	**46.1**	**46.2**	*ns*	*ns*	**45.2**	**46.6**	**33.7**	**45.7**
UMA047	3.17	3.29	3.05	3.17	3.25	3.18	3.08	2.99	3.07	3.24	3.22	3.24
UMA106	0.584	0.601	0.747	0.67	0.837	1.13	0.489	1.40	0.759	0.83	0.861	1.49
UMA164	4.35	ns	4.55	4.53	4.56	4.37	4.27	*ns*	4.56	4.56	*na*	*ns*
Maximum per sampling event	**47.8**	**46.7**	**44.1**	**43.4**	**46.1**	**46.2**	**13.0**	**12.7**	**45.2**	**46.6**	**33.7**	**45.7**
Median per sampling event	4.4	6.8	4.6	4.5	4.6	4.37	3.7	3.0	4.6	4.6	6.3	7.5
Average per sampling event	13.4	15.2	12.4	12.4	13.0	13.5	5.2	5.7	13.2	13.1	11.8	15.5

Table 1
Comparison of Nitrate Values (in ppm) from Selected Sampling Events
Lower Umatilla Basin Groundwater Management Area

Alluvial Aquifer

Well ID	Jan-02	Mar-02	May-02	Jul-02	Sep-02	Nov-02	Jan-03	Mar-03	May-03	Jul-03	Sep-03	Nov-03
UMA033	7.22	7.26	7.28	7.01	7.28	7.2	7.57	7.08	7.39	7.18	6.97	6.98
UMA034	3.73	4.49	4.22	2.26	2.55	2.35	2.65	3.63	3.97	2.77	2.03	1.43
UMA038	2.88	2.76	*ns*	3.16	2.82	1.99	*ns*	3.37	9.68	3.14	2.20	2.08
UMA039	4.71	4.41	4.56	4.57	5.04	5.67	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
UMA046	0.479	0.461	1.08	3.5	3.24	1.96	0.665	0.576	0.531	1.09	1.98	0.575
UMA048	2.17	1.99	1.71	1.69	1.64	2.02	1.88	2.02	1.83	1.73	1.65	2.18
UMA056	6.64	6.13	6.13	6.2	5.15	6.55	6.63	6.48	6.60	6.23	6.27	6.14
UMA058	7.2	8.4	14.4	12.9	9.96	8.31	7.2	8.28	8.4	9.22	9.55	8.30
UMA066	9.12	9.18	9.24	6.24	5.58	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
UMA084	6.75	4.36	3.94	3.35	5.68	7.61	4.23	3.68	7.66	9.06	11.8	10.0
UMA085	**37.9**	**37.0**	**38.3**	**37.8**	**38.1**	*ns*	**40.2**	**38.8**	39.3	**39.2**	**37.9**	**38.7**
UMA088	16.4	15.8	16.5	18.5	17.9	17.5	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
UMA094	7.16	6.79	6.78	7.16	7.56	8.01	7.66	7.62	*ns*	4.24	7.3	6.84
UMA096	31.4	32.8	34.0	29	19.7	12.8	25.5	31.5	32.4	30.3	19.9	18.5
UMA103	22.6	22.2	23.3	20.4	13.9	20	*ns*	*ns*	*ns*	26.6	23.3	18.7
UMA109	5.32	5.02	5.71	4.15	3.88	4.43	4.53	4.79	4.51	3.19	3.16	3.72
UMA110	3.09	2.63	2.95	4.64	5.63	4.85	4.41	3.74	4.40	5.45	5.17	4.68
UMA112	4.28	4.32	4.51	4.12	4.01	3.73	3.68	3.68	3.65	3.47	3.72	3.22
UMA116	4.85	4.75	4.81	4.07	3.23	3.43	4.58	4.61	4.43	3.97	3.29	3.61
UMA119	16.1	19	16.1	9.16	8.05	13.3	17.9	20.5	11.7	12.6	8.31	9.97
UMA122	25.9	29.7	30	31.8	26.9	**28.6**	28.1	29.0	32.0	32.8	28.7	27.8
UMA133	20	18.8	16.4	14	15.8	16	17.1	17.2	15.5	14.1	13.3	15.2
UMA144	12.5	14.8	14.3	10.5	8.30	7.74	8.59	12.1	9.85	9.34	9.81	9.16
UMA156	27.3	27	17.4	14.9	12.0	17.3	22.5	27.0	17.7	11.9	10.8	17.7
UMA160	<0.0050	8.46	5.84	7.99	15.4	13.6	2.74	1.52	0.0245	12.7	18.5	14.4
UMA168	3.62	2.1	3.55	3.2	3.36	3.95	4.11	2.71	3.79	3.42	3.22	4.21
UMA180	3.86	3.48	5.52	5.37	5.24	2.75	3.58	3.70	3.88	3.88	3.81	2.82
UMA185	0.149	0.138	0.145	0.151	0.152	0.149	0.147	0.146	0.146	0.145	0.150	0.161
UMA187	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
UMA190	5.3	2.39	1.88	1.73	0.655	5.21	*ns*	2.43	4.92	2.41	1.5	5.30
UMA191	0.712	1.42	1.19	2.07	0.160	0.523	0.521	0.869	2.62	0.769	0.239	0.179
UMA198	15.8	15.2	7.16	28.7	26.8	20.7	16.6	16.5	**42.6**	36.1	32.6	32.6
UMA201	20.7	20.2	22.8	18.6	24.3	24.5	23.9	21.6	22.1	20.4	16.2	18.2
Maximum per sampling event	**37.9**	**37.0**	**38.3**	**37.8**	**38.1**	**28.6**	**40.2**	**38.8**	**42.6**	**39.2**	**37.9**	**38.7**
Median per sampling event	6.8	6.5	6.1	6.2	5.7	6.9	5.6	4.7	6.6	6.2	7.0	6.8
Average per sampling event	10.8	10.7	10.7	10.3	9.7	9.1	10.3	10.2	11.2	10.9	10.1	10.1

