STATE OF OREGON

DEPARTMENT OF ENVIRONMENTAL QUALITY

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NORTHERN MALHEUR COUNTY GROUNDWATER MANAGEMENT ACTION PLAN

By

MALHEUR COUNTY
GROUNDWATER MANAGEMENT COMMITTEE

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GROUNDWATER MANAGEMENT ACTION PLAN

1.0 INTRODUCTION

Groundwater contamination has been found in a 115,000 acre area in Northeastern Malheur County. Groundwater samples from private water wells have documented nitrate contamination. Sampling has also confirmed that the herbicide Dacthal is present in the groundwater, however, at levels well below the U.S. Environmental Protection Agency Health Advisory. There are three aquifer units underlying this area including the Glens Ferry Formation or deeper aquifer, the upland gravels and the alluvial sand and gravel aquifer. 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 (Gannett, 1990). The Northern Malheur County Groundwater Management Action Plan (action plan) will focus on this aquifer.

Traditional fertilizer and agricultural chemical application practices are believed to be the main source of the contamination. As the irrigation water has percolated over time from the surface to groundwater it has carried with it soluble agricultural chemical residues that remained in the soil profile. Because of the groundwater quality problems identified in northern Malheur County (the project area), the area has been designated by the Department of Environmental Quality as a Groundwater Management Area under the provisions of the Groundwater Protection Act of 1989 (ORS 468.698).

1.1 Groundwater Protection Goal and Strategy

The Groundwater Quality Protection Act of 1989 established a goal and strategy to protect groundwater from contamination and to restore groundwater quality when the resource is contaminated from nonpoint sources of contamination. It is applicable to the nonpoint source contamination of groundwater in the project area and is the goal and strategy for this action plan. The goal and a summary of the strategy are presented below as follows:

1.1.1 Goal

"The Legislative Assembly declares that is the goal of the people of the State of Oregon to prevent contamination of Oregon's ground water resource while striving to conserve and restore this resource and to maintain the high quality of Oregon's ground water resource for present and future users."

1.1.2 Summary of Strategy

- Coordinate projects.
- Develop programs designed to reduce impacts on groundwater from commercial and industrial activities, commercial and residential use of fertilizers and pesticides, residential and sewage treatment activities, and any other activity that may result in contaminates entering the groundwater.
- Provide educational and informational materials to promote public awareness and involvement in the protection, conservation and restoration of Oregon's groundwater resource.
- Coordinate development of local groundwater protection programs.
- Award grants for projects to protect groundwater quality.
- Develop and maintain centralized repository of information.

- Identify research or information about groundwater.
- Cooperate with federal entities to ensure federal plans meet state's intent.
- Aid in development of voluntary programs to reduce the quantity of hazardous or toxic waste generated in order to reduce the risk of groundwater contamination.

1.2 Northern Malheur County Groundwater Management Action Plan

This action plan has been developed to coordinate the activities to be undertaken by the local agricultural community, Malheur County, the State of Oregon, and the Federal Government. Sections 1 through 8 describe problems to be addressed. Sections 9 and 10 discuss the recommended actions to be taken by the local community. Section 11 describes the actions to be taken by County, State and Federal agencies associated with this project. The Department of Environmental Quality (DEQ) will monitor groundwater quality conditions to determine seasonal cycles and trends and provide general analytical support. The Oregon State Department of Agriculture (ODA), the Soil and Water Conservation District (SWCD), and the United States Department of Agriculture Soil Conservation Service (SCS), in cooperation with the Oregon State University Experiment Station (OSU), will identify and evaluate the land use activities influencing the groundwater quality cycles and trends.

OSU, in cooperation with the ODA and SCS, will explore and develop technically sound alternatives and revisions to replace or compensate for those activities identified as adversely impacting groundwater quality. Along with the development of alternative technologies, field studies will be conducted to compliment the formal research and verify the effectiveness of the alternative technology. These studies will be performed as a joint effort by ODA, SCS, OSU, and DEQ.

In conjunction with the development and verification of the best alternative technologies ODA, SCS, OSU, and DEQ will provide public and group demonstrations, and educational programs to establish the strategy objectives within the community. To compliment this, the Agricultural Stabilization and Conservation Service (ASCS) will explore and develop economic implementation incentives to assist agricultural producers in the acceptance of the recommended management practices.

Much has been learned concerning the nature and extent of groundwater quality problems in northern Malheur County over the last several years. However, there are many questions still unanswered. The action plan is to a large extent a plan for developing answers to some of the remaining questions. To be effective the action plan must be a dynamic plan and be changed as new information becomes available and better management practices are developed.

2.0 BACKGROUND

In the past, water quality issues in Malheur County have centered on surface water quality and irrigation water needs. Concerns have been primarily directed towards the erosion and sediment problems caused by overland flow and irrigation runoff and the chemical loads associated with that runoff. Poor surface water quality resulting from runoff was easily recognized and surface water quality protection was determined to be a necessity. In 1981, Malheur County adopted a surface water management plan to provide a solution to the surface water quality problems identified. As with most water quality problems resulting from non-point source activities, the most practicable solution was determined to be the implementation of alternative land use management practices.

The plan adopted in 1981 is based on recommended Best Management Practice (BMP) systems established in USDA's Soil Conservation Service (SCS) Field Office Technical Guide. The "BMPs" contained in the plan are current and remain applicable for surface water quality protection in Malheur County. Advancements in water quality protection, such as reduced suspended sediment loads, have been obtained since the problem was identified. However, the strategy was originally formulated to address surface water only. As such, it is not adequate for addressing the current groundwater quality problems in Malheur County.

The value of maintaining Malheur County's groundwater resource is apparent and more recently has gained the attention of the State Legislature. The legislature recognized that groundwater quality protection is an issue which involves multiple concerns founded on immediate individual needs at the local level and society's overall responsibility to future generations. Adoption of the 1989 Groundwater Protection Act established the direction to be taken by the State in resolving area-wide nonpoint source groundwater quality issues.

2.1 Management Strategy Development

The strategy established by the Oregon State 1989 Groundwater Protection Act is designed to be implemented through the State Strategic Water Management Group (SWMG). The SWMG was formed in 1985 by the Oregon State Legislative assembly to coordinate and manage state agencies involved in water resource issues. The group is composed of the Directors of the State resource management agencies and is chaired by the Governor's Assistant for Natural Resources. Any actions implemented through this plan must first be reviewed and approved by SWMG.

Oregon Revised Statute 468.698 describes a Groundwater Management Area and the conditions for which a declaration occurs. Basically, such an area will be declared when contaminants are found at 50 percent of the established maximum measurable level (MML) for all contaminants except nitrates in groundwater. For nitrate contaminants the law requires that a Groundwater Management Area be established when contaminant levels exceed 70 percent of the MML.

The 1989 Groundwater Protection Act calls for the appointment of a local groundwater management committee to assist in the development of a management plan. The goal of the plan is to reduce nitrate/nitrite-nitrogen contamination in the groundwater to a level below that which caused the declaration of the management area. The Malheur County committee was appointed August 22, 1989 and first met November

1989. Since November of 1989 the committee has met nine times and has assisted the Oregon Department of Environmental Quality in developing this plan by offering comments, suggestions, and recommendations.

2.1.1 Malheur County Groundwater Management Committee

The committee members were chosen from a list of recommendations submitted by local civic groups, agricultural organizations, state, county, and city agencies, environmental organizations, and a variety of private citizens. The committee selection was made by SWMG through a careful evaluation of several important factors. Of most importance was the nominee's ability to contribute to the development of a practical plan of action to respond to the region's groundwater quality problem, and their ability to work productively in open forum discussions with other committee members while formulating management decisions which will inherently affect the entire County.

The following list of people were appointed to the Groundwater Management Committee:

Mr. Barry Fujishin, Chairman

Mr. Darrel Standage
Mr. Dave Cloud
Mr. Rod Frahm
Mr. Ray Winegar
Ms. Mary Thiel
Mr. Cliff Bentz
Mr. Jim Nakano
Mr. Tom Anderson
Ms. Caroline Nysingh
Mr. Rodger Findley
Ms. Kathy Jordan
Mr. Bob Butler
Mr. Don Bowers
Mr. Glen Hill
Mr. Joe Hobson
Mr. Nico Hopman
Mr. Ron Schoenman

The following people were asked by SWMG to participate in a subcommittee formed to supply the technical answers to committee inquiries:

Mr. Lynn Jensen
Mr. Ray Perkins
Mr. Herb Futter
Ms. Zadean Auyer

Mr. Ray Huff
Dr. Clint Shock
Mr. Ray Dunten
Ms. Marti Bridges
Dr. John Miller
Mr. John Ross
Mr. Ben Simko
Ms. Kit Kamo
Mr. Mike Howell

2.1.2 Required Components

Required components of the management plan are listed in the 1989 Groundwater Protection Act. In summary, the plan shall include the following:

- Identification and evaluation of the management practices contributing to the contamination.
- Consideration of all reasonable alternatives which will reduce the contaminants found in the groundwater.
- Recommended mandatory actions which will reduce contaminant levels below that required for declaration of a groundwater management area.
- An implementation schedule for estimated contaminant reductions and public review.
- Amendments to local comprehensive plans and land use regulations required by the groundwater management plan.

3.0 CONTAMINANT CHARACTERIZATION

The United States Environmental Protection Agency (USEPA), has set a maximum contaminant level (MCL) of 10 mg/l for nitrate/nitrite-nitrogen in public water supplies. Nitrate/nitrite-nitrogen levels above 10 mg/l may represent a serious health concern for infants under 6 months of age and pregnant or nursing women. Adults receive most nitrate exposure from food. Infants, however, receive the greatest exposure from drinking water because most of their food is liquid form (Department of Human Resources, Health Division, 1990).

Nitrate can interfere with the ability of the blood to carry oxygen to vital tissues of the body in infants one year old or younger. The result is called methemoglobinemia or "blue baby syndrome". There have not been any cases of methemoglobinemia reported in northern Malheur County resulting from consuming nitrate/nitrite-nitrogen contaminated water.

According to an OSHD fact sheet, it has been suggested in preliminary studies that excessive nitrate ingestion may be linked to gastric cancer, but this has not been confirmed (Department Human Resources, Health Division, 1990). There have also been research studies on rats which have not determined a relationship between nitrate consumption and cancer (European Chemical Industry Ecology and Toxicology Centre, 1988).

The USEPA has reviewed the available health studies on Dacthal. These studies are based on Dacthal alone, and not on the di-acid breakdown products or impurities. In northern Malheur County, the data generated to describe the Dacthal contamination is based on the di-acid breakdown products rather than the Dacthal parent material.

The USEPA has established a lifetime health advisory for consuming Dacthal in drinking water to be 4000 ppb (Discussion with Dennis Nelson, Department of Human Resources, Health Division, 1991). The USEPA believes that no adverse human health effects are likely to result from drinking water with 4000 ppb or less of Dacthal. Based on discussions with Health Division personnel, it appears that there may be serious health risks from long-term exposure to Dacthal at levels above the health advisory of 4000 ppb. Long-term exposure to large quantities of Dacthal by animals has resulted in severe liver, kidney and thyroid damage (Discussion with Dennis Nelson, Department of Human Resources, Health Division, 1991).

4.0 BACKGROUND INFORMATION

Malheur County encompasses 6,352,640 acres in the southeastern corner of Oregon (Figure 1). The county is the second largest in the State and twelfth largest in the nation. Malheur County's population of 26,000 is primarily supported by agriculture. The county has approximately 260,000 acres of irrigated crop land and approximately 5,971,200 acres of range land.

Malheur County is bordered by Idaho on the east and Nevada to the south. In Oregon, Baker and Grant Counties border Malheur County on the north and Harney County borders to the west. There are three major river basins in the county. The Malheur River drainage and the Owyhee River drainage originate in high desert uplands to the south and west and flow north and east to the Snake River (Malheur County Planning Office, 1981).

The area this plan addresses lies in Malheur County's northeastern corner near the convergence of these three river valleys (Figure 2). This area consists mainly of alluvial flood plains and terraces. The lower valleys of the Malheur, Owyhee and Snake drainage form fertile farmland which supports intensive agricultural production.

Malheur County summers are hot and winters are very cold. The average July temperature is 75° Fahrenheit; the long-term average January temperature is 29° Fahrenheit. The average annual precipitation is 9.8 inches.

Normally, July, August, and September have minimum amounts of rainfall with 0.11, 0.40, and 0.48 inches respectively. With 140 to 160 frost free days and an arid climate, this region is good for intensive agriculture. Yields are high and product quality is excellent.

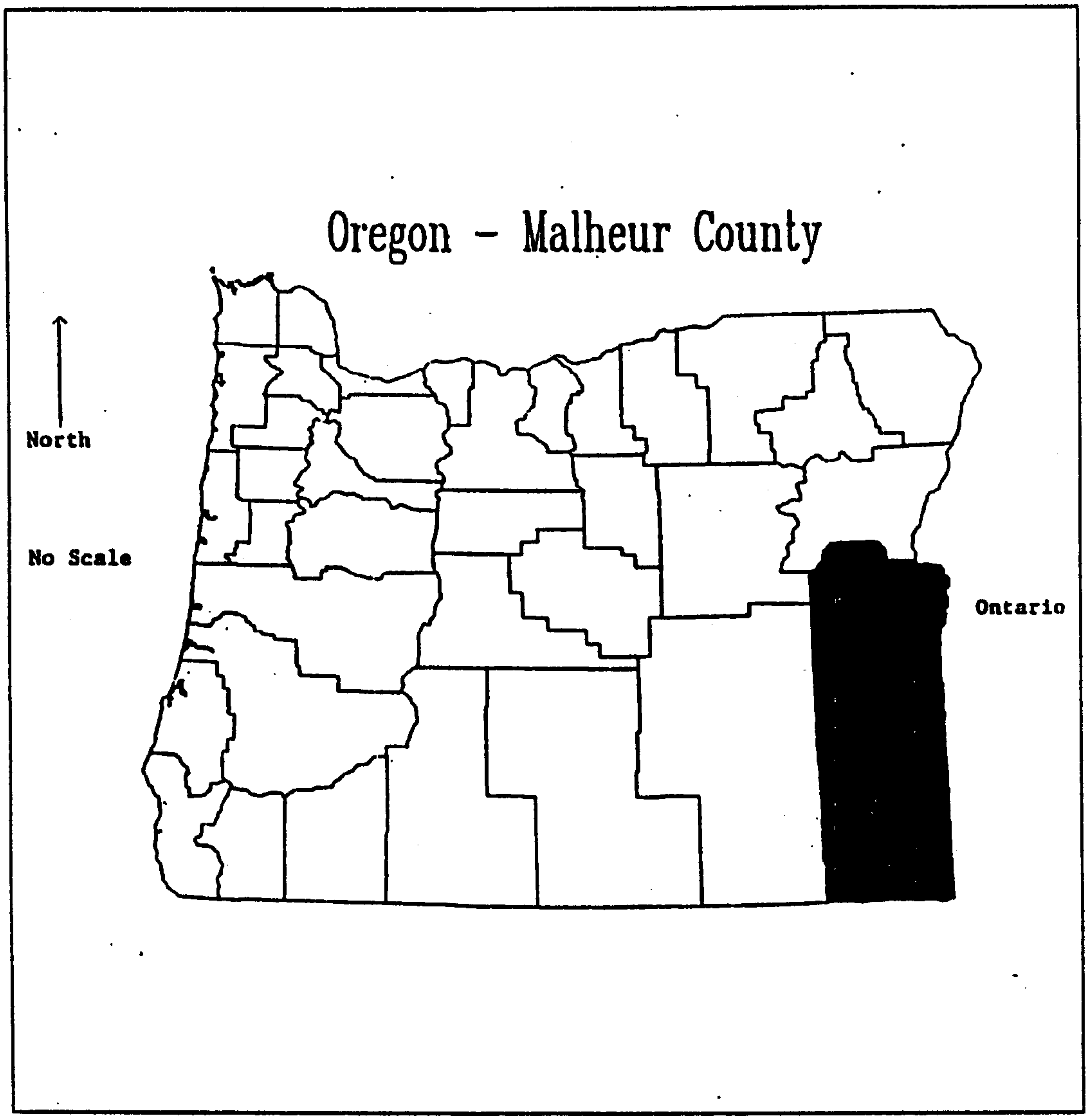

FIGURE 1
Oregon —— Malheur County

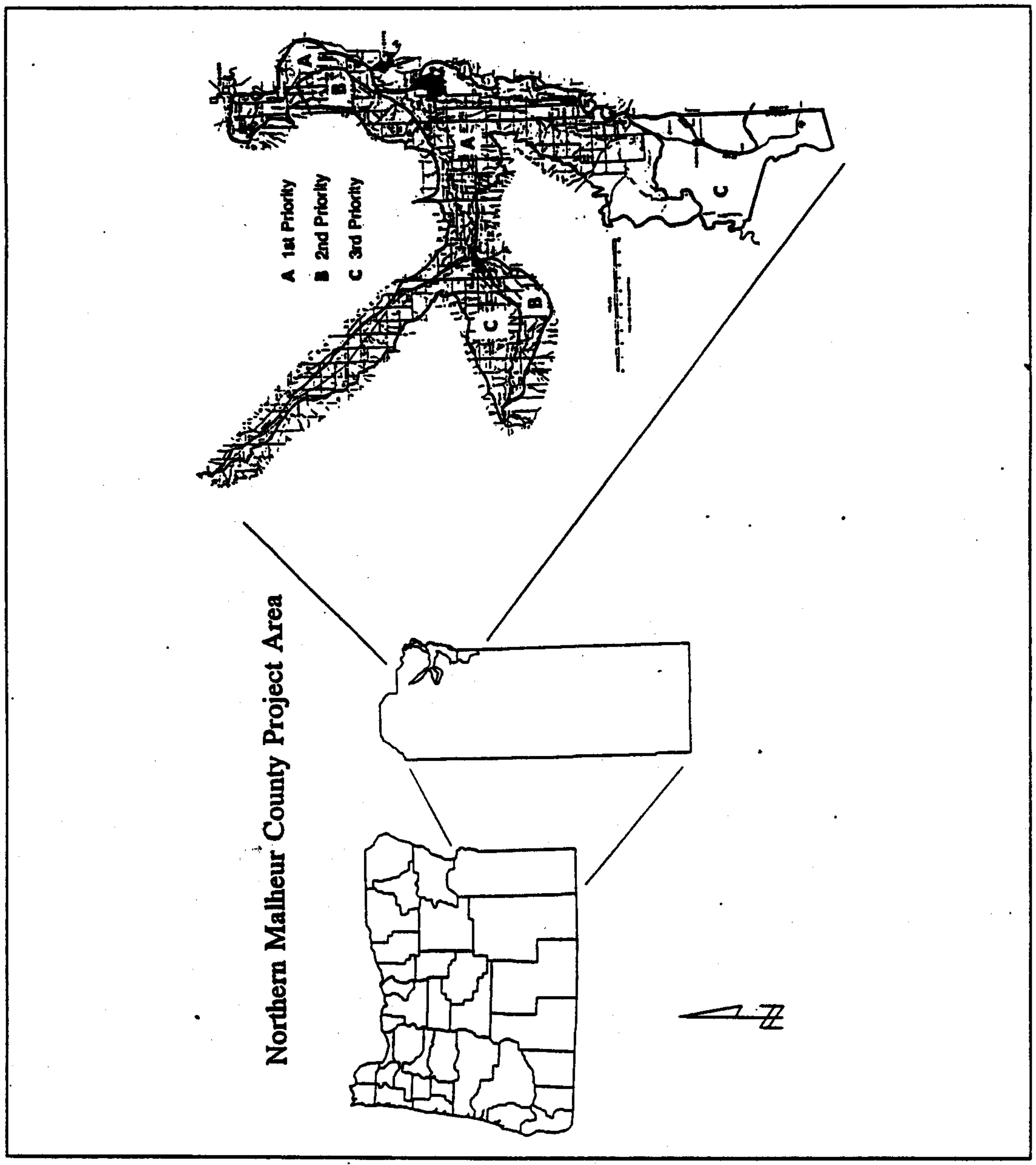

FIGURE 2
Northern Malheur County Project Area

5.0 HYDROGEOLOGY

(Marshall Gannett, Oregon State Water Resources Department, Groundwater Report No. 34, 1990)

In 1988, the Oregon State Water Resources Division (WRD) began an intensive field study to characterize the local hydrogeologic environment (Appendix A). The characterization was limited to the shallow groundwater aquifer of the area since the uppermost aquifer has been most impacted by the agricultural chemical contamination. The following hydrogeologic description gives an overview of the findings as discussed in the WRD report.

The sand and gravel aquifer ranges in thickness from approximately 10 to 30 feet and is present throughout the valley and lower terraces around Ontario, Nyssa, and Vale. This aquifer is the most widely used source of groundwater in the area for both drinking water and irrigation.

The shallow aquifer is overlain by approximately 25 feet of silt. The thickness and character of the silt varies from place to place. The silt is generally permeable and allows the downward movement of water from the surface into the shallow aquifer. Therefore, the shallow sand and gravel aquifer is considered unconfined to semi-confined.

The shallow aquifer is recharged by infiltration of local precipitation, snow melt, leakage of irrigation canals and ditches, and by deep percolation of irrigation water. Conveyance and application of irrigation water is the biggest source of recharge. The water level in the shallow aquifer is highest during the irrigation season. Records from continuous water level recorders show that groundwater levels rise in response to melting snow, to canal leakage and irrigation. Groundwater levels decline after the irrigation season is over. Deep percolation of irrigation water is believed to be the primary process by which agricultural chemicals are entering the shallow groundwater.

The rate of recharge from various sources can be estimated by modelling groundwater flow. Based on a groundwater flow model prepared by Davis S. Walker (graduate student at Oregon State University) for part of the project area, it is estimated that the rate of recharge from precipitation, seepage from lateral canals and ditches and deep percolation of water applied to fields may be approximately 2 feet per year for each irrigated acre (Davis S. Walker, unpublished Master of Science Thesis, Oregon State University). There is no independent data to verify this figure. Although relative contributions from each source have not been determined, members of the technical subcommittee have suggested that based on practical knowledge, less than one foot per year can be attributed to deep percolation of irrigation water, with the balance attributed to precipitation and canal and ditch leakage (discussion with the technical subcommittee on May 15, 1991).

Prior to irrigation development, the water level in the shallow aquifer was at or above the elevation of the adjacent rivers. The increase in annual recharge due to irrigation development has raised water levels into the overlying silt, especially at the valley edges. This has increased the gradient of the water table and increased groundwater flow velocities. The increased recharge due to irrigation development has not increased storage in the shallow aquifer as much as it has served to greatly increase the annual flow through the system. This means that the shallow sand and gravel aquifer is a naturally saturated aquifer and not an artifact of human activity.

The shallow sand and gravel aquifer in the Ontario area is underlain by several thousand feet of fine sand, silt and clay. These materials were deposited in a large lake which occupied portions of eastern Oregon and western Idaho a few million years ago. The sediments, which are often described as "blue clay" by drillers, are too fine-textured to allow easy movement of groundwater. These sediments generally do not yield significant amounts of water to wells. Within the fine sediments there are occasional coarse sand layers and gravel layers which in some places produce substantial quantities of water. These deep aquifers are part of the regional groundwater flow system which is recharged by rain and snow over a large part of the basin. These deep aquifers are limited in extent and do not underlie the entire Ontario area.

The static water level elevation in these deep aquifers appears to be slightly higher than in the shallow gravel aquifer. This means that the deep aquifer water is under pressure and there is a natural tendency for groundwater to flow upward from the deep zones to the shallow aquifer. Some improperly constructed wells in the area interconnect both the deep and shallow aquifers and provide an avenue for this upward movement of water.

The approximate rate and direction of groundwater movement in the shallow aquifer has been determined by measuring water level elevations in wells throughout the area and conducting pumping tests on several wells. Groundwater generally flows from the edges of the valley toward major surface streams. The velocity of groundwater flow in the shallow gravel aquifer ranges from 2 to 10 feet per day in much of the area. "At an average velocity of 6 feet per day, groundwater moves at about 0.4 mile per year. Therefore it may take between 5 and 11 years for water in the Cairo junction area to discharge from the system" (Groundwater Report No. 34, p. 34).

Dr. Jonathan Istok of the Oregon State University Civil Engineering Department has been working on an analysis of the vadose zone in the project area. This study is scheduled for completion in summer 1991. The analysis to date suggests that nitrate/nitrite-nitrogen contaminant travel time through the vadose zone to the aquifer may be greater than 10 years. This suggests that to move nitrates through the entire system may take as long as 20 years; 10 years to move through the vadose zone and 10 years for nitrates in water to discharge from the aquifer.

6.0 WATER QUALITY CONDITIONS

Historic data to establish naturally occurring water quality conditions in the area's shallow groundwater are not available. Therefore, there is no means by which this survey can establish natural groundwater quality conditions for the region. However, portions of data from both existing information and information generated by this project can be interpreted to indicate past water quality conditions generally. The following discussion describes this information.

6.1 Surface Water

Typical for arid regions, the naturally occurring surface water in the Owyhee and Malheur Basins tends to be higher in total dissolved solids than in areas of the state that receive higher rainfall amounts. This difference is reflected in the surface water standards for the Malheur and Owyhee basins. The maximum limit for total dissolved solids is 750 milligrams per liter (mg/l) for the Owyhee and Malheur Basins, in contrast to 500 mg/l for the Columbia Basin and 100 mg/l for the Willamette Basin. These standards are established in the Oregon Administrative Rules, Chapter 340, Division 41.

The Malheur and Owyhee Rivers have a minimum dissolved oxygen standard of 75 percent (%) of saturation as compared to the Columbia and Willamette Rivers of 90 percent. The range of pH values for the Owyhee and Malheur waters is to be maintained between 7.0 and 9.0, compared to 7.0 to 8.5 for the Columbia and 6.5 to 8.0 for the Willamette.

Elevated levels of nitrate/nitrite-nitrogen and the presence of traces of Dacthal di-acid have been identified in most surface waters in the area, including the irrigation delivery and drainage network and the Malheur River. Surface water conditions in both the Malheur and Owyhee Basins have been characterized by the State of Oregon as severely impacting fish, aquatic habitat and water contact recreation (Department of Environmental Quality, 1988). Severe impact is defined as substantial or nearly complete interference or elimination of a designated beneficial use.

Surface water pollution as a result of groundwater discharge to streams has not been verified. However, the hydrologic system acts as a continuum. It should be recognized that groundwater discharge to streams can affect surface water quality; conversely surface water discharge (from canals, creeks, etc.) to the groundwater table can affect groundwater quality.

6.2 Groundwater

Groundwater quality conditions in the area demonstrate similar effects due to the arid climate. Data from DEQ's groundwater monitoring program revealed elevated concentrations of most indicator parameters in the shallow aquifer and mineralized hard water. For example, approximate average levels are as follows:

- Alkalinity - 420 mg/l,
- Conductivity - 1400 uMhos/cm2,
- Total dissolved solids - 900 mg/l,
- Hardness - 375 mg/l,
- Sodium - 190 mg/l,
- Calcium - 75 mg/l,
- Sulfate - 200 mg/l, and
- pH is slightly elevated above neutral at 7.7.

Since elevated nitrogen levels identified in the area's shallow groundwater supply has triggered a groundwater management area declaration, identifying the approximate background nitrogen concentration is important when projecting achievable contaminant reduction levels. However, actual groundwater data reflecting natural nitrogen levels does not exist. Therefore other information must be referenced when discussing natural nitrogen concentrations in the area's shallow groundwater.

In general, naturally occurring levels of nitrates in groundwater result from decaying organic matter and except in isolated instances do not exceed 2 milligrams per liter (Nitrate Fact Sheet, Department of Human Resources, Health Division, 1990). Naturally low levels of nitrate/nitrite-nitrogen can also be substantiated through the current water quality survey since very low levels (0.2 mg/l) have been documented. Perhaps the best source of information on background nitrate levels is the United States Geological Survey report 84-4242, Oregon Groundwater Quality and Its Relation to Hydrogeologic Factors: A Statistical Approach. Utilizing data from 1,077 total analyses, this report establishes a median statewide nitrate/nitrite-nitrogen concentration of 0.15 mg/l and a 75 percentile level of 0.73 mg/l. When only data from basin fill and alluvial aquifers of the type found in the study area are considered, results from 300 analyses yield a median concentration of 0.46 mg/l and a 75 percentile level of 1.7 mg/l.

The areal pattern of the groundwater nitrate/nitrite-nitrogen levels reveals that the highest levels occur in the areas that are subject to the most intensive agricultural practices, and statistical analysis has indicated a strong correlation between the nitrate/nitrite-nitrogen level and the Dacthal di-acid level. All of this information together, along with the lack of any known source of naturally occurring nitrates, indicates that the nitrate/nitrite-nitrogen concentrations observed are well above natural levels.

6.3 Past Water Quality Studies

Several water quality assessments have been performed in northern Malheur County. The early assessment studies were performed primarily to address existing water quality concerns or impacts resulting from particular sources. Assessments have been performed to identify natural arsenic contamination (Oregon State Health Division, 1980), surface water impacts resulting from irrigation runoff (Malheur County Nonpoint Source Water Quality Management Program, 1980), Public Water Supply Impacts Resulting from Agricultural Chemicals (Oregon State Health Division, 1987), and to determine the correlation coefficient between the Dacthal di-acid contamination and nitrate/nitrite-nitrogen contamination (Istok, et. al, 1988).

In 1985, the Department of Environmental Quality coordinated a reconnaissance study in northern Malheur County as part of a statewide groundwater assessment project. Project participants included the U.S. Environmental Protection Agency, U.S. Geological Survey, Oregon State

University Department of Agricultural Chemistry, Oregon State Health Division, Oregon Water Resources Department, Oregon Department of Agriculture, and Oregon Department of Environmental Quality.

The statewide assessment study consisted of sampling select private domestic wells and public water systems. Wells sampled in each area were selected on the basis of suspected vulnerability and susceptibility to contamination, and availability of well construction information. Sample analyses included general water quality parameters, nutrients, and select pesticides. Pesticides were selected on the basis of quantity used in the area, persistence, toxicity, and leaching potential. Whenever sampling results indicated potential water quality problems the well was re-sampled and analyzed for confirmation of results.

