



State of Oregon
Department of
Environmental
Quality

Evaluation of Northern Malheur County Groundwater Management Area Action Plan Success

December 29, 2003



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Executive Summary

Introduction

The Northern Malheur County Groundwater Management Area (NMC GWMA) was declared in 1989 after widespread groundwater nitrate contamination was identified that had resulted primarily from nonpoint source activities. Oregon DEQ and a citizen's advisory committee created an Action Plan for restoring the groundwater nitrate concentrations to acceptable levels. The Action Plan identifies specific "measures" to gauge the success of groundwater restoration activities in the area.

Purpose of this Report

The purpose of this report is to draw conclusions regarding the success of the NMC GWMA Action Plan by summarizing two companion reports: the December 2003 "Northern Malheur County Groundwater Management Area Trend Analysis Report" which describes the analysis of groundwater quality data from the area, and the December 2003 "Northern Malheur County Groundwater Management Area BMP Implementation Report" which describes information related to the implementation of best management practices (BMPs) that are protective of groundwater quality.

Gauging Success

The Action Plan specified four specific "measures" of success. Three of these measures are based on groundwater quality concentrations and trends. The fourth measure is based on implementation of practices that reduce nitrate loading to groundwater.

Conclusions

Based on the information presented in the Trend Analysis Report and the BMP Implementation Reports identified above, it is concluded that sufficient progress has been made to continue the voluntary nature of the Action Plan.

The major conclusions from the Trend Analysis Report are:

- The three measures of Action Plan success based on groundwater quality values have not yet been met. These measures of success were overly optimistic; it is clear that a longer time frame will be required for these measures of success to be met, and
- The area-wide nitrate trend appears to be no longer increasing. This conclusion is based on four estimates of the area-wide nitrate trend that suggest it is either flat or slightly declining (up to 0.3 parts per million (ppm) decline per year). This conclusion is not definitive because the nitrate trends at individual wells were mixed (i.e., they included increasing, decreasing, flat, and statistically insignificant trends).
- Because the trend analysis was conducted approximately four years after DCPA use essentially ended, the increasing DCPA & metabolites trends in wells located near the end of groundwater flow paths illustrates the need for a longer time frame to flush the aquifer. Continued monitoring of DCPA & metabolites could provide useful information in assessing the nature of contaminant transport in the area thus allowing a more accurate evaluation of nitrate transport in the area.

Conclusions from the BMP Implementation Report include:

- The fourth measure of Action Plan success (i.e., the one stating that "other indicators of progress" be implemented) has been met. However, documentation of BMP implementation from 1997 to the present is needed to confirm the continued implementation of BMPs.
- There is a strong local commitment to maintain and expand the implementation of BMPs so that economic and environmental benefits can be realized and maintained.
- The factors limiting widespread BMP implementation are very real and difficult to overcome.



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- Continued education and research into new technologies and practices are necessary to maintain and build upon the successes realized to date.

Recommendations

Based on the conclusions presented in the Trend Analysis Report and the BMP Implementation Report, the following recommendations are made. These recommendations are grouped according to the responsible parties.

Northern Malheur County Groundwater Management Committee, Malheur County SWCD, NRCS, FSA, Malheur and Owyhee Watershed Councils, and Oregon State University

- As available and appropriate, provide financial and technical support to assist in the implementation of established BMPs and continued research to identify additional appropriate BMPs in the GWMA.
- Seek to educate growers and other citizens about factors related to groundwater contamination.
- Encourage projects such as deep soil sampling to evaluate changes in the amount and movement of nitrate within the unsaturated zone.
- Develop and maintain documentation of the extent to which the other indicators of progress identified in the Action Plan have been implemented since 1997.
- Re-evaluate and fine tune BMP implementation in the Owyhee River area and near specific well locations with increasing nitrate trends and/or elevated nitrate concentrations.
- As appropriate and as resources allow, evaluate the possibility of point source contributions in the vicinity of wells with increasing nitrate trends.
- As available and appropriate, provide financial and technical support to assist in the continued research, documentation, and implementation of appropriate BMPs in the GWMA as well as projects such as deep soil sampling to evaluate changes in the amount and movement of nitrate within the unsaturated zone.
- Re-evaluate progress in developing and implementing BMPs in 2005 using data through December 2004.

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- As available and appropriate, provide financial and technical support to assist in the implementation and documentation of established BMPs and continued research to identify additional appropriate BMPs in the GWMA.
- Encourage projects such as deep soil sampling to evaluate changes in the amount and movement of nitrate within the unsaturated zone.
- Perform a geostatistical analysis to evaluate the appropriateness of the existing well network
- Perform another trend analysis and a geostatistical analysis to explore the possibility of reducing the sample frequency and/or modifying the existing well network to produce a cost-effective yet representative well network.