Basalt Aquifer

Well ID	Jan-02	Mar-02	May-02	Jul-02	Sep-02	Nov-02	Jan-03	Mar-03	May-03	Jul-03	Sep-03	Nov-03
UMA028	**12.0**	**11.4**	10.6	8.31	7.59	8.15	8.48	**8.13**	7.54	6.54	5.8	**6.26**
UMA029	*ns*	*ns*	**49.6**	**48.6**	**49.2**	**49.3**	**52.1**	*ns*	**33.5**	**51.8**	**49.5**	*ns*
UMA047	3.31	3.19	3.38	3.43	3.4	3.31	3.29	3.44	3.41	3.50	3.49	*ns*
UMA106	0.743	0.469	0.595	0.894	0.552	1.25	*ns*	0.574	0.965	1.1	0.944	1.85
UMA164	*ns*	4.27	4.58	4.27	4.13	3.97	4.18	4.14	4.3	4.14	3.98	3.9
Maximum per sampling event	**12.0**	**11.4**	**49.6**	**48.6**	**49.2**	**49.3**	**52.1**	**8.13**	**33.5**	**51.8**	**49.5**	**6.26**
Median per sampling event	3.3	3.7	4.6	4.3	4.1	4.0	6.3	3.8	4.3	4.1	4.0	3.9
Average per sampling event	5.4	4.8	13.8	13.1	13.0	13.2	17.0	4.1	9.9	13.4	12.7	4.0

Table 1
Comparison of Nitrate Values (in ppm) from Selected Sampling Events
Lower Umatilla Basin Groundwater Management Area

Alluvial Aquifer

Well ID	Jan-04	Mar-04	May-04	Jul-04	Sep-04	Nov-04	Jan-05	Mar-05	May-05	Jul-05	Sep-05	Nov-05
UMA033	7.28	7.08	7.22	6.95	6.92	6.93	7.09	6.89	6.92	6.97	7.15	6.85
UMA034	3.36	4.6	4.71	3.29	2.98	1.36	2.96	4.18	4.07	2.87	2.42	1.12
UMA038	*ns*	2.53	5.02	2.66	3.2	2.23	1.33	2.28	2.71	1.92	*ns*	2.62
UMA039	*ns*	*ns*	*ns*	ns	1.08	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
UMA046	0.359	0.66	0.404	1.09	0.653	0.519	0.519	0.51	0.469	0.513	1.13	0.517
UMA048	2.22	1.92	2.06	1.88	2.05	2.09	2.19	1.92	1.55	1.78	1.9	2.02
UMA056	6.27	6.31	6.49	6.01	6.09	5.88	6.32	6.14	5.9	6.15	6.18	5.83
UMA058	8.11	7.91	9.63	9.31	7.89	7.01	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
UMA066	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
UMA084	6.91	4.54	10.7	13.7	15.1	12.5	*ns*	6.4	9.3	9.9	13.5	18.6
UMA085	**39.2**	**37.7**	**40.2**	**39.9**	**40.1**	**39.7**	**41.6**	**41.2**	**42.1**	**41.6**	**43.2**	**42.5**
UMA088	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
UMA094	6.45	6.12	6.13	6.03	7.95	8.51	8.9	8.52	7.99	8.35	*ns*	10.6
UMA096	29	31.9	33.1	31.8	21.1	19.6	31.9	33.2	37.1	35	36	35.6
UMA103	29	27.5	ns	27	20.4	24.4	30.3	30.5	27.1	26.3	24.4	24.2
UMA109	3.75	3.9	3.74	3.08	3.03	2.84	3.55	3.82	3.25	3.46	3.23	3.04
UMA110	3.8	3.27	2.68	3.48	4.07	3.01	2.83	2.46	1.89	2.4	4.42	3.03
UMA112	3.04	3.06	3.12	3.01	2.82	2.72	2.7	2.65	2.59	2.49	2.48	2.37
UMA116	4.67	4.11	4.55	3.93	3.22	3.32	4.98	4.62	4.12	3.92	3.4	3.51
UMA119	11.3	14.4	14.5	13.9	13.9	17.4	19.1	21.5	17.7	15.3	13.2	17.6
UMA122	27.7	24.3	31.5	30.9	25.1	24.5	25.7	31.4	29.8	31.5	32.9	*ns*
UMA133	16.6	15.5	14.6	14.2	13.7	15.6	*ns*	16.9	15.4	13.9	13.9	15.9
UMA144	14.5	16.2	12.5	13.5	14.6	12.1	12.2	18	13.9	10.9	18.4	17.6
UMA156	22.3	25.6	25.9	12.5	13.3	14.8	*ns*	20.9	21.4	12.8	12.6	20.2
UMA160	5.6	15.1	13.6	17	27.5	10.7	16.2	0.122	9.44	15.4	23.4	0.156
UMA168	4.31	3.34	3.65	3.55	3.15	3.77	5.39	4.93	3.66	3.51	3.5	4.13
UMA180	3.28	3.4	3.65	4.05	4.11	4.33	4.09	4.34	4.57	4.89	0.224	6.78
UMA185	*ns*	0.143	0.143	0.147	0.152	0.152	0.157	0.146	0.151	0.147	0.153	*ns*
UMA187	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
UMA190	4.95	3.01	2.35	2.27	1.86	5.46	1.98	3.06	2.84	1.16	1.6	1.89
UMA191	0.185	6.1	2.86	1.47	0.253	0.46	0.673	0.868	0.868	0.674	0.836	0.962
UMA198	9.18	20.1	12.3	14.1	35.9	19.4	22.1	13.5	7.42	7.21	7.35	18.6
UMA201	19.5	19.2	20.6	13.7	25.5	26.7	28.8	27.1	25.5	25.1	20.9	23.7
Maximum per sampling event	**39.2**	**37.7**	**40.2**	**39.9**	**40.1**	**39.7**	**41.6**	**41.2**	**42.1**	**41.6**	**43.2**	**42.5**
Median per sampling event	6.5	6.1	6.3	6.0	6.5	6.9	5.4	5.5	6.4	6.6	6.7	6.3
Average per sampling event	10.8	11.0	10.6	10.5	10.9	10.3	11.3	11.4	11.1	10.6	11.5	11.2