The analytical results for northern Malheur County generated by this study revealed 34 percent (37) of the 107 wells sampled contained nitrate/nitrite-nitrogen at levels above the 10 milligrams per liter (mg/l) federal EPA drinking water standard. The highest contamination found was 49 mg/l. Dacthal di-acid was found in 67 percent (54) of the 81 wells sampled. The highest Dacthal di-acid concentration found was 431 parts per billion (ppb). The drinking water health advisory issued by EPA for Dacthal is 4000 ppb.

6.4 Current Water Quality Assessment

In August of 1988, the State initiated a program to monitor and evaluate groundwater quality in northern Malheur County. The purpose was to provide information to develop and implement a groundwater management strategy to ameliorate the problems identified. Specific agency tasks were delegated by the Strategic Water Management Group under the provisions of the 1989 Groundwater Protection Act.

6.4.1 Interagency Work

For the project, the Oregon State Department of Human Resources Health Division performed health risk evaluations and public notification of sample analyses results. The Oregon State Department of Agriculture provided analytical assessment of agricultural chemicals and coordinated local project activities with the Soil and Water Conservation District.

The Oregon State University Agricultural Experiment Station and Extension Service assisted in evaluation of agricultural chemical analyses and evaluated and explored agricultural management practices relative to groundwater quality protection. The Oregon State Water Resources Department provided a regional hydrogeologic characterization of the project area. The Oregon State Department of Environmental Quality developed and implemented the sampling and analyses program of the project.

6.4.2 Sampling Program

The project encompassed a 115,000 acre area extending from Annex on the north to Adrian on the south, and from Vine Hill west of Vale, east to the Snake River (Figure 2). Nitrate/nitrite-nitrogen and Dacthal di-acid contamination has not been identified in the higher elevations outside the lower lying irrigated valleys. The program began in August of 1988 and continued through April of 1990. During this time 122 sites were sampled and 469 samples were collected and analyzed (Figure 3).

Existing public and private domestic and irrigation water wells as well as selected surface water locations within the study area were used in this project. Sites were selected on the basis of location, depth, availability of a well log or well construction information, accessibility, and any previous sample analyses results. The program generated data used to identify existing water quality conditions, seasonal fluctuations, and trends or cycles associated with land use activities.

Sampling of a select network of sites as well as a few exploratory sites was conducted every other month. Compounds investigated on a bi-monthly basis are listed in Section A of Table 1. In addition, two complete pesticide screenings were conducted during the duration of

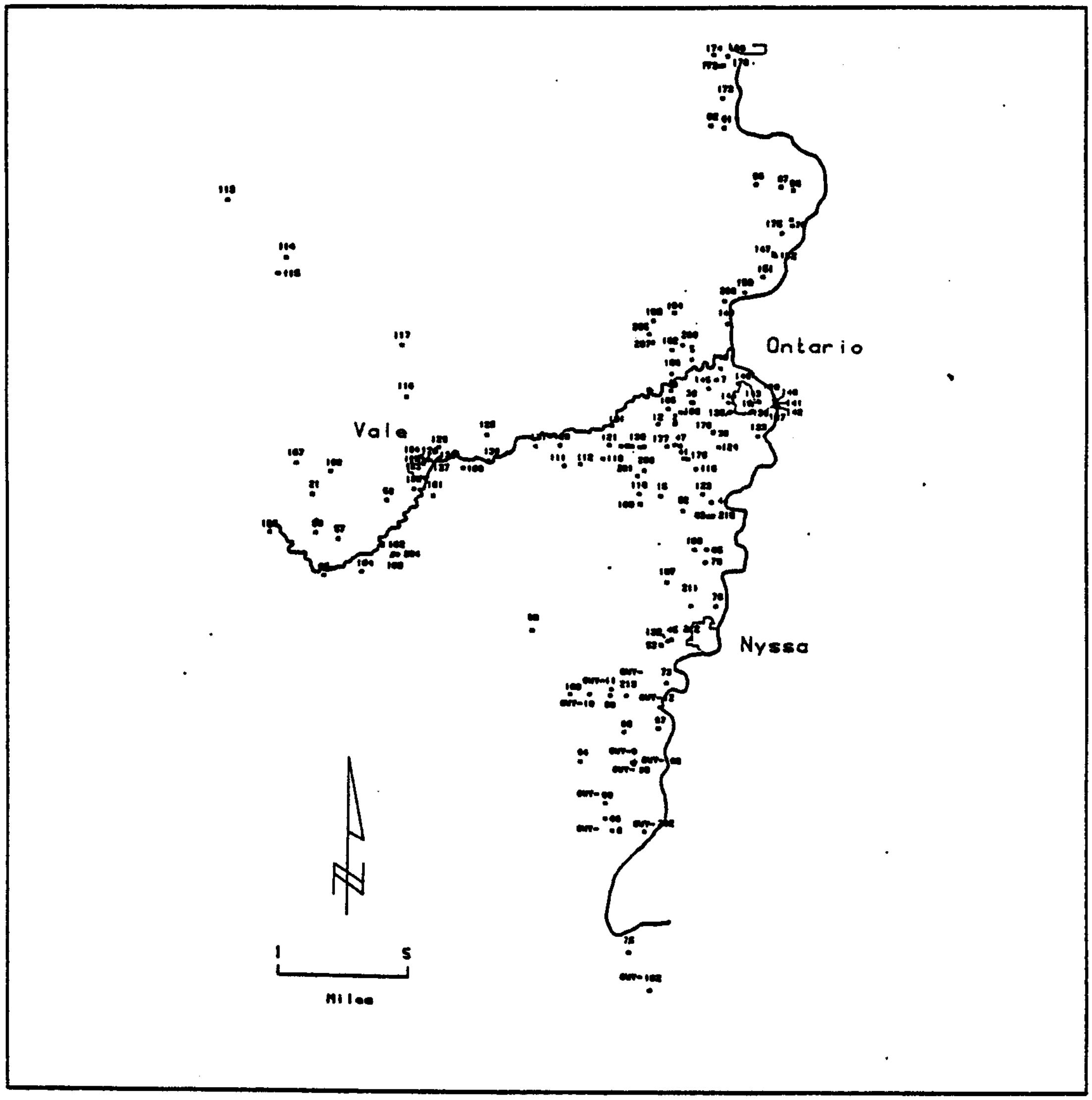

FIGURE 3

Sample Site Locations

TABLE 1

Compounds Investigated

A. COMPOUNDS INVESTIGATED ON A BI-MONTHLY BASIS:

Organics:
- COD
- TOC

Nutrients:
- TKN
- NH_3-N
- NO_2+NO_2-N
- Total Phosphorus

Volatiles:
- EDB
- Dichloropropene

Physical:
- Alkalinity
- pH
- Conductivity
- Turbidity

Total Ions & Metals:

Ca	Cl	Mg	SiO_2
Mn	SO_4	Pb	
Na	As	Se	
K	Fe	Cr	

B. PESTICIDES INVESTIGATED:

Dichloropropene	Metribuzin	Thiabendazole	Diquat	Disulfotan
Chlorpropham	Ethion	Terbufos	Ethalfluralin	Propham
Alachlor	Carbofuran	Oxyfluorfen	Terbacil	
DCPA	Parathion	Bromoxynil	Fonofos	
Cycloate	Ethoprop	Carbaryl	Maneb	
EPTC	Chlorothalonil	Captan	Endothall	
Dinoseb	MCPA	Desmedipham	Endosulfan	
2,4-D	Pronamide	Triadimefon	Acephate	
Bensulide	Fensulfothion	Naled	Demeton	
Mancozeb	Azinphos Methyl	Trichlorfon	Thiophanate M	
Phorate	Vernolate	Pendimethalin	Dicamba	
Trifluraline	M-Parathion	2,4-DB	Metalxyl	
Metolachlor	Ethofumesate	Phenmedipham	Benomyl	
Aldicarb	Malathion	Oxydemeton M	Bentazon	
Propargite	Atrazine	Methamidophos	Glyphosate	

this project. The analytical screening methods were developed by the U.S. EPA for the National Pesticide Program. The analyses of 61 agricultural chemical compounds were selected on the basis of quantity used, persistence, toxicity, and leaching potential. The 61 compounds measured are listed in Section B of Table 1. Besides widespread Dacthal di-acid detection, the only other pesticide detected was 1,2-dichloropropane, which was found in two wells.

6.4.3 Sampling Program Results

In April of 1990, enough information existed to determine approximate seasonal fluctuations, ambient water quality conditions, and the general areas within the valley most impacted by the nitrate and Dacthal di-acid contamination. Beginning in June of 1990, the program was reduced in scope to monitoring only for the contaminants of concern and the effects of specific experimental agricultural management practices on ambient water quality conditions.

Overall results from the 119 wells sampled since August of 1988 can be found in Appendix B. 32 percent (38) of the wells were found to have nitrate/nitrite-nitrogen levels above 10 mg/l. Of the wells exceeding the standard, 10 percent (12 of 119) were found to be above 20 mg/l. The highest concentration recorded was 52 mg/l. Dacthal di-acid was found in 63 of the 111 (58%) wells sampled for pesticides. Concentrations ranged from less than 0.1 ppb (threshold of detection) to greater than 300 ppb. None of the concentrations found were within 25 percent of the EPA Health Advisory level. The highest concentrations for both nitrate/nitrite-nitrogen and Dacthal di-acid were found in the Cairo Junction area.

A noticeable decline in the proportion of contaminated wells was detected between 1986 and 1990, and is considered to result in part, from having a larger sampling area. The sampling was changed to be more representative. The number of wells sampled consistently between 1986 and 1990 is somewhat limited, so care should be exercised in attempting to draw any conclusions based on data from the full range of wells sampled.

6.4.4 Distribution of Contaminants

After a thorough review of the available data, several observations can be made. The greatest percentage of sites exceeding the nitrate/nitrite-nitrogen drinking water standard are generally located immediately southwest of the city of Ontario (Figure 4). Here 23 of 51 wells (45%) exceed the federal drinking water standard. Groundwater sampling in the Oregon Slope/Annex area revealed 6 of 15 (40%) of the wells sampled exceeded the federal drinking water standard. Analysis of samples collected from the Nyssa/Adrian area showed 3 of 19 (16%) sites in the area exceed the federal drinking water standard. The Vale area had the lowest exceedence percentage with 2 of 28 (7%) of the sites tested exceeding the federal drinking water standard.

Dacthal di-acid detection patterns were very similar to nitrate/nitrite exceedence patterns (Figure 5). The di-acid was detected in 32 of 45 (71%) of the wells sampled in the Cairo Junction area, with an average concentration of 72 ppb. In the Oregon Slope/Annex area 10 of 15 (67%) of the wells sampled had detectable amounts of Dacthal di-acid at an average concentration of 30 ppb. Eleven of 18 or (61%) of the wells sampled in the Nyssa/Adrian area contained Dacthal di-acid at an average concentration of 10 ppb. And in the Vale area 4 of 27 (15%) of the wells sampled contained detectable amounts of the di-acid at an average concentration of 0.2 ppb.

Analytical results of 28 surface water samples collected from 8 sites indicate that irrigation tail water exiting cultivated fields transports nitrate/nitrite-nitrogen and Dacthal di-acid from the fields and into the irrigation and drainage water systems. Dacthal di-acid and nitrate/nitrite-nitrogen data from these surface water samples are presented at the end of Appendix B.

The difference in the contaminant concentrations identified in the wells sampled in the Nyssa, Vale, and Ontario areas may be contributed to by both the geological and geographical environments. The major environmental factors influencing the extent of contamination are depth to groundwater, amount of nutrients and pesticides applied to the surface, amount and source of irrigation water applied, use of the

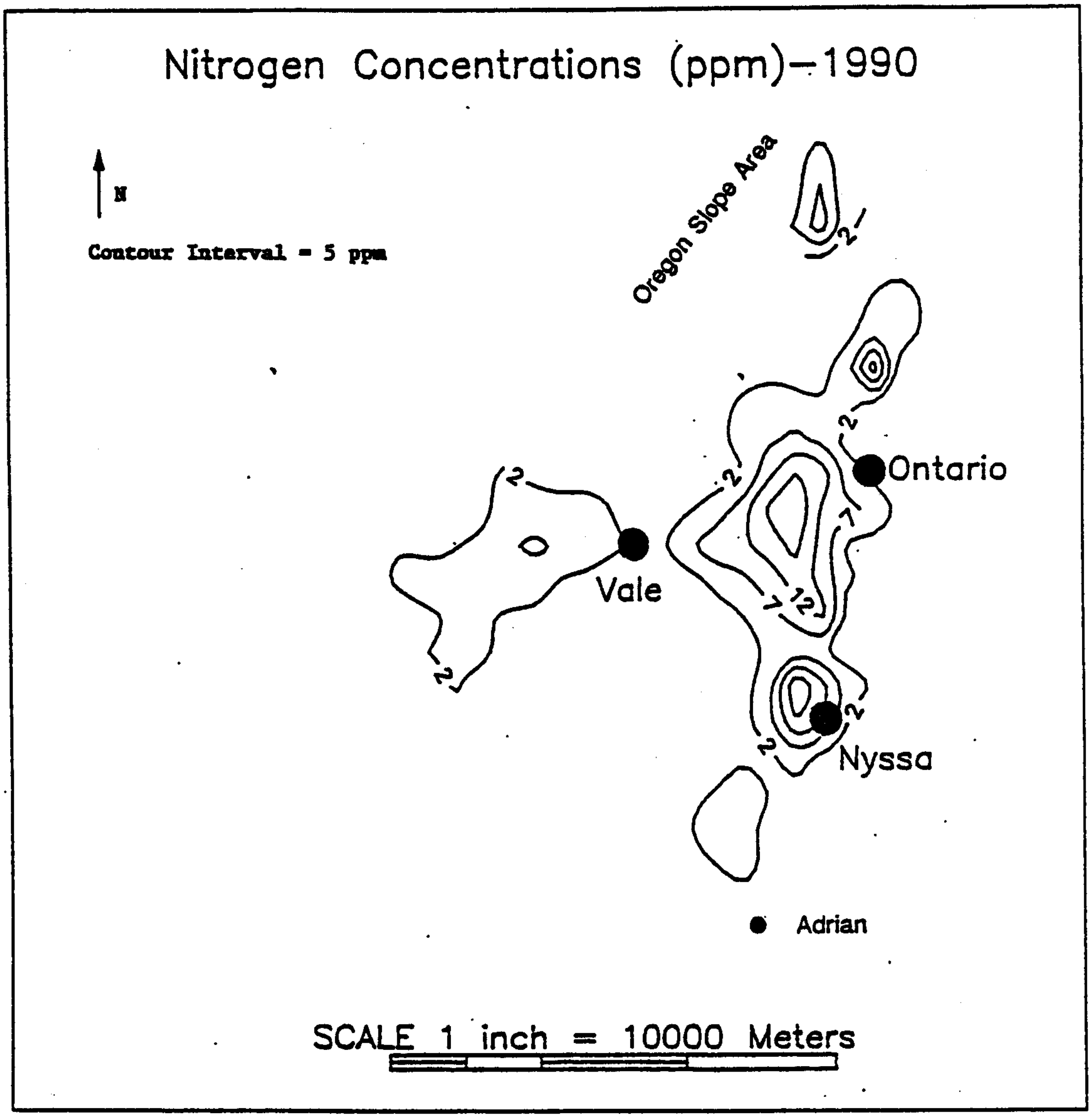

FIGURE 4

Nitrate/Nitrite-Nitrogen Concentration Contours

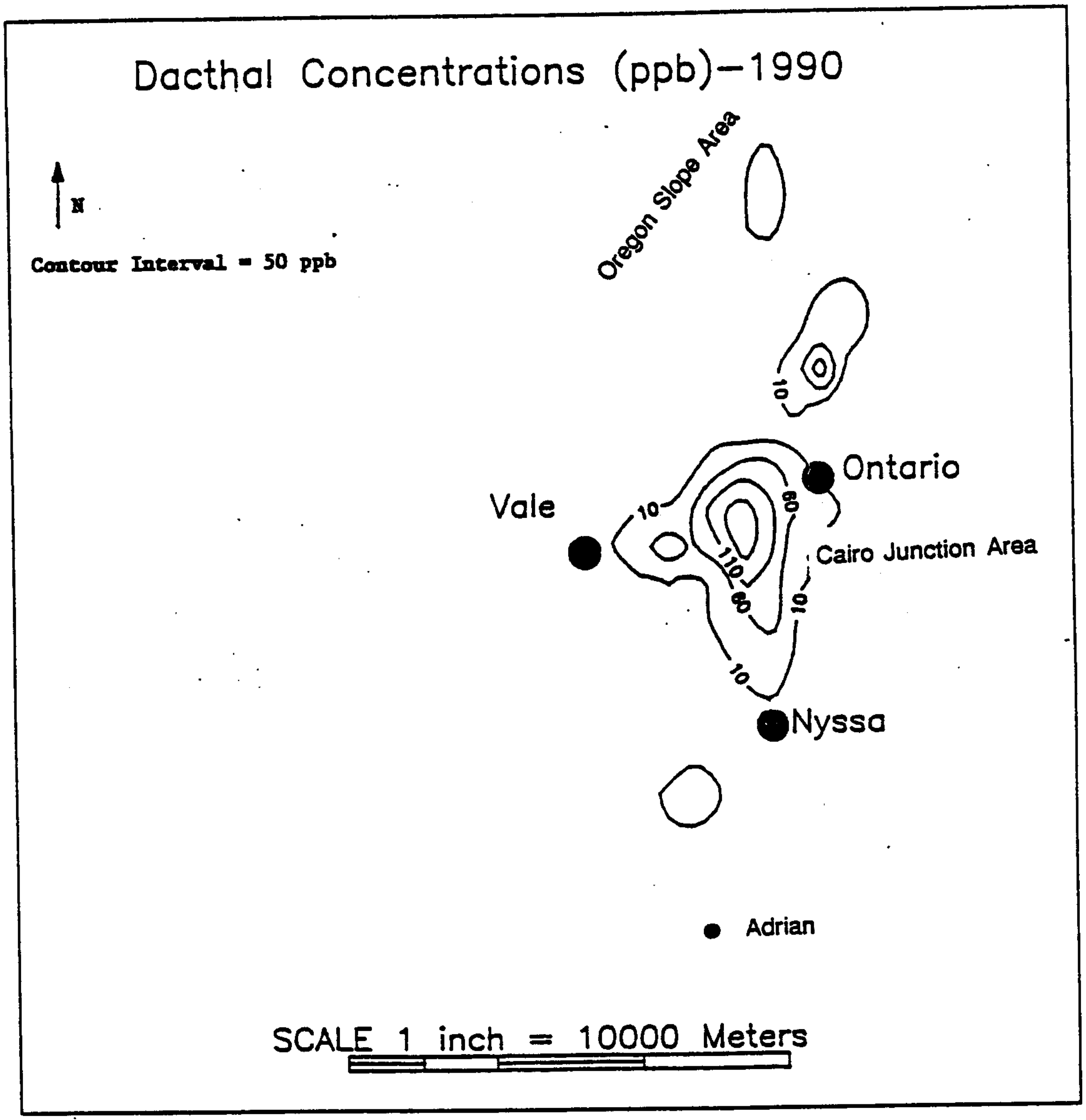

FIGURE 5

Dacthal Concentration Contours

land, and the general groundwater flow direction. Other factors which may influence nitrate/nitrite-nitrogen leaching include subsoil characteristics and the amount of contaminant accumulated in the soil profile, agricultural management practices employed, and seasonal variables such as annual precipitation and snow melt.

A few potential correlations exist between high and low impact areas and should be discussed. The high impact areas of Cairo Junction, Oregon Slope/Annex, and Nyssa/Adrian are similar in that they are generally underlain by the same soil unit, the Owyhee/Greenleaf silt loams (Figure 6). The lesser impacted areas of Vale, Vines Hill, Willow Creek, and White Settlement are underlain by Powder and Umapine silt loams.

Information on soil unit similarities and differences, such as permeability and organic content, and theories of impact mechanisms, such as fluctuating water tables, do not completely characterize contaminant concentration influences because of other factors present. Such factors include prevailing crop production practices relative to a given soil type. For example, the Owyhee/Greenleaf soil unit appears to overlie the most impacted groundwater areas. This does not mean that impacts can only be expected in this soil unit. Rather, this soil unit is preferred for row crop production, which alone may be the prevailing influence.

Without substantially more information about subsurface soil, vadose zone characteristics and crop production differences or similarities relative to the soil units, it is not possible to make a reasonable correlation between physical characteristics and contamination concentrations. Section 11.10 addresses this lack of information.

6.5 Trend Analysis

Groundwater quality data collected from 1983 to 1990 were examined for trends. This evaluation included correlation between Dacthal di-acid and nitrate/nitrite-nitrogen, analysis of seasonal trends and an analysis of long-term trends in nitrate/nitrite-nitrogen and Dacthal di-acid contamination. Several figures were developed to support the

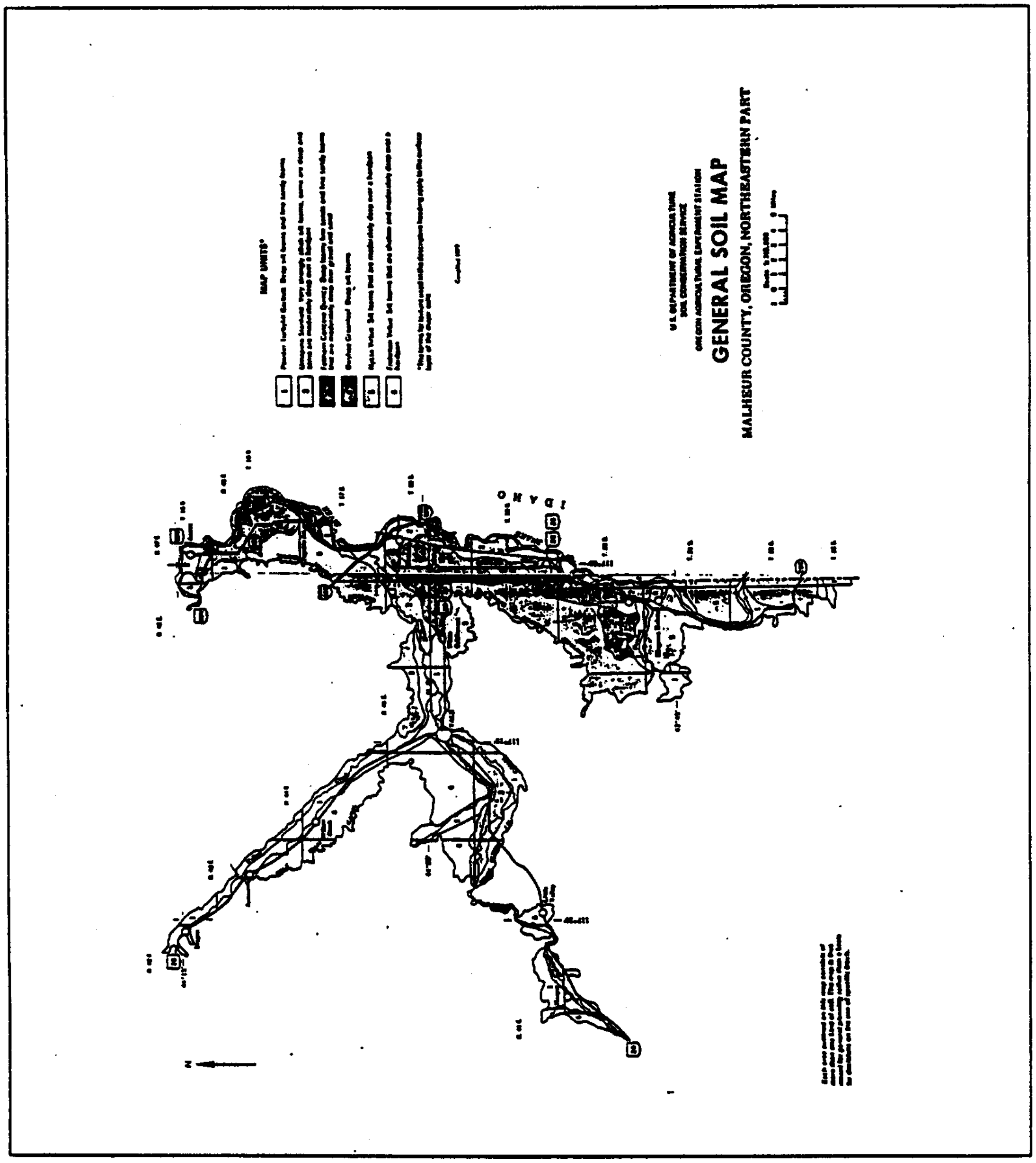

FIGURE 6
Project Area Soil Units

evaluation — these figures are included in Appendix F, Trends in nitrate/nitrite-nitrogen and Dacthal di-acid, and in Appendix G, Background Information on Long-Term Contamination Trends. Information presented below summarizes relevant information about groundwater quality trends in the project area. Appendices F and G should also be reviewed for more complete information.

6.5.1 Correlation Between Dacthal Di-Acid and Nitrate/Nitrite-Nitrogen

A simple linear regression correlation coefficient between the Dacthal di-acid and nitrate/nitrite-nitrogen has been determined to be 0.57 (Appendix F, Figure 1). The graph plots Dacthal di-acid concentrations versus nitrate/nitrite-nitrogen concentrations of samples analyzed during this project. The graph shows that for a population of 447 sample sets there is a 99.9 percent probability that a linear relation exists between Dacthal di-acid and nitrate/nitrite-nitrogen contamination.

6.5.2 Seasonal Trends

To examine seasonal trends of Dacthal di-acid and nitrate/nitrite-nitrogen, all data accumulated between 1983 and 1990 were averaged by quarter, and statistical significance evaluated using a student's t-Test. There is a statistically significant increase in Dacthal di-acid concentration during the third (July through September) quarter of the year at the 95 percent confidence level (Appendix F, Figure 2). Nitrate/nitrite-nitrogen concentration is significantly higher in both the second (April through June) quarter and the third (July through September) quarter at the 95 percent confidence level (Appendix F, Figure 3).

When confining the examination to data accumulated at only 15 wells that were consistently sampled from 1983 through 1990, Dacthal di-acid concentration is significantly higher in both the second and third quarter of the year (Appendix F, Figure 4). However, no statistically significant quarterly differences in nitrate/nitrite-nitrogen concentration can be observed using 15 consistently sampled wells (Appendix F, Figure 5).

At this time the size of the data base may be too small to permit reasonable evaluation of these trends. However, the higher concentrations of Dacthal di-acid observed during the third quarter seem reasonable in view of deep percolation of water applied to agricultural cropland during the irrigation season. The Dacthal di-acid may dissipate in the aquifer during the fall, winter, and spring.

6.5.3 Long-Term Trends

Long-term trends in Dacthal di-acid concentration were examined using simple linear regression analysis. When data from 12 wells consistently sampled between June 1983 and August 1990 were examined, a statistically insignificant downward trend in Dacthal di-acid is observed (Appendix F, Figure 6).

Long-term trends in nitrate/nitrite-nitrogen concentration were also examined through a linear regression analysis. Data from 15 wells sampled between 1983 and 1990 were evaluated for each well individually. Data from 9 wells showed upward trends, four wells showed a downward trend and there was no evident trend in 2 wells. This data is presented in Appendix F. Further analysis of trends in nitrate/nitrite-nitrogen are presented in Appendix G. When data from the above 15 wells are averaged quarterly, there is an upward trend in nitrate/nitrite-nitrogen concentration (see Appendix G). Conversely, when averaged data from the 38 wells are examined, the long-term trends are downward. The trend analyses vary based on inconsistency in sampling frequency, locations of wells used, etc. Following thorough analysis of the available data (see Appendices F and G), the Department and the Technical Subcommittee have concluded that the database is currently insufficient for statistical analysis. Based on the available data it appears that a long-term statistically reliable trend in nitrate/nitrite-nitrogen concentrations cannot be determined at this time. Further sampling and analysis will be needed to determine long-term trends in nitrate/nitrite-nitrogen concentrations in the project area.

7.0 WATER QUALITY IMPACTS

There is little information available regarding impacts resulting from the groundwater contamination other than drinking water impacts. The contamination does not seem to be impairing use of groundwater for irrigation. Nutrient levels in the lower Malheur River are increased in the winter when most of the natural flow is restricted in reservoirs and the groundwater discharge to the river accounts for a greater percentage of the flow. Dacthal di-acid has been detected in the Malheur River in both winter and summer sampling, with the highest concentration (35 ppb) detected in August.

7.1 Drinking Water Impacts

There are five public drinking water wells within the project area that have been evaluated by the State Health Division due to elevated levels of nitrate/nitrite-nitrogen. The wells are operated by Golf Mobile City, Shadow Butte Golf Course, Malheur County Child Development Center, Annex School, and Pioneer School. Three of these, Golf Mobile City, Shadow Butte Golf Course, and the Malheur County Child Development Center, have been required to minimize health risks associated with consuming the water by providing bottled water to the public.

Due to the nitrate/nitrite-nitrogen concentrations identified in the Pioneer School water well, the school has been required to construct a second well. The second well was completed much deeper than the original well. Nitrate concentrations in the new well are quite low. However, Dacthal di-acid is present in the new well at concentrations of 3 to 38 ppb.

The public water supply for Annex school has been identified by the State Health Division as fluctuating in and out of compliance. Under the current federal safe drinking water act requirements, the school has posted notice of the elevated nitrate/nitrite-nitrogen levels. The notice is to inform risk group members of the potential health risks associated with consuming the water. Notification of the health risk is required until a permanent solution is found.

A large number of private domestic and irrigation water wells have been affected by the contamination of the shallow groundwater aquifer. Unless the well water is consumed by a person identified as being in the high risk group (infants and pregnant women), the majority of the contaminated water wells are not posing a known threat to human health.

Although water treatment devices and bottled water were popular prior to the identification of the nitrate/nitrite-nitrogen and Dacthal di-acid contamination, increasing public concern of drinking water quality has lead many residences to install water treatment devices or use various types of bottled water. Reverse osmosis treatment is the only device proven by this assessment to remove both the nitrate/nitrite-nitrogen and Dacthal di-acid contaminants found in the area's groundwater. Since 1986, over 80 units have been installed in the area (Personal communication. Charles Wonka, 1990). Current sales records from a local vender indicate approximately 4 units per month are sold in the area with sales increasing. In addition to treatment devices, over 3500 gallons of bottled water per month are consumed (personal communication Charles Wonka, 1990). Currently, bottled water sales are increasing at approximately 33 percent per year. Economic impacts have also surfaced during real estate transactions. The Federal Housing Administration's (FHA) and Veterans Association's (VA) current policy is to deny home mortgage insurance if nitrate/nitrite-nitrogen concentrations exceed the federal drinking water standard of 10 mg/l and if the problem is not corrected. In home treatment systems are not considered acceptable treatment (phone conversation with John Davis, Portland FHA office, June 1991). Since many home mortgage loans obtained in northern Malheur County are insured through the FHA or VA programs, obtaining future home mortgages for properties with water wells containing elevated levels of nitrite/nitrate-nitrogen is considered to be a potential problem for the property seller, buyer, and real estate broker (phone conversation with Zelda Bertalotto, Blackaby Real Estate, Ontario, June 1991).