Groundwater Management Committee and DEQ with support from Federal, State, and County Agencies associated with this project

- Propose an amendment to the Action Plan that allows the use of the Seasonal Kendall method for the evaluation of water quality trends rather than requiring the use of the ordinary least squares method.
- Because the target date has passed, propose an amendment to the Action Plan that deletes the measure of Action Plan success regarding July 1, 2000 nitrate levels.



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Evaluation of Northern Malheur County GWMA Action Plan Success

1.0 INTRODUCTION

The Northern Malheur County Groundwater Management Area (NMC GWMA) was declared in 1989 after widespread groundwater nitrate contamination was identified that had resulted primarily from nonpoint source activities. Oregon DEQ and a citizen's advisory committee created an Action Plan for restoring the groundwater nitrate concentrations to acceptable levels. The Action Plan identifies specific "measures" to gauge the success of groundwater restoration activities in the area.

This report evaluates the success of the NMC GWMA Action Plan by summarizing two companion reports: the December 2003 "Northern Malheur County Groundwater Management Area Trend Analysis Report" which describes the analysis of groundwater quality data from the area, and the December 2003 "Northern Malheur County Groundwater Management Area BMP Implementation Report" which describes information related to the implementation of best management practices (BMPs) that are protective of groundwater quality.

This section of the report provides information on the establishment of the Northern Malheur County Groundwater Management Area, the purpose of this report, and ways to measure success of the Northern Malheur County Groundwater Management Action Plan.

1.1 Establishment of Northern Malheur County Groundwater Management Area

Oregon's Groundwater Protection Act of 1989 requires the Oregon Department of Environmental Quality (DEQ) to declare a Groundwater Management Area (GWMA) if area-wide groundwater contamination, caused primarily by nonpoint source pollution, exceeds certain trigger levels.

Nonpoint source pollution of groundwater results from contaminants coming from diffuse land use practices, rather than from discrete sources such as a pipe or ditch. The contaminants of nonpoint source pollution can be the same as from point source pollution, and can include sediment, nutrients, pesticides, metals, and petroleum products. The sources of nonpoint source pollution can include construction sites, agricultural areas, forests, stream banks, roads, commercial areas, industrial areas, and residential areas.

The Groundwater Protection Act also requires the establishment of a local Groundwater Management Area Committee comprised of affected and interested parties. The committee works with and advises the state agencies that are required to develop an action plan that will reduce groundwater contamination in the area.

The Northern Malheur County GWMA was declared in 1989 after groundwater contamination was identified in an 115,000-acre area in the northeastern portion of the county where land use is dominated by agriculture. Its boundary starts at the mouths of the Malheur and Owyhee Rivers where they converge with the Snake River and extends to the uppermost irrigation canals. The approximate location of the Northern Malheur County GWMA is indicated in Figure 1-1. Major roads and water bodies within the GWMA are identified in Figure 1-2.

Groundwater samples from private water wells identified nitrate contamination and the presence of the pesticide Dacthal¹ and its breakdown products (hereafter known as DCPA & metabolites). Traditional fertilizer and agricultural chemical application practices are believed to be the main source of the contamination. Other possible sources of nitrate identified in northern Malheur County include residential lawn care, on-site sewage systems (i.e., septic tanks), confined animal feed lot operations, and food processing facilities.

Sampling confirmed that most of the contaminated groundwater is present in the shallow alluvial sand and gravel aquifer which receives a large proportion of its recharge from canal leakage and irrigation water. Therefore, the shallow aquifer is the focus of the Northern Malheur County Groundwater Management Action Plan, hereafter referred to as the Action Plan.

¹ Dacthal is a trade name for dimethyl tetrachloroterephthalate (DCPA). Dacthal is the term used in the Action Plan and on analytical reports.

Evaluation of Northern Malheur County GWMA Action Plan Success

The Northern Malheur County Groundwater Management Committee, the Technical Advisory Subcommittee, and representatives from the DEQ, the Oregon Department of Agriculture (ODA), the Oregon Water Resources Department (OWRD), the Oregon Department of Human Services (formerly known as the Oregon Health Division (OHD)), and Oregon State University (OSU) conducted an 18-month effort ending with the approval in December 1991 of the Action Plan which is aimed at reducing groundwater contamination in the GWMA.