Basalt Aquifer

Well ID	Jan-04	Mar-04	May-04	Jul-04	Sep-04	Nov-04	Jan-05	Mar-05	May-05	Jul-05	Sep-05	Nov-05
UMA028	**6.27**	**6.14**	5.71	4.74	5.46	5.62	6.26	6.25	6.17	5.85	5.93	6.2
UMA029	*ns*	*ns*	**36.8**	**35.4**	**52.7**	**53.2**	**54.2**	**52.9**	**53.3**	**52.8**	**54.5**	**54.6**
UMA047	3.33	3.4	3.45	3.52	3.35	3.4	3.45	3.46	3.75	3.45	3.57	3.54
UMA106	0.819	0.825	1.03	0.915	*ns*	1.79	1.24	0.554	0.758	0.805	0.987	1.38
UMA164	3.81	4.19	4.21	4.19	4.03	4.03	4.23	4.4	4.62	4.48	4.53	4.56
Maximum per sampling event	**6.27**	**6.14**	**36.8**	**35.4**	**52.7**	**53.2**	**54.2**	**52.9**	**53.3**	**52.8**	**54.5**	**54.6**
Median per sampling event	3.6	3.8	4.2	4.2	4.7	4.0	4.2	4.4	4.6	4.5	4.5	4.6
Average per sampling event	3.6	3.6	10.2	9.8	16.4	13.6	13.9	13.5	13.7	13.5	13.9	14.1

Table 1
Comparison of Nitrate Values (in ppm) from Selected Sampling Events
Lower Umatilla Basin Groundwater Management Area

Alluvial Aquifer

Well ID	Jan-06	Mar-06	May-06	Jul-06	Sep-06	Nov-06	Jan-07	Mar-07	May-07	Jul-07	Sep-07	Nov-07
UMA033	6.83	6.76	6.63	7.08	7.04	6.69	6.77	7.1	7.2	7.35	6.99	7.13
UMA034	1.84	3.46	3.58	3.13	2.34	2.24	3.34	4.5	4.3	2.36	2.73	2.43
UMA038	3.04	4	*ns*	4.04	3.1	1.46	1.44	1.45	1.8	1.83	1.36	1.28
UMA039	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
UMA046	0.42	0.461	0.356	0.619	0.588	0.297	0.286	0.406	0.32	0.556	0.36	0.284
UMA048	1.69	1.49	1.4	1.51	1.98	1.45	1.87	1.47	1.34	1.96	1.67	2.05
UMA056	6.2	6.07	0.578	6.12	5.82	5.06	5.71	6.24	5.5	6.22	5.67	6.29
UMA058	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
UMA066	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
UMA084	11.8	9.34	15.3	17.5	16.6	*ns*	5.56	13.8	14.8	13.1	45.3	**46.3**
UMA085	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
UMA088	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
UMA094	10.5	10.4	9.4	10.8	11.6	11.6	11.5	11.2	10.4	10.6	11.1	11.4
UMA096	**32.2**	**33.5**	**35**	**35.9**	**36.2**	**30.5**	**32.7**	**35.3**	**37.7**	**35.6**	35.2	26.4
UMA103	27.1	27.1	30.5	25.5	17.7	21.7	24.4	24.6	23.1	19.5	13.2	14
UMA109	3.21	3.96	4.79	4.77	3.84	*ns*	3.81	4	4.19	2.96	2.92	3.1
UMA110	2.24	2.59	2.9	4.41	5.65	4.51	3.86	5	4.8	7.32	9.23	10.6
UMA112	2.32	2.2	2.11	2.12	2.01	2.01	1.86	1.86	1.81	2.09	1.93	1.7
UMA116	4.87	5.12	4.44	4.14	3.38	3.02	3.81	4.82	3.88	3.2	3.25	3.43
UMA119	17.1	17.9	22	13.8	14.1	14.2	13.7	14.5	17.4	11.3	9.22	13.5
UMA122	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*
UMA133	16.8	16	15.5	15.2	13.8	*ns*	16.1	17.1	16.8	16	15.3	11.7
UMA144	14.6	10.8	14.6	11.8	7.52	7.55	9.23	16.1	21.5	7.71	7.43	9.98
UMA156	18.7	26.6	25.4	15.5	21.8	*ns*	27.1	30	30.4	14.5	12.4	25.8
UMA160	5.91	8.96	11.5	26.4	14.4	7.88	12	3.69	5.37	2.64	9.9	10.3
UMA168	4.26	3.84	2.88	3.04	4.28	5.19	4.37	1.59	2.5	2.19	2.82	3.97
UMA180	7.91	6.87	4.26	8.93	7.45	6.23	6.02	7.25	7.09	7.45	7.5	8.71
UMA185	0.16	0.15	0.144	0.151	0.151	0.143	*ns*	0.146	0.143	0.156	0.154	*ns*
UMA187	0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	*ns*
UMA190	3.15	1.8	2.18	2.67	2.17	0.695	*ns*	*ns*	3.28	2.38	1.49	1.87
UMA191	0.744	1.08	1.23	0.576	0.276	0.469	0.7	1.24	0.777	0.424	0.632	0.745
UMA198	15.5	16.2	*ns*	7.56	39.5	19.6	9.06	10.9	12.8	16.9	**46.4**	33
UMA201	23.1	23.9	25.2	7.4	11.2	23.8	24.8	25	13.6	8.15	11.3	23.1
Maximum per sampling event	**32.2**	**33.5**	**35.0**	**35.9**	**39.5**	**30.5**	**32.7**	**35.3**	**37.7**	**35.6**	**46.4**	**46.3**
Median per sampling event	5.9	6.4	4.6	6.6	6.4	5.1	5.9	6.2	5.4	6.8	7.2	8.7
Average per sampling event	9.0	9.6	10.1	9.3	9.8	8.0	9.6	10.0	9.7	7.9	10.2	11.2

Basalt Aquifer

Well ID	Jan-06	Mar-06	May-06	Jul-06	Sep-06	Nov-06	Jan-07	Mar-07	May-07	Jul-07	Sep-07	Nov-07
UMA028	4.49	6.66	6.32	5.74	5.84	4.68	*ns*	*ns*	5.78	*ns*	3.86	4.1
UMA029	**52.3**	**44.8**	**43.8**	**49.4**	**53.6**	**61.3**	**48.9**	**45.1**	**45.9**	**42.8**	**45**	**47**
UMA047	3.56	3.47	3.4	3.84	3.54	3.5	3.35	3.53	3.57	3.79	3.53	3.54
UMA106	*ns*	0.785	0.692	1.03	0.72	*ns*	*ns*	0.62	0.78	0.644	0.924	2.03
UMA164	4.53	4.47	4.7	4.88	4.62	4.63	4.74	4.93	4.95	4.85	4.58	4.64
Maximum per sampling event	**52.3**	**44.8**	**43.8**	**49.4**	**53.6**	**61.3**	**48.9**	**45.1**	**45.9**	**42.8**	**45.0**	**47.0**
Median per sampling event	4.5	4.5	4.7	4.9	4.6	4.7	4.7	4.2	5.0	4.3	3.9	4.1
Average per sampling event	16.2	12.0	11.8	13.0	13.7	18.5	19.0	13.5	12.2	13.0	11.6	12.3