7.2 Treatment Options

From the information generated by this assessment, the most effective device for treating water contaminated with nitrate/nitrite-nitrogen and Dacthal is the reverse osmosis treatment device. Results from monitoring five treatment units show an 81-99.9 percent reduction in Dacthal levels and a 76-87 percent reduction in nitrate/nitrite-nitrogen levels. A sixth unit reduced Dacthal di-acid levels by 94 percent, but reduced nitrate/nitrite-nitrogen by only 2 percent. A seventh unit reduced Dacthal by 81 percent, but nitrate concentration failed to decrease. Effectiveness of installed units will also vary depending on whether they are properly installed. As described in section 7.1 over 80 units have been installed in the impact area and new installations are currently estimated at 4 per month.

Other proven and reliable treatment methods available for the removal of nitrate/nitrite-nitrogen from drinking water include ion exchange, distillation and electrodialysis reversal (Fact Sheet-Nitrates, Department of Human Resources, Health Division, 1990). This equipment requires frequent, careful maintenance and sampling to achieve and confirm effective operation. If a treatment device is desired, one with National Sanitation Foundation certification should be selected (Department of Human Resources, Health Division, 1990).

Boiling drinking water containing elevated levels of nitrate/nitrite-nitrogen will not remove or reduce the contaminant but may actually concentrate it. Bottled water, or another source of drinking water, should be used for those individuals without effective treatment devices who may be susceptible to methemoglobinemia (Department of Human Resources, Health Division, 1988).

8.0 IDENTIFICATION OF CONTAMINANT SOURCES

Several possible sources of nitrate/nitrite-nitrogen contamination have been identified in northern Malheur County. These sources include: residential lawn care, agricultural chemicals, on-site sewage systems, confined animal feed lot operations, and food processing facilities.

Nationally, Dacthal di-acid contamination is a frequently encountered chemical contaminant of groundwater due to its widespread use of the parent product Dacthal on residential and commercial property. In the project area the primary use of Dacthal is on agricultural land. A large volume (40,000 lbs/yr) of this pre-emergent herbicide is used exclusively for agricultural production. Of the crops produced in northern Malheur County, the largest amount of Dacthal is used for onion production (Rinehold and Witt, OSU, 1989).

8.1 Nitrate/Nitrite-Nitrogen

As discussed in section 6.1, historic levels of nitrate/nitrite-nitrogen levels are considered to have been far below the levels currently being documented. The following sections describe possible sources of the elevated nitrate/nitrite-nitrogen levels found in the project area groundwater.

8.1.1 Residential Lawn Care

Turf lawns have been suggested to be potential contributors to the groundwater contamination through the use of residential fertilizer. Overwatering and overfertilization of home lawns can lead to nitrogen leaching.

8.1.2 Food Processing Facilities

Food processing facilities in Malheur County are regulated through existing waste water permits. None of these facilities are located in the immediate vicinity of project priority areas.

8.1.3 Cull Onion Disposal Pits

In the past the commonly accepted method of disposing of cull onions was to bury the culls in large earth trenches. This method was developed by local growers and shippers in cooperation with Oregon

State University (OSU) and the Oregon Department of Agriculture (ODA) to break the life cycle of the onion maggot and reduce pesticide use. Currently, OSU Extension Service is assisting local shippers in conducting research to determine the feasibility of alternative cull onion disposal methods, such as land application.

8.1.4 On-Site Septic Systems & Confined Animal Feed Operations (CAFO)

As with food processing sources, pollution from septic systems and CAFOs is regulated and monitored through permits administered by the DEQ and ODA respectively. Although on-site septic systems and confined animal feed operations are potential pollution sources, they are not considered to be major contributors to northern Malheur County's groundwater quality problems.

8.1.5 Agriculture

Generally nitrogen fertilizer is applied close to the amount required to sustain a substantial crop (Vomocil, 1988). In certain situations however, excess nitrogen fertilizer is applied to reduce the limiting yield effect resulting from underfertilization and in some cases to compensate for other deficiencies which affect crop yields. This practice creates groundwater quality problems when the applied nitrogen far exceeds the crop uptake and the excess is not fixed by the environment (Vomicil, 1988). This may allow remaining nitrogen to be available to contaminate surface water and groundwater.

When coupled with unmonitored nitrogen fertigation, (the practice of applying nitrogen fertilizer through irrigation water), furrow and rill irrigation methods allow transport, and possible accumulation, of nitrogen fertilizer as the water moves from one field to the next. The problem is accentuated when water with elevated levels of nitrogen fertilizer is used to irrigate a field which already has received nitrogen fertilizer applications. The net result is a substantial increase in the nitrogen fertilizer content of the soil profile and irrigation water leaving the field.

8.2 Primary Nitrogen Contamination Sources

At the request of the Department of Environmental Quality, members of the technical subcommittee of the groundwater management committee and members of the Oregon State University Malheur Experiment Station recently calculated effluent nitrogen concentration carryover from fertilizer application in the project area from wheat, sugar beets, onions and potatoes. A letter report was prepared entitled "Nitrogen Uptake and Removal by Selected Crops," May 1991. Based on empirical data gained through field studies in the project area, estimates were made of nitrogen applied, plant uptake, and fertilizer nitrogen carryover. For the four crops mentioned above there were roughly 3.6 million pounds of nitrogen available for leaching to groundwater during 1990. This report is included as Appendix C. As more information becomes available the estimates can be updated, refined and applied to other crops in the project area.

As listed in Table 3 of Appendix C, it is estimated that onion production practices contribute a higher nitrogen concentration effluent relative to other major crops produced in northern Malheur County.

Nitrogen is essential to all animal and plant life. Plant yields are directly related to nitrogen supply and plant product quality is often directly related to nitrogen content due to nitrogen's key role in protein. Soil may have a considerable nitrogen supply — up to 5000 lbs/acre or more. Yet most of the soil nitrogen is tied up in the soil organic matter and is not available for plant growth during a single growing season. The process of nitrogen release from the soil organic matter is usually less then 20 pounds nitrogen per year. Nitrogen is the most widely applied fertilizer element because plant requirements usually exceed available soil nitrogen supplies. Farming practices that increase soil organic matter may cause a short term loss of available soil nitrogen, because nitrogen is utilized by microorganisms to break down organic materials.

Nitrogen can be applied to the soil in many forms. All forms tend to be converted to nitrate. Ammonium contains chemical energy that microorganisms can use. These bacteria take in ammonium and give off nitrate. Conversion of ammonium to nitrate ("nitrification") can be retarded by inhibitors, a potential option for intensive agriculture. Similarly urea is converted to ammonium and then converted to nitrates. The release of urea from fertilizer particles can be retarded by sulfur coating the urea. Nitrification inhibitors and sulfur coated urea particles are alternatives that may increase nitrogen fertilizer efficiency and reduce losses.

Growers often seek to make nitrogen non-limiting to protect yield and profit goals. If nitrogen fertilizer inputs plus soil nitrogen supplies consistently are greater than plant nutrient removal, there will certainly be nitrogen losses. Nitrogen losses can be to the groundwater, to runoff, to the air, or to soil organic matter. As of today, we do not know the patterns of losses for intensely managed crops in the project area, the distribution of losses over the fields, or the times of the year that the losses occur.

The total amount of nitrogen leaching to the groundwater is primarily determined by the amount of nitrogen applied, amount already in the soil, and the amount of water percolating through the soil. Currently, there is little data on the amount of nitrogen in the unsaturated soil zone. This is important for predicting leachate concentrations over the short run. However, over long-term steady state conditions this becomes less of a factor. A drilling and testing project to acquire information on nitrate concentrations in the unsaturated zone is scheduled for completion in the summer of 1991.

For northern Malheur County, the most appropriate way to reduce the amount of nitrogen leaching to the shallow groundwater is through a more efficient irrigation management program which reduces the amount of deep percolation as well as a more efficient nutrient management program which balances the amount of nitrogen fertilizer applied to the soil and the amount of nitrogen fertilizer removed by the crop.

8.3 Dacthal Di-Acid

The Dacthal di-acid contamination has two potential transport mechanisms. These are: 1) normal application of the herbicide or 2) point source contamination. No major distribution problems have been documented which may have caused the wide spread contamination found. Estimates from vendors indicate that over 40,000 pounds of Dacthal are sold in Malheur County each year. The herbicide is currently registered for use for a variety of agricultural crops such as melons, onions and potatoes. The most common use of the herbicide in Malheur County today is for onion production. Appendix H, Nature of Dacthal, provides additional information on the chemistry of Dacthal and its importance in onion production.

9.0 CONSIDERATION OF ALL REASONABLE ALTERNATIVES FOR AMELIORATIVE ACTIONS

There is a limited choice of alternatives that will eventually reduce or eliminate the groundwater problems identified in northern Malheur County. Any solution to reduce current nitrogen in the groundwater must reduce nitrogen fertilizer and irrigation water application rates. Nitrogen fertilizer and irrigation water should be applied at the right time and in the right amounts to allow greater efficiency of nitrogen use and create less leaching.

There are two alternative approaches which may be applied in the effort to reduce contamination of northern Malheur County's groundwater - the Regulatory Approach or the Voluntary Approach. Both the regulatory approach and the voluntary approach to reducing groundwater contamination have favorable and unfavorable features. The major advantages and disadvantages of these approaches are enumerated as follows:

1. The Groundwater Protection Act mandates that actions be taken to improve groundwater such that contamination is reduced to a level below the level requiring the declaration of the groundwater management area. The regulatory approach would be a direct extension of the statutory language.

2. The regulatory approach can be very specific in its requirements and direct enforcement actions can be prescribed if the required actions are not performed or do not result in improvements.

3. Because the project area contamination is caused primarily by nonpoint sources, it would be difficult to assign responsibility to individuals for failure to reduce contamination.

4. The regulatory approach could be very expensive in that substantial compliance monitoring may be required to determine progress in reducing contamination. The cost would have to be borne either by farmers in the project area or by regulatory agencies.

5. The voluntary approach would allow for the development of customized best management practices on a farm by farm basis rather than less effective blanket regulatory requirements.

6. The local technical and citizens advisory committees believe that the voluntary approach is more practical, implementable and would result in more positive cooperation as opposed to the mandatory approach.

7. Whenever possible, the Department and the Environmental Quality Commission have encouraged and fostered voluntary cooperation to solve pollution problems. This policy is expressed in ORS 468.035.

8. Based on a Justice Department review of statutory authority there may be sufficient authority to require implementation of a regulatory program to control nonpoint sources of waste but it is not clear. Even if the statutes do cover nonpoint waste sources, development of rules would be necessary to require implementation of the action plan.

Based on a review of the two approaches which can be used to reduce contamination of groundwater in the project area the voluntary approach is the most workable, flexible and acceptable for control of nonpoint sources of waste.

10.0 IMPLEMENTATION OF AMELIORATIVE ACTIONS

This section describes the essential implementing actions necessary to reduce groundwater contamination in northern Malheur County. This includes the voluntary approach, regulatory approach, development of individual farm plans, customized best management practices, implementation schedule, schedule of estimated reductions in contaminant concentrations and financing. The duties, roles and responsibilities of the participating agencies and organizations are presented in the following section.

10.1 Voluntary Approach

Based on the above review of a voluntary versus a regulatory approach to reduce groundwater contamination, the voluntary approach is preferred and is selected to initiate implementation of this action plan. Using this approach, the agricultural best management practices ("BMPs") would be voluntarily implemented to insure groundwater quality amelioration. This approach will allow each farm to have the opportunity to customize a sequence or system of available best management practices (BMPs) complimentary to their individual farm operation needs.

Best management practices shall include but not be limited to the management practices established by the SCS Technical Field Office, OSU Extension Service Recommended Fertilizer Application Guides, and any practices adopted by the Malheur County Groundwater Management Committee (Appendix D).

The best methods to efficiently use nitrogen fertilizer and irrigation water to simultaneously protect groundwater and growers economic interest are not known. Further research is necessary to develop locally adapted and optimized BMP's. The OSU Agricultural Experiment Station has presented recommendations for further research and experimentation of potential BMP's for Malheur County in 1989, 1990, and 1991. The 1990 recommendations from Benno Warkentin, et al., are contained in a report entitled "Northern Malheur County Groundwater Management Area Crop Production Practices and Groundwater Quality," prepared by Oregon State University for DEQ. Copies of this report are available by request at Department of Environmental Quality offices and at the Malheur County Soil and Water Conservation District.

As new BMPs develop, or as existing BMPs are field tested, they will be reviewed and evaluated by the agencies involved with this project for their applicability to this program. If it is determined that the particular "BMP" being evaluated does not meet the needs of the project area's groundwater management plan it will be excluded. Best management practices developed and determined to be adequate for the county's groundwater management program will be promoted. Such periodic assessments should be performed annually, or as information becomes available.

10.2 Regulatory Approach

If the voluntary approach does not result in satisfactory progress in reducing nitrate contamination, then a regulatory approach with mandatory actions will be considered. If there are not sufficient indications of progress towards the goals of this plan by the end of five years, then the action plan will be evaluated and revised at that time, perhaps to include mandatory actions or other appropriate measures. The revision and recommendations will be formulated by the groundwater management committee, the technical subcommittee, and the DEQ.

10.3 Individual Farm Management Plans

As discussed in the preceding section, an individual farm plan, formulated using "BMPs" to create a nutrient management program which is customized for each individual farm's operational needs, is considered to be the best available solution to insure adoption and implementation of protective water quality management practices.

To help facilitate this, the SCS has developed a Field Office Technical Guide for nutrient, pest, and irrigation water management practices, which, when applied, will reduce the amount of agricultural chemicals contaminating the groundwater. To encourage adoption and implementation at the local level, the ASCS has and will continue to provide, where possible, cost share programs to help offset costs incurred by producers when implementing these practices.

Using this approach, individual farm management plans should be formulated to meet the individual farmer's desired operation and should incorporate recommended nutrient, pest and irrigation management practices. The management plans should be approved by the local Soil and Water Conservation District. Technical assistance to develop and implement individual farm plans will be provided by the SWCD, the USDA Soil Conservation Service, the OSU's Cooperative Extension Service and knowledgeable representatives from the fertilizer and chemical industry.

To insure adequate adaptation of a farm plan to each farm's operation, any particular "BMP" or "BMP" sequence which the grower believes is not appropriate and should not be included in the plan, may be revised to meet the farm's needs. The revisions must be shown to be technically sound, meet SCS guidelines (as reflected in the field guide) and must be approved by the Soil and Water Conservation District.

To encourage the acceptance and implementation of the farm plans, it will be necessary for the SWCD to perform periodic visits to individual farms to review and discuss the project. These visits will allow "feedback" as to whether expectations are being met and whether recommended "BMPs" incorporated in the plan are providing the groundwater protection required. If it is determined that a particular farm plan is inadequate, revisions can be made to correct the plan.

10.4 Customized "BMPs" For Northern Malheur County

Since the discovery of northern Malheur County's groundwater quality problems, the agricultural industry and local community have explored, developed, and promoted farming methods designed to protect groundwater quality from the contamination sources identified. Appendix D contains specific BMPs that have been established by the Northern Malheur County Groundwater Management Committee. This list of recommended BMPs will be updated by the groundwater management committee as new BMPs are developed.

10.5 Implementation Schedule

The schedule and process for public review and adoption of this groundwater management action plan are established in ORS 536.161 and 536.165. The entire process from public comment through rule adoption should take one to two years. ORS 536.161 states, after completion and distribution of the draft action plan, a 60-day period of public comment shall be provided.

Within 60 days after the close of the public comment period DEQ shall complete the final action plan. Within 30 days after completion of the final action plan, SWMG shall accept or require revisions to the plan. Revisions must be completed within 30 days of the request. Time extensions can be granted by the Strategic Water Management Group, if necessary.

Within 120 days after adoption of the plan by SWMG, each agency responsible for implementing all or part of the plan shall adopt rules necessary to carry out the agency's duties.

Participating state and federal agencies' responsibilities, as described above, shall be adopted upon approval of this plan by the Strategic Water Management Group (SWMG).

It is important to note that to be effective, the action plan must be a dynamic plan. As new information is developed that can contribute to the solution it will be incorporated into the plan. This is particularly the case with the development of new BMPs.

Priority areas have been established in relation to the contamination concentrations identified in the area and the location of the area relative to groundwater and surface water flow. These areas may be re-prioritized upon obtaining additional information on the contaminant concentrations found in the area's deep soil profile. This work is scheduled for completion in the summer of 1991. A preliminary designation of priority areas is illustrated in Figure 7.

For the 1992 agricultural season, the farm plans will incorporate the existing "BMPs" considered to be groundwater protective. "BMPs" currently scheduled for development will be available for the 1993 agricultural season and these "BMPs" will be included in the farm plans for the 1993 agricultural season. After the 1993 agricultural season, newly developed "BMPs" and existing "BMPs" will be evaluated periodically as information comes available to determine the applicability of the "BMP" for this program.

Adoption of new "BMPs" specifically designed to aid in the protection of the regional groundwater quality will take place upon verification of the methods as "BMPs". To verify a "BMP", an evaluation of the "BMP" will be performed by each of the state and federal agencies participating in this strategy.

10.6 Schedule of Estimated Reductions in Contaminant Concentrations

As stated in the Groundwater Act of 1989, the ultimate goal of this plan is to reduce the levels of nitrite/nitrate-nitrogen found in the shallow groundwater supply to below the level which causes a Groundwater Management Area declaration, or 70 percent of the maximum measurable level (MML) of 10 milligrams per liter (mg/l), which is 7.0 mg/l.

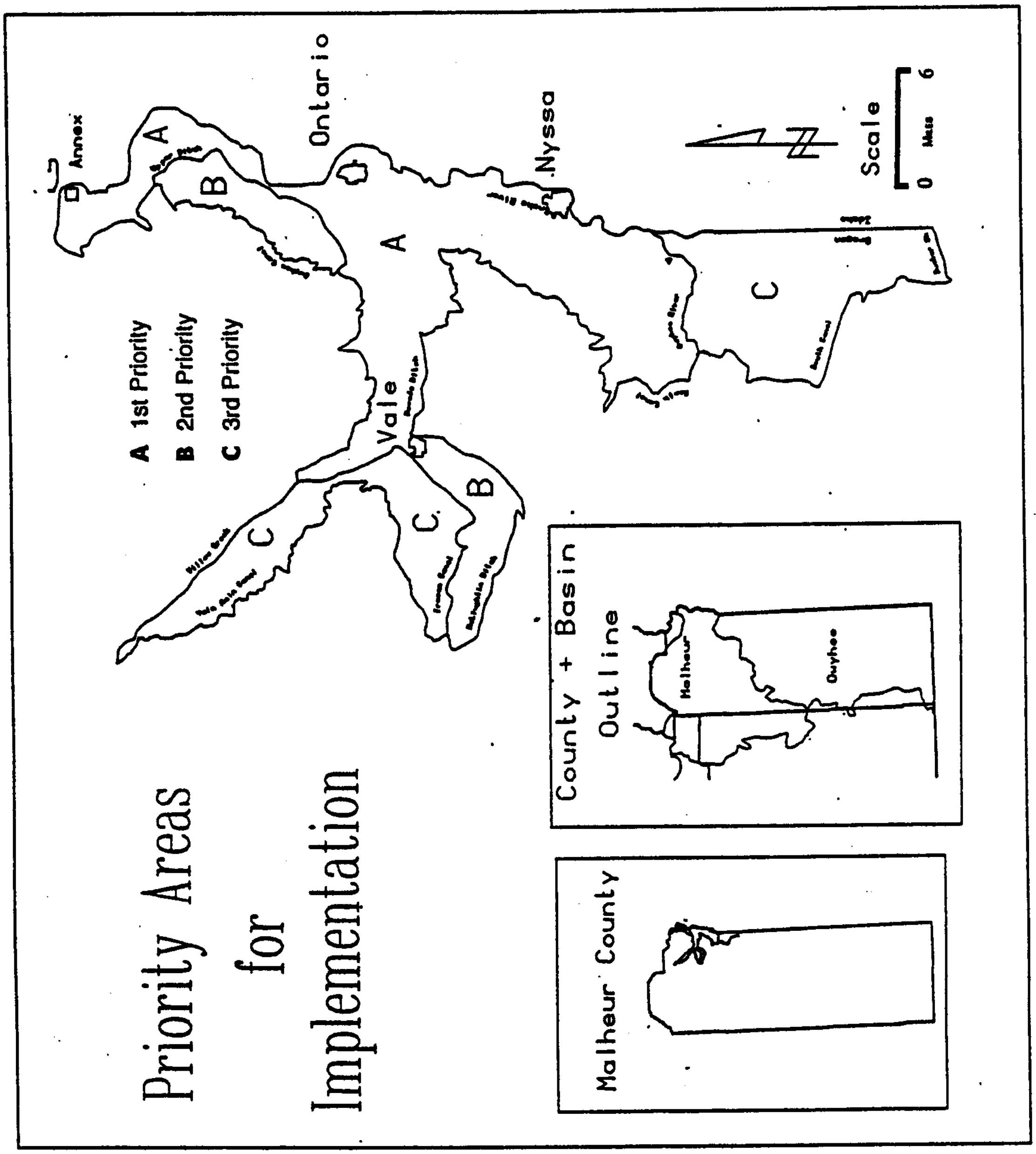

FIGURE 7
Priority Areas for Implementation

In order to evaluate the effectiveness of the management plan, an analysis will be conducted of data collected from the indicator wells 5 years after adoption of the plan. If the analysis indicates that the 0.75 percentile level of the nitrate/nitrite-nitrogen monitoring data for the entire management area is below 7 mg/l or a trend analysis indicates at the 80 percent confidence level that nitrate/nitrite-nitrogen will reach the 7 mg/l level by July 1, 2000, the management plan will be considered to be successfully achieving its goals.

In Section 5.0 it was suggested that it may take 10 or more years for contaminants to move from the surface through the vadose zone to the aquifer. It was also suggested that it may take between 5 to 11 years for groundwater to move from the Cairo junction area to the Malheur or Snake Rivers. If the estimates in contaminant travel time are reasonably correct, then it may be some time before an implementation program will result in significant reduction in nitrate/nitrite-nitrogen in the groundwater. If there is not significant reduction after five years, it may not be a result of inadequate implementation of BMPS but rather a result of an inadequate length of time to measure progress, i.e., reduction in nitrate/nitrite-nitrogen. The management plan will also be considered successful if a statistically significant downward trend can be demonstrated (at the 80 percent confidence level) or other indicators show progress toward this goal.

Other indicators of progress may include but are not limited to the following:

1. Number of producers adopting farm plans.

2. An increase in utilization of soil testing to improve fertilization practices.

3. An increase in efficiency of nitrogen fertilizer application: timing, placement, form, rate.

4. An increase in irrigation efficiency, reducing deep percolation.

5. A vadose zone drilling project — demonstrating decrease in concentrations of nitrate.

6. Numbers of water quality practices being applied.

7. Ontario hydrologic unit area reports and evaluations of progress and effectiveness.

Nitrate trends over time will be determined by using linear regression of nitrate from the indicator wells from July 1, 1991, to the present at any future date. All data will be used as scatter plot data, with only dates included in the relationship for which complete data sets are available for the regression. That is to say there will be no missing data in the nitrate data used. The designated indicator wells will not be changed except through a formal amendment to the action plan.

If there are not sufficient indications of progress towards the goals of this plan by the end of five years, then the action plan will be evaluated and revised at that time, perhaps to include mandatory actions or other appropriate measures. The revision and recommendations will be formulated by the groundwater management committee, the technical subcommittee, and the DEQ.

In addition to the formal evaluation conducted after five years, informal reviews will be conducted annually. The informal reviews will provide some indication of progress in contaminant reduction. Furthermore the information gained through this annual review can be used in development of new practices and in modifying existing practices.

The indicator wells from which samples are collected are displayed in Figure 8, and listed in the last section of Appendix B. Samples will be collected from these wells on a bi-monthly basis and tested for nitrates and for Dacthal di-acid. Additional analyses will be performed semi-annually for all constituents listed in Tables 1 and 2. Samples will be taken for a minimum of five years after adoption of the action plan.

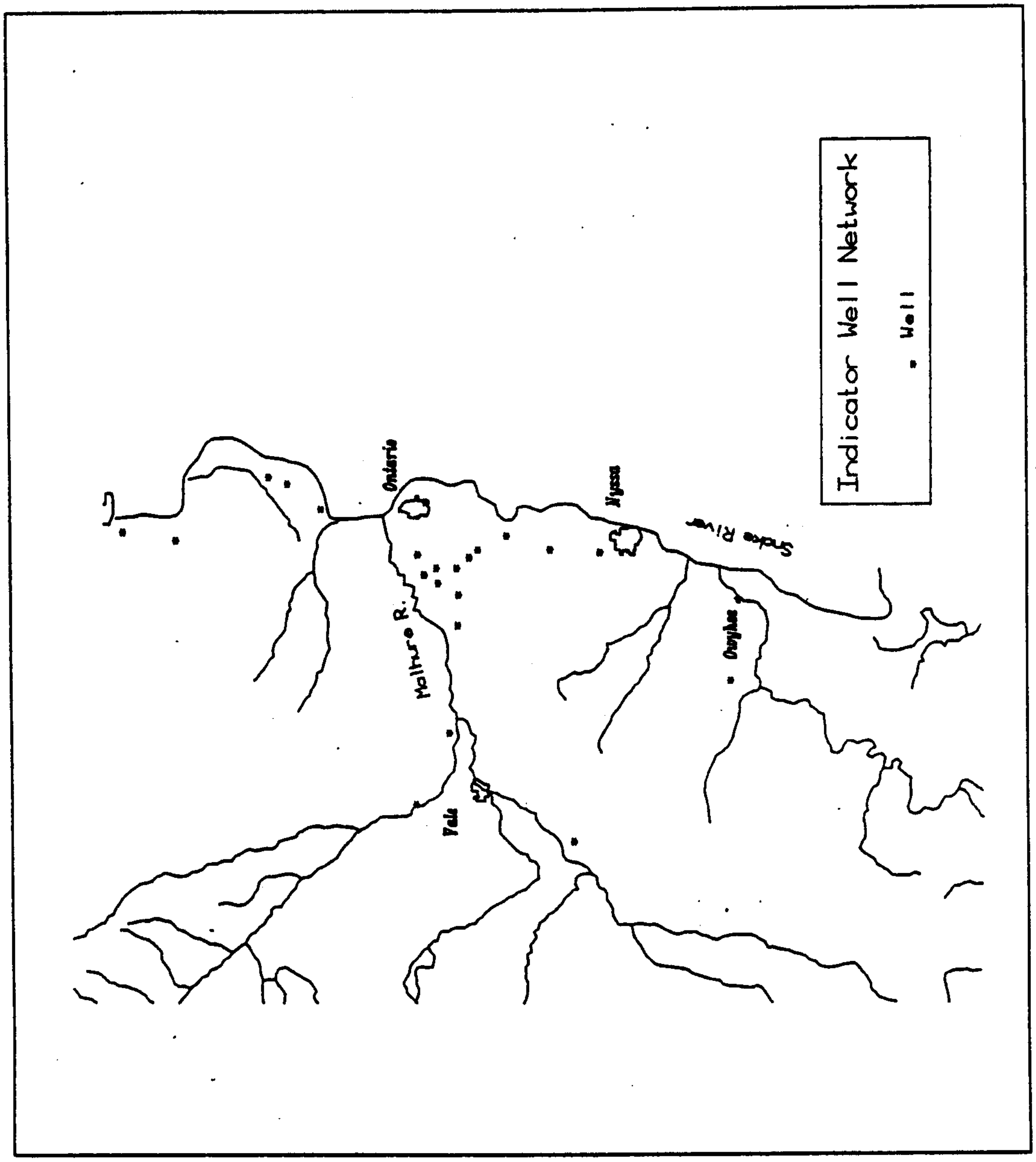

FIGURE 8
Location of Indicator Wells

10.7 Financing

Implementation of the action plan will require a substantial number of activities by participating agencies, committees and interested parties. Many of these activities are described for each participating agency in the following section 11 covering tasks, duties, roles and responsibilities. Activities which will require a financial commitment include educational programs, demonstration projects, research and development, preparation of the individual farm plans and associated BMPs, on-farm implementation of farm plans, administration of cost-share and other federal financial assistance programs, technical assistance, coordination of agencies, programs and the general public, annual and five year evaluations of nitrate/nitrite-nitrogen reduction, ongoing sampling and analysis, and complaint investigations and resolution. These activities will require resources, funds to pay for the resources and sources of funds.

Currently the participating agencies are financing many activities on an ongoing basis. Examples include completion of general planning activities, committee support, initial development of farm plans, research and demonstration projects, monitoring, and extensive coordination. Major fund sources include the U.S. Department of Agriculture, through its hydrologic unit area designation, EPA 319 grant monies, direct expenditures and pass-through monies from DEQ, fertilizer fee and other monies from the Department of Agriculture and funds shifted within existing budgets to water quality related activities, particularly at the local level from the Malheur Soil and Water Conservation District, and OSU Extension Service and Experiment Station. Many of these funding commitments are short term or temporary, however; consequently they are not sufficient for a sustained effort. Continued activities in the area will be contingent on long-term availability of resources.

During the past two years participating state and federal agencies have spent substantial amounts of monies to assist in developing the action plan. These expenditures were funded in part by general fund appropriations from the 1989 Oregon State Legislature and from several sources of agency funds. Now that the implementation phases has started, a continued source of funds from these agencies is essential.

The DEQ has prepared generalized expenditure estimates in support of action plan implementation by participating state and federal agencies for fiscal year 1992 (see Table 2). Since the 1991 legislature has not approved agency budgets, these estimates should be considered very preliminary. Part A of Table 2 presents expenditure estimates before any transfers of funds to other agencies. An example of a fund transfer would be a grant from a state agency to another agency performing project related work in the project area. Part B of the table presents expenditure estimates after agency fund transfers. Part B of the table gives a good indication of agency direct effort to develop farm plans and related water quality best management practices and to implement the action plan.