The Action Plan includes detailed information on water quality, identification of contaminant sources, and recommendations for implementation of BMPs to improve groundwater quality. This approach allows farmers to customize a sequence or system of available BMPs to their individual farm operations. The Committee chose to implement the Action Plan on a voluntary basis recognizing that individuals, businesses, organizations, and governments will, if given adequate information and encouragement, take positive actions and adopt or modify practices and activities to reduce contaminant loading to groundwater.

1.2 Purpose Of This Report

The purpose of this report is to draw conclusions regarding the success of the NMC GWMA Action Plan by summarizing two companion reports: the December 2003 “Northern Malheur County Groundwater Management Area Trend Analysis Report” which describes the analysis of groundwater quality data from the area, and the December 2003 “Northern Malheur County Groundwater Management Area BMP Implementation Report” which describes information related to the implementation of best management practices (BMPs) that are protective of groundwater quality. These documents, as well as the Action Plan, are available at <http://www.deq.state.or.us/wq/groundwa/NMalheurGWMgmtArea.htm>

1.3 Measures Of Action Plan Success

The Action Plan specifies four specific ways to gauge success. Three of these are related to water quality trends (i.e., changes in groundwater quality over time) in response to adoption of BMPs. The fourth measure of success involves the adoption of BMPs (i.e., “other indicators of progress”).

According to these criteria, the Action Plan will be considered successful if:

- (1) a trend analysis indicates, at a 75% confidence level, that the level of the nitrate monitoring data for the entire management area is 7 mg/l; or
- (2) a trend analysis indicates, at an 80% confidence level, that nitrate levels will reach 7 mg/l by July 1, 2000; or
- (3) a statistically significant downward trend can be demonstrated at the 80% confidence level; or
- (4) other indicators show progress toward this goal. Other indicators of progress may include but are not limited to the following:
 - number of producers adopting farm plans;
 - an increase in utilization of soil testing to improve fertilization practices;
 - an increase in efficiency of nitrogen fertilizer application: timing, placement, form, & rate;
 - an increase in irrigation efficiency, reducing deep percolation;
 - a vadose zone drilling project demonstrating decrease in concentrations of nitrate;
 - number of water quality practices being applied; and
 - Ontario Hydrologic Unit Area reports and evaluations of progress and effectiveness.

The first three measures of success (i.e., those related to water quality trends) are discussed in the document titled “Northern Malheur County Groundwater Management Area Trend Analysis Report”. The fourth measure of success (i.e., the other indicators of progress) is discussed in the document titled “Northern Malheur County Groundwater Management Area BMP Implementation Report”.

Evaluation of Northern Malheur County GWMA Action Plan Success

2.0 GAUGING SUCCESS

This section of the report provides a summary of the measures of success evaluated in the Trend Analysis Report and the BMP Implementation Report. More detailed information is provided in the above-referenced reports.

2.1 Measuring Groundwater Quality Improvement

The three measures of success based on groundwater quality values have not yet been met. Details of the three groundwater quality measures of Action Plan success are as follows:

- 1) The measure that nitrate levels for the entire management area reach 7 mg/l has not yet been met. The median and average nitrate concentrations from the December 1999 sampling event were 11.3 and 13.4 ppm, respectively.
- 2) The measure that a trend analysis indicates nitrate levels will reach 7 mg/l by July 1, 2000 was not met. The August 2000 sampling event results indicate median and average values exceeded 7 mg/l.
- 3) The measure that a statistically significant downward trend be demonstrated at the 80% confidence level has not yet been met. The four estimates of area-wide nitrate trends suggest either a flat or slightly declining trend (up to 0.3 ppm decline per year). Because nitrate trends at individual wells include increasing, decreasing, and flat or statistically insignificant trends, area-wide trend estimates are not statistically meaningful.

These measures of success were overly optimistic. It is clear that a longer time frame will be required for these measures of success to be met.

Figure 2-1 is a summary of the area-wide nitrate trend analyses. The figure includes many stacks of data points at two-month intervals. Each of these stacks of data points represents one sampling event, and contains one data point for each well sampled that event. The figure also contains lines representing the area-wide trend evaluated by the Regional Kendall test, the area-wide annual average trend estimate, and the area-wide monthly average trend estimate. The average slope of statistically significant trends is also identified. It should be noted that the four statistical estimates of an overall area-wide nitrate trend suggest either a flat or slightly declining trend (at most 0.3 ppm/yr), with the best estimate (i.e., the Regional Kendall result) suggesting a flat trend. As discussed in the Trend Analysis Report, these overall trends are based on a set of wells exhibiting variable trend directions (i.e., some are increasing, some are decreasing, and some are flat) so that the overall trends are not statistically valid.