Table 1
Comparison of Nitrate Values (in ppm) from Selected Sampling Events
Lower Umatilla Basin Groundwater Management Area

Alluvial Aquifer

Well ID	Jan-08	Mar-08	May-08	Jul-08	Sep-08	Nov-08	Minimum value per well; 1998 thru 2008	Maximum value per well; 1998 thru 2008	Median value per well; 1998 thru 2008	Average per well; 1998 thru 2008
UMA033	6.98	6.98	7.29	6.89	13.8	7.01	6.47	13.8	6.99	7.10
UMA034	3.75	5	5.69	2.12	2.75	3.11	1.12	7.37	3.47	3.65
UMA038	1.66	2.24	3	3.33	1.73	*ns*	0.983	9.68	2.73	2.82
UMA039	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	1.08	5.67	4.13	3.91
UMA046	*ns*	*ns*	*ns*	0.247	0.396	0.282	0.247	3.50	0.51	0.70
UMA048	2.15	2.07	1.73	1.59	1.45	*ns*	1.34	2.22	1.88	1.85
UMA056	6.21	6.1	6.18	5.79	5.85	6.04	0.578	7.32	6.22	6.10
UMA058	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	7.01	21	9.67	10.89
UMA066	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	5.58	9.38	8.55	8.29
UMA084	*ns*	4.09	4.49	12.05	16	*ns*	3.35	46.3	10.10	11.12
UMA085	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	28	43.2	36.90	36.21
UMA088	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	14	18.5	16.20	16.00
UMA094	12	11	10.5	9.75	11.15	12.5	4.24	12.5	8.00	8.48
UMA096	32.2	**34.3**	**40.5**	**35.3**	15.4	28	12.8	40.5	31.20	29.80
UMA103	25.2	25.5	24.9	21.1	9.06	22.8	9.06	30.5	21.35	21.67
UMA109	3.31	4.1	4.02	3.66	3.35	3.28	2.8	6.43	3.90	4.11
UMA110	11.7	12.5	9.68	9.19	14.6	19.6	1.89	19.6	4.70	5.62
UMA112	1.77	1.74	1.66	1.76	1.53	1.52	1.52	6.9	3.11	3.19
UMA116	4.2	4.85	4.09	3.2	3.64	3.6	3.02	5.12	4.26	4.17
UMA119	15.7	17.7	*ns*	15.5	6.93	15.8	3.5	22.4	14.20	14.04
UMA122	*ns*	*ns*	*ns*	*ns*	*ns*	*ns*	11.9	34.4	26.00	25.54
UMA133	17.6	1.82	17.5	15	13.9	16.15	1.82	32	16.28	18.32
UMA144	11.6	16.7	22.8	11.4	**42.3**	17.8	1.46	42.3	12.15	13.25
UMA156	**36.3**	17.8	23.9	13.2	16	**31.1**	8	36.3	21.45	20.82
UMA160	*ns*	6.49	6.45	5.84	13	*ns*	0.0052	27.5	6.00	7.52
UMA168	4.76	1.98	2.29	1.96	2.56	2.83	1.59	5.39	3.28	3.25
UMA180	11	9.99	11.5	9.54	9.54	11.6	0.224	11.6	4.50	5.29
UMA185	0.151	0.139	0.149	0.15	0.164	0.138	0.12	0.164	0.15	0.15
UMA187	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.005	0.0202	0.01	0.01
UMA190	0.812	1.64	2.49	2.39	3.17	1.77	0.612	7.8	2.35	2.57
UMA191	0.584	0.949	0.681	0.73	0.73	0.855	0.16	6.1	0.87	1.06
UMA198	24.8	24.8	26	2.71	8.57	21.3	2.71	46.4	16.60	18.98
UMA201	25.3	27.6	28.7	9.56	13.1	26.7	7.4	29.4	22.25	21.34
Maximum per sampling event	**36.3**	**34.3**	**40.5**	**35.3**	**42.3**	**31.1**				
Median per sampling event	7.0	6.1	6.3	5.8	7.8	9.3				
Average per sampling event	11.3	9.9	11.1	7.8	8.9	11.5				

Basalt Aquifer

Well ID	Jan-08	Mar-08	May-08	Jul-08	Sep-08	Nov-08	Minimum value per well; 1998 thru 2008	Maximum value per well; 1998 thru 2008	Median value per well; 1998 thru 2008	Average per well; 1998 thru 2008
UMA028	5.44	*ns*	*ns*	*ns*	*ns*	*ns*	3.86	13.0	7.12	7.74
UMA029	**41.8**	**41.2**	**41.2**	**42.5**	**44.7**	**38.8**	33.5	61.3	46.25	46.29
UMA047	3.68	3.66	3.75	3.71	3.86	3.72	2.99	3.86	3.40	3.37
UMA106	*ns*	0.564	0.852	0.973	0.961	1.325	0.469	2.03	0.83	0.91
UMA164	4.82	4.99	5.14	4.89	4.74	4.62	2.04	5.14	4.39	4.33
Maximum per sampling event	**41.8**	**41.2**	**41.2**	**42.5**	**44.7**	**38.8**				
Median per sampling event	5.1	4.3	4.4	4.3	4.3	4.2				
Average per sampling event	13.9	12.6	12.7	13.0	13.6	12.1				

Notes:

na = not analyzed

ns = not sampled

Maximum Nitrate Concentrations

The maximum nitrate value observed between January 1998 and November 2008 at each well is identified in Table 1 with shading. The scattered distribution of the shaded cells indicates maximum nitrate values over the past eleven years occurred at different times at different locations. This suggests some wells may have increasing nitrate trends while other wells may have decreasing nitrate trends.

The maximum nitrate value observed at each sampling event is identified in Table 1 with large bold numbers. The maximum values in alluvial aquifer wells have most often been at well UMA085 (41 events) but have also occurred at well UMA096 (16 events), UMA198 (3 events), UMA156 (3 events), and UMA122 (1 event). Well UMA085 has not been sampled since November 2005, and that the average nitrate concentration through 2005 was 36.2 ppm.