11.0 TASKS, DUTIES, ROLES, AND RESPONSIBILITIES

The following is a brief description of the roles and responsibilities to be undertaken by the participating agencies and organizations.

11.1 Malheur County Groundwater Management Committee

The Malheur County Groundwater Management Committee and Subcommittee have been appointed to assist the State of Oregon (SWMG) in the formation and implementation of a groundwater management plan. After the adoption of the plan by SWMG, the technical subcommittee will continue to periodically meet to review the implementation of the management plan.

The technical subcommittee will periodically review and report plan implementation progress to the management committee. The management committee will review these reports and provide recommendations for plan revisions to the technical subcommittee. The technical subcommittee will further refine the proposed revisions and promote the objectives of the plan.

TABLE 2

Agency Expenditure Estimates in Project Area

Fiscal Year 1992

A. EXPENDITURE ESTIMATES BEFORE AGENCY FUND TRANSFERS:	
Department of Agriculture	$235,300
Department of Environmental Quality	$ 80,000
Malheur County Court	$ 10,000
Oregon State University:	
• Corvallis	$ 15,000
• Malheur Experiment Station	$ 25,000
• Malheur Extension Service	$ 48,000
U.S.D.A./Hydrologic Unit Area	$172,000
Environmental Protection Agency (319 Grants)	$134,500
TOTAL	$719,800
B. EXPENDITURE ESTIMATES AFTER AGENCY TRANSFERS:	
Department of Agriculture	$172,000
Department of Environmental Quality	$ 80,000
Malheur SWCD	$ 94,800
Oregon State University:	
• Corvallis	$ 15,000
• Malheur Experiment Station	$153,000
• Malheur Extension Service	$113,000
U.S.D.A./Hydrologic Unit Area	$ 92,000
TOTAL	$719,800

SOURCE:

Estimates Prepared by Department of Environmental Quality Staff, Groundwater Section, June 1991.

In addition to the technical subcommittee, a research management subcommittee should be formed to provide oversight management and project approval of agricultural research activities occurring in northern Malheur County. The research subcommittee will evaluate and review research projects to insure appropriate research projects are funded and duplication of efforts does not occur. In addition the research subcommittee will follow through with research and to see that new BMPs are formalized and promoted. This subcommittee shall be composed of at least three technical subcommittee members and should be chaired through the SWCD.

11.2 Oregon State University Agricultural Experiment Station

The Oregon State University Agricultural Experiment Station serves as the principal agricultural research agency in the state. For the northern Malheur County Groundwater Management Program, the Agricultural Experiment Station will seek to test technological alternatives. Research projects will seek to provide practical information for groundwater quality "BMPs" including the following:

1. The influence of nitrogen fertilizer rates, placement, timing, and form.

2. Water use efficiency to reduce nitrate leaching, minimize plant water stress, and improve soil water monitoring.

3. Efficiency of nitrogen use by the crop, nitrate movement through the soil, and nitrogen losses to irrigation water runoff from various practices.

4. Phosphate and soil loss in irrigation water runoff from various practices.

5. Effectiveness of irrigation water-applied nitrogen alternatives.

6. Crop rotation patterns and associated irrigation management which will allow recovery of nitrogen residue in the soil.

7. When feasible, perform nitrogen analysis of water samples submitted by the local community.

11.3 Oregon State University Cooperative Extension Service

The Oregon State University, Cooperative Extension Service (CES), provides educational programs for a variety of commercial, home, and youth audiences emphasizing agricultural management practices, and environmental safety. For this project, OSU Extension Service shall develop, and provide educational programs to individuals, organizations, and the public to facilitate the acceptance and implementation of the groundwater protective agricultural management practices developed for northern Malheur County.

Specifically, Malheur County Extension Service shall seek to:

1. Design and develop an educational program to provide state of the art information concerning soil fertility testing and fertilizer application.

2. Conduct a reduced fall fertilizer application demonstration project.

3. Conduct a slow release nitrogen fertilizer demonstration project.

4. Conduct a cull onion alternative disposal demonstration project.

5. Continue to conduct water quality education awareness programs.

11.4 USDA Agricultural Stabilization & Conservation Service

The US Department of Agriculture Stabilization & Conservation Service (ASCS), administers federal cost share programs which provide financial assistance to farmers for conserving soil and irrigation water and reducing farm-originated non-point source pollution to improve water quality.

For this program ASCS, in cooperation with DEQ, ODA, OSU, SWCD, and SCS, will develop policies for preferred "BMPs" and request national ASCS approval of the specified practices.
Specifically the ASCS will:

1. Develop applications for nationally funded special water quality projects for determined areas.

2. Channel annual ACP (Agricultural Conservation Program) cost-share funds to practices prioritized by the state and county ASC committees.

3. Coordinate funding requests for ACP agricultural producers for implementation of USDA Nonpoint Source Water Quality Hydrologic Unit areas designated in northern Malheur County.

4. Continue to administer the cost share programs to provide financial assistance to land operators in northern Malheur County while implementing SCS-approved practices for nutrient management, pest management, and irrigation management. If program progress can be demonstrated then potential exists to establish these programs for continued use in northern Malheur County.

11.5 USDA Soil Conservation Service

The Soil Conservation Service (SCS) activities include implementation through the local Soil and Water Conservation Districts of technical and financial assistance programs relating to soil and water resources.

After formal research and development of "BMPs", SCS, in cooperation with ASCS, DEQ, ODA, and OSU, will perform public, group, and individual demonstration projects to insure the acceptance of the established "BMPs" by the industry and community. In addition SCS shall, in cooperation with ASCS and SWCD, provide technical and financial assistance that assist land operators in the planning and implementation of nutrient, pest, and irrigation management plans designed to protect groundwater and surface water quality through the use of "best management systems" for northern Malheur County.

SCS personnel will assist in establishing a groundwater monitoring network which will provide water quality data to be used to describe conditions for regional water characterization and for the determination of progress resulting from the implementation of water quality protective management systems.

11.6 USDA Hydrologic Unit Area

Northern Malheur County has been designated by USDA as a Hydrologic Unit Area (HUA). The area boundary is consistent with the groundwater management action plan boundary.

The HUA is a major effort by USDA to coordinate efforts by federal, state, and local agencies to solve water quality problems. The Ontario HUA addresses both groundwater and surface water quality concerns.

A Hydrologic Unit Area Plan — including a plan of work and program objectives and goals has been approved. This is the result of a coordinated effort among the involved state and federal agencies and the Malheur County Soil and Water Conservation District.

The HUA plan will be evaluated and accessed annually as to its effectiveness for improving water quality.

11.7 Oregon State Water Resources Department

The Water Resources Department (WRD), groundwater programs and activities mainly concern water supply. However, these programs directly affect groundwater management and protection. The Department is also involved in a number of programs to ensure water is used efficiently and without waste.

For this project the WRD shall provide hydrogeologic characterization as it relates to water quality and quantity and recommend solutions where problems exist or may develop, enforce well construction standards to protect the quality and quantity of the region's groundwater resource, and insure proper regulation and distribution of water in accordance with water rights and allocation. The WRD also shall cooperate with and assist other involved agencies in the planning and implementation of measures to improve the efficiency of water use in the area.

11.8 Oregon State Department of Environmental Quality

The Department of Environmental Quality, administers the Oregon State Groundwater Quality Protection Policy and implements the groundwater quality protection requirements for federal and state agencies, cities, counties, industry, and citizens.

For this project the DEQ shall establish a regional groundwater monitoring network and perform periodic water quality assessments to evaluate the performance of the management plan in reducing the groundwater contamination resulting from agricultural activities. DEQ will establish monitoring requirements for determining water quality status and establish and coordinate local monitoring efforts to obtain information on groundwater quality.

The DEQ also administers a pollution control tax credit program. An Oregon taxpayer who makes a capital investment in a pollution control facility may qualify for a state tax credit if the facility is constructed in response to a regulatory requirement or if the sole function of the facility is for pollution control, prevention, reduction, or for material recovery. The amount of the tax credit is up to 50% of the certified cost of the facility at a rate of 5% per year for 10 years. The Malheur County Groundwater Management Committee recommends that the Environmental Quality Commission include investment in equipment for best management practices in designated groundwater management areas to be eligible for pollution control tax credits. If such facilities are not eligible the committee recommends that the DEQ and Commission pursue legislation at the 1993 Legislature to broaden eligibility to include best management practices for water pollution control.

11.9 Oregon State Health Division

The Department of Human Resources Health Division (HD), carries out the provisions of the federal Safe Drinking Water Act by establishing drinking water standards and certifying water and treatment systems and operators. HD is responsible for identifying health hazards, and issuing public notification on such hazards.

For this project the HD will perform all health risk assessments concerning groundwater quality and provide for the regulation and protection of all public water supplies within the management area.

11.10 Oregon State Department of Agriculture

As agricultural activities are potential nonpoint sources of pollution, ODA is involved with the identification of existing agricultural management practice problems and development and implementation of alternatives for such practices. ODA's network with OSU's Experiment Station and Agricultural Extension Service and the Soil and Water Conservation Districts, provides an avenue for financial assistance to farmers for conservation projects, research and demonstration projects, and public education and information.

The Natural Resources Division of the Oregon Department of Agriculture provides administrative, financial and technical support to all of the soil and water conservation districts in the state, including Malheur County Soil and Water Conservation District. The Natural Resources Division reviews and evaluates district projects, practices, budgets, contracts, regulations and assists with coordination of district activities to assure obligations are being met.

11.11 Malheur County Soil and Water Conservation District

Primary activities of the Soil and Water Conservation Districts (SWCD), include soil erosion control; conservation and development of water resources; control of water pollution from agricultural non-point sources; and protection, conservation, development and enhancement of the quality and productive potentials of land and water resources in Oregon. The SWCD is administered and coordinated by the Department of Agriculture.

The Malheur County SWCD has been authorized under the amended Oregon State Statute 568.225 to participate in effectuating the policy set forth in the Oregon State Groundwater Quality Protection Act Of 1989. As such, the Malheur County SWCD is recognized by the State of Oregon to be the principal local agency responsible for implementing and coordinating water quality protection programs in Malheur County. As such, the SWCD shall investigate complaints and violations of this strategy and the Oregon State Groundwater Protection Act of 1989 in Malheur County, assist landowners in obtaining compliance, and compile and issue reports and assessments on such matters to the ODA, DEQ, and Strategic Water Management Group.

For this project, the SWCD will coordinate activities which need to be taken by the plan. SWCD will establish schedules for plan renewals and responses to plan applications, voluntary compliance actions, technical assistance, designated management agreements, intensive groundwater monitoring efforts, priority area activities, and water quality protection education programs.

The Malheur County Soil And Water Conservation District (SWCD) is developing and will be coordinating a soil investigation in select locations within the project area. The SWCD is receiving financial assistance from the Oregon State Department of Agriculture (ODA) to fund this project. The project has been developed to provide additional information for soil profile characterization. The project is being performed as a cooperative effort with the U.S. Soil Conservation Service and the Oregon State University.

12.0 REQUIRED AMENDMENTS OF AFFECTED COMPREHENSIVE PLANS AND LAND USE REGULATIONS

This plan is not expected to require any adjustments to comprehensive plans or land use regulations in Malheur County.

Future comprehensive plan amendments and new land use regulations will be required to consider the current groundwater management area declaration. Comprehensive plans and land use regulations should not allow nitrate/nitrite-nitrogen pollution to be discharged to the environment in such a manner that threatens groundwater quality or have the potential to impact the water quality.

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APPENDIX A

GROUNDWATER REPORT NO. 34

HYDROGEOLOGY OF THE ONTARIO AREA

MALHEUR COUNTY, OREGON

Prepared By:

Water Resource Department

(Report Available on Request)

APPENDIX B

DEQ ANALYTICAL QUALITY ASSURANCE PROGRAM, SUMMARY OF SAMPLE ANALYSIS, INDICATOR WELL NETWORK, AND SURFACE WATER DATA

Prepared By:

Department of Environmental Quality

DEQ
Analytical Quality Assurance Program

APPENDIX B

ANALYTICAL QUALITY ASSURANCE PROGRAM PLANS

All analyses were performed according to U.S. Environmental Protection Agency or Standard Methods Procedures. The analytical parameters, the analytical methods and techniques, the minimum reportable value, and the quality assurance objectives are listed in Tables 1 and 2.

The minimum reportable value was at or below the U.S. EPA Federal Drinking Water Standard if the parameter evaluated has an assigned standard. Analyses of parameters with Federal Drinking Water Standards were used for health risk assessments.

Routine quality control procedure were employed during this project as listed in EPA SW-846, *Test Methods for Evaluating Solid and Hazardous Wastes*, 3rd Ed., 1986. Acceptable limits for the laboratory quality assurance (QA) objectives are listed in Table 3.

In addition to the EPA QA requirements, the following procedures were performed. Spiked samples were analyzed to measure analytical accuracy. Duplicate samples were analyzed on 10 percent of the samples collected to measure analytical precision. Transport blanks were analyzed to detect interferences introduced during sampling and reagent blanks were analyzed to detect interferences introduced during analyses and to verify method detection limits. The date generated by this program are summarized in following section, *Summary of Sample Analyses*.

The quality assurance plan was in place at the beginning of the project. Prior to release of data, the quality assurance section of the DEQ laboratory reviewed the sampling information for consistency with quality assurance objectives.

TABLE 1
Laboratory Analyses

Parameter	Reference	Analytical Technique	Minimum Report Value mg/l
Organics:			
COD	R2-410.4	Dichro. Spectro	5.0
TOC	R2-415.2	UV/Sulfate Oxidation	1.0
Volatiles:			
EDB	EPA 8240	Purge & Trap, GC/MS	0.001
Dichloropropane	EPA 8240	Purge & Trap, GC/MS	0.001
Total Ions & Metals:			
Ca	R2-200.7	ICP	1.0
Mn	R2-200.7	ICP	0.02
Na	R2-200.7	ICP	1.0
K	R2-200.7	ICP	1.0
Cl	R2-325.1	Auto Ferricyanide	0.1
SO_4	R2-375.2	Auto Methyl Thymol	0.5
As	R2-206.2	Graphite Furnace	0.005
Fe	R2-200.7	ICP	0.05
Mg	R2-200.7	ICP	1.0
Pb	R2-239.2	Graphite Furnace	0.01
Se	R2-270.2	Graphite Furnace	0.005
Cr	R2-218.2	Graphite Furnace	0.002
SiO_2	R2-170.1	Silica	1.0
Nutrients:			
TKN	R2-351.1	Block Digestion	0.2
NH_3-N	R2-350.1	Auto Phenate	0.02
NO_3+NO_2-N	R2-353.2	Auto Cd Reduction	0.02
Total Phosphorus	R1-424F	Ascorbic Acid Reduct.	0.01
Pesticides:			
Dacthal	NPS 515	OSU Modified App. D	0.0001
Physical:			
Alkalinity	R2-310.1	Titration	1.0
pH	R2-150.1	Electrode	0-14 SU
Conductivity	R2-120.1	Wheatstone Bridge	1uMho/cm^2
Turbidity	R2-180.1	Nephelometric	0.1 NTU

Referenced methodologies are detailed in the following publications. Method modifications unique to this project are listed in Appendix D.

R1 -- *Standard Methods For The Examination of Water and Wastewater*, 16th edition, APHA, AWWA, WPCF, 1985.

R2 -- *Methods For Chemical Analysis of Water and Wastes*, EPA/4-79-020.

EPA -- *SW-846 Test Methods For Evaluating Solid And Hazardous Wastes*, 3rd edition, 1986. Conforms with EPA Drinking Water Method 524.1

NPS -- *National Pesticide Survey Methodology*, EPA Technical Support Division, Office of Drinking Water.

TABLE 2

Pesticide Compounds Investigated

Pesticides of concern, analyzed utilizing the EPA standard methods developed for the National Pesticide Program:

Dichloropropene	Terbufos
Chlorpropham	Oxyfluorfen
Alachlor	Bromoxynil
DCPA	Carbaryl
Cycloate	Captan
EPTC	Desmediapham
Dinoseb	Triadimefon
2,4-D	Naled
Bensulide	Trichlorfon
Mancozeb	Pendimethalin
Phorate	2,4-DB
Trifluraline	Phenmedipham
Metolachlor	Oxydemeton M
Aldicarb	Methamidophos
Propargite	Diquat
Metribuzin	Ethalfluralin
Ethion	Terbacil
Carbofuran	Fonofos
Parathion	Maneb
Ethoprop	Endothall
Chlorothalonil	Endosulfan
MCPA	Acephate
Pronamide	Demeton
Fensulfothion	Thiophanate M
Azinphos Methyl	Dicamba
Vernolate	Metalxyl
M-Parathion	Benomyl
Ethofumesate	Bentazon
Malathion	Glyphosate
Atrazine	Disulfoton
Thiabendazole	Propham

TABLE 3

Quality Assurance Objectives

Parameter	Concentration Range	Precision Range or	RPC	100% + Accuracy
Physical:				
Conductivity	≥25 uMhos/cm[3]		±5%	±5%
pH	0 - 14 SU	±0.2 SU		±0.1 SU
Alkalinity	≥10 mg/l		±5%	NA
Nutrients:				
TKN	0.2-1.0 mg/l ≥1.0 mg/l	±0.1 mg/l	±20%	±20%
NH_3-N	0.02-0.2 mg/l ≥0.2 mg/l	±0.05 mg/l	±20%	±20%
NO_3+NO_2-N	0.02-0.2 mg/l ≥0.2 mg/l	±0.05 mg/l	±10%	±15%
Total Phosphorus	0.01-0.1 mg/l ≥0.1 mg/l	±0.05 mg/l	±20%	±20%
Organics:				
COD	5.0-10.0 mg/l ≥10.0 mg/l	±0.5 mg/l	±20%	±20%
TOC	1.0-5.0 mg/l ≥5.0 mg/l	±0.5 mg/l	±20%	±20%
VOC (8240)	0.001-0.010 mg/l ≥0.01 mg/l	±0.001 mg/l	±15%	±15%
Total Ions and Metals:				
Mn	0.02-0.10 mg/l ≥0.10 mg/l	± 0.01 mg/l	±15%	±15%
Ca, Na, K, Mg, SiO_2	1.0-10.0 mg/l ≥10.0 mg/l	±1.0 mg/l	±15%	±15%
Cl	0.1-5.0 mg/l ≥5.0 mg/l	±1.0 mg/l	±15%	±15%
SO_4	0.5-5.0 mg/l ≥5.0 mg/l	±1.0 mg/l	±15%	±15%
Fe	0.05-0.5 mg/l ≥0.5 mg/l	±0.05 mg/l	±15%	±15%
As	0.005-0.1 mg/l ≥0.1 mg/l	±0.001 mg/l	±15%	±15%
Pb	0.01-0.1 mg/l ≥0.1 mg/l	±0.005 mg/l	±15%	±15%
Se	0.005-0.03 mg/l ≥0.03 mg/l	±0.005 mg/l	±15%	±15%
Cr	0.002-0.1 mg/l ≥0.1 mg/l	±0.005 mg/l	±15%	±15%

Figures 1 and 2 are graphs displaying the quality assurance evaluation results of the NO_2+NO_3-N analysis performed by the DEQ Laboratory. Figure 1 plots the relative percent difference (RPD) of duplicate samples versus sample concentration to yield an average method precision, or the difference between duplicate samples divided by the mean, of 5.3 percent. Figure 2 plots the percent recovery versus sample concentration to yield an accuracy, or the average percent recovery of samples spiked with a known amount, of 99.5 percent. In accordance with the DEQ Laboratory Quality Control requirements, the NO_2+NO_3-N analysis data generated by this project have met and exceeded the project quality control objectives.

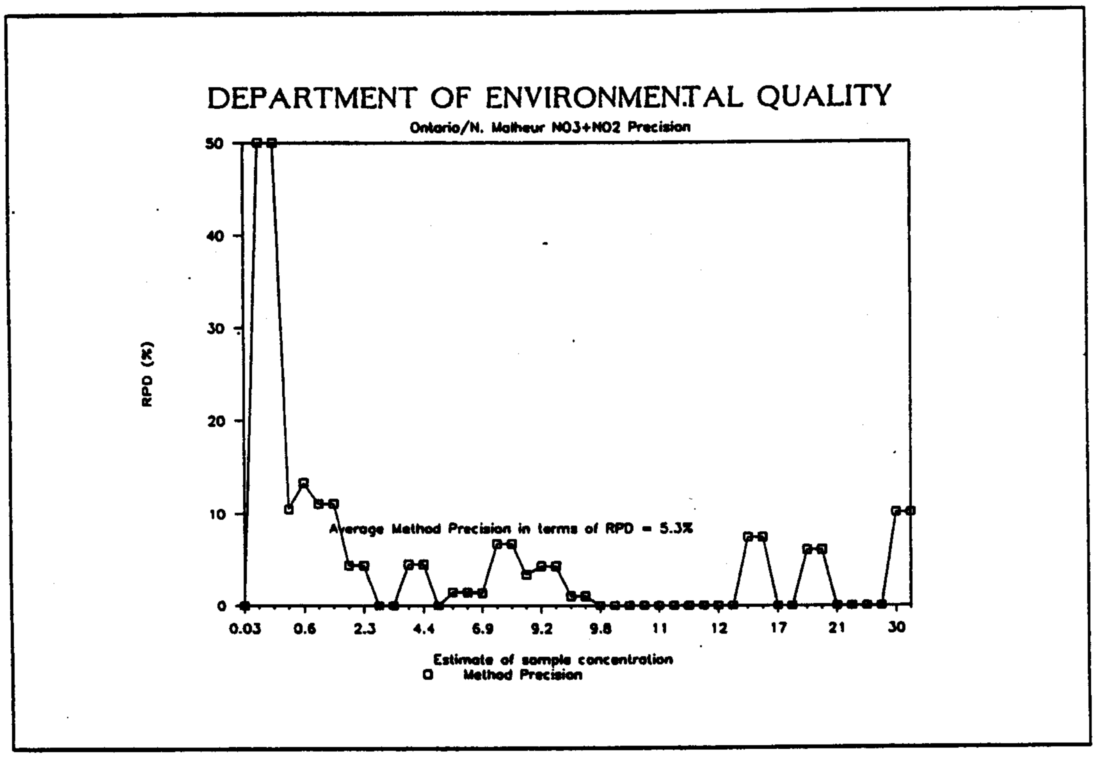

FIGURE 1

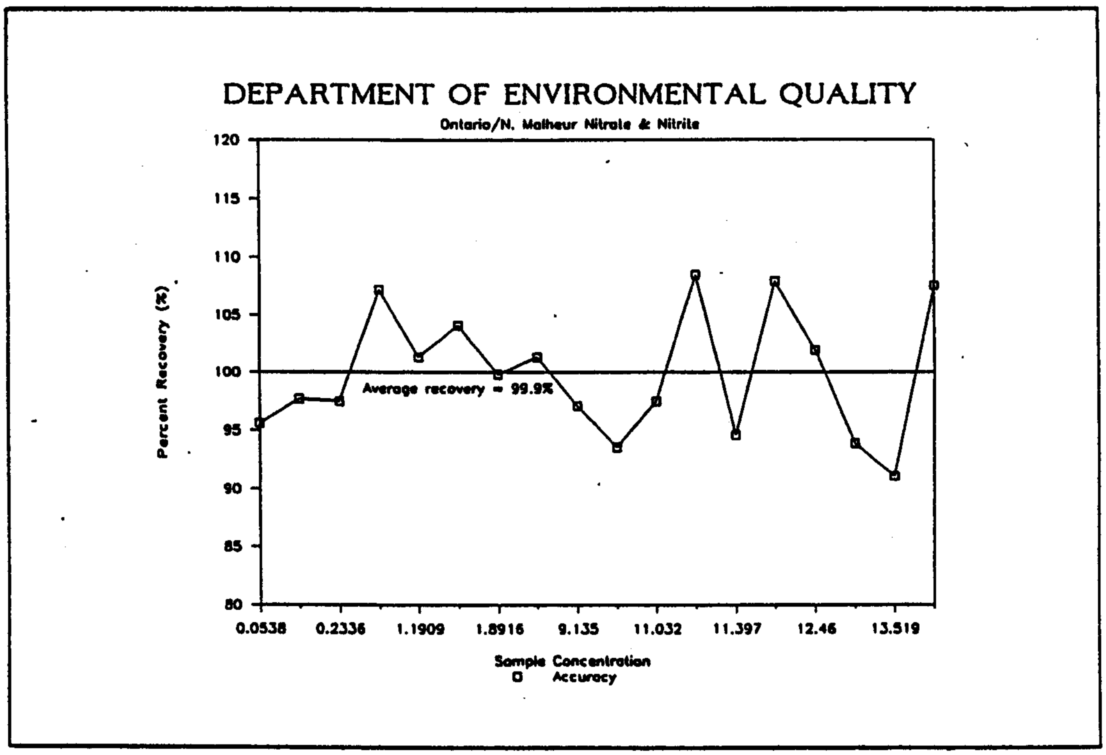
DEPARTMENT OF ENVIRONMENTAL QUALITY
Ontario/N. Malheur Nitrate & Nitrite
120
115
110
105
100
95
90
85
80
Percent Recovery (%)
Average recovery = 99.9%
0.0538
0.2336
1.1909
1.8916
9.135
11.032
11.397
12.46
13.519
Sample Concentration
Accuracy

FIGURE 2

Summary of Sample Analysis

NORTHERN MALHEUR COUNTY GROUNDWATER DATA

STORET STATION NAME	SAMPLING DATE (YYMMDD)	LAB	ADDRESS	CITY	QUADRANT T/R-Sqq	WELL DEPTH (FEET)	NO2+ NO3-N (PPM)	DACTHAL di-acid (PPB)
MAL001	830627	E	Rt. 3, Box 488	Ontario	17S/46E-35		2.5	
MAL002	830627	E	Rt. 3, Box 610	Ontario	17S/47E-29		2.1	
MAL003	830627	E	Rt. 3, Box 599	Ontario	17S/47E-29		2	
MAL004	830627	E	Rt. 3, Box 537	Ontario	17S/47E-31		3.2	
MAL005	830627	E	525 Peterson Rd.	Ontario	17S/47E-31Ab	210	3.8	
MAL005	850522	E					4.2	
MAL005	880809	D					8.3	
MAL005	881018	A						<0.1
MAL005	881213	O						<0.1
MAL005	881213	O						<0.1
MAL005	881213	D-QA					8.3	
MAL005	881213	D					8.3	
MAL006	830627	E	Rt. 3, Box 590	Ontario	17S/47E-32		3.5	
MAL007	830627	E	1501 Malheur Dr.	Ontario	17S/47E-32Dd	98	0.015	
MAL007	830829	E					<0.005	
MAL007	850522	E					0.015	
MAL007	860313	O					0.13	
MAL007	860313	E						1.9
MAL007	860923	E					0.015	2.4
MAL007	880809	D					0.03	
MAL007	890418	A						0.6
MAL007	890418	D					0.02	
MAL007	890815	D					<0.02	
MAL007	890815	A						13
MAL007	891025	A						0.3
MAL007	891025	D					0.02	
MAL008	830627	E	1503 NW 12th	Ontario	17S/47E-33Ca		13.9	
MAL008	850523	E					11.8	
MAL009	830627	E	629 Claggett Ln.	Nyssa	18S/46E-1Ad	70	0.05	
MAL009	830829	E					0.08	
MAL009	880809	O					0.34	
MAL00X	830315	M	SW 18th Ave.	Ontario	18S/47E-7Dd		25	
MAL010	830627	E	Rt. 3, Box 396	Ontario	18S/46E-2		0.015	
MAL011	830627	E	Rt. 3, Box 416	Ontario	18S/46E-12Ac	40	34.00	
MAL011	830627	E					39.2	
MAL011	830829	E					28.8	
MAL011	850522	E					32	265.6
MAL011	860313	O					34	
MAL011	860313	E					34	163.0
MAL011	860314	O						274.8
MAL011	860314	S						240.0
MAL011	860314	E						149.3
MAL011	860923	E					28.2	144.7
MAL011	860923	O						187.3
MAL012	830627	E	650 Butler Blvd.	Ontario	18S/46E-12Cd	59	8.1	
MAL012	830829	E					11.8	
MAL012	850522	E					16.2	
MAL012	860924	E					11	62.3
MAL012	881020	O						130
MAL012	890606	A						189
MAL012	890606	D					11	

NORTHERN MALHEUR COUNTY GROUNDWATER DATA

STORET STATION NAME	SAMPLING DATE (YYMMDD)	LAB	ADDRESS	CITY	QUADRANT T/R-Sqq	WELL DEPTH (FEET)	NO2+ NO3-N (PPM)	DACTHAL di-acid (PPB)
MAL012	890816	O						112
MAL012	890816	A						120
MAL012	890816	D-QA					11	
MAL012	890816	D					11	
MAL012	891025	D					22	
MAL012	891025	A						38
MAL012	900111	A						174
MAL012	900111	D					21	
MAL012	900417	A						213.6
MAL012	900417	D					11	
MAL012	900605	A					18.3	241
MAL012	900814	A						57.4
MAL012	900814	D					11	
MAL013	830627	E	Rt. 3, Box 346	Ontario	18S/46E-13Bb		0.015	
MAL013	830829	E					<0.005	
MAL013	850522	E					0.005	
MAL014	830627	E	Rt. 3, Box 271	Ontario	18S/46E-13Ac	23	16.9	
MAL014	830627	E					12.00	
MAL014	830829	E					19	
MAL014	850522	E					11.2	
MAL014	860313	E						28.4
MAL014	860313	D					12	
MAL015	830315	M	653 Morgan Ave.	Ontario	18S/46E-36Ab	150	0.3	
MAL015	830627	E					6.8	
MAL015	830829	E					6.6	
MAL015	850522	E					7	
MAL015	860314	D					7.50	
MAL015	860314	O						<0.5
MAL015	860314	S						<0.5
MAL015	880809	D					9.2	
MAL015	880809	D-QA					9.4	
MAL015	881213	D					9.7	
MAL015	881213	O						<0.1
MAL015	890419	D-QA					9	
MAL015	890419	D					9.4	
MAL015	890419	A						<0.1
MAL015	890419	A-QA						<0.1
MAL015	890607	D					9.8	
MAL015	890607	A						<0.1
MAL016	830627	E	690 SE 4th Str.	Ontario	18S/47E-10Bd	30	9.7	
MAL016	830829	E					11	
MAL016	850522	E					11.9	
MAL016	860312	D					11	
MAL016	860312	E						4.7
MAL016	860923	E					10.2	4.6
MAL016	880809	D					13	
MAL016	890419	A						44
MAL016	890419	D					12	
MAL016	890606	D					13	
MAL016	890606	A						75
MAL016	890815	D					13	
MAL016	890815	A						120
MAL016	891025	A						88
MAL016	891025	D					12	
MAL016	900109	A						69
MAL016	900109	D					9.4	
MAL016	900227	A						9.1
MAL016	900227	D					9.9	
MAL016	900417	A						32