However, it is encouraging to note that none of these estimates suggest area-wide nitrate concentrations are increasing. Furthermore, considering the factors inhibiting rapid improvement in groundwater quality (see Section 5.4 of the Trend Analysis Report), these results are not surprising. To put the area-wide nitrate trend analyses into context, a conceptual model of how an area-wide nitrate trend might develop in response to extensive agriculture followed by BMP implementation is presented in Figure 2-2. It is important to note that the axes in Figure 2-2 are relative scales. No values are included or implied.

As illustrated in Figure 2-2, the conceptual model assumes nitrate concentrations were at some low steady-state background concentration prior to the introduction of extensive agriculture. During the early years of agriculture, over-fertilization and over-irrigation cause the accumulation of nitrate in the unsaturated zone beyond the reach of plants and a dramatic increase of nitrate concentrations in groundwater. As BMPs that improve fertilization and irrigation practices are implemented, the nitrate loading at land surface decreases but the nitrate in the unsaturated zone beyond the reach of plants persists. As time progresses under BMP implementation, the nitrate in the unsaturated zone continues to leach, thus maintaining the increase of groundwater nitrate concentrations, but at a slower rate. When a sufficient amount of nitrate has moved through the system and fertilization and irrigation closely approximates crop needs, nitrate concentrations in groundwater stabilize. Eventually, under continued improvement and expansion of BMPs, groundwater quality gradually improves as the majority of remaining nitrate moves out of the unsaturated zone and through the

Evaluation of Northern Malheur County GWMA Action Plan Success

groundwater system. Ultimately, nitrate concentrations are expected to reach a new steady-state concentration likely higher than the original background concentration (Figure 2-2).

An explanation for the flat to slightly decreasing area-wide trends calculated in this study that is consistent with the conceptual model is if these data reflect the portion of the conceptual model curve that is flattening out and beginning to decline (Figure 2-2). The measures of success in the Action Plan requiring area-wide nitrate concentrations of 7 mg/l, or even a statistically significant downward trend, within five years of BMP implementation were overly optimistic. It is clear that a longer time frame will be required for these measures of success to be met².

2.2 Measuring BMP Implementation

As indicated in Section 1.3, the success of the Action Plan can be measured in ways other than the evaluation of groundwater quality numbers. Advances in these “other indicators of progress” reflect the positive effects of BMP implementation and education. Some of this progress is documented in the Ontario Hydrologic Unit Area (HUA) Final Report 1990 - 1997 and summarized below. In addition to the information documented in the HUA Report, other efforts by local growers, suppliers, and agency personnel are also summarized below. Additional documentation of BMP implementation from 1997 to the present is needed.

Major changes in agricultural practices have occurred since groundwater contamination was identified in the Malheur River area in the late 1980s. The method of nitrogen application in this area has been changed. Reduced nitrogen loading has been accomplished by changes in the timing and the application of nitrogen as well as the rate of application. Plant tissue and soil sampling have also played a major role in modifying practices for the application of nitrogen by enabling the producers to apply only the amount of nutrient needed and only when that nutrient is needed. Changes in irrigation management practices have also occurred that increase the protection of groundwater quality.

Table 2-1 identifies the extent of specific BMPs implemented between 1990 and 1997 for groundwater protection, surface water protection, erosion protection, irrigation water management, and animal waste management. Specific details regarding “other indicators of progress” identified in the Action Plan are discussed in the BMP Implementation Report.

In summary, sufficient progress has been made over the past decade on these “other indicators of progress” identified in the Action Plan to conclude the fourth measure of Action Plan success has been met. In addition, there is a strong local commitment to maintain and expand the implementation of BMPs so that economic and environmental benefits can be realized and maintained. It is important to recognize, however, that continued education and outreach to encourage implementation of established practices, as well as continued development of new practices, will be necessary to maintain and build upon the successes realized to date.

² DEQ reconsidered the five year time frame for improving groundwater quality during preparation of the Action Plan for the second GWMA in Oregon: the Lower Umatilla Basin GWMA. The Lower Umatilla Basin GWMA was declared after the Northern Malheur County GWMA and the LUB Action Plan was finalized in 1997. In the Lower Umatilla Basin GWMA, groundwater quality data is to be collected for 12 years following Action Plan adoption before the first area-wide trend analysis is conducted.