The large bold numbers also indicate the maximum nitrate value during the past eleven years in the basalt aquifer wells has always been at well UMA029, if this well was sampled. Well UMA028 exhibited the highest nitrate concentration during the eight events well UMA029 was not sampled. The average nitrate concentration at well UMA029 through 2008 is 46.3 mg/l. The average nitrate concentration at well UMA028 is 7.7 mg/l.

Thirty-two wells have been sampled consistently since the adoption of the Action Plan in December 1997. Table 2 summarizes the number and percentage of wells that exhibited their maximum nitrate concentrations during each of the past 11 years. As indicated in Table 2, almost one-third of the wells exhibited their maximum nitrate concentration during 2008 while one half of the wells exhibited their maximum nitrate concentration during 2006, 2007, or 2008. The recent timing of maximum nitrate concentrations suggests a significant portion of the wells have increasing nitrate trends.

Table 2
Timing of Maximum Nitrate Concentrations

Year of Maximum Observed Concentration	# Wells with Maximum Observed Concentration	Percentage	Cumulative Percentage
2008	10	31.3%	31.3%
2007	3	9.4%	40.6%
2006	3	9.4%	50.0%
2005	1	3.1%	53.1%
2004	3	9.4%	62.5%
2003	1	3.1%	65.6%
2002	1	3.1%	68.8%
2001	4	12.5%	81.3%
2000	2	6.3%	87.5%
1999	2	6.3%	93.8%
1998	2	6.3%	100.0%

Figure 1 is a graph of all nitrate data from the bi-monthly well network from 1998 through 2008. Figure 1 consists of many stacks of data points at 2-month intervals. Each of these stacks of data represents one sampling event and contains one data point for each well sampled that event. It is evident from Figure 1 that the highest concentrations detected have occurred in the latter portion of the dataset. It is also evident that most of the highest concentrations are from two wells: UMA029 and UMA085. Figure 1 includes 2,260 data points with nitrate concentrations ranging from <0.0050 (plotted as 0.0025 mg/l) to 61.3. The median value is 5.7 while the average value is 10.2.

Area-Wide Trend

The area-wide trend is also indicated in Figure 1. The area-wide trend was calculated using the Regional Kendall test[2]. The area-wide trend is a nearly flat trend increasing at 0.006 ppm/yr, which is statistically significant at an 88% confidence level.

Overall, there are slightly more increasing "seasonal trends" than decreasing "seasonal trends", and they are steeper. Specifically, there are 119 increasing seasonal trends with an average increase of 0.52 ppm/yr. In contrast, there are 107 decreasing seasonal trends with an average decrease of 0.31 ppm/yr. With the exception of March, the same pattern holds true when looking at the number and magnitude of seasonal trends by month. Specifically, there are more, and steeper, increasing trends than decreasing trends in January, May, July, September, and November. When calculating the area-wide trend, the underlying predominance of more and steeper increasing trends results in the overall slightly increasing trend.

LOWESS Line

Although not included in Figure 1, a LOWESS line through these data suggest nitrate concentrations slightly declined from about 8.1 mg/l in 1998 to about 6.9 mg/l at the end of 2008. The LOWESS line was not included in Figure 1 because it is probably misleading. As explained below, the declining LOWESS line is likely due to a change in the well sampling frequency and not a change in water quality.

Four wells (UMA039, UMA058, UMA066, and UMA088) were not sampled at all during 2005, 2006, 2007, and 2008 while 2 wells (UMA085 and UMA122) were only sampled in 2005. Five of these six wells have average concentrations higher than the LOWESS line (Table 1). Fewer (or no) recent data points from these wells skew the latter portion of the data set towards lower concentrations which results in a decreasing LOWESS line.

This idea was verified by eliminating all data from these six wells and recalculating an area-wide trend and LOWESS line. The recalculated area-wide trend was a statistically insignificant flat trend (i.e., slope = 0 at a confidence level of 11%) but the LOWESS line was essentially flat rather than decreasing. The LOWESS line through this subset of data started at 6.5 mg/l in 1998, decreased to about 6.4 by November 2004, and increased to about 6.7 mg/l at the end of 2008.

The LOWESS line is widely considered an excellent tool to visualize the general trend of a data set. However, it seems that changes to a well network should be considered when using this tool to characterize an area-wide trend.

[2] The Regional Kendall test is a test to determine whether a consistent pattern of trend occurs across an entire area, at multiple locations. This is done by altering the Seasonal Kendall test so that instead of testing data from all sample locations collected from a specific time interval (e.g., a particular month), data from individual sample locations collected from specific time intervals are tested. In both the Seasonal Kendall test and the Regional Kendall test, data blocks are tested individually, and then combined into one overall test result. The Regional Kendall test looks for consistency in the direction of trend at each location, and tests whether there is evidence for a general trend in a consistent direction throughout the region. Patterns at an individual location occurring in the same direction as the regional trend provide some evidence toward a significant regional trend, even if there is insufficient evidence of trend for that one location.