NORTHERN MALHEUR COUNTY GROUNDWATER DATA

STORET STATION NAME	SAMPLING DATE (YYMMDD)	LAB	ADDRESS	CITY	QUADRANT T/R-Sqq	WELL DEPTH (FEET)	NO2+ NO3-N (PPM)	DACTHAL di-acid (PPB)
MAL016	900417	D					9.8	
MAL016	900605	O						67
MAL016	900605	A-QA						47.5
MAL016	900605	A					13.5	
MAL016	900807	O						48
MAL016	900807	O-QA					11	
MAL016	900807	D					11	
MAL016	900807	A-QA						15
MAL016	900807	A						24.5
MAL017	830627	E	775 N Park Blvd.	Ontario	18S/47E-4Bd	33	7.4	
MAL017	850522	E					9.1	
MAL017	860312	E						0.4
MAL017	860312	D					0.26	
MAL017	860923	E					1.6	8.3
MAL018	830627	E	363 SW 12th Str.	Ontario	18S/47E-4		6.2	
MAL019	830627	E	1258 W Idaho	Ontario	18S/47E-4		12.6	
MAL020	830627	E	1197 Verde Dr.	Ontario	18S/47E-5		17.2	
MAL021	830315	M	1617 Hunter Lane	Ontario	18S/47E-5Ab	59	14	
MAL021	830627	E					14.8	
MAL021	830829	E					15	
MAL021	850522	E					15.6	
MAL021	860312	E						35.7
MAL021	860312	O					16	
MAL023	830627	E	190 N Dorian	Ontario	18S/47E-5Db	49	12.5	
MAL023	830627	E					26.00	219.8
MAL023	830829	E					23.4	
MAL023	850522	E					24.5	219.8
MAL023	860312	D					26	251.9
MAL023	860923	E					25.3	287.6
MAL023	860923	O						394.8
MAL024	830627	E	279 SW Verde Dr.	Ontario	18S/47E-5Dd	52	13.6	
MAL024	830829	E					14.2	
MAL024	850522	E					14.5	
MAL024	860312	E						87.0
MAL024	860312	O					13	
MAL024	860923	E					16.6	137.4
MAL025	830627	E	314 Hillcrest Dr.	Ontario	18S/47E-5		9.8	
MAL026	830627	E	2538 NW 4th Ave.	Ontario	18S/47E-5		<0.005	
MAL026	830829	E					<0.005	
MAL026	860312	O						0.9
MAL026	860312	S						6.8
MAL027	830627	E	Rt. 2, Box 608	Adrian	22S/46E-13Aa		5.20	
MAL028	830315	M	2914 NW 6th Ave.	Ontario	18S/47E-6Dd		0.26	
MAL028	830627	E					0.07	
MAL028	830829	E					<0.005	
MAL028	850523	E					0.025	
MAL030	830627	E	3179 4th Ave.	Ontario	18S/47E-6Dc	50	19.2	
MAL030	830829	E					19	
MAL030	850521	E					23	
MAL030	860312	O					25.00	
MAL030	860312	E						79.7

NORTHERN MALHEUR COUNTY GROUNDWATER DATA

STORET STATION NAME	SAMPLING DATE (YYMMDD)	LAB	ADDRESS	CITY	QUADRANT T/R-Sqq	WELL DEPTH (FEET)	NO2+ NO3-N (PPM)	DACTHAL di-acid (PPB)
MAL030	860923	E					22.2	114.5
MAL030	860923	O						164.9
MAL030	880809	O					27	
MAL030	890419	O					27	
MAL030	890419	A						17
MAL030	890608	A						315
MAL030	890608	O					26	
MAL030	890815	A						505
MAL030	890815	O					24	
MAL030	891025	O					28	
MAL030	891025	A						156
MAL030	900111	A						181
MAL030	900111	O					27	
MAL030	900111	O						120
MAL030	900227	A						92.3
MAL030	900227	O					27	
MAL030	900417	A						6.8
MAL030	900417	O					27	
MAL030	900606	A					30	183
MAL030	900815	A-QA						66.4
MAL030	900815	O					26	
MAL030	900815	O-QA					26	
MAL030	900815	A						73.2
MAL030	900815	O						185
MAL031	830627	E	P.O. Box 879	Ontario	18S/47E-7Ab	45	18	
MAL031	830829	E					17.8	
MAL031	850522	E					19.8	90.7
MAL031	860312	O					22	79.7
MAL031	860312	E						106.3
MAL031	860312	E						106.3
MAL031	860923	E					23.3	125.5
MAL031	860923	O						172.2
MAL032	830627	E	Rt. 3, Box 153	Ontario	18S/47E-7Ad	56	32.00	
MAL032	830627	E					30.6	
MAL032	830829	E					28.6	
MAL032	850521	E					31.2	
MAL032	860312	O					32	
MAL032	860312	E						224.4
MAL033	830303	H	Rt. 3, Box 210	Ontario	18S/47E-7Cd		28	
MAL033	830320	W					31	
MAL033	830627	E					31.00	84.3
MAL033	830627	E					29.4	
MAL033	830829	E					28.8	
MAL033	850521	E					32.5	84.3
MAL033	860312	O					31	
MAL033	860312	E						72.4
MAL033	860922	E					26.5	120.9
MAL033	860922	O						177.7
MAL034	690526	O	444 SW 4th St.	Ontario	18S/47E-7Dc	43	16	
MAL034	700519	O					14	
MAL034	720509	O					16.8	
MAL034	740819	O					10.34	
MAL034	760525	O					0.18	
MAL034	830516	C					27.4	
MAL034	830627	E						
MAL034	830829	E					24.2	
MAL034	850522	E					28	
MAL034	860313	O					29	
MAL034	860313	E						175.0

NORTHERN MALHEUR COUNTY GROUNDWATER DATA

STORET STATION NAME	SAMPLING DATE (YYMMDD)	LAB	ADDRESS	CITY	QUADRANT T/R-Sqq	WELL DEPTH (FEET)	NO2+ NO3-N (PPM)	DACTHAL di-acid (PPB)
MAL034	860313	O					30	
MAL034	860923	O						289.5
MAL034	860923	E					21.5	221.7
MAL035	830627	E	4014 Clark Blvd.	Ontario	18S/47E-7Cc		32	
MAL035	830829	E					27.2	
MAL035	850522	E					25.8	
MAL035	860313	O					29	
MAL035	860313	E						142.9
MAL035	860313	O					25	
MAL035	860923	E					27.4	130.1
MAL035	860923	O						195.1
MAL035	891025	A						359
MAL035	891025	O					26	
MAL035	900111	O					27	
MAL035	900111	A						155
MAL035	900301	O					25	
MAL035	900301	A						87.2
MAL035	900417	A						192.6
MAL035	900417	O					26	
MAL035	900605	A					35	207
MAL035	900814	A						42.2
MAL035	900814	D					26	
MAL036	830627	E	1412 Sunset Dr.	Ontario	18S/47E-8Dd		2.7	
MAL036	830829	E					2.5	
MAL036	850522	E					4.6	
MAL037	830627	E	SW 12th Ave.	Ontario	18S/47E-9Bc	53	13.20	
MAL037	830829	E					12.3	
MAL037	850522	E					12.8	
MAL037	860312	O					13	
MAL037	860313	E					12.3	7.4
MAL037	860923	O						110.8
MAL037	860923	E					12.3	72.4
MAL038	830627	E	1412 Sunset Dr.	Ontario	18S/47E-17Bc		24.6	
MAL038	830829	E					24.6	
MAL038	850522	E					28.5	
MAL038	860313	E						96.2
MAL038	860313	O					27	
MAL038	860922	E					30.6	143.3
MAL038	860922	O						216.2
MAL039	830627	E	2375 Laurel Dr.	Ontario	18S/47E-17Ad	65	2.5	
MAL039	830829	E					1.1	
MAL039	850522	E					0.98	
MAL039	860312	O					0.42	
MAL039	860313	E						5.2
MAL039	860924	E					0.36	7.3
MAL039	880809	D					5.5	
MAL039	881020	O						18
MAL039	881020	O						16
MAL039	890419	A						39
MAL039	890419	O					1.7	
MAL039	890608	A						29
MAL039	890608	D					2.2	
MAL040	830627	E	Rt. 3, Box 249	Ontario	18S/47E-18Bc		12.8	
MAL040	830829	E					9.2	
MAL040	850523	E					7.2	
MAL040	860313	O					11	
MAL040	860313	D					11	

NORTHERN MALHEUR COUNTY GROUNDWATER DATA

STORET STATION NAME	SAMPLING DATE (YYMMDD)	LAB	ADDRESS	CITY	QUADRANT T/R-Sec	WELL DEPTH (FEET)	NO2+ NO3-N (PPM)	BACTHAL di-acid (PPB)
MAL040	860313	E						59.5
MAL041	830627	E	2375 Laurel Dr.	Ontario	18S/47E-19Db	61	26.8	
MAL041	830829	E					10.1	
MAL041	850522	E					17.5	
MAL041	860313	D					19.00	
MAL041	860313	E						141.06
MAL041	860922	E					16.5	0.42
MAL041	880809	D					17	
MAL041	880809	D-QA					17	
MAL041	881018	A						102.8
MAL041	881018	O						200
MAL041	881018	D					16	
MAL041	881018	D-QA					16	
MAL041	881018	A						71.9
MAL041	890308	A						155
MAL041	890308	O						202
MAL041	890308	D					17	
MAL041	890418	O						170
MAL041	890418	A						178
MAL041	890418	D					18	
MAL041	890607	D					17	
MAL041	890607	A						284
MAL041	890607	O						171
MAL041	890607	D-QA					17	
MAL041	890817	D					16	
MAL041	890817	A						532
MAL041	891025	A						114
MAL041	891025	D-QA					16	
MAL041	891025	D					17	
MAL041	900110	A						193
MAL041	900110	D					16	
MAL041	900228	O						170
MAL041	900228	A						77.6
MAL041	900228	D					16	
MAL041	900418	O						150
MAL041	900418	A						187.3
MAL041	900418	D					17	
MAL041	900605	A					22.5	184
MAL041	900814	D					18	
MAL041	900814	A						64.4
MAL042	830627	E	Rt. 1, Box 620	Ontario	18S/46E-30Bb		15.1	
MAL042	830829	E					23	
MAL042	850522	E					14.4	0.1
MAL042	860314	S						<1
MAL042	860314	D					15	
MAL042	860314	O						<0.5
MAL042	860926	E					0.005	<0.16
MAL043	830627	E	Rt. 1, Box 610	Ontario	18S/47E-30Cb		7	
MAL043	830829	E					<0.005	
MAL044	830627	E	3669 Arcadia Dr.	Ontario	18S/47E-32Ac	86	12.8	
MAL044	830829	E					13.6	
MAL044	850523	E					14.8	
MAL044	860312	E						17.37
MAL044	860312	D					14.00	
MAL044	880809	D					16	
MAL044	881013	O						99
MAL044	881019	O						44
MAL044	890419	D					16	
MAL044	890419	A						67

NORTHERN MALHEUR COUNTY GROUNDWATER DATA

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MAL044	890407	A						53
MAL044	890407	D					16	
MAL044	890816	D					13	
MAL044	890816	A						231
MAL044	891024	D					15	
MAL044	891024	A						69
MAL044	900110	A						50
MAL044	900110	D					15	
MAL044	900228	A						10.9
MAL044	900228	D					15	
MAL044	900418	D					15	
MAL044	900418	A						38.6
MAL044	900606	A					18	48.8
MAL044	900807	D					14	
MAL044	900807	A						13
MAL045	830829	E	3890 Hwy 201	Ontario	18S/47E-20Bb		0.005	
MAL045	850522	E					0.005	
MAL046	830829	E	Rt. 3, Box 274	Ontario	18S/46E-13Bc		0.02	
MAL046	850523	E					0.01	
MAL047	830829	E	580 Railroad Blvd.	Ontario	18S/47E-18Cc	45	49	
MAL047	850522	E					30	224.4
MAL047	860313	E						198.5
MAL047	860313	O						280.3
MAL047	860313	S						228.0
MAL047	860313	D					36	
MAL047	860314	E						152.1
MAL047	860922	O						333.4
MAL047	860922	E					17	198.8
MAL047	881020	O						320
MAL047	890607	A						522
MAL047	890607	D					27	
MAL047	890817	A						986
MAL047	890817	D					31	
MAL047	890817	D-QA					28	
MAL047	890817	Q						290
MAL047	891024	D					31	
MAL047	891024	A						211
MAL047	900111	D					30	
MAL047	900111	Q						270
MAL047	900111	A						310
MAL047	900228	A						74.1
MAL047	900228	D					21	
MAL047	900418	A						269.3
MAL047	900418	D					26	
MAL047	900605	A					35	312
MAL047	900815	D					30	
MAL047	900815	A						101.8
MAL048	830829	E	Rt. 3, Box 345	Ontario	18S/46E-13Bd		1.3	
MAL049	830829	E	Rt.1, off Butler Blvd.	Ontario	18S/46E-12Ac		<0.005	
MAL049	850522	E					<0.005	
MAL050	830829	E					8.4	
MAL050	850523	E					5.2	
MAL051	860312	O	Rt. 2, Box 2734	Vale	16S/43E-4Ca	90		<0.5
MAL051	860312	D					0.06	
MAL052	860312	O	Rt. 2, Box 2798	Vale	16S/43E-26Da	98		<0.5

NORTHERN MALHEUR COUNTY GROUNDWATER DATA

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MAL052	860312	D					0.62	
MAL053	860312	E	Rt. 2, Box 2695	Vale	16S/44E-0d			<0.5
MAL053	860312	O					3.30	
MAL053	860312	D						
MAL054	860312	O	Rt. 2, Box 3048	Vale	17S/44E-16Da	40	0.30	<0.5
MAL054	860312	D						
MAL055	860312	O	Rt. 3, Box 213	Adrian	17S/45E-36Dd	25	<0.02	<0.5
MAL055	860312	D						
MAL056	860312	D	Rt. 1, Box 519	Vale	19S/44E-9Ab	40	4.10	<0.5
MAL056	860312	O						
MAL057	860312	D	Rt. 1, Box 1325	Vale	19S/44E-10Ac	25	8.90	<0.5
MAL057	860312	O						
MAL058	860312	D	Rt. 1, Box 1275	Vale	19S/44E-36C+	25	10.00	<0.5
MAL059	860312	O	Rt. 3, Box 4446	Vale	18S/45E-24Aa	25	9.80	1.8
MAL059	860312	D						
MAL060	860312	D	Rt. 3, Box 4496	Vale	18S/44E-1B	113	0.14	<0.5
MAL061	860312	O	Rt. 2, Box 656	Ontario	16S/47E-9Bb	60	12.00	18.3
MAL061	860312	D						
MAL062	860312	D	432 Ripple Rd.	Ontario	16S/47E-5Cd	77	6.00	52.2
MAL062	860312	O						38
MAL062	890309	A					32	
MAL062	890309	D					30	
MAL062	890419	D						4
MAL062	890606	A					33	
MAL062	890606	D					29	
MAL062	890815	D						90
MAL062	890815	A					30	
MAL062	891025	D						21
MAL062	891025	A					34	
MAL062	900109	D						14
MAL062	900109	A					36	
MAL062	900227	D						8.1
MAL062	900227	A						14.3
MAL062	900417	A					42	26.5
MAL062	900605	A					33	8.2
MAL062	900806	D-QA						27
MAL062	900806	O					33	8.9
MAL062	900806	D						8.9
MAL062	900806	A						8.2
MAL062	900806	A-QA						
MAL063	860312	D	Rt. 2, Box 72	Ontario	17S/47E-8Dd	100	0.03	<0.5
MAL063	860312	O						
MAL064	860312	D	301 Boat Landing Rd.	Ontario	17S/47E-15Bb	55	19.00	183.2
MAL064	860312	O						28
MAL064	890418	A					6.2	
MAL064	890418	D					7.9	18.6
MAL064	900605	A						45
MAL064	900814	O					18	
MAL064	900814	D						15.3
MAL064	900814	A					18	
MAL064	900814	D-QA						

NORTHERN MALHEUR COUNTY GROUNDWATER DATA

STORET STATION NAME	SAMPLING DATE (YYMMDD)	LAB	ADDRESS	CITY	QUADRANT T/R-Sqq	WELL DEPTH (FEET)	NO2+ NO3-N (PPM)	DACTHAL di-acid (PPB)
MAL064	900814	A-QA						13.1
MAL065	890308	O	2145 Bishop Rd.	Vale	19S/44E-16Dd	40		<0.1
MAL065	890308	D					0.23	
MAL065	890308	A						<0.1
MAL065	890418	A						<0.1
MAL065	890418	D					0.64	
MAL065x	860312	O	1906 1st Ave. S	Payette,	ID9N/5W-34Db	40		0.9
MAL065x	860312	D					0.08	
MAL066	860312	D	Rt. 2, Box 790	Ontario	16S/47E-22Bd	59	11.00	
MAL066	860312	O						4.6
MAL067	860313	D	Rt. 2, Box 760	Ontario	16S/47E-23Db	50	17.00	
MAL067	860313	O						91.6
MAL068	860313	O	Rt. 2, Box 750	Ontario	16S/47E-24Cb	100		<0.5
MAL068	860313	D					0.05	
MAL069	860313	D	Rt 2, Box 743	Ontario	16S/47E-25Cc	140	13.00	
MAL069	860313	O						66.9
MAL070	860313	O	Rt. 2, Box 206	Ontario	16S/47E-36Bc	45		100.76
MAL070	860313	D					15.00	
MAL071	860312	D	Rt. 3, Box 3209	Adrian	21S/46E-24Ba		0.12	
MAL071	860312	O						<0.5
MAL072	860312	O	Rt. 3, Box 3203	Adrian	21S/46E-26Cd			<0.5
MAL072	860312	D					0.08	
MAL073	860312	O	Big Bend Rd.	Adrian	21S/46E-23Dc	100		<0.5
MAL073	860312	D					<0.02	
MAL074	860312	D	Rt. 3, Box 161	Parma	21S/46E-23Ca	100	<0.02	
MAL074	860312	O						<0.5
MAL075	860312	D	1697 Napton Rd.	Adrian	22S/46E-11Ab	280	19.00	
MAL075	860312	S						87.0
MAL075	860312	O						126.4
MAL075	900419	D					12	
MAL075	900419	A						30.6
MAL075	900806	A						5.6
MAL075	900806	D					4.7	
MAL077	860313	O	Rt. 2, Box 251	Nyssa	19S/47E-25Dc	50		14.7
MAL077	860313	S						11.0
MAL077	860313	D					14	
MAL077	860313	D					15.00	
MAL077	860314	D					<0.02	
MAL078	860312	S	480 Columbia Ave.	Nyssa	18S/47E-20Cc	40		<1
MAL078	860312	D					<0.02	
MAL078	860312	D					<0.02	
MAL078	860312	O						<0.5
MAL078	880809	D					<0.02	
MAL078	900419	A						17.1
MAL078	900419	D					30	
MAL078	900807	D					14	
MAL079	860312	O	3394 Arcadia Blvd.	Nyssa	19S/47E-17Ab	40		176.0
MAL079	860312	D					12.00	

NORTHERN MALHEUR COUNTY GROUNDWATER DATA

STORET STATION NAME	SAMPLING DATE (YYMMDD)	LAB	ADDRESS	CITY	QUADRANT T/R-Sqq	WELL DEPTH (FEET)	NO2+ NO3-N (PPM)	DACTHAL di-acid (PPB)
MAL079	860312	S						152.0
MAL079	881215	D-QA					0.11	
MAL079	881215	O						3.1
MAL079	881215	O						3
MAL079	881215	D					0.1	3.1
MAL079	890607	A						90
MAL079	890607	D					13	
MAL079	900807	A						25.3
MAL079	900807	D					11	
MAL080	860312	S	Rt. 2, Box 4175	Nyssa	18S/47E-17Bb			<1
MAL080	860312	D					0.05	
MAL080	860312	O						2.7
MAL082	860314	O	Rt. 1, Box 3087	Nyssa	18S/47E-31Cd	50		<0.5
MAL082	860314	D					0.02	
MAL082	860314	S						<1
MAL083	860314	S	3608 Arcadia Blvd.	Nyssa	18S/47E-32Dc	55		4.6
MAL083	860314	D					0.41	
MAL083	860314	O						9.2
MAL083	880809	D					13	
MAL083	881019	O						94
MAL083	890419	A						6
MAL083	890419	D					17	
MAL083	890607	A						78
MAL083	890607	D					17	
MAL083	890816	A						347
MAL083	890816	D					16	
MAL083	891024	D					18	
MAL083	891024	A						75
MAL083	900418	D					18	
MAL083	900418	A						62.9
MAL083	900807	A						23.4
MAL083	900807	D					16	
MAL084	860314	O	Rt. 1, Box 750	Nyssa	19S/47E-4Dd	80		<0.5
MAL084	860314	D					0.03	
MAL084	860314	S						<1
MAL085	860314	O	3450 Arcadia Blvd.	Nyssa	19S/47E-8Cb	150		11.9
MAL085	860314	S						9.6
MAL085	860314	D					<0.02	
MAL085	890607	D					1.4	
MAL085	890607	A						47
MAL085	890607	C						
MAL086	850522	E	off Clark Blvd.	Nyssa	18S/47E-30Bd		8	
MAL086	860314	D					9.30	
MAL086	860314	O						<0.5
MAL086	860314	S						<1
MAL087	860312	O	Rt. 3, Box 4435	Vale	18S/45E-26Aa	80		<0.5
MAL087	860312	D					<0.02	
MAL087	860312	S						<1
MAL088	860314	O	Rt. 1, Box 315	Nyssa	21S/47E-10Ad	40		4.6
MAL088	860314	S						2.6
MAL088	860314	D					9.60	2.6
MAL089	860314	O	Rt. 1, Box 131	Nyssa	21S/47E-30d	80	0.29	
MAL089	860314	S						53.0
MAL089	860314	E						54.0

NORTHERN MALHEUR COUNTY GROUNDWATER DATA

STORET STATION NAME	SAMPLING DATE (YYMMDD)	LAB	ADDRESS	CITY	QUADRANT T/R-Sqq	WELL DEPTH (FEET)	NO2+ NO3-N (PPM)	DACTHAL di-acid (PPB)
MAL089	860314	O						80.6
MAL090	860314	O	Rt. 2, Box 114	Nyssa	20S/46E-12Ba	25		<0.5
MAL090	860314	E						
MAL090	860314	D					0.06	
MAL090	860314	S						<1
MAL092	860313	O	Rt. 2, Box 4647	Nyssa		168		<0.5
MAL092	860313	D					<0.02	<0.5
MAL093	860313	D	1128 Klamath Ave.	Nyssa	20S/46E-19Dc	61	4.50	
MAL094	860313	D	Rt. 1, Box 509	Nyssa	20S/46E-28Dc	85	0.03	
MAL094	860313	O						<0.5
MAL096	860313	O	Rt. 1, Box 3213	Nyssa	20S/46E-25Ba	95		0.9
MAL096	860313	D					0.05	
MAL098	860312	O	Rt. 1, Box 285	Nyssa	20S/46E-23Db	50		21.1
MAL098	860312	D					12	
MAL098	860312	E						
MAL099	860312	O	Rt. 2, Box 4836	Nyssa	20S/46E-15Aa	917		<0.5
MAL099	860312	D					0.05	
MAL0XX	860312	O				60		<0.5
MAL0XX	860312	D					3.00	
MAL100	860312	D	Rt. 2, Box 4860	Nyssa	20S/46E-9Cc	300	2.50	
MAL100	860312	O						<0.5
MAL101	880809	D	3964 Butte Dr.	Ontario	18S/46E-15Ba	25	1.7	
MAL101	881213	O						<0.1
MAL101	881213	D					0.95	
MAL101	881214	A						<0.1
MAL101	890418	A						0.5
MAL101	890418	D					1.5	
MAL101	890606	D					1.9	
MAL101	890606	A						<0.1
MAL101	890817	A						<0.1
MAL101	890817	D					7.3	
MAL101	891024	D					7.1	
MAL101	891024	A						<0.1
MAL101	900111	D					2	
MAL101	900111	A						0.3
MAL101	900227	D					1	
MAL101	900227	A						<0.1
MAL101x	860312	D	Rt. 1, Box 727	Nyssa	19S/46E-36Da		<0.02	
MAL101x	860312	S						<1
MAL101x	860312	O						<0.5
MAL102	880809	D	4321 Community Rd.	Ontario	17S/46E-25Da	50	5.8	
MAL102	881018	A						<0.1
MAL102	881213	D					6.7	
MAL102	881213	O						<0.1
MAL102x	860313	O	Rt. 1, Box 721	Nyssa	19S/46E-36Dc	50		<0.5
MAL102x	860313	D					<0.02	
MAL102x	860313	S						<1
MAL102x	860314	E						0.2
MAL102x	860314	D					<0.02	

NORTHERN MALHEUR COUNTY GROUNDWATER DATA

STORET STATION NAME	SAMPLING DATE (YYMMDD)	LAB	ADDRESS	CITY	QUADRANT T/R-Sqq	WELL DEPTH (FEET)	NO2+ NO3-N (PPM)	DACTHAL di-acid (PPB)
MAL103	880809	D	4454 Sage Rd.	Ontario	17S/46E-24Bc	40	5.3	
MAL103	881213	O						<0.1
MAL103	881213	D					4.2	
MAL103	890418	D					5.5	
MAL103	890418	A						<0.1
MAL103	890606	A						<0.1
MAL103	890606	D					7.1	
MAL103x	850523	E	1225 Ferry St. SE	Salem	20S/47E- 8d	113	5.2	
MAL103x	860313	S						11.0
MAL103x	860313	O						14.7
MAL103x	860313	D					4.80	
MAL104	880809	D	4489 Community Rd.	Ontario	17S/46E-24Aa	50	2.4	
MAL104	881213	O						<0.1
MAL104	881213	D					3	
MAL104x	860313	S	Rt. 1, Box 713	Nyssa	20S/47E-12Bb	40		25.0
MAL104x	860313	O						32.1
MAL104x	860313	D					10.00	
MAL105	881020	O	421 Sugar Ave.	Ontario	18S/46E-12Ad	39		180
MAL105	890419	D					24	
MAL105	890419	A						13
MAL105	890606	D					22	
MAL105	890606	A						159
MAL105	890815	D					23	
MAL105	890815	A						377
MAL105	891025	A						61
MAL105	891025	D					17	
MAL105	900111	A						103
MAL105	900111	D					24	
MAL105	900227	D					22	
MAL105	900227	A						49.1
MAL105	900815	D					23	
MAL105	900815	A						34.7
MAL106	880809	D	Golf Course Rd.	Ontario	18S/47E-7Bd	43	12	
MAL106	881020	O						260
MAL106	890418	A						205
MAL106	890418	D					20	
MAL106	890606	D					29	
MAL106	890606	A						317
MAL106	890816	A						225
MAL106	890816	D					22	
MAL106	891025	D					24	
MAL106	891025	A						169
MAL106	900815	D					25	
MAL106	900815	A						115.5
MAL107	880809	D	614 Eureka Ave.	Ontario	19S/46E-13Dd	71	2.3	
MAL107	881213	O						<0.1
MAL107	881213	D					2.3	
MAL108	890419	D	3452 Hwy 201	Nyssa	19S/47E-8Cb	44	1.2	
MAL108	890419	A						2
MAL108	890607	A						32
MAL108	890607	D					2.3	
MAL108	890816	D-QA					2.3	
MAL108	890816	A						18
MAL108	890816	D					2.2	
MAL108	890816	O						21
MAL108	891024	A						10

NORTHERN MALHEUR COUNTY GROUNDWATER DATA

STORET STATION NAME	SAMPLING DATE (YYMMDD)	LAB	ADDRESS	CITY	QUADRANT T/R-Sqq	WELL DEPTH (FEET)	NO2+ NO3-N (PPM)	DACTHAL di-acid (PPB)
MAL108	891024	D					0.37	
MAL108	900228	A						5.3
MAL108	900228	D-QA					0.56	
MAL108	900228	O						13
MAL108	900228	D					0.64	
MAL108	900511	O						16
MAL108	900511	A-QA						19
MAL108	900511	A						36.7
MAL108	900606	A					3.4	21.3
MAL108	900807	D					3.2	
MAL108	900807	A						5.7
MAL109	880809	D	745 Morgan Ave.	Ontario	18S/46E-35Ac	305	3.6	
MAL109	881213	D					3.5	
MAL109	881213	O						<0.1
MAL110	880809	D	745 Morgan Ave.	Ontario	18S/46E-35Ab	160	4.4	
MAL110	881213	O						<0.1
MAL110	881213	D					5.2	
MAL111	880809	D	1144 US Hwy 20/26	Vale	18S/46E-20Cd	47	1.3	
MAL112	880809	D	1144 US Hwy 20/26	Vale	18S/46E-21Cc	166	1.7	
MAL113	881018	A						<0.1
MAL113	881018	D	4962 John Day Hwy:	Vale	16S/43E-26Da	98	3.2	
MAL114	881018	D	2275 9th Ave. E	Vale	17S/44E-15	30	3.6	
MAL114	881018	A						<0.1
MAL115	881018	A	4619 S. Rd. G	Vale	17S/47E-7Dd	106		<0.1
MAL115	881018	D					2.7	
MAL116	881018	D	4115 John Day Hwy.	Vale	18S/45E-6Cc	38	2	
MAL116	881018	A						<0.1
MAL116	890419	A						<0.1
MAL116	890419	D					5	
MAL116	890608	A						<0.1
MAL116	890608	D					5.3	
MAL116	890817	O					3.3	
MAL116	890817	A						<0.1
MAL116	891026	A						<0.1
MAL116	891026	O					5.5	
MAL116	900228	D					8	
MAL116	900228	A						0.01
MAL116	900605	O						<0.1
MAL116	900605	A					6	<0.1
MAL116	900806	A						0.27
MAL116	900806	D					6	
MAL117	881018	O	1807 E. 5th	Vale	17S/44E-25Da	160	2.4	
MAL117	881018	A						<0.1
MAL118	880809	D	3848 Butte Dr.	Ontario	18S/46E-22Cb	177	2.6	
MAL118	881213	D					2.6	
MAL118	881213	O						<0.1
MAL119	880809	D	496 Onion Ave.	Ontario	18S/47E-20Cc	40	12	
MAL119	881213	D					15	
MAL119	881213	O						140
MAL119	890419	A						80
MAL119	890419	D					11	
MAL119	890607	A						175