Evaluation of Northern Malheur County GWMA Action Plan Success

3.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the Trend Analysis Report and the BMP Implementation Report, a conclusion regarding the success of the Action Plan has been made. In addition, major conclusions and recommendations from the Trend Analysis Report and the BMP Implementation Report are reiterated below.

3.1 Conclusions

Based on the information presented in the Trend Analysis Report and the BMP Implementation Reports identified above, it is concluded that sufficient progress has been made to continue the voluntary nature of the Action Plan.

The major conclusions from the Trend Analysis Report are:

- The three measures of success based on groundwater quality values have not yet been met. These measures of success were overly optimistic; it is clear that a longer time frame will be required for these measures of success to be met, and
- The area-wide nitrate trend appears to be no longer increasing. This conclusion is based on four estimates of the area-wide nitrate trend that suggest it is either flat or slightly declining (up to 0.3 parts per million (ppm) per year). This conclusion is not definitive because the nitrate trends at individual wells were mixed (i.e., they included 37.5% increasing, 22.5% decreasing, 5% flat, and 35% statistically insignificant trends).

The conclusions from the BMP Implementation Report are:

- The fourth measure of Action Plan success (i.e., the one stating that “other indicators of progress” be implemented) has been met to date and such efforts need to continue. However, documentation of BMP implementation from 1997 to the present is needed to confirm the continued implementation of BMPs.
- There is a strong local commitment to maintain and expand the implementation of BMPs so that economic and environmental benefits can be realized and maintained.
- The factors limiting widespread BMP implementation are very real and difficult to overcome.
- Continued education and research into new technologies and practices are necessary to maintain and build upon the successes realized to date.

Recommendations

Based on the conclusions presented in the Trend Analysis Report and the BMP Implementation Report, the following recommendations are made. These recommendations are grouped according to the responsible parties.

Northern Malheur County Groundwater Management Committee and Malheur County SWCD

- As available and appropriate, provide financial and technical support to assist in the implementation of established BMPs and continued research to identify additional appropriate BMPs in the GWMA.
- Encourage projects such as deep soil sampling to evaluate changes in the amount and movement of nitrate within the unsaturated zone.
- Develop and maintain documentation of the extent to which the other indicators of progress identified in the Action Plan have been implemented since 1997.
- Re-evaluate and fine tune BMP implementation in the Owyhee River area and near specific well locations with increasing nitrate trends and/or elevated nitrate concentrations.
- As appropriate and as resources allow, evaluate the possibility of point source contributions in the vicinity of wells with increasing nitrate trends.
- As available and appropriate, provide financial and technical support to assist in the continued research, documentation, and implementation of appropriate BMPs in the GWMA as well as projects such as deep soil sampling to evaluate changes in the amount and movement of nitrate within the unsaturated zone.
- Re-evaluate progress in developing and implementing BMPs in 2005 using data through December 2004.

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DEQ

- As available and appropriate, provide financial and technical support to assist in the implementation of established BMPs and continued research to identify additional appropriate BMPs in the GWMA.
- Encourage projects such as deep soil sampling to evaluate changes in the amount and movement of nitrate within the unsaturated zone.

Additional recommendations were made to assess non-agricultural influences on the groundwater monitoring well network, perform a geostatistical analysis to evaluate the appropriateness of the existing well network, and to perform another trend analysis and a geostatistical analysis to explore the possibility of reducing the sample frequency and/or modifying the existing well network to produce a cost-effective yet representative well network.

Groundwater Management Committee and DEQ with support from Federal, State, and County Agencies associated with this project

- Amend the Action Plan to allow the use of the Seasonal Kendall method for the evaluation of water quality trends rather than requiring the use of the ordinary least squares method.

Evaluation of Northern Malheur County GWMA Action Plan Success

Table 2-1
Implementation of BMPs Within the Ontario HUA (FY 1990 – 1996)
Evaluation of Northern Malheur County GWMA Action Plan Success