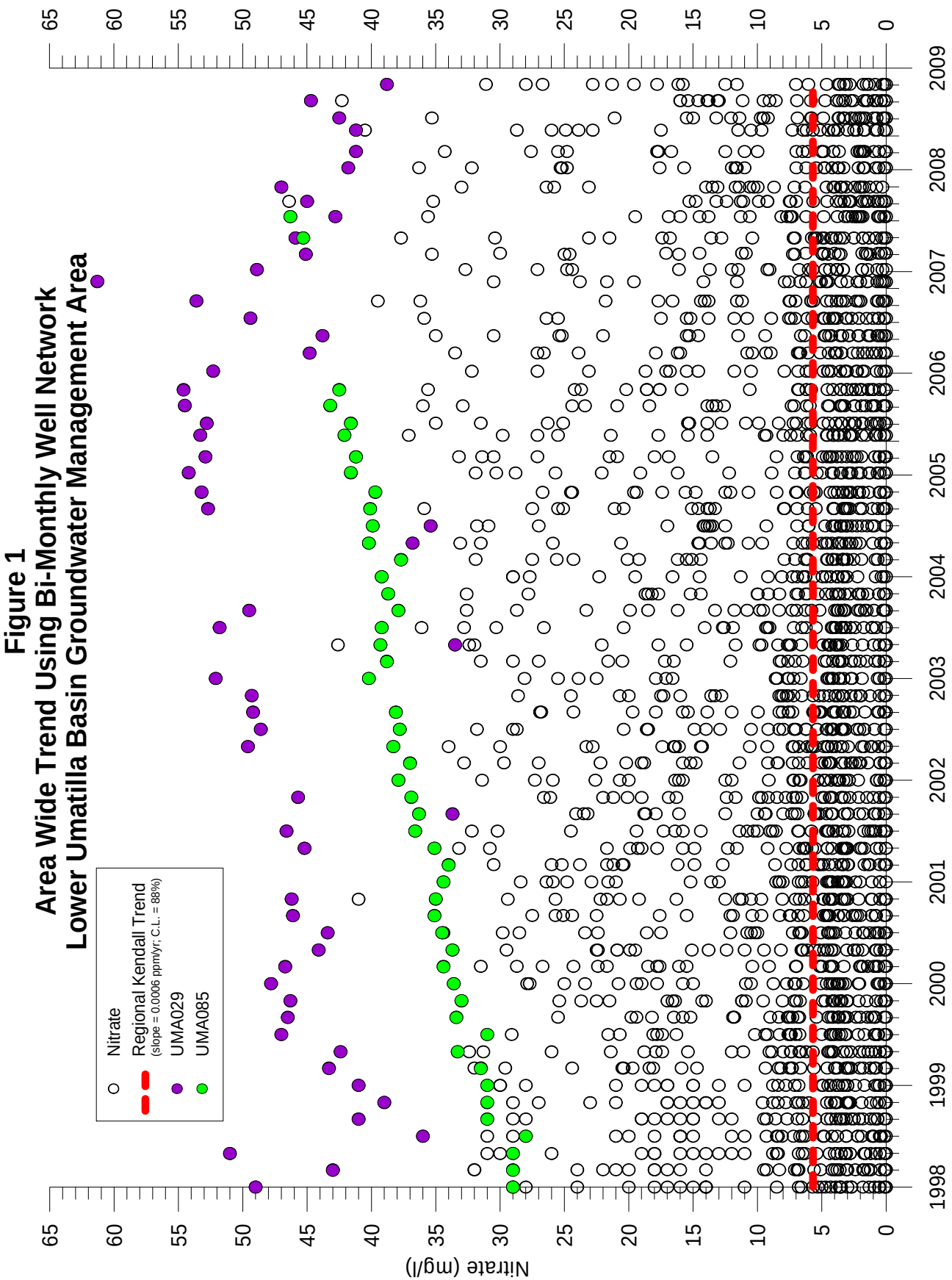
Figure 1
Area Wide Trend Using Bi-Monthly Well Network
Lower Umatilla Basin Groundwater Management Area
Nitrate
Regional Kendall Trend
(slope = 0.0006 ppm/yr; C.L. = 88%)
UMA029
UMA085
Nitrate (mg/l)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009

4.2 Monitoring at the US Army Umatilla Chemical Depot Washout Lagoons

The following information appears in the 2008 Annual Report Umatilla Chemical Depot Explosives Washout Lagoons Groundwater Treatment System prepared by SCS Engineers.

> RDX, the most mobile of the contaminants, has the largest plume. RDX appears to have spread beyond the Explosives Washout Lagoons. The TNT plume extends over a smaller area as a result of TNT having lower transport mobility. The TNT plume is centered under the Explosive Washout Lagoons.

As indicated by the information presented below, the existing treatment system has removed much of the initial contamination, but is now minimally effective in further reducing contaminant levels. Ways to enhance the treatment system are currently being evaluated.

The following information appears in the April 2009 document "Explosives Washout Lagoons Pump and Treat System Enhancement Study – Umatilla Chemical Depot Hermiston, Oregon".

> The washout lagoons pump and treat system was initially extremely effective in terms of removal of contaminant mass. Over 13,000 lbs of explosives have been removed to date; however, the rate of removal of contaminant mass has steadily decreased over time as groundwater concentrations decline (the current removal rate is 0.5 lb/day or less), and recent data indicate that the removal rates and concentrations have leveled off. That is, groundwater concentrations are no longer declining; however, the ROD remediation levels have not been met.
>
> The decreasing effectiveness of the extraction and treatment system and the resulting question of the ability of the present groundwater treatment system to meet the ROD cleanup requirements by facility transfer in 2015 indicate the need to consider augmentation of the pump and treat system. This enhancement study was conceived to help identify actions that may speed up the process of restoring groundwater quality.
>
> Specifically, this study aims to evaluate three areas that could improve the remedial progress of the existing system:
> 1. Consideration of the possible presence of contaminants remaining in the unsaturated zone beneath the lagoons that were not completely flushed and could be an on-going source of low-level contaminants to groundwater;
> 2. Implementation of an in situ remediation technique for TNT which is strongly adsorbed to soils and may not be quickly addressed by the pump and treat system; and
> 3. Reconfiguration of the extraction wells (locations and pumping rates) to more efficiently target contaminant hot spots of RDX. The plume has a different footprint now that much of the contaminant mass has been removed, and the hydrogeologic conditions at the site make it difficult to address the entire plume, as it now exists, with a single primary extraction well.

5.0 DECEMBER 2009 GOALS

Section VIII.C.3 of the Action Plan states that after twelve years of implementation, the first quantitative evaluation of whether groundwater quality is improving will be made. It also says that groundwater quality will be evaluated along with an assessment of whether there is continued promotion and adequate adoption of groundwater quality protection practices, activities and strategies by individuals, organizations, businesses and governments.

Goals were identified in Section VIII.G of the Action Plan as having December 2009 deadlines. These goals relate to the five contributors of nitrate, and are reiterated below.

5.1 Irrigated Agriculture

Goal

By December of 2009, 95% of the irrigated acreage is implementing an accepted system of BMPs or are covered by an implementation plan and the recommendations are in place and being used. Practices are being evaluated and further improvements have been identified that would further improve and optimize management plans for groundwater quality protection. Responsible parties – SWCDs, NRCS, OSU Extension, and private agricultural service providers.

Goal

By December of 2009, analysis and trending of monitoring well network data indicates a downward trend in nitrate levels throughout most of the GWMA. Responsible parties – DEQ, ODA, and GWMA Committee

5.2 Rural Residential

Goal

By December of 2009, through a random survey, 80% of area residents are still aware of the groundwater nitrate problem and are aware of at least one activity or practice that contributes to the problem. 75% of those surveyed can cite at least one activity or practice they have changed because of their awareness of its impact on groundwater quality. Responsible parties – Local governments, SWCD and OSU Extension Service.

Goal

By December of 2009, all local governments can cite procedures, requirements and/or practices they have instituted as a result of the declaration of the GWMA. Responsible parties – local governments.