NORTHERN MALHEUR COUNTY GROUNDWATER DATA

STORET STATION NAME	SAMPLING DATE (YYMMDD)	LAB	ADDRESS	CITY	QUADRANT T/R-Sqq	WELL DEPTH (FEET)	NO2+ NO3-N (PPM)	DACTHAL di-acid (PPB)
MAL119	890607	D					13	
MAL119	890816	A						167
MAL119	890816	D					13	
MAL119	891026	D					14	
MAL119	891026	A						76
MAL119	900110	A						108
MAL119	900110	D					15	
MAL119	900301	D					13	
MAL119	900301	A						38.6
MAL119	900418	A						177.4
MAL119	900418	D					13	
MAL119	900606	A					17.5	33.3
MAL119	900807	D					13	
MAL119	900807	A						30.9
MAL120	880809	D	1088 Malheur Dr.	Ontario	18S/46E-17Cc	210	<0.02	
MAL120	881213	D					0.11	
MAL120	881213	O						<0.1
MAL120	881214	A						0.27
MAL120	890608	A						<0.1
MAL120	890608	D					0.05	
MAL121	880809	D	880 Railroad Ave.	Ontario	18S/46E-15Cd	33	14	
MAL121	881213	O						92
MAL121	881213	D					13	
MAL121	881214	A						68.6
MAL121	890418	D					14	
MAL121	890418	A						92
MAL121	890607	A						156
MAL121	890607	D					12	
MAL121	890817	A						384
MAL121	890817	D					13	
MAL121	891026	A						64
MAL121	891026	D					13	
MAL121	900111	D					13	
MAL121	900111	A						78
MAL121	900228	D					12	
MAL121	900228	A						29.5
MAL121	900418	D					12	
MAL121	900418	A						67.2
MAL121	900418	O						65
MAL121	900418	D-GA					12	
MAL121	900605	A					14.5	105
MAL121	900814	D					13	
MAL121	900814	A						31.6
MAL123	880809	D	460 Morgan Ave.	Ontario	18S/47E-32Ba	58	14	
MAL123	881213	D					18	
MAL123	881213	O						99
MAL123	890607	A						128
MAL123	890607	D					14	
MAL123	890816	D					12	
MAL123	890816	A						353
MAL123	891026	A						57
MAL123	891026	D					14	
MAL123	900110	D					14	
MAL123	900110	A						91
MAL123	900301	A						47.6
MAL123	900301	D					12	
MAL123	900606	A					14	168
MAL124	'880809	D-GA	1401 SW 18th Ave.	Ontario	18S/47E-16Ca	51	<0.02	
MAL124	880809	D					<0.02	

NORTHERN MALHEUR COUNTY GROUNDWATER DATA

STORET STATION NAME	SAMPLING DATE (YYMMDD)	LAB	ADDRESS	CITY	QUADRANT T/R-Sqq	WELL DEPTH (FEET)	NO2+ NO3-N (PPM)	BACTHAL di-acid (PPB)
MAL124	881213	D					<.02	
MAL124	881213	O						<0.1
MAL125	881018	A	1393 Foothill Dr.	Vale	18S/45E-15Da	33		7.1
MAL125	881018	D					12	
MAL125	890418	A						0.9
MAL125	890418	D					8.3	
MAL125	890608	D					7.7	
MAL125	890608	A						<0.1
MAL125	890817	A						8
MAL125	890817	D					9.3	
MAL125	891024	A						0.8
MAL125	891024	D					9	
MAL125	900605	A					15	0.5
MAL125	900814	A						5.55
MAL125	900814	D					11	
MAL126	881018	D	John Day Hwy.	Vale	18S/45E-20Ca		20	
MAL126	881018	A						-0.1
MAL126	890418	O						0.6
MAL126	890418	D					11	
MAL126	890418	A						0.5
MAL126	890608	A						<0.1
MAL126	890608	D					6.5	
MAL126	890817	D					7.6	
MAL126	890817	A						3.5
MAL126	891024	A						<0.1
MAL126	891024	D					8.8	
MAL126	900110	O						<0.1
MAL126	900110	D					9.3	
MAL126	900110	A						<0.1
MAL126	900605	A					5.3	<0.1
MAL129	880809	D	246 N. Holland	Vale	18S/45E-20Aa	30	7.7	
MAL129	881213	O						<0.1
MAL129	881213	D					6.5	
MAL129	890418	D					7.7	
MAL129	890418	A						<0.1
MAL129	890608	D					7.2	
MAL129	890608	A						<0.1
MAL130	880809	D	1405 Frontier Ln.	Vale	18S/45E-22Da	25	0.54	
MAL131	880809	D	1137 Sunset Dr.	Ontario	18S/46E-19Db	27	0.78	
MAL133	880809	D	975 E. Island Rd.	Ontario	18S/47E-15Ac	74	<0.02	
MAL133	881213	O						<0.1
MAL133	881213	D					<.02	
MAL135	880809	D	444 SW 4th	Ontario	18S/47E-9Bd	50	6.2	
MAL135	880809	D					6.2	
MAL136	880809	D	730 Railroad Ave.	Ontario	18S/46E-14Dc	40	12	
MAL136	881213	O						<0.1
MAL136	881213	D					13	
MAL136	900111	A						54
MAL136	900111	D					12	
MAL136	900815	D					13	
MAL136	900815	A						25.1
MAL140	830427	E	444 SW 4th	Ontario	18S/47E-2Cd	50	0.53	
MAL140	880809	D					0.54	

NORTHERN MALHEUR COUNTY GROUNDWATER DATA

STORET STATION NAME	SAMPLING DATE (YYMMDD)	LAB	ADDRESS	CITY	QUADRANT T/R-Sqq	WELL DEPTH (FEET)	NO2+NO3-N (PPM)	DACTHAL di-acid (PPB)
MAL140	881213	O						<0.1
MAL140	881213	D					1.2	
MAL140	900227	D					1.7	
MAL140	900227	A						0.2
MAL140	900417	O						1
MAL140	900417	A						1.2
MAL140	900419	A						1
MAL140	900606	A					1	0.6
MAL143	880809	D	1508 Idaho St.	Ontario	18S/47E-30c	40	2.9	
MAL144	881213	O	351 SW 9th St.	Ontario	18S/47E-4Cd	400		2.3
MAL144	881213	D					<.02	
MAL145	881213	D	529 Ridge Way	Ontario	18S/47E-5Ac	80	1.6	
MAL145	881213	O						0.5
MAL145	890608	A						159
MAL145	890608	D					15	
MAL146	880809	D	444 SW 4th	Ontario	18S/47E-4Aa	50	3.5	
MAL147	890308	D	4744 Pioneer Rd.	Ontario	17S/47E-2Ca	145	0.02	
MAL147	890308	O						9.2
MAL147	890308	A						7.5
MAL147	890419	O						12
MAL147	890419	D-OA					0.03	
MAL147	890419	D					0.05	
MAL147	890419	A						15
MAL147	890606	A						24
MAL147	890606	D					0.03	
MAL147	890815	O					0.09	
MAL147	890815	A						38
MAL147	891025	A						8
MAL147	891025	D					0.02	
MAL147	900109	A						13
MAL147	900109	D					0.02	
MAL147	900227	O					0.05	
MAL147	900227	A						9.8
MAL147	900417	A						12.2
MAL147	900417	O					<0.02	
MAL147	900605	A					<1	9
MAL147	900814	A						2.7
MAL147	900814	O					0.04	
MAL148	881213	D	2180 N. Verdi	Ontario	17S/47E-33Cb	397	0.02	
MAL148	881213	O						<0.1
MAL151	890418	D	224 Cedar Rd.	Ontario	17S/47E-10Ad	47	11	
MAL151	890606	D					12	
MAL151	890606	A						9
MAL151	890606	D-OA					12	
MAL151	890606	O						7.4
MAL152	890606	A	4744 Pioneer Rd.	Ontario	17S/47E-2Ca	32		191
MAL152	890606	D					20	
MAL152	890815	D					27	
MAL152	890815	A						383
MAL152	891025	D					21	
MAL152	891025	A						126
MAL152	891025	D-OA					21	
MAL152	900417	O						126
MAL152	900417	D-OA					22	
MAL152	900417	D					22	

NORTHERN MALHEUR COUNTY GROUNDWATER DATA

STORET STATION NAME	SAMPLING DATE (YYMMDD)	LAB	ADDRESS	CITY	QUADRANT T/R-Sqq	WELL DEPTH (FEET)	NO2+ NO3-N (PPM)	DACTHAL di-acid (PPB)
MAL152	900417	A-QA						4.9
MAL152	900417	A						105.6
MAL152	900605	A					28	88.4
MAL152	900814	A						23.4
MAL152	900814	D					22	
MAL160	890309	A	3776 Rhinehart Butte Ln.	Vale	18S/45E-28Aa	200		<0.1
MAL160	890309	D					0.03	
MAL161	890310	A	3707 Lytle Blvd.	Vale	18S/45E-32Ac	48		<0.1
MAL161	890310	D					2.9	
MAL161	890418	A						<0.1
MAL161	890418	D					2.9	
MAL162	890308	D	1810 Sand Hollow Rd.	Vale	19S/44E-12Dd	65	0.44	
MAL162	890308	A						<0.1
MAL163	890308	A	1946 Sand Hollow Rd. Vale		19S/44E-8Aa	65		<0.1
MAL163	890308	D					6.8	
MAL164	890310	D	1949 Sand Hollow Rd.	Vale	19S/44E-14Db	145	20	
MAL164	890310	A						<0.1
MAL164	890608	D					13	
MAL164	890608	A						<0.1
MAL164	890817	D					8.6	
MAL164	890817	A						0.5
MAL164	900110	D					7.9	
MAL164	900110	A						<0.1
MAL164	900301	A						0.06
MAL164	900301	D					12	
MAL164	900418	D					13	
MAL164	900418	A						1.3
MAL164	900605	A					14.5	<0.1
MAL164	900806	A						<0.1
MAL164	900806	D					11	
MAL166	890308	A	2355 Grove School Ln.	Vale	19S/44E-7Ab	28		<0.1
MAL166	890308	D					1.2	
MAL166	890418	A						<0.1
MAL166	890418	D					0.99	
MAL167	890308	D	2247 Graham Blvd.	Vale	18S/44E-29Ab	60	4.2	
MAL167	890308	A						<0.1
MAL167	890608	D					3.9	
MAL167	890608	A						<0.1
MAL168	890308	D	3748 Greenfield Rd.	Vale	18S/44E-27Bc		6.5	
MAL168	890308	A						<0.1
MAL168	890308	D-QA					6.6	
MAL168	890308	A						<0.1
MAL168	890308	D						<0.1
MAL168	890418	D					6.6	
MAL168	890418	A						<0.1
MAL169	890309	A	382 Bass	Ontario	15S/47E-28Bb	34		<0.1
MAL169	890309	D					1.8	
MAL170	890309	A	5595 Busy	Ontario	15S/47E-28Bb	38		<0.1
MAL170	890309	D					1.8	
MAL171	890309	A	5566 Buckhorn Rd.	Ontario	15S/47E-29Be	23		<0.1
MAL171	890309	D					0.41	

NORTHERN MALHEUR COUNTY GROUNDWATER DATA

STORET STATION NAME	SAMPLING DATE (YYMMDD)	LAB	ADDRESS	CITY	QUADRANT T/R-Sqq	WELL DEPTH (FEET)	NO_2+ NO_3-N (PPM)	DACTHAL di-acid (PPB)
MAL172	890309	O-QA	402 Annex Rd.	Ontario	15S/47E-29Ad	33	9.3	
MAL172	890309	A-QA						5.8
MAL172	890309	O					9.4	
MAL172	890309	A						5.4
MAL172	890419	A						8
MAL172	890419	O						8.1
MAL172	890419	O-QA					11	
MAL172	890419	O					11	
MAL172	890606	A						12
MAL172	890606	D					11	
MAL172	890815	O-QA					7.7	
MAL172	890815	O					7.2	
MAL172	890815	O						6.6
MAL172	890815	A						30
MAL172	891025	O					5.5	
MAL172	891025	A						2
MAL172	900109	A						2
MAL172	900109	O					5.9	
MAL172	900109	O						2
MAL172	900109	O-QA					5.9	
MAL172	900227	A						1.1
MAL172	900227	O					7.8	
MAL172	900417	A						3.5
MAL172	900417	O					12	
MAL172	900605	A					8.2	2.7
MAL172	900806	A						2.2
MAL172	900806	O					6.1	
MAL173	890310	A	5401 Hwy 201	Ontario	15S/47E-33Cc	76		10
MAL173	890310	O-QA					13	
MAL173	890310	A-QA						39
MAL173	890310	O					14	
MAL173	890419	A						38
MAL173	890419	O					14	
MAL173	890606	A						51
MAL173	890606	O					13	
MAL173	890815	A						47
MAL173	890815	O					12	
MAL173	891025	A						39
MAL173	891025	O					13	
MAL173	900109	O					14	
MAL173	900109	A						26
MAL173	900227	A						3
MAL173	900227	O					14	
MAL173	900417	A						37
MAL173	900417	O					14	
MAL173	900605	A					17	1.5
MAL175	890310	O	4829 Elderberry Ln.	Ontario	16S/47E-35Db	65	17	
MAL175	890310	A						123
MAL175	890419	A						115
MAL175	890419	O					17	
MAL175	890606	A						71
MAL175	890606	O					7.5	
MAL175	890815	O					15	
MAL175	890815	A						153
MAL175	891025	A						<0.1
MAL175	891025	O					14	
MAL175	900227	O						59
MAL175	900227	O-QA					13	
MAL175	900227	A						27.1
MAL175	900227	O					13	
MAL175	900605	A					16.5	58.2

NORTHERN MALHEUR COUNTY GROUNDWATER DATA

STORET STATION NAME	SAMPLING DATE (YYMMDD)	LAB	ADDRESS	CITY	QUADRANT T/R-Sqq	WELL DEPTH (FEET)	NO2+ NO3-N (PPM)	DACTHAL di-acid (PPB)
MAL175	900605	O						50
MAL175	900806	D					13	
MAL175	900806	A						16.7
MAL176	890310	D	531 Hwy 20-26	Ontario	18S/47E-19Db	200	0.03	
MAL176	890310	A						<0.1
MAL177	890310	A	626 Railroad Ave.	Ontario	18S/45E-13Dc			63
MAL177	890310	D					14	
MAL177	890418	A						53
MAL177	890418	D					14	
MAL177	890608	D					12	
MAL177	890608	A						71
MAL177	890816	A						69
MAL177	890816	D					12	
MAL177	891026	D					13	
MAL177	891026	A						71
MAL177	900111	A						66
MAL177	900111	D					14	
MAL177	900228	D					13	
MAL177	900228	A						11
MAL177	900418	D					11	
MAL177	900418	A						48.9
MAL177	900605	A					15.5	34.1
MAL178	890310	A	2217 Laurel Rd.	Ontario	18S/47E-17Ac			147
MAL178	890310	D					1.7	
MAL178	890608	D					4.3	
MAL178	890608	A						213
MAL178	890815	D					3.9	
MAL178	890815	A						132
MAL178	891025	D					2.6	
MAL178	891025	A						107
MAL178	900301	D					3.2	
MAL178	900605	A					3.4	85.8
MAL180	890608	O	1776 Airport Rd.	Vale	18S/45E-30Dd	25		<0.1
MAL180	890608	D					4	
MAL180	890608	D-QA					4	
MAL180	890608	A						<0.1
MAL180	890817	A						<0.1
MAL180	890817	D					4.3	
MAL181	890310	D	53709 Reed Rd	Vale	18S/43E-26Dd	25	2.8	
MAL181	890310	A						<0.1
MAL181	890310	C						<0.1
MAL183	891024	D	City	Vale	18S/45E-29Db		5.1	
MAL183	891024	A						<0.1
MAL183	900418	A						<0.1
MAL183	900418	D					5	
MAL184	891024	D	City	Vale	18S/45E-29Db		1.5	
MAL184	891024	A						<0.1
MAL184	900418	A						<0.1
MAL184	900418	D					1.3	
MAL185	891024	A	City	Vale	18S/45E-29Db			<0.1
MAL185	891024	D					1.9	
MAL185	891024	D-QA					1.7	
MAL185	900418	A						<0.1
MAL185	900418	D					1.8	

NORTHERN MALHEUR COUNTY GROUNDWATER DATA

STORET STATION NAME	SAMPLING DATE (YYMMDD)	LAB	ADDRESS	CITY	QUADRANT T/R-Sqq	WELL DEPTH (FEET)	NO2+ NO3-N (PPM)	DACTHAL di-acid (PPB)
MAL187	891026	D	790 Railroad Ave.	Ontario	18S/46E-14Ca		0.23	<0.1
MAL187	891026	A						
MAL188	891026	D	790 Railroad Ave.	Ontario	18S/46E-14Ca		11	71
MAL188	891026	A						
MAL189	891026	D	790 Railroad Ave.	Ontario	18S/46E-14Ca	42	11	77
MAL189	891026	A					9.8	
MAL189	900111	D-GA					9.8	
MAL189	900111	D						29
MAL189	900111	A						18
MAL189	900111	G						4.8
MAL189	900301	A					8.9	
MAL189	900301	D						46.9
MAL189	900418	A					10	
MAL189	900418	D					10.3	64.5
MAL189	900405	A						10.5
MAL189	900814	A					7.7	
MAL189	900814	D						
MAL190	891025	D	4824 Pioneer Rd.	Ontario	17S/47E-2		11	35
MAL190	891025	A	417 Annex Road	Annex	15S/47E-29Da		9.9	
MAL190	900109	D						29
MAL190	900109	G						25
MAL190	900109	A						
MAL191	900109	D	5552 Hwy 95 Spur	Annex	15S/47E-28Bc		15	<0.1
MAL191	900109	A						
MAL192	900109	D	4739 Pioneer Rd.	Ontario	17S/47E-2Bd		9.4	29
MAL192	900109	A						30
MAL192	900109	G						
MAL193	900111	A	3130 SW 4th Ave.	Ontario	18S/47E-7Aa		27	161
MAL193	900111	D						
MAL194	900111	D	3725 SW 18th Ave.	Ontario	18S/47E-11		16	90
MAL194	900111	A						
MAL195	900111	A	552 Hwy 20/26	Ontario	18S/47E-19Ca		20	173
MAL195	900111	D						
MAL196	900111	D	538 Railroad Ave.	Ontario	18S/47E-18Dc		19	197
MAL196	900111	A						
MAL197	900111	D	828 Railroad Ave.	Ontario	18S/46E-15Dc		0.2	0.5
MAL197	900111	A						
MAL198	900111	A	741 Railroad Ave.	Ontario	18S/46E-14Dc		11	51
MAL198	900111	D						
MAL199	900227	D	621 Foothill Dr.	Ontario	17S/46E-34Da		5.2	<0.1
MAL199	900227	A					10	<0.1
MAL199	900405	A						
MAL200	900228	A	731 Onion Ave.	Ontario	17S/46E-26Ab		3.1	<0.1
MAL200	900228	D						
MAL201	900228	D	3447 Siphon Dr.	Ontario	17S/46E-26Ac		8.1	0.04
MAL201	900228	A						
MAL202	900228	A	650 Mendiola Rd.	Nyssa	21S/47E-12Cd		0.1	<0.1
MAL202	900228	D						

NORTHERN MALHEUR COUNTY GROUNDWATER DATA

STORET STATION NAME	SAMPLING DATE (YYMMDD)	LAB	ADDRESS	CITY	QUADRANT T/R-Sqq	WELL DEPTH (FEET)	NO2+ NO3-N (PPM)	DACTHAL di-acid (PPB)
MAL203	900228	A	3341 Hope Rd.	Vale	19S/44E-4Ba			<0.1
MAL203	900228	O						<0.1
MAL203	900228	D					0.33	
MAL204	900301	D	1791 Sand Hollow Rd.	Vale	19S/44E-12Dd		0.03	
MAL204	900301	A						0.02
MAL204	900301	A-QA						0.02
MAL204	900301	D-QA					0.03	
MAL205	900301	A	703 Ontario Hts Rd.	Ontario	17S/46E-26Aa			0.03
MAL205	900301	D					8.2	
MAL206	900301	A	552 Eastway Ln.	Ontario	17S/46E-30Bd			<0.1
MAL206	900301	D					8.7	
MAL207	900301	A	4205 Hopkin Rd.	Ontario	17S/46E-25Bc			0.02
MAL207	900301	D					5	
MAL208	900301	D	4553 Hyline Rd.	Ontario	17S/47E-16Cb		0.04	
MAL208	900301	A						<0.1
MAL209	900417	A	550 King Ave.	Ontario	18S/47E-31Cd			<0.1
MAL209	900417	D					<0.02	
MAL210	900417	A	418 King Ave.	Ontario	18S/47E-32Dd			<0.1
MAL210	900417	D					0.02	
MAL211	900419	A	506 Columbia Ave.	Nyssa	19S/46E-19Dd			3.6
MAL211	900419	D					46	
MAL211	900807	D					48	
MAL211	900807	O						2.7
MAL211	900807	O-QA						2.8
MAL212	900419	A-QA	1300 Grant Ln.	Nyssa	19S/47E-31Ad			0.1
MAL212	900419	D					7	
MAL212	900419	D-QA					6.9	
MAL212	900419	A						<0.1
MAL213	900419	A	747 Grand Ave.	Nyssa	20S/46E-14Aa			43.3
MAL213	900419	D					6.7	
MAL213	900807	A						11.2
MAL213	900807	D					7.3	
MAL214	900606	O	3396 Hwy 201	Nyssa	19S/47E-8Bb			8.1
MAL214	900606	D-QA					<0.02	
MAL214	900606	A					<1	8.8
MAL215	900606	A	3397 Hwy 201	Nyssa	19S/47E-8Bb		<1	17.9
MALP01	860312		3616 Hwy 201	Ontario		50	0.024	
MALP02	830216	E	SW 18th Ave.	Ontario	18S/47E-7Dc		32	
MALP02	830400	W					30	
MALP03	780614	W	off Hwy 201	Ontario	18S/47E-7Aa		12.6	
MALP03	780700	W					12.5	
MALP04	780614	W	off Hwy 201	Ontario	18S/47E-7Aa		4.69	
MALP04	780700	W					3.63	
MALP04		W					6.7	
MALP05	860314	S	444 SW 4th Str.	Ontario	18S/47E-11Ba			

NORTHERN MALHEUR COUNTY GROUNDWATER DATA

STORET STATION NAME	SAMPLING DATE (YYMMDD)	LAB	ADDRESS	CITY	QUADRANT T/R-Sqq	WELL DEPTH (FEET)	NO2+ NO3-N (PPM)	DACTHAL di-acid (PPB)
MALP05	860314	D					1.1	
MALP05	860314	E						0.4
MALP05	860314	O						0.9
MALP06	860314	D	444 SW 4th Str.	Ontario	18S/47E-11Ba		2.4	
MALP06	860314	E						0.2
OWY002	860313	O	RT. 3, Box 4703	Nyssa	20S/45E-25Dd	43		0.9
OWY002	860313	D					8.90	
OWY002	890607	D					4	
OWY002	890607	A						<0.1
OWY002	890816	D					3.9	
OWY002	890816	A						<0.1
OWY002	891024	A						<0.1
OWY002	891024	D					4.2	
OWY002	900110	D					2.4	
OWY002	900110	A						<0.T
OWY002	900228	A						<0.1
OWY002	900228	D					4.6	
OWY002	900606	A					5.1	<0.1
OWY002	900806	A						<0.1
OWY002	900807	D					4.1	
OWY009	860313	O	716 Owyhee Ave.	Nyssa	20S/44E-26Dd	30		<0.5
OWY009	860313	D					7.1	
OWY009	890419	A						<0.1
OWY009	890419	D					3.7	
OWY009	890607	D-QA					4.5	
OWY009	890607	A						<0.1
OWY009	890607	O						<0.1
OWY009	890607	D					4.3	
OWY009	890816	A						0.5
OWY009	890816	D					4.5	
OWY009	900110	D					3.4	
OWY009	900110	A						<0.1
OWY009	900606	A					3	0.6
OWY009	900807	O					6	
OWY010	890607	D	17 S. First	Nyssa	19S/47E-32Ac	256	0.03	
OWY010	890607	A						<0.1
OWY099	900110	D	713 Owyhee Blvd.	Nyssa	20S/44E-35Aa		3.2	
OWY099	900110	A						<0.1
OWY100	900110	D	2491 Hwy 201	Nyssa	20S/44E-35Aa		<0.02	
OWY100	900110	A						<0.1
OWY101	900110	A	2534 Norwood Dr.	Nyssa	20S/44E-30Da			11
OWY101	900110	O						8
OWY101	900110	D-QA					8.6	
OWY101	900110	D					8.9	
OWY101	900419	A						12.1
OWY101	900419	D					8.4	
OWY101	900606	A					10	14.6
OWY101	900807	A						4.8
OWY101	900807	O					8.5	
OWY102	900419	D	1500 Hampton Rd.	Adrian	22S/44E-13Dd		0.03	
OWY102	900419	A						0.2

NITRATE + NITRITE NITROGEN
in
Primary Indicator Wells
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled		20
Total Number of Analyses		166
Number of Duplicate Analyses		19
Mean Value Detected	16.4 mg/l	
Maximum Value Detected	48 mg/l	
Minimum Value Detected	0.37 mg/l	
Standard Deviation	9.05 mg/l	
75th Percentile	22.5 mg/l	
25th Percentile	10.3 mg/l	

NITRATE + NITRITE NITROGEN
in
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled		118
Total Number of Analyses		426
Number of Duplicate Analyses		36
Mean Value Detected	10.8 mg/l	
Maximum Value Detected	48 mg/l	
Minimum Value Detected	<0.02 mg/l	
Standard Deviation	9.04 mg/l	
75th Percentile	16.9 mg/l	
25th Percentile	4.7 mg/l	

DACTHAL
in
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled		118
Total Number of Analyses		426
Number of Duplicate Analyses		68

Mean Value Detected	58.1	mg/l
Maximum Value Detected	986	mg/l
Minimum Value Detected	0.01	mg/l
Standard Deviation	94.1	mg/l
75th Percentile	121.6	mg/l
25th Percentile	<0.01	mg/l

NH_3 + NH_4 NITROGEN in Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled		118
Total Number of Analyses		395
Number of Duplicate Analyses		36

Mean Value Detected	0.75	mg/l
Maximum Value Detected	15.0	mg/l
Minimum Value Detected	<0.02	mg/l
Standard Deviation	2.1	mg/l
75th Percentile	2.2	mg/l
25th Percentile	<0.02	mg/l

TOTAL KJELDAHL NITROGEN
in
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled		118
Total Number of Analyses		394
Number of Duplicate Analyses		36
Mean Value Detected	1.05 mg/l	
Maximum Value Detected	13.0 mg/l	
Minimum Value Detected	<0.02 mg/l	
Standard Deviation	2.0 mg/l	
75th Percentile	2.4 mg/l	
25th Percentile	<0.02 mg/l	

TOTAL PHOSPHATE PHOSPHOROUS
in
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled		118
Total Number of Analyses		394
Number of Duplicate Analyses		36
Mean Value Detected	0.209 mg/l	
Maximum Value Detected	2.0 mg/l	
Minimum Value Detected	<0.01 mg/l	
Standard Deviation	0.19 mg/l	
75th Percentile	0.34 mg/l	
25th Percentile	0.08 mg/l	

CHEMICAL OXYGEN DEMAND (COD)
in
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled		118
Total Number of Analyses		394
Number of Duplicate Analyses		36

Mean Value Detected	4.8 mg/l
Maximum Value Detected	27 mg/l
Minimum Value Detected	<5 mg/l
Standard Deviation	3.9 mg/l
75th Percentile	7.4 mg/l
25th Percentile	<5 mg/l

TOTAL ORGANIC CARBON (TOC)
in
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled		118
Total Number of Analyses		394
Number of Duplicate Analyses		36
Mean Value Detected	3.2 mg/l	
Maximum Value Detected	17 mg/l	
Minimum Value Detected	<1 mg/l	
Standard Deviation	1.7 mg/l	
75th Percentile	4.4 mg/l	
25th Percentile	2.1 mg/l	

SODIUM
in
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled		118
Total Number of Analyses		373
Number of Duplicate Analyses		34

Mean Value Detected	188.3	mg/l
Maximum Value Detected	1200	mg/l
Minimum Value Detected	14	mg/l
Standard Deviation	110.7	mg/l
75th Percentile	263.0	mg/l
25th Percentile	113.6	mg/l

POTASSIUM
in
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled	118
Total Number of Analyses	373
Number of Duplicate Analyses	35

Mean Value Detected	13.1	mg/l
Maximum Value Detected	43	mg/l
Minimum Value Detected	0.9	mg/l
Standard Deviation	6.52	mg/l
75th Percentile	17.5	mg/l
25th Percentile	8.7	mg/l

CALCIUM
in
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled		118
Total Number of Analyses		374
Number of Duplicate Analyses		35
Mean Value Detected	73.4 mg/l	
Maximum Value Detected	280 mg/l	
Minimum Value Detected	<2 mg/l	
Standard Deviation	31.2 mg/l	
75th Percentile	94.4 mg/l	
25th Percentile	52.3 mg/l	

MAGNESIUM
in
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled		118
Total Number of Analyses		374
Number of Duplicate Analyses		35

Mean Value Detected	35.0	mg/l
Maximum Value Detected	120	mg/l
Minimum Value Detected	<0.5	mg/l
Standard Deviation	15.9	mg/l
75th Percentile	45.8	mg/l
25th Percentile	24.3	mg/l

CHLORIDE
in
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled		118
Total Number of Analyses		375
Number of Duplicate Analyses		35
Mean Value Detected	56.7 mg/l	
Maximum Value Detected	450 mg/l	
Minimum Value Detected	0.42 mg/l	
Standard Deviation	52.2 mg/l	
75th Percentile	91.9 mg/l	
25th Percentile	21.5 mg/l	