Best Management Practice	Extent of Implementation	Protective of Groundwater	Protective of Surface Water	Protective Against Erosion	Irrigation Water Mgt Practice	Animal Waste Mgt Practice
Conservation Cropping Sequence	27,576 acres	✓	✓	✓		
Grasses & Legumes in Rotation	1,231 acres	✓	✓	✓		
Irrigation Water Management	46,891 acres	✓	✓	✓	✓	
Pasture / Hay Land Management	676 acres	✓	✓	✓		
Pasture / Hay Land Planting	285 acres	✓	✓	✓		
Nutrient Management	44,010 acres	✓	✓			
Waste Utilization	1,670 acres	✓				✓
Soil Testing	35,595 acres	✓	✓			
Fertilizer Application Timing	21,324 acres	✓	✓			
Tissue Analysis	19,098 acres	✓				
Split Application of Nitrogen	15,125 acres	✓	✓			
Banding of Nutrients	7,625 acres	✓	✓			
Surge Irrigation	160 acres	✓	✓	✓	✓	
Irrigation Scheduling	18,053 acres	✓	✓		✓	
Sprinkler Irrigation	6,737 acres	✓	✓	✓	✓	
Filter Strip	618 acres		✓	✓		
Tail Water Recovery System	16 systems		✓	✓	✓	
Irrigation Land Leveling	1,587 acres	✓	✓	✓	✓	
Straw Mulching	5,490 acres		✓	✓	✓	
Polyacrylamide (PAM)	16,725 acres		✓	✓		
Sediment Basins	8 basins			✓		
Irrigation Water Conveyance – Ditches	117,646 feet			✓	✓	
Irrigation Water Conveyance - Pipe	373,178 feet			✓	✓	
Structures for Water Control	330 structures				✓	
Bubblers	386 structures				✓	
Waste Management System	11 systems					✓
Waste Storage Structure	4 structures					✓
Waste Treatment Lagoon	2 lagoons					✓
Waste Storage Pond	5 ponds					✓

Figure 1-1
Location of Northern Malheur County Groundwater Management Area
Evaluation of Northern Malheur County GWMA Action Plan Success