Goal

By December of 2009, methods to address and reduce the impact of groundwater quality of septic systems have adopted in all areas considered high risk for nitrate loadings from high densities of septic systems. Responsible parties – Local Governments

Goal

By December of 2009, analysis of trending of monitoring well network data indicates a downward trend in nitrate levels throughout the GWMA. Responsible parties – DEQ, ODA, and GWMA Committee

5.3 Food Processor Process Water

Goal

By December of 2009, monitoring data shows no violation of specific concentration limits since its establishment. Responsible parties – DEQ and food processor permitees.

Goal

By December of 2009, analysis and trending of monitoring well network data indicates a downward trend in nitrate levels throughout most of the GWMA. Responsible parties – DEQ, ODA, and GWMA Committee

5.4 CAFOs

Goal

By December of 2009, 90% of CAFOs are implementing an accepted system of BMPs or are covered by an implementation plan. Responsible parties – ODA, SWCDs, NRCS, OSU Extension, and private agricultural service providers.

Goal

By December of 2009, analysis and trending of monitoring well network data indicates a downward trend in nitrate levels throughout most of the GWMA. Responsible parties – DEQ, ODA, and GWMA Committee

5.5 Umatilla Chemical Depot Washout Lagoon

Goal

By December of 2009, monitoring data should show that the treatment system is working as expected and that reinjection water is not migrating beyond the capture zone of the treatment system. Responsible parties – US Army and DEQ.

Goal

By December of 2009, analysis and trending of monitoring well network data indicates a downward trend in nitrate levels throughout most of the GWMA. Responsible parties – DEQ, ODA, and GWMA Committee

6.0 RESEARCH NEEDS FOR HYDROGEOLOGIC CHARACTERIZATION

From July 30, 2001 to August 2, 2001, a field visit of the Lower Umatilla Basin Ground Water Management Area (LUB GWMA) was conducted to identify research needs related to nitrate pollution of the GWMA.

The field visit was conducted by Tom Straughan (ODA water quality planner), Ray Denny (program manager for Umatilla SWCD), Phil Richerson (DEQ nonpoint source hydrogeologist), and Erick Burns (ODA hydrogeologist). Sites visited include many of the monitoring well locations, permitted confined animal feeding operation (CAFOs), and the Hermiston Agricultural Research and Extension Center. Don Horneck and George Clough represented OSU Extension for a half-day meeting designed to identify research needs.

Those research needs identified fell into two broad categories: 1) hydrogeologic character of the GWMA, and 2) BMP implementation. The first category encompasses those research topics that will allow interpretation of nitrate trend data. This is critical since there currently are severe limitations to the ability to predict when and how observed nitrate data relate to improvement of water quality within the GWMA. The hydrogeologic research needs are discussed below. The second category is an important aspect of action plan implementation and will allow spatial analysis of management factors as they relate to water quality. The BMP research needs are discussed in Section 3.3. The research topics listed below may be used as an overall research plan. Each item will improve the utility of the other items, and in only rare instances will the research efforts be redundant at all. It is recommended that most of the items be accomplished, followed by re-assessment of the research plan.

A primary concern of both landowners and regulators was premature interpretation of BMP implementation effect on water quality change. In order to understand when, where, and how to look for water quality improvements, an adequate understanding of travel time through the groundwater system is necessary. Such information is currently not available for the GWMA.

This research topic focuses on hydrogeologic characterization of the groundwater management area. Travel time and geochemical character of the hydrogeologic system are critical pieces of information for assessing when water quality improvements are expected.

a. Analyze current monitoring well network for additional analytes that will improve our understanding of the hydrogeologic system and potential nitrate sources (e.g., isotopic analysis, redox potential, etc.).

An increasing number of studies are utilizing geochemical indicators to evaluate travel time of groundwater. These indicators should be analyzed for potential usefulness in the current monitoring network. Since these wells are already sampled regularly, costs should be nominal (i.e., only for analyses).

Isotopic analysis of various chemical constituents may allow estimation of groundwater age or of likely nitrate source (e.g., septic tanks, manure, and commercial fertilizer). An understanding of the age of the groundwater in various parts of the basin will allow estimates of time until BMP implementation will be detected at each well. Evaluation of likely sources of pollution will allow BMPs to be focused where they will do the most good.

Other geochemical indicators may also prove useful (e.g., redox potential, Cl/N ratios, etc.) for detecting water quality improvements (resulting from BMP implementation) or for understanding why some wells are consistently lower in nitrate concentration. While nitrate is very mobile in groundwater, in some geochemical environments, it is likely not conservative. [Primary candidates for work are DEQ, OSU Ext, OSU Bioresource Engineering, OSU Forest Engineering, or other departments or universities exhibiting sufficient expertise.]

b. Re-sample the 200+ wells sampled during the synoptic sampling round in 1992.

2009 will be the seventeenth year since the first synoptic sampling event, and six years since the second synoptic sampling event. Re-sampling of these wells in 2009 would aid in the first GWMA-wide quantitative evaluation of water quality required by the Action Plan. Having a large number of locations with a few data points over 17 years could augment the more statistically robust, but more

limited geographic coverage, of the analysis of trends using the 30+ wells in the bi-monthly well network. If additional analytes will prove beneficial (see *a.* above), then these should be added to the synoptic sampling round. For this reason, it may be beneficial to accomplish *a.* (above) first (i.e., it would minimize cost to know which additional analytes are most likely to succeed). [Primary candidate for work is DEQ.]

c. Vadose zone sampling.

Vadose zone sampling was accomplished early during the action plan implementation. Additional vadose zone sampling may prove beneficial, but research objectives need to be clearly identified. Reductions in amounts of applied irrigation and fertilizer have a synergistic effect that may provide misleading results. Also, vadose sampling will be expensive if the goal is to provide statistically relevant results to be applied at the basin scale. [Primary candidates for work are DEQ, OSU Ext, OSU Bioresource Engineering, and OSU Soil Sciences.]

d. Hydraulic aquifer testing (i.e., hydraulic conductivity determination).

Pump and slug testing are standard tools used in hydrogeology. Estimates of hydraulic conductivity would prove very beneficial in formulation of conceptual models of the flow in the GWMA. Further, this data can be used at future dates for development of numerical models. Unfortunately, there are a number of technical challenges associated with use of the existing monitoring network, and aquifer testing is relatively expensive (especially if the goal is to characterize the entire GWMA). [Primary candidates for work are DEQ or a contracted consultant.]

e. Development of new statistical tools for analysis of trend data.