SULFATE
in
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled		118
Total Number of Analyses		375
Number of Duplicate Analyses		35
Mean Value Detected	214.8 mg/l	
Maximum Value Detected	2800 mg/l	
Minimum Value Detected	1.6 mg/l	
Standard Deviation	202.5 mg/l	
75th Percentile	351.4 mg/l	
25th Percentile	78.2 mg/l	

TURBIDITY
in
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled		118
Total Number of Analyses		349
Number of Duplicate Analyses		33

Mean Value Detected	1.1	NTU
Maximum Value Detected	23	NTU
Minimum Value Detected	<1	NTU
Standard Deviation	2.3	NTU
75th Percentile	2.7	NTU
25th Percentile	<1	NTU

CALCULATED HARDNESS (as $CaCO_3$) in Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled		118
Total Number of Analyses		373
Number of Duplicate Analyses		35
Mean Value Detected	328.7 mg/l	
Maximum Value Detected	1200 mg/l	
Minimum Value Detected	20 mg/l	
Standard Deviation	126.2 mg/l	
75th Percentile	413.8 mg/l	
25th Percentile	243.6 mg/l	

TOTAL DISOLVED SOLIDS
in
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled		118
Total Number of Analyses		344
Number of Duplicate Analyses		33
Mean Value Detected	888.4 mg/l	
Maximum Value Detected	5300 mg/l	
Minimum Value Detected	240 mg/l	
Standard Deviation	402.0 mg/l	
75th Percentile	1159.5 mg/l	
25th Percentile	617.2 mg/l	

ARSENIC
in
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled		118
Total Number of Analyses		371
Number of Duplicate Analyses		34

Mean Value Detected	0.0387	mg/l
Maximum Value Detected	0.322	mg/l
Minimum Value Detected	<0.005	mg/l
Standard Deviation	0.0441	mg/l
75th Percentile	0.0684	mg/l
25th Percentile	0.0089	mg/l

IRON
in
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled	**118**
Total Number of Analyses	**370**
Number of Duplicate Analyses	**35**

Mean Value Detected	**0.135**	**mg/l**
Maximum Value Detected	**4.2**	**mg/l**
Minimum Value Detected	**<0.05**	**mg/l**
Standard Deviation	**0.391**	**mg/l**
75th Percentile	**0.399**	**mg/l**
25th Percentile	**<0.05**	**mg/l**

MANGANESE
in
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled		118
Total Number of Analyses		370
Number of Duplicate Analyses		35
Mean Value Detected	0.339 mg/l	
Maximum Value Detected	90 mg/l	
Minimum Value Detected	<0.02 mg/l	
Standard Deviation	4.908 mg/l	
75th Percentile	3.650 mg/l	
25th Percentile	<0.02 mg/l	

SILICON (as SiO_2)
in
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled		118
Total Number of Analyses		298
Number of Duplicate Analyses		28

Mean Value Detected	54.3 mg/l
Maximum Value Detected	76 mg/l
Minimum Value Detected	9 mg/l
Standard Deviation	10.0 mg/l
75th Percentile	61.0 mg/l
25th Percentile	47.6 mg/l

BORON
in
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled	118
Total Number of Analyses	323
Number of Duplicate Analyses	30

Mean Value Detected	0.431	mg/l
Maximum Value Detected	5.3	mg/l
Minimum Value Detected	0.07	mg/l
Standard Deviation	0.481	mg/l
75th Percentile	0.755	mg/l
25th Percentile	0.107	mg/l

ALKALINITY (as $CaCO_3$)
in
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled		118
Total Number of Analyses		385
Number of Duplicate Analyses		47
Mean Value Detected	389.9 mg/l	
Maximum Value Detected	818 mg/l	
Minimum Value Detected	141 mg/l	
Standard Deviation	96.4 mg/l	
75th Percentile	455.0 mg/l	
25th Percentile	324.9 mg/l	

pH in Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled		118
Total Number of Analyses		418
Number of Duplicate Analyses		58

Mean Value Detected	7.72	SU
Maximum Value Detected	8.4	SU
Minimum Value Detected	7.0	SU
Standard Deviation	0.20	SU
75th Percentile	7.85	SU
25th Percentile	7.59	SU

CONDUCTIVITY
in
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled	118	
Total Number of Analyses	417	
Number of Duplicate Analyses	57	
Mean Value Detected	1352.9	uMhos/cm
Maximum Value Detected	6396	uMhos/cm
Minimum Value Detected	350	uMhos/cm
Standard Deviation	513.0	uMhos/cm
75th Percentile	1699.0	uMhos/cm
25th Percentile	1006.9	uMhos/cm

WATER TEMPERATURE
in
Northern Malheur County Groundwater

(Aug 1988 through Aug 1990)

Number of Wells Sampled		118
Total Number of Analyses		429
Number of Duplicate Analyses		40
Mean Value Detected	14.33 °C	
Maximum Value Detected	26.2 °C	
Minimum Value Detected	7.0 °C	
Standard Deviation	2.04 °C	
75th Percentile	15.71 °C	
25th Percentile	12.96 °C	

Indicator Well Network

1. MAL012 — Well Depth - 59ft.
2. MAL016 — Well Depth - 30ft.
3. MAL030 — Well Depth - 50ft.
4. MAL035 — Well Depth - __ft.
5. MAL041 — Well Depth - 61ft.
6. MAL044 — Well Depth - 86ft.
7. MAL047 — Well Depth - 45ft.
8. MAL062 — Well Depth - 77ft.
9. MAL064 — Well Depth - 55ft.
10. MAL105 — Well Depth - 39ft.
11. MAL108 — Well Depth - 44ft.
12. MAL116 — Well Depth - 38ft.
13. MAL119 — Well Depth - 40ft.
14. MAL121 — Well Depth - 33ft.
15. MAL125 — Well Depth - 35ft.
16. MAL136 — Well Depth - 40ft.
17. MAL147 — Well Depth - 44ft.
18. MAL164 — Well Depth - 145ft.
19. MAL172 — Well Depth - 33ft.
20. MAL175 — Well Depth - 65ft.
21. MAL211 — Well Depth - 23ft.
22. OWY002 — Well Depth - 43ft.
23. OWY101 — Well Dept - __ft.

Surface Water Data

NORTHERN MALHEUR COUNTY - SURFACE WATERS

STATION NAME	SAMPLING DATE (YYMMDD)	SITE	LOCATION	QUADRANT T/R-Sqq	NO2+ NO3-N (ppm)	DACTHAL di-acid (ppb)	DACTHAL di-acid [Duplicate] (ppb)
RIV001	890418	Malheur River	36th Ave. Bridge	17S/47E-31Cdcc	0.79	3	
RIV001	890815				0.04	35	
RIV001	891025				3.1	6	
RIV001	900109				2.8	9	
RIV001	900227				3.1	10.2	8.1
RIV001	900417				3.4	2.8	
RIV001	900605				3.4	6.9	
DRN001	890815	Dork Canal	Malheur Drive & Dork Canal	17S/47E-32Dccc	3.6	55	
DRN001	900109				10	47	
DRN001	900417				5.3	12.3	
DRN001	900606				4.4	20.2	
DRN002	890816	Halliday Drain	Bultler Blvd & Golf Course Rd	18S/47E-7Cccc	0.83	2	
DRN002	900417				0.46	1.5	
DRN002	900605				<1	1.3	
DRN003	890816	Arcadia Drain	Arcadia & King Rds	18S/47E-32Dcdc	3	9	
DRN003	900109				6.6	22	
DRN003	900417				2.4	8.9	
DRN003	900606				3.5	8.5	
DRN004	890815	Stewart Carter Ditch	at Butler Blvd	18S/47E-8Dcdc	6.4	272	
DRN004	900417				3.2	18.8	
DRN004	900606				3.5	24.9	
DRN005	890816	Hwy 201 Drain	Hwy 201 btwn King & Morgan Rds	18S/47E-32Bccc	4	ND	
DRN005	900109				11	39	
DRN005	900418				3.6	12.7	
DRN005	900606				8.3	23.3	
OWYDRN001	900815	Overstreet Drain		20S/46E-33Ccdb	0.9	0.19	
OWYDRN002	900815	Fletcher Gulch		20S/46E-31Cadb	1.7	1.1	

APPENDIX C

NITROGEN UPTAKE AND REMOVAL

BY

SELECTED CROPS

Prepared By:

Technical Subcommittee
and
Oregon State University
Malheur Experiment Station

APPENDIX C

NITROGEN UPTAKE AND REMOVAL BY SELECTED CROPS

Clint Shock and Tim Stieber
Malheur Experiment Station
Oregon State University
Ontario, Oregon, 97914

Objectives

Crop nitrogen use and nitrogen removal at harvest have not been determined for Malheur County crops. Nitrogen fertilizer management trials in 1990 can be used to provide nitrogen uptake and nitrogen removal for five crops.

Procedures

Sugar beets, onions, wheat, and barley were grown on Owyhee silt loam and potatoes were grown on a Nyssa silt loam at the Malheur Experiment Station. Experiments were designed to study crop responses to nitrogen fertilizer, the efficiency of nitrogen uptake, and the movement of nitrate and ammonium in the soil profile.

Crop yield was determined for all crops. Plants were sampled before or at harvest. Plant parts were divided into harvested and non-harvested portions and analyzed for nitrogen content to provide estimates of total nitrogen uptake, nitrogen removed in the harvested portion, and nitrogen in the remainder of the plant. Plants were divided as follows:

Crop	Harvested Portion	Remainder	Not Measured
Wheat	Grain	Stubble	Roots
Sugar Beets	Beet	Leaves and crown	Fine roots
Onions	Bulb	Leaves and neck	Fine roots
Potatoes	Tuber	Leaves and stems	Roots
Barley	Grain	Stubble	Roots

Results and Discussion

Nitrogen needs for plant development were estimated for five crops using the 1990 results at the Malheur Experiment Station (Table 1). Plant nitrogen content per unit yield was averaged over the entire range of nitrogen treatments for each crop. Comprehensive estimates of average nitrogen available from irrigation water and average nitrogen available from organic matter mineralization were not considered. Nitrogen uptake and removal by these same five crops can be estimated for Malheur County. Lynn Jensen and Ben Simko (Malheur County Cooperative Extension, OSU) have recently surveyed Malheur County fertilization practices, agricultural chemical use, and yields. In addition Gary Schneider (Malheur county Cooperative Extension, OSU) regularly publishes estimated average crop yields and acreage, Combining average nitrogen contents in (Table 1) with average yield from Jensen and Simko provides an estimate of average crop nitrogen uptake (Table 2). Using the acreage estimates of Gary Schneider, relative nitrogen loading can be estimated for four crops (Table 3).

The "estimated nitrogen balance" is a rough approximation for the total of all Malheur County acreage for four crops (Table 3). Onions and potatoes show positive nitrogen balances based on average grower N applications and yield but actual balances vary from field to field. If a particular crop in a given field receives more nitrogen fertilizer than there is crop nitrogen removal, the "extra" nitrogen is not automatically leached to the groundwater. Part of fertilizer nitrogen is lost to the atmosphere, lost in runoff water, or becomes part of the residual soil nitrogen supply. Residual soil nitrogen occurs in many chemical and biological forms. These forms include nitrate, ammonium, and nitrogen in the organic matter. The fate of fertilizer nitrogen is strongly influenced by application timing, placement, fertilizer form, irrigation management, and other factors which vary from field to field and vary among growers. Through a better understanding of all nitrogen movements, nitrogen use efficiency can be increased.

Table 1. Nitrogen uptake and removal by five crops grown in Malheur County Oregon. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1990[c].

Crop	Number of Plots Measured for Nitrogen	Available Soil N at Planting	Range of Applied N Fertilizer	Average Yield	Average Total Plant Uptake	Average N in Harvested Crop	Average Pounds of N Per Unit Yield: In Harvested Portion	Average Pounds of N Per Unit Yield: Total Uptake
		-- lbs N/acre --			-- lbs N/acre --		----- lbs -----	
Wheat	30	246[a]	0-200	162 bu/ac	266	211	1.28/bu	1.63/bu
Sugar beets	12	57[a]	100-220	43.6 t/ac	331	189	4.33/ton	7.62/ton
Onions	108	67[b]	0-400	506 cwt/ac	102	81	0.16/cwt	0.21/cwt
Potatoes	24	159[b]	40	484 cwt/ac	196	157	0.32/cwt	0.40/cwt
Barley	29	246[a]	0-200	137 bu/ac	177	133	0.96/bu	1.28/bu

[a] based on nitrate and ammonium in the top 3 feet of soil
[b] based on the nitrate and ammonium in the top foot of soil
[c] numbers in the table are not consistent to the last digit because each number is based on the average of the actual field data, not calculated from previous columns

Table 2. Average Malheur County crop yield, N fertilization, estimated crop N uptake, and estimated fertilizer carry over. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1990.

Crop	Average Yield	Average N applied	Estimated Average N Uptake: Total Plant Uptake	Estimated Average N Uptake: In Harvested Portion	Estimated Average N Uptake: N in Crop Residue after Harvest	Estimated Fertilizer N Carryover
		lbs/acre	-------- lbs/acre		-------	lbs/ac
1. Alfalfa hay	4.5 t/ac[b]	0	*	*	*	*
2. Wheat	111 bu/ac[a]	136[a]	181[c]	142[c]	39[c]	-45
3. Sugar beets	31.3 t/ac[a]	205[a]	239[c]	136[c]	103[c]	-34
4. Onions	621 cwt/ac[a]	284[a]	130[c]	99[c]	31[c]	154
5. Potatoes	405 cwt/ac[a]	215[a]	162[c]	130[c]	32[c]	53
6. Alfalfa Seed	542 lbs/ac[b]	0	*	*	*	*
7. Dry Beans	25.4 cwt/ac[a]	74[a]	*	*	*	*
8. Corn (grain)	132 bu/ac[b]	*	*	*	*	*
9. Corn (silage)	21.3 t/ac[b]	*	*	*	*	*
10. Sweet corn	8.02 tons/ac[a]	204[a]	*	*	*	*
11. Barley	82 bu/ac[b]	*	105[c]	79[c]	26[c]	*
12. Mint	75 lb/ac[b]	*	*	*	*	*
13. Others	*	*	*	*	*	*

a) based on the 1991 survey of crop production practices by Lynn Jensen and Ben [illegible], OSU extension.
b) based on the 1988-1989 data collected by Gary Schneider, OSU extension.
c) based on 1990 crop research at the Malheur Experiment Station as presented in Table 1 and survey yields by Jensen and Simko.
* data not yet determined

Table 3. Estimated relative nitrogen loading from Malheur County irrigated crops and forages. Malheur Experiment Station, Oregon State University, Ontario, Oregon, 1990.

Crop	Irrigated Crop And Pasture Area[a]	Balance Of Nitrogen Fertilization And Crop Uptake: Net Nitrogen Remaining In Field After Crop Harvest[b]				
		Per Acre		County Wide		
		Crop Residue N	Mineral N	Crop Residue N	Mineral N	Total N
	acres	lbs/ac		Total lbs of N		
1. Alfalfa hay	53,000	*	*	*	*	*
2. Wheat	32,800	39	-45	1,279,200	-1,476,000	-196,800
3. Sugar beets	16,300	103	-34	1,678,900	-554,200	1,124,700
4. Onions	9,620	31	154	298,220	1,481,480	1,779,700
5. Potatoes	7,300	32	53	233,600	386,900	620,500
6. Alfalfa Seed	7,300	*	*	*	*	*
7. Dry Beans	7,200	*	*	*	*	*
8. Corn (grain)	6,400	*	*	*	*	*
9. Corn (silage)	6,400	*	*	*	*	*
10. Sweet corn	4,125	*	*	*	*	*
11. Barley	4,000	*	*	*	*	*
12. Mint	2,350	*	*	*	*	*
13. Others	113,205	*	*	*	*	*
Total	270,000	Incomplete data to tabulate total loading				

[a] Based on the 1991 survey of crop acreages by Gary Schneider, OSU extension.

[b] Based on 1990 crop research at the Malheur Experiment Station as presented in Table 1 and survey results by Jensen and Simko.

* data not yet determined

APPENDIX D

EXAMPLE BEST MANAGEMENT PRACTICES

FOR

USE IN FARM PLANS

Prepared By:

Technical Subcommittee

APPENDIX D

EXAMPLE BMPs MANAGEMENT PRACTICES FOR USE IN FARM PLANS

What are BMPs?

No one set of Best Management Practices can be applied uniformly throughout the county. In order to implement BMPs, a farmer can work with the technical staff of the Soil Conservation Service, the County Extension Office, or the SWCD. They can design the practices that will best address the soils, topography, climate, and crop rotation the farmer is dealing with. Since BMPs can be site specific to an individual field, the plan can also define other various alternative practices that can be applied to improve water quality.

The term "Best Management Practices" originates with the rules and regulations developed pursuant to the "continuing planning process" required by Section 208 of the Federal Water Pollution Control Act.

The Federal Register defines BMPs as follows:

> "The term Best Management Practices means a practice or a combination of practices that is determined by a state (or designated area-wide planning agency) after problem assessment examination of alternative practices and appropriate (including technological, economic, and institutional considerations) means of preventing or reducing the amount of pollution generated by non-point sources to a level compatible with water quality goals."

The Federal Register also states several criteria or tests which should be applied in choosing BMPs. They are:

1. Best Management Practices should manage "pollution generated by non-point sources."

2. Best Management Practices should be "compatible with water quality goals."

3. Best Management Practices should be "most efficient in preventing or deducing the amount of pollution generated."

4. Best Management Practices should be "practicable."

A list of Best Management Practices that would address groundwater quality would include:

1. ***Nutrient Management*** -- Managing the amount, form, placement, and timing of applications of plant nutrients. Some specific examples of this practice may include:

   a. **Soil and Water Testing**.

   Prior to applying nitrogen fertilizer, soil test should be conducted to determine the amount of available nitrogen in the soil profile prior to planting a crop or applying additional nitrogen fertilizer. Nitrogen available in the soil profile should be considered and incorporated in the calculations used to determine the amount of nitrogen fertilizer to be applied. In addition, irrigation water should also be tested periodically to determine the relative nitrate/nitrite contribution resulting from use of the water.

   b. **Nitrogen Applications for Potatoes**.

   - Sample soil to determine the nitrogen fertilizer deficiency to produce the crop.

- Apply the balance of nutrients that the soil test results indicates is required to meet the total uptake of the crop.

- Nitrogen fertilizer shall not be applied after the last day of June during a growing season, unless the crop has been shown to be nitrogen deficient.

- Total nitrogen fertilizer applied during a given growing season shall not exceed 200 pounds of active nitrogen per acre, unless the crop has been shown to be nitrogen deficient.

- Crop rotation patterns shall restrict potato production to a maximum of once every three years.

c. <u>Nitrogen Applications for Onions</u>.

- Sample soil to determine the fertilizer deficiency to produce the crop.

- Between planting and 125 days after planting, apply the nitrogen fertilizer deficiency, as determined by the soil test.

- Nitrogen fertilizer shall not be applied after the last day of July in a particular growing season, unless the crop has been shown to be nitrogen deficient.

- Total nitrogen fertilizer applied during a growing season shall not exceed 300 pounds of active nitrogen per acre, unless the crop has ben shown to be nitrogen deficient.

- Crop rotation patterns should restrict onion production to a maximum of two out of four years.

d. <u>Nitrogen Applications for Sugar Beets.</u>

- Sample soil to a minimum of 3 ft. or hard pan to determine the fertilizer deficiency to product the crop.

- If the soil test indicates the available nitrogen is less than the recommended rate of 8 lbs. nitrogen per ton of beets anticipated at harvest, apply the amount of nitrogen to reach the recommended rate.

- Petiole sampling and testing will be performed periodically during the growing season to manage nitrogen applications.

- Total nitrogen fertilizer applied during a growing season should not exceed 300 pounds of active nitrogen per acre, unless the crop has been shown to be nitrogen deficient.

- Crop rotation patterns shall restrict beet production to a maximum of once every three years.

- Nitrogen fertilizer shall not be applied after July 15th during a particular growing season.

e. Nitrogen fertilizer should only be applied in the spring or during the growing season.

f. When using water run nitrogen, the nitrogen in the irrigation tailwater needs to be minimized.

2. Pest Management Managing agricultural pest infestations (including weeds, insects and diseases) to

reduce adverse effects on plant growth, crop production and environmental resources. An example of this practice is:

To control weeds in Onions, *Dacthal* will be applied by banding along the furrow. This is to replace the former practice of applying *Dacthal* by broadcasting. This practice reduces the amount of *Dacthal* applied and subsequently reduces the amount of *Dacthal di-acid* available to reach and impact the groundwater by one third.

3. ***Conservation Cropping Sequence*** -- An adapted sequence of crops designed to provide adequate organic residue for maintenance or improvement of soil tilth or improve water quality.

4. ***Grass and Legumes in Rotation*** -- Establishing grasses and legumes or a mixture of them and maintaining the stand for a definite number of years a part of a conservation cropping system.

5. ***Mulching*** -- Applying plant residues or other suitable materials not produced on the site to the soil. This practice applies to mulching irrigation furrows to reduce furrow erosion, conserve water and improve water quality.

6. ***Irrigation Water Management*** -- Determining and controlling the rate, amount, and timing of irrigation water, in a planned and efficient manner which prevents or minimizes soil erosion, sedimentation, and nutrient loss.

7. ***Irrigation Water Conveyance/Pipeline*** -- A pipeline and appurtenances in an irrigation system.

8. ***Irrigation Water Conveyance/Ditch Lining*** -- A fixed lining of impervious material installed in an existing

on newly constructed irrigation field ditch or irrigation canal or lateral.

9. *Irrigation Water Conveyance/Gated Pipe* -- A rigid pipeline, with closely spaced gates, installed a part of a surface irrigation system.

10. *Irrigation System/Sprinkler* -- A planned irrigation system in which all necessary facilities are installed for efficiently applying water by means of nozzles operated under pressure.

11. *Irrigation System/Surface* -- A planned irrigation system in which all necessary water-control structures have been installed for the efficient distribution of irrigation water by surface means, such as furrows or corrugations.

12. *Structure for Water Control* -- A structure in an irrigation, drainage, or other water management systems that conveys water, controls the direction or rate of flow, or maintains a desired water surface elevation.

13. *Irrigation System/Tail Water Recovery* -- A facility to collect, sore, and transport irrigation tail water for reuse in a farm irrigation distribution system.

APPENDIX E

MALHEUR COUNTY AGRICULTURE

Prepared By:

Oregon
State University Malheur Extension Service

MALHEUR COUNTY

AGRICULTURE

PREPARED BY:

OREGON STATE UNIVERSITY EXTENSION SERVICE
MALHEUR COUNTY OFFICE

APPENDIX E

MALHEUR COUNTY AGRICULTURE

GENERAL DESCRIPTION

Malheur County is located in the southeast corner of Oregon bordered by Idaho to the east, Nevada to the south, Harney County to the west and Baker County to the north. The name which Malheur County bears was first given to the Malheur River by a party of French trappers who referred to it as "Riviere-au-Malheur" (unfortunate river) because of property and furs stolen from their river encampment.

Formerly a part of Baker County, Malheur County is the second largest in Oregon and 12th largest in the nation with an area of 9926 square miles. It is larger than eight individual states. Population of the county is 26,000.

Malheur County is 94 percent rangeland, two-thirds of which is controlled by the Bureau of Land Management. The Basques settled in Jordan Valley in the 1890's and were primarily engaged in sheep raising. Agriculture plays the dominant role in the county's economy. Today, the irrigated fields of the northeastern corner, known as Western Treasure Valley, are the center of intensive and diversified farming.

Elevations range from around 2,000 feet near the Snake River to the mountainous plateaus that reach about 5,000 feet with isolated peaks up to 6,000 feet. Vale, the county seat, has an elevation of 2243 feet.

CLIMATE

The CLIMATE in Malheur County is characterized by its cold winters, hot summers, and low annual precipitation. The average date for the last spring frost is May 3 and the first fall frost is October 7. The 1986-88 three year average heat units (growing degree days) is 3292 using a base of 50 degrees and an 86 degree F maximum cutoff. The average high temperature for the month of July is 92 degrees F and the average number of days above 100 degrees F for the entire year is five. The average low temperature for the month of January is 19 degrees F and the average number of days below zero for the year is four. Average annual snowfall is 18 inches. The all time annual record for most days below zero is 36 and the all time record for most days over 100 degrees F is 17. The annual precipitation ranges from 5 to 16 inches with an average of 10 in the lower elevations and from 8 to 14 inches in the upper basin areas. Mean temperature at Ontario is 50.2 degrees with a frost free season of 158 days.

SOILS

The SOILS in the irrigated areas of Malheur County consist of low elevation terraces and flood plains that have been reworked through the years by wind and water. The soils are generally quite deep and are characterized by high silt concentrations. Many soils will be in the range of 60-70% silt, 15-20% clay, and 5-10% sand. The majority of the irrigated soils are very productive. Native soils have a pH of 7.5 to 8.5 and are generally high in potash. Soils are becoming more acid due to heavy use of acid-residue fertilizers. The organic matter ranges from one to one-and-a-quarter percent. Soils of the lower flood plains of the Owyhee, Malheur, Willow Creek and the Snake River tend to be alkaline with pH's ranging from 8.5 to 10.0. These soils in order to become productive, must be drained and treated for alkali reclamation.

WATER RESOURCES

The Owyhee, Malheur and Snake Rivers are major streams of the county, providing irrigation water. Jordan Creek, Bully Creek, Willow Creek and other tributaries contribute significantly to the irrigation water supply.

Owyhee, Antelope, Warm Springs, Beulah, Bully Creek and Malheur Reservoirs provide storage so that stream flow can be regulated and released as needed during the irrigation season. These reservoirs also provide recreation in the form of fishing and boating.

There are approximately 260,000 irrigated acres in the county served by stored water, river flow and intermittent stream flow. Control and management of the irrigation water resource rests with a number of irrigation districts each with a governing body and some sharing management with other districts. Inter-district coordination assures most effective use of the water resource.

Development of control and distribution systems has been both by private companies and under Federal Bureau of Reclamation projects.

The Vale area is served by both a Bureau of Reclamation project and private company known as Warm Springs Irrigation District. Water for that area and part of the area between Vale and Ontario comes from the Malheur River with three reservoirs (Beulah, Warm Springs and Bully Creek) storing water for later release into the system.

The Jamieson-Brogan area is served by the Orchard Ditch Company with the Malheur Reservoir and Willow Creek as supply sources. The Jordan Valley area relies on Antelope Reservoir and Jordan

Creek plus intermittent local stream flow for water. The area between Ridgeview and the north end of the project near Weiser receives water from Owyhee Reservoir with supplemental ater pumped from the Snake River. One pumping plant is located between Nyssa and Adrian and the other in the Dead Ox Flat area.

The Malheur Siphon which crosses the valley just west of Cairo Junction carries the north canal to the Hyline area, Dead Ox Flat area and north to the end of the project. The north canal also serves an area along the north side of the valley between Vale and Ontario.

Hyline Farms and Skyline Farms located north and west of Ontario are private developments utilizing water pumped from the Malheur and Snake Rivers.

WATER DISTRIBUTION

Water is distributed by the irrigation district from the point of diversion (storage, river diversion) through the main canal to a system of smaller canals and laterals to a diversion point at or near the individual farm at which point it is put into the farm's distribution system.

Water is adjudicated to specific areas of land and is allocated in a specific amount to those areas. There are provisions for delivering water in excess of the allocation subject to availability of water and at additional cost.

Growers on the Vale project are normally allocated 3.4 feet per acre per season at a total cost of $20.05 per acre. The cost is broken down as follows: $16.25/ac. operation and maintenance and $3.80/ac. repayment on project construction loan. On the Warm Springs district growers pay $37.00/ac for the first 5 acres and $17.25 per acre for each acre above 5 for operation and maintenance with no construction indebtedness. Their normal water allocation is 3.0 feet/acre/season.

On the Owyhee Project 4.0 acre feet/acre is the base allocation, again with provision for delivering in excess of this amount when available. Growers pay $25.18/ac for operation and maintenance plus $.50 for construction repayment for a total of $25.68. An additional fee of $6.78/ac foot is also levied for water delivered in excess of the 4.0 acre feet/acre allocation.

The North Canal of the Owyhee project extends 72 miles and carries 1,000 cu. ft. per second or 2,000 acre feet per day at the point of diversion, spilling about 8 second feet at the north end. This water is diverted into some 348 miles of laterals along the way to its destination on the farms served by the project. A total of 65,606 acres are irrigated by the North Canal.

WATER APPLICATION

Surface irrigation is the principal method of application. Surface irrigation methods range from wild flooding on pasture lands to controlling the water through corrugates or furrows. To improve the efficiency of surface irrigation and better control the application of irrigation water, farmers have invested heavily in land leveling and in cement ditches. Leveling costs vary with topography but $200.00 per acre is about average. Concrete ditches cost about $4.35 per linear foot for the usual field ditch, including the cost of establishing the base for the ditch. Thousands of acres have been leveled to establish uniform grades for best water control. Literally hundreds of miles of concrete ditches have been installed which reduce seepage, improve water transportation efficiency, enable farmers to more effectively control weeds and reduce irrigation labor. Portable checks control water level in the ditch and farmers use siphon tubes to bring the water over the ditch bank and direct it into the field furrow.

ROW CROPS

Malheur County ranks first in the state of Oregon in terms of production and acreage of onions and sugar beets and fourth in potato production. These three crops contributed $64 million to the county agricultural income in 1989, with onions leading the way at $30,159,000. These three crops have a very large impact on the county economy in terms of jobs created by processing and handling in addition to the field production end of it.

Onions are generally considered the most important cash crop in Malheur County. All are produced for the open market which can be quite volatile. The county's overall economy can be impacted quite heavily by the fluctuating onion market. A large majority of the onions produced are yellow, Sweet Spanish. Some acreage is also being planted to reds and whites. Onions are packed locally and then shipped by truck or rail to eastern markets. Some are also marketed in Japan. Onion growers are highly organized and meet regularly through promotion, marketing and research committees. A voluntary checkoff from each sack marketed provides funding for marketing research and promotion programs.