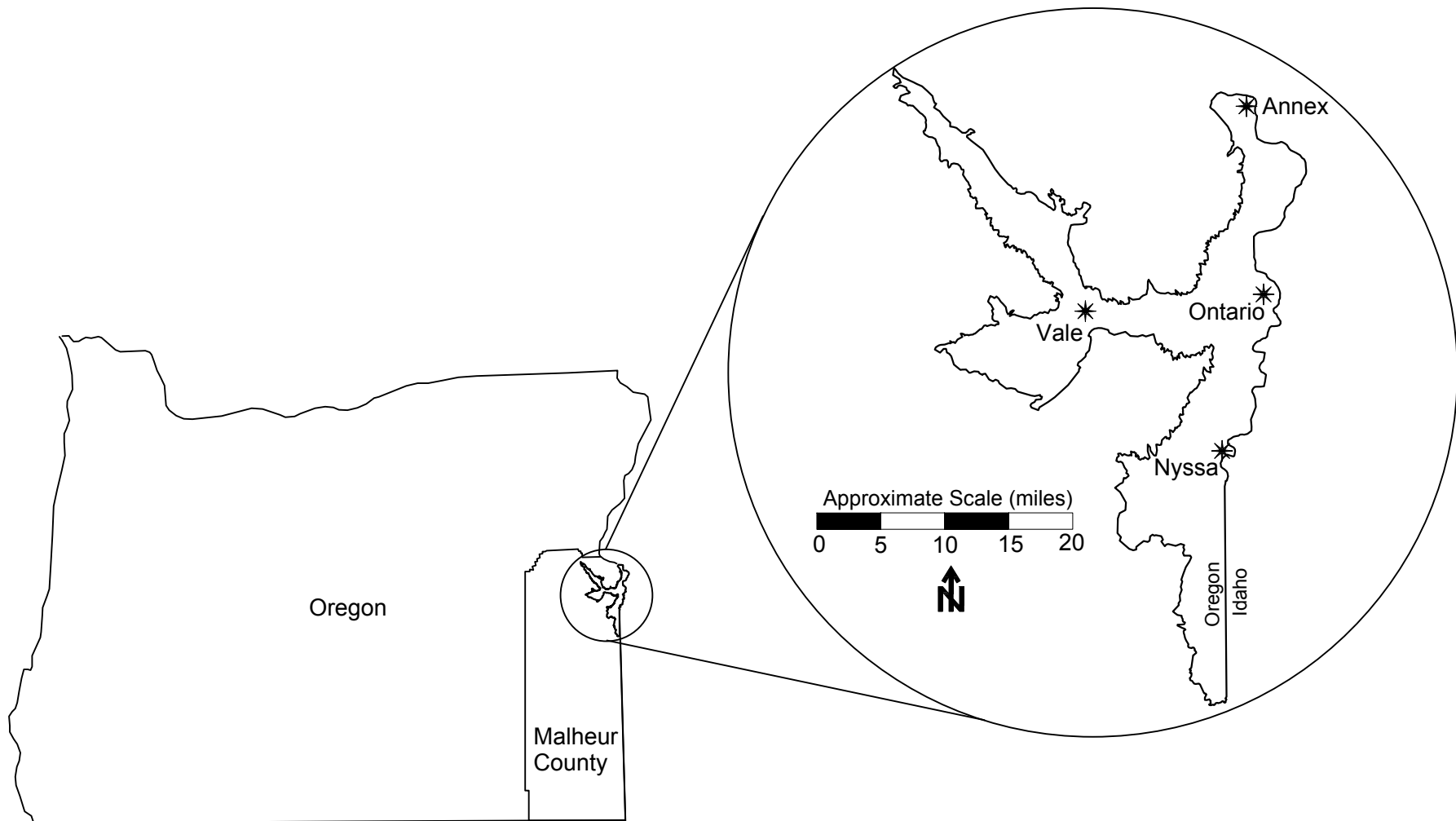


Figure 1-2
 Site Layout Map
 Evaluation of Northern Malheur County GWMA Action Plan Success

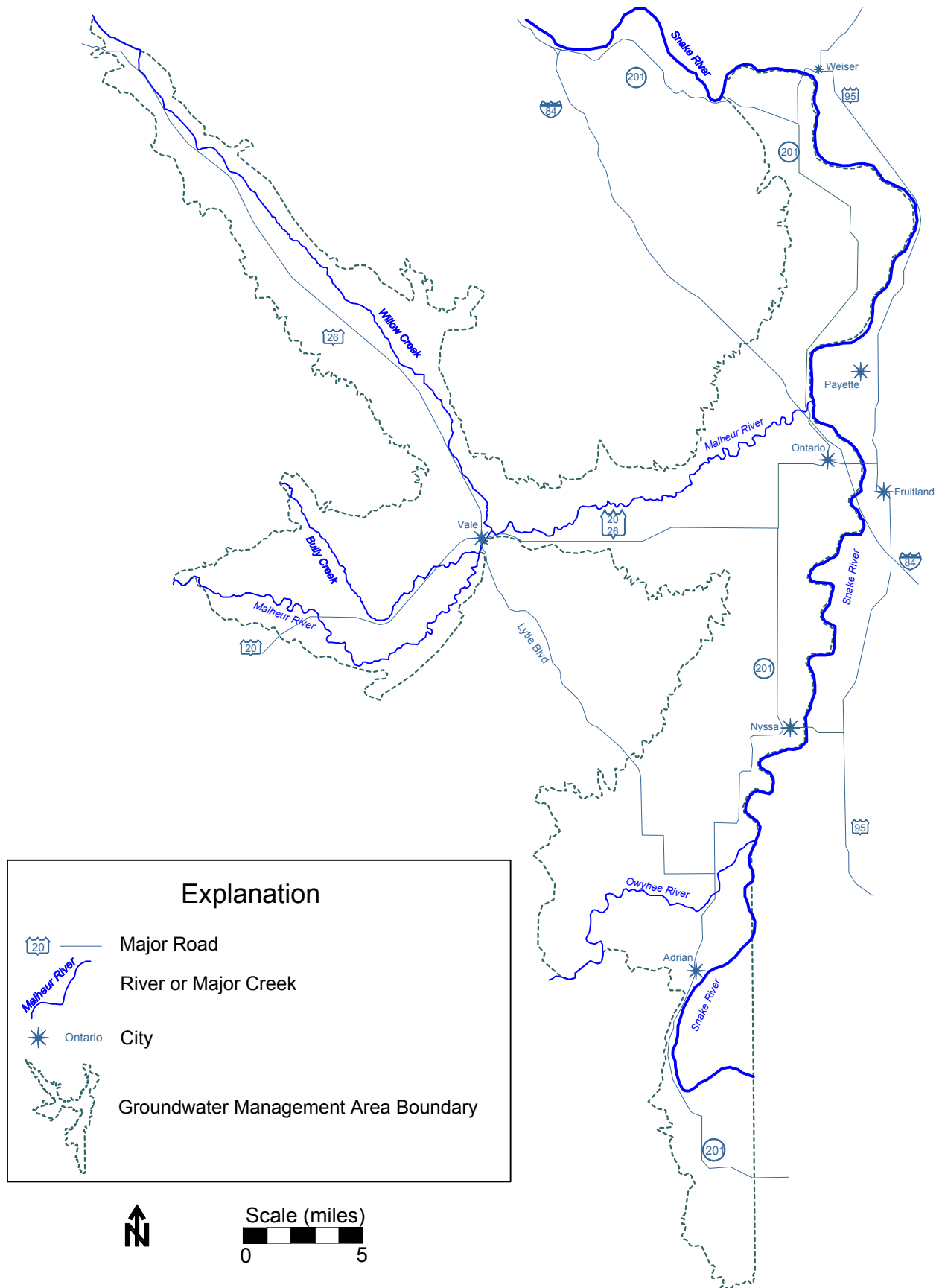


Figure 2-1
Summary of Area-Wide Nitrate Trend Analyses
Evaluation of Northern Malheur County GWMA Action Plan Success