Statistical analysis of Northern Malheur County GWMA data indicate Dacthal trends are decreasing faster than nitrate trends. This is likely due to the fact that Dacthal use essentially ended in the mid 1990s while nitrate continues to be added to the system.

If proper statistical methods can be developed, analysis of the Malheur nitrate and Dacthal data together may provide some method of estimating system response time to nitrate BMP implementation. If this proves to be the case, it may be beneficial to attempt to identify some chemical in the LUB GWMA that may also provide a temporal signature that coincides with BMP implementation. [Primary candidates for work are DEQ and OSU Mathematics (or others).]

f. Case-by-case evaluation of anomalously high nitrate concentrations.

A few wells were noted to have anomalously high nitrate levels (e.g., there is a basalt well that would normally be assumed to have high protection against agricultural or septic tank pollution). These wells might benefit from a more detailed inspection to ensure that there are no well construction or siting problems that invalidate their use as a GWMA monitoring well. It is anticipated that these additional inspection items will be low cost actions (e.g., sending a camera down the borehole to ensure there is no cross-connection of aquifers). Anomalous high pollutant levels may have large impacts on trend analyses depending on the types of statistics that are employed. [Primary candidate for work is DEQ.]

g. Spatial analysis of other vulnerability factors (e.g., soil type, septic density, distance from irrigation canals, etc.).

Site visits to wells indicated that many of the possible confounding factors for aquifer vulnerability were not easy to assess. In order to evaluate these factors, it may be desirable to be able to perform spatial analysis between high concentration wells and factors that may affect aquifer vulnerability. This item might best be accomplished following geochemical analysis of monitoring wells and documentation of BMP implementation. This will ensure the analysis of the other vulnerability factors occurs in the proper context. [Primary candidates for work are DEQ, OSU Ext, OSU Bioresource Engineering, and OSU Soil Sciences.]

h. Evaluation of groundwater / surface water interaction.

Although not identified during the field visit discussed above, an evaluation of the interaction of groundwater and surface water could be very useful. An increased knowledge of groundwater surface water interaction (throughout the basin as a whole and at specific locations) could shed light on issues where surface water issues and groundwater issues intersect (e.g., Total Maximum Daily Loads for surface water bodies versus GWMA needs, BMPs protective of surface water quality but detrimental to groundwater quality). A comprehensive groundwater study that will characterize the groundwater system (including surface water interaction) for the entire Umatilla River basin is desired. Funding partners are being pursued to allow this project to proceed. [OWRD and USGS are the agencies that will lead this investigation.]

7.0 PAST AND CURRENT RECOMMENDATIONS

This section of the report identifies past recommendations that have been, at least partially, addressed as well as recommendations for the future. Some recommendations appear in both sections because they have been partially, but not completely, addressed.

7.1 Past Recommendations That Have Been Accomplished

- Completion of the surveys to gauge the 2001 and 2005 goals.
- DEQ and others should pursue funding for the research needs identified for BMP determination and implementation as well as the hydrogeologic characterization of the GWMA (partially completed).
- Consider a more proactive approach to education efforts such as a door-to-door information campaign, direct mailing, and/or meetings specific to the Spanish-speaking population. The Clean Water Neighborhood Project has begun to address this recommendation.
- Begin efforts to encourage routine maintenance of septic systems and to encourage periodic inspections and replacement or upgrading of septic systems.
- Begin efforts to address rural residential animal pastures per items VII.D.5a & b.
- DEQ should do a better job at reviewing documents submitted by food processor facilities in a timely manner and providing comments that will assist the food processor facilities meet their permit conditions and objectives.
- Food processor facilities continue to strive to meet permit conditions and objectives.
- Develop an inventory of CAFOs in the LUB GWMA.

7.2 Recommendations for the Future

- Two recommendations from the Second Four-Year Evaluation of Action Plan Success and 2005/2006 Progress Report (available at http://www.deq.state.or.us/wq/groundwater/docs/lubgwma/AnnualReport20052006.pdf with 2008 deadlines that remain to be completed include the following:
    - ODA, DEQ and the Agriculture Sub-Committees will develop a list of actions that are likely to lead to improvements in groundwater quality, that can be documented, and have mechanisms to assure actions are implemented. This task was to be completed by December 31, 2008.
    - ODA, DEQ and the Agriculture Sub-Committees will develop a method to document implementation of the recommended actions. This task was to be completed by December 31, 2008
- All interested and affected parties should work towards accomplishing the December 2009 goals.
- DEQ and others should further investigate the anomalously high nitrate values at several network wells.
- DEQ and others should pursue funding for the research needs identified for BMP determination and implementation as well as the hydrogeologic characterization of the GWMA.
- DEQ should work towards implementing an economical alternative septic system demonstration project.
- Develop a plan to document how well activities, practices and alternative practices recommended in the Action Plan are being adopted. Include what is meant by an “accepted system of BMPs”. Include specifics on types of practices, aerial extent, location, time of adoption, continued use of recommendations and other factors relevant to document progress in implementing the action plan.
- Explore the possibility of performing deep soil sampling at locations where high nitrates have been detected.
- Completion of a Memorandum of Agreement between the SWCDs, ODA and DEQ along with a work plan for activities associated with this action plans implementation (Section VII, item A.3).
- DEQ should get additional educational materials produced in Spanish and make them available to the Spanish-speaking population within the GWMA.
- Develop Public Information and Education plans that emphasize groundwater quality protection in the LUB GWMA.
- Direct more education to growers regarding nutrient management to help reduce over-fertilization.

- Direct more general education on maintenance and management of wheel and permanent set irrigation systems.
- Define an "acceptable system of BMPs" for irrigated agriculture.
- Implement a more proactive approach to education efforts such as a door-to-door information campaign, direct mailing, and/or meetings specific to the Spanish-speaking population. Implementation of the Clean Water Neighborhood Project will address this recommendation.
- Continue efforts to encourage routine maintenance of septic systems and to encourage periodic inspections and replacement or upgrading of septic systems.
- Continue efforts to address rural residential animal pastures per items VII.D.5a & b.

7.3 Recommendations for Changes to the Action Plan

It is recommended that the Action Plan be amended to:

- recognize the new EPA and ODA definitions of CAFOs and AFOs, and
- better define what acceptable systems of BMPs are for irrigated agriculture, rural residential properties, and CAFOs.