Over 90% of the potatoes in the county are produced for processing under contract with two primary processors. Contracts are continually becoming more stringent based on quality. It has been a strong trend in recent years for potato producers to convert to sprinkler irrigation in order to make it easier to achieve quality standards compared to the traditional furrow irrigation technique. However, converting to sprinkler is very expensive and the economic justification is questionable. Potatoes are the most difficult crop to produce because of their sensitivity to heat stress which makes it imperative that excellent irrigation techniques be practiced. Potato acreage in the county has declined the past several years due primarily to market conditions. Potato growers have their own bargaining association that negotiates contracts either on a one or two year basis.

Sugar beets are a traditonal row crop that have been produced in Malheur County for many years. All are grown under contract with the Amalgamated Sugar Company located at Nyssa. The beet growers association through its executive secretary and elected board of directors negotiate contracts with the beet company. The beet company regulates the number of acres and subsequent production that can be produced based on the plant's processing capacity. The sugar beet plant contributes heavily to local employment. In addition to the permanent employees, several hundred seasonal employees are hired through the winter months to handle the processing requirements. Sugar beets are a relatively stable crop in terms of price and yield and contribute significantly to the county agricultural economy.

SEED CROPS

Alfalfa seed contributes the largest portion to our seed production industry with 7,300 acres produced in 1990. Other seed crops include red clover, plus various vegetable and flower seeds. Both private and public varieties of alfalfa seed are produced whereas the vegetable seed and flower seed are all produced under private contracts in relatively small acreages of each. A large percentage of the clover and alfalfa seed is produced under the guidelines of the Oregon State University seed certification program. This ensures the producer and consumer that the seed is produced according to strict quality standards that are enforced by the seed certification program. Leafcutter bees contribute heavily towards the pollination of alfalfa seed, and are an important aspect of overall alfalfa seed production and management.

CEREAL CROPS

Wheat is the major cereal crop produced. Soft white wheat is famous in world markets for quality pasta and pastries. In addition to serving as a cash crop wheat is also produced as a rotation crop with row crops in order to maintain clean, disease free soil. Over 90% of the wheat is raised on irrigated soil. Barley is raised primarily as a feed grain and is primarily locally consumed by feed lots and dairies. It is an excellent feed source.

Field corn is also raised for grain that is also mostly consumed locally by feedlots and dairies. It too provides an excellent source of feed for local cattle needs.

FORAGE CROPS

Malheur County produces more alfalfa hay than any other county in Oregon at over 50,000 acres per year. Eighty-five percent of the alfalfa hay produced in the county is either fed by the producer or sold for local consumption. Some is shipped to western Oregon for dairy feed. Alfalfa, commonly referred to as the queen of forages, provides over 200,000 tons of hay each year to the local cattle and dairy industry. The best quality is normally utilized by dairies and the remainder is utilized as feeder hay. The outlying areas of the county also produce considerable acreages of other types of hay such as grass and rye that is consumed locally.

Corn grown for silage also is very common in the county. It is all fed locally, either by the grower or nearby neighbors. It contributes heavily to the nutrient requirements for local dairy cattle and also feedlots.

About 40,000 irrigated acres are devoted to pasture production. The majority of pasture is produced on ground that is not well suited for intensive farming. The ground may either be too steep or too shallow for annual cropping but it still is quite productive for producing feed. The majority of pasture is utilized by beef cattle with some also being produced on dairies as well as sheep operations.

OTHER CROPS

Dry field beans contribute quite heavily toward the agricultural economy of the county. Several thousand acres are grown each year. Some are grown under contract. Prices fluctuate considerably from year to year and consequently acreages also fluctuate. Dry beans are a relatively easy crop to grow and can fit into rotations in many instances.

Sweet corn is also grown locally under contract with two major processors. A bargaining group of producers elected locally negotiate with the processors for a fair contract. The processors determine when the corn will be planted and also provide the equipment and manpower for harvesting and transporting to the processing plants.

Peppermint and spearmint are produced by a few producers in the county. All of the mint is processed locally and marketed out of the area. It is a specialized crop that requires specialized processing equipment.

Other crops include relatively small acreages of fruit such as apples, cherries, peaches, pears, as well as minor acreages of berries. A large mushroom operation located at Vale contributes significantly to the agricultural economy by providing employment and also utilizing straw in part of its production process.

CATTLE

Malheur County has more beef cows (70,000) than any county in Oregon. Commercial herds average about 500 cows. Gross income from cattle was $48 million in 1990. A large percentage of the beef cattle are located in the outlying areas of the county. Most of these operators run on BLM rangeland as well as deeded property. The 4.5 million acres of public rangeland in the county comprises 75% of our total land base. Rangeland contributes heavily toward our cow and calf operations and is a significant segment of many ranch operations. Most ranch operations operate as cow/calf and some of them retain their calves the following year and market them as yearlings.

Several feedlots operate in the county that purchase locally grown feed.

DAIRY

The Malheur County dairy industry ranks fifth in the state in regards to milk sales and averages around $12 million annually. Most of the dairies are located within the Owyhee and Malheur drainage systems.

Most dairies produce a significant portion of their roughages in the form of hay, silage and pasture. Since there are no milk processors located in Malheur County, all of the milk produced in the county is processed in Idaho. There are two dairy cooperatives and one proprietory handler that bottle milk and there are also two cheese plants that purchase manufacturing grade milk from local producers. About one-half of the county's dairymen produce grade A milk which means they are inspected regularly by the Oregon State Department of Agriculture. Only grade A milk can be bottled. Grade B or manufacturing grade milk is used only in manufactured products such as cheese, butter, ice cream and powdered milk. Idaho Department of Agriculture provide inspectors for manufacturing grade dairies. Malheur County dairies are becoming fewer and larger which parallels the nationwide trend. Production per cow is increasing at a rapid rate due to increased technology and improved genetics.

1990
ESTIMATE OF MALHEUR COUNTY GROSS AGRICULTURE INCOME

CROP	ACREAGE	YIELD/ACRE		ESTIMATED SALES
Sugar Beets	16,3000	31.5	Tons	$19,768,000.
Potatoes	7,300	371.	Cwt	$14,403,000.
Onions	9,620	570.	Cwt	$30.159,000.
Alfalfa Hay	53,000	4.5	Tons	$4,472,000.
Alfalfa Seed	7,300	625.	Lbs	$5,472,000.
Wheat	32,800	90.	Bu	$7.522,000.
Barley	4,000	80.	Bu	$589,000.
Dry Field Beans	7,200	20.	Cwt	$3,600,000.
Corn (grain)	6,400	126.	Bu	$1,502,000.
Corn Silage	6,400	21.1	Tons	$894,000.
Sweet Corn	4,125	7.2	Tons	$1,901,000.
Peppermint & Spearmint	2,350	70 Lbs.	+ 90 Lbs.	$2,685,000.
Other Crops (Fruit, Vegetable Seed, Red Clover Seed, Mushrooms, Meadow hay, Oats & Rye & Miscellaneous)				$5,472,000.
Cattle.	66,000 Cows			$48,459,000.
Sheep	12,000 Ewes			$334,000.
Hogs	1500 Head			$329,000.
Milk	6500 Cows			$12,548,000.
All Other Livestock & Livestock Products				$678,000.
		TOTAL SALES		$160,653,000.
		1989 Adjusted		$167,557,000.
Agriculture Income		1988 Adjusted		$150,008,000.
		1987 Adjusted		$148,318,000.
		1986 Adjusted		$153,452,000.
		1985 Adjusted		$124,846,000.

1985 - 1990 PRICE + YIELD FOR SELECTED CROPS - MALHEUR COUNTY

CROP	PRICES						YIELDS					
	1985	1986	1987	1988	1989	1990	1985	1986	1987	1988	1989	1990
Sugarbeets (T)	39.00	36.00	36.00	35.50	38.50	38.50	26.5	30.0	32.0	27.0	28.0	31.5
Potatoes (Cwt)	4.15	4.10	4.10	3.60	4.60	5.31	370.0	360.0	400.0	390.0	380.0	371.0
Onions (Cwt)	3.00	9.00	8.50	8.00	9.50	5.50	520.0	510.0	560.0	530.0	540.0	570.0
Alfalfa Hay (T)	67.50	55.00	52.50	75.00	70.00	75.00	5.0	5.0	4.8	4.0	5.0	4.5
Alfalfa Seed (Lb)	1.00	1.10	1.20	1.25	1.07	1.20	400.0	550.0	475.0	450.0	550.0	625.0
Wheat (Bu)	3.20	2.30	2.40	3.50	3.93	2.60	80.0	104.0	105.0	84.0	100.0	90.0
Barley (Bu)	2.10	1.87	1.90	2.70	2.30	2.30	70.0	90.0	90.0	81.0	85.0	80.0
Dry Beans (Cwt)	17.50	21.50	15.00	26.50	25.00	25.00	17.0	21.0	25.0	18.0	23.0	20.0
Grain Corn (Bu)	2.40	1.95	2.20	3.20	2.83	2.66	135.0	145.0	150.0	130.0	140.0	126.0
Corn silage (T)	16.50	14.00	14.00	18.00	18.00	19.00	22.5	23.0	24.0	20.0	23.0	21.0
Sweet Corn (T)	56.40	57.75	58.00	57.00	63.87	64.00	8.3	8.9	9.6	8.0	8.4	7.2
Peppermint (Lb)	9.50	8.15	10.00	11.70	10.40	12.00	62.5	72.0	65.0	62.0	69.0	70.0
Spearmint (lb)	14.00	14.00	14.00	14.00	15.00	15.50	74.0	74.0	74.0	74.0	80.0	90.0

November 1990
Malheur County

OREGON STATE UNIVERSITY EXTENSION SERVICE

ACTIVE AGRICULTURAL ORGANIZATIONS IN MALHEUR COUNTY

Malheur County Onion Growers Association
Malheur County Potato Growers Association
Malheur County Cattlemen's Association
Oregon Alfalfa Seed Growers Association
Nyssa/Nampa Beet Growers Growers Association
Malheur County Wheat League
Malheur County Farm Bureau
Idaho-Eastern Oregon Seed Trade Association
Eastern Oregon Woolgrowers
Eastern Oregon Hereford Breeders
Malheur County Dairy Herd Improvement Association
Eastern Oregon Dairymen's Association
Pomona Grange
Malheur County Potato Bargaining Association
Malheur County Sweet Corn Bargaining Association
Idaho-Eastern Oregon Onion Committee
Malheur Soil and Water Conservation District

GOVERNMENTAL AGENCIES PROVIDING ASSISTANCE TO AGRICULTURE

Malheur County office of the Oregon State University Extension Service (County Extension Agent's Office), 710 S.W. 5th Avenue, Ontario (503) 881-1417. - Provides adult and youth agricultural educational programs including individual office and telephone consultations, farm and ranch visits, workshops, shortcourses, newsletters and bulletins. Four agricultural agents provide technical assistance pertaining to row crops, seed crops, cereal crops, forage crops, home horticultural crops, entomology, livestock, dairy and farm management.

Farmers' Home Administration (FHA), 381 N. Oregon, Ontario, (503) 889-7634 - Provides various types of financing to qualifying producers including operating and long term loans.

Agricultural Stabilization and Conservation Service (ASCS), 381 N. Oregon, Ontario, (503) 889-9689 - Provides assistance to producers pertaining to commodity programs, conservation programs, and emergency programs. Elected committeemen provide leadership for the program.

Soil Conservation Service (SCS), 381 N. Oregon, Ontario, (503) 889-7637 - Provides technical assistance to producers pertaining to various soil and water conservation practices. The Malheur Soil and Water Conservation District provides guidance to the SCS.

Bureau of Land Management (BLM), 100 Oregon St., Vale, (503) 473-3144 - Administers over 4 million acres of public lands in Malheur County. Cooperates with livestock producers regarding grazing of public lands.

Irrigation Districts are organized to administer the allocation and distribution of water stored in reservoirs constructed by the Bureau of Reclamation. In some districts managers are hired to administer the day-to-day operations. Elected boards of directors provide leadership and set policies for the districts. Three districts have offices with appropriate staffs. Others are smaller and operate more informally.

North Board of Control (Owyhee), 27 S. 1st, Nyssa - (503) 372-3540
Vale Oregon Irrigation District, 521 West A St., Vale - (503) 473-3243
Warm Springs Irrigation District, 334 Main St. N., Vale - (503) 473-3951

Oregon State Watermaster (Malheur County) 251 B. Street W., Vale, (County Courthouse) - (503) 473-5130 - administers the waters of the state in regards to waterrights and associated allocation of water to appropriate landowners.

Oregon Department of Agriculture

Food and Dairy Inspector - Ontario - (503) 889-7921
Commodity Inspection Service - Ontario - (503) 889-5274
Livestock Brand Inspector - Ontario - (503) 889-3276

Prepared by:
Gary Schneider,
Oregon State University Extension Service
Malheur County Office
December 1990

APPENDIX F

NITRATE/NITRITE–NITROGEN

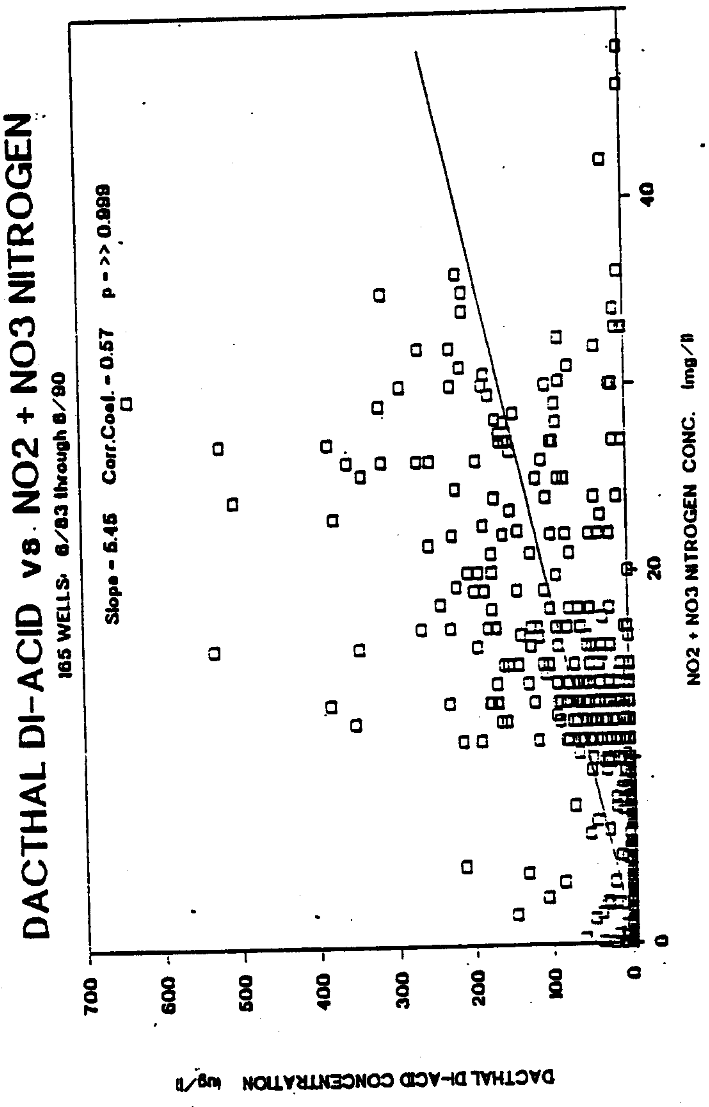
AND

DACTHAL DI–ACID TRENDS

Prepared By:

Department of Environmental Quality

FIGURE 1


DACTHAL DI-ACID vs. NO2 + NO3 NITROGEN
165 WELLS: 6/83 through 6/90
Slope = 5.45 Corr.Coef. = 0.57 p = >> 0.999
DACTHAL DI-ACID CONCENTRATION (ug/l)
NO2 + NO3 NITROGEN CONC. (mg/l)
0
100
200
300
400
500
600
700
0
20
40

F-1

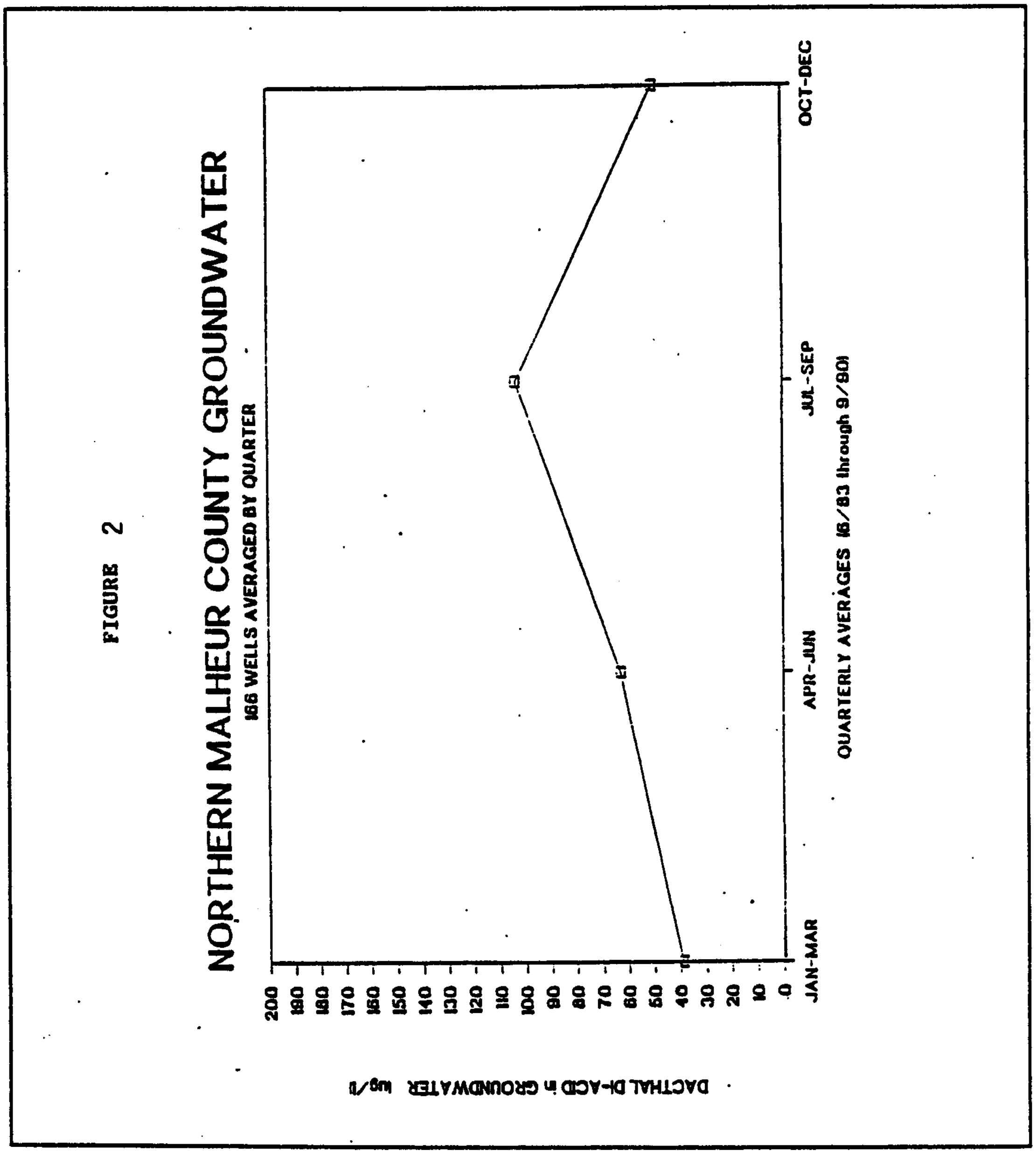

NORTHERN MALHEUR COUNTY GROUNDWATER
166 WELLS AVERAGED BY QUARTER
DACTHAL DI-ACID in GROUNDWATER ug/l
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
JAN-MAR
APR-JUN
JUL-SEP
OCT-DEC
QUARTERLY AVERAGES (6/83 through 9/90)

FIGURE 2

F-2

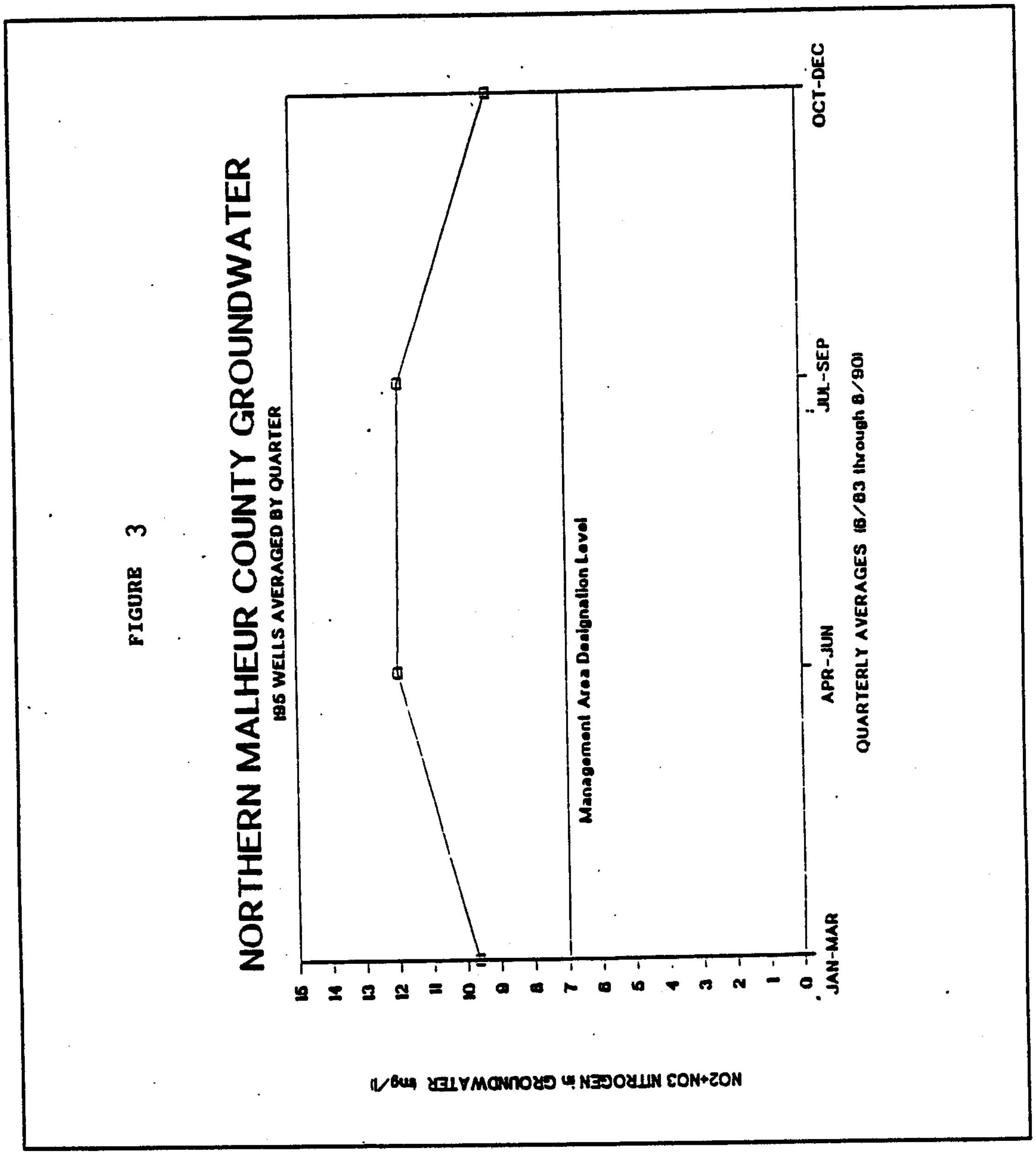


FIGURE 3
NORTHERN MALHEUR COUNTY GROUNDWATER
195 WELLS AVERAGED BY QUARTER
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Management Area Designation Level
JAN-MAR
APR-JUN
JUL-SEP
OCT-DEC
QUARTERLY AVERAGES (6/83 through 8/90)

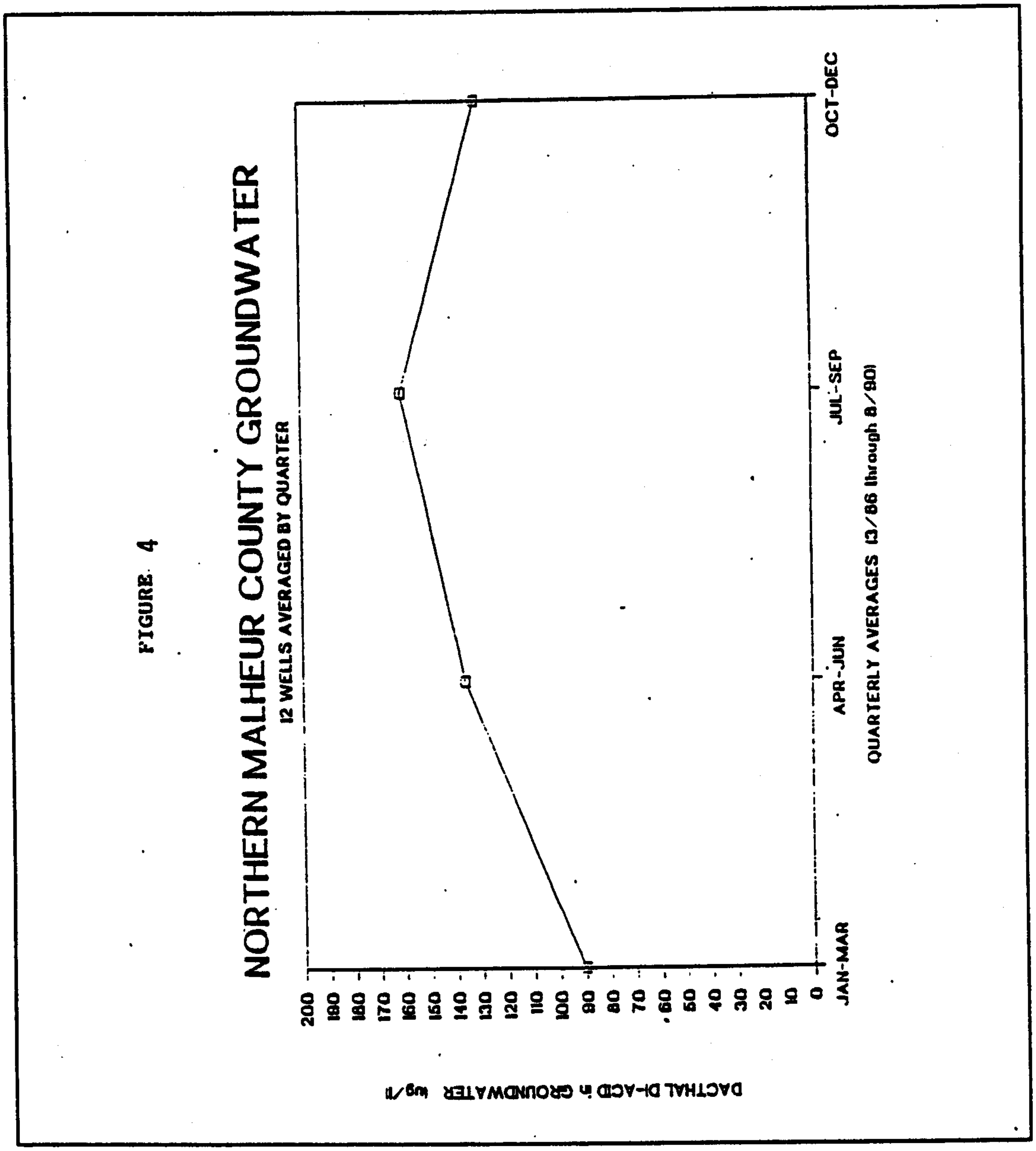


FIGURE 4
NORTHERN MALHEUR COUNTY GROUNDWATER
12 WELLS AVERAGED BY QUARTER
DACTHAL DI-ACID in GROUNDWATER ug/l
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
JAN-MAR
APR-JUN
JUL-SEP
OCT-DEC
QUARTERLY AVERAGES (3/86 through 8/90)

FIGURE 5

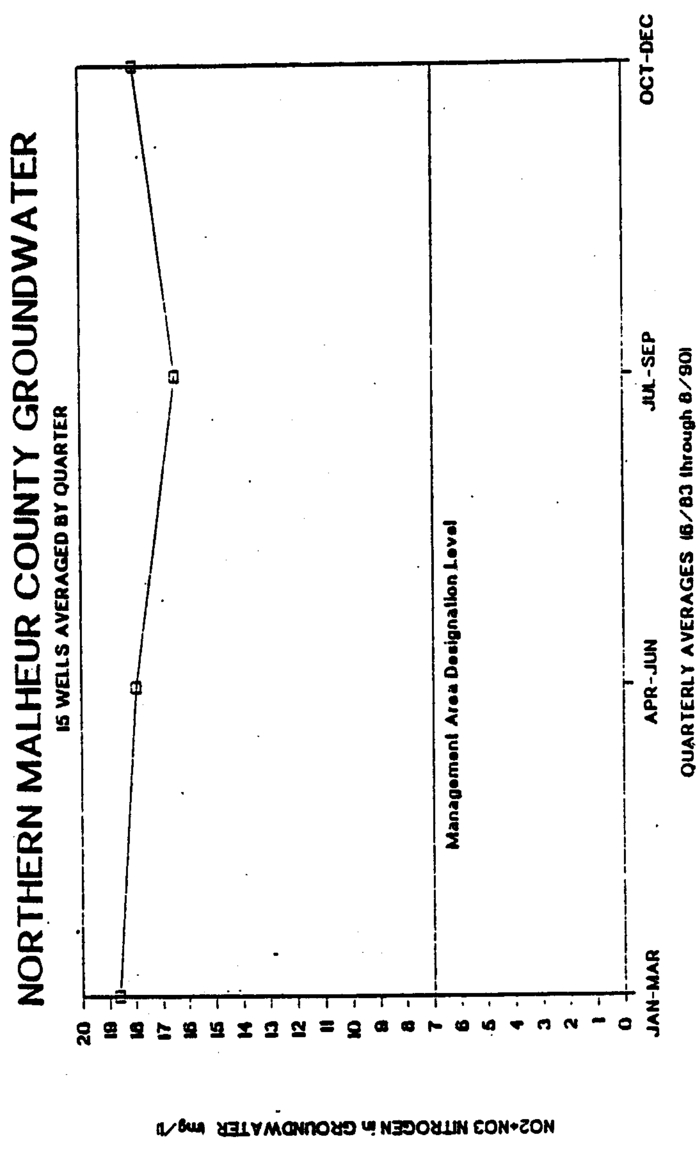