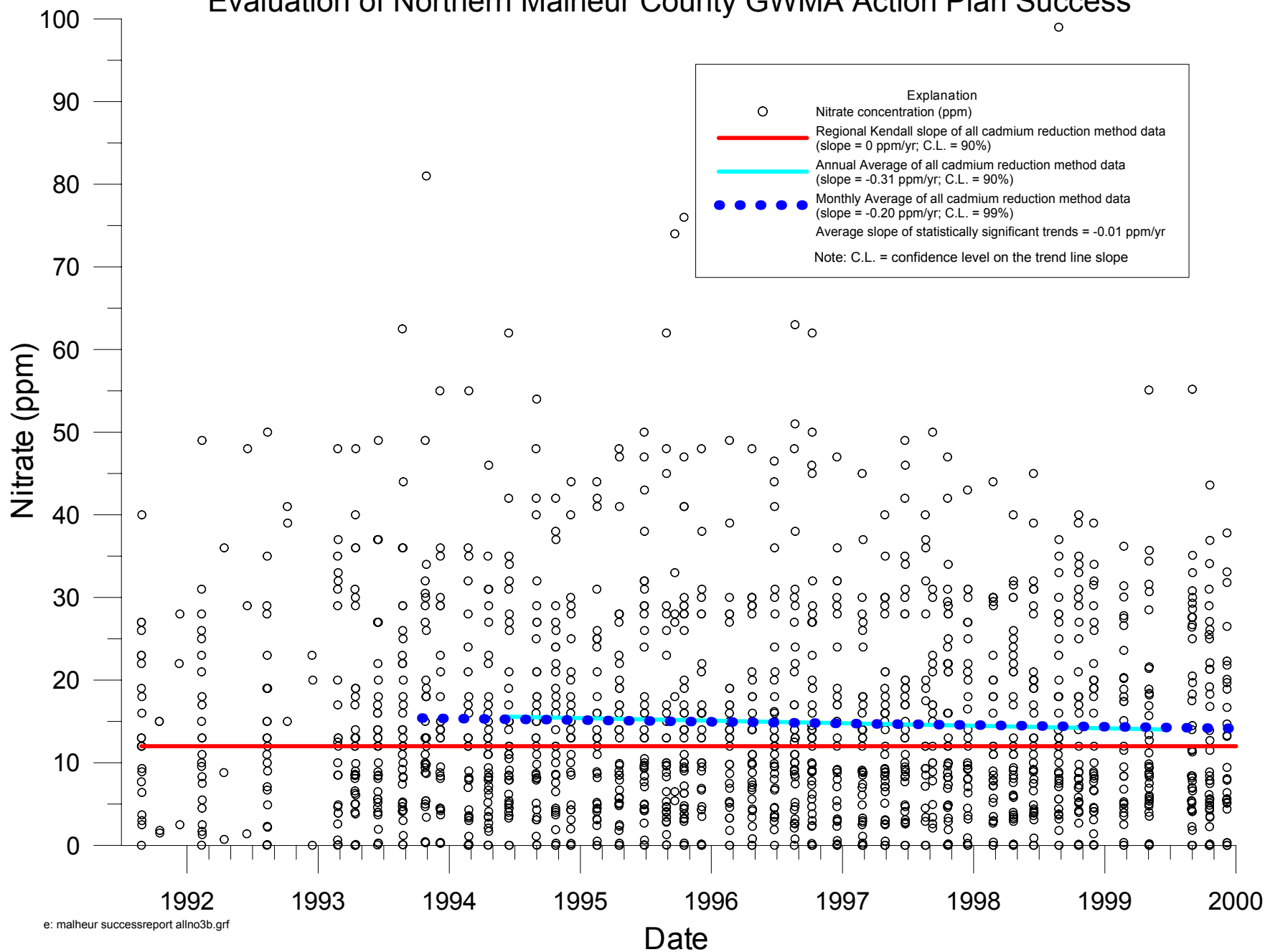


Figure 2-2
A Conceptual Model of Area-Wide Nitrate Trend
Evaluation of Northern Malheur County GWMA Action Plan Success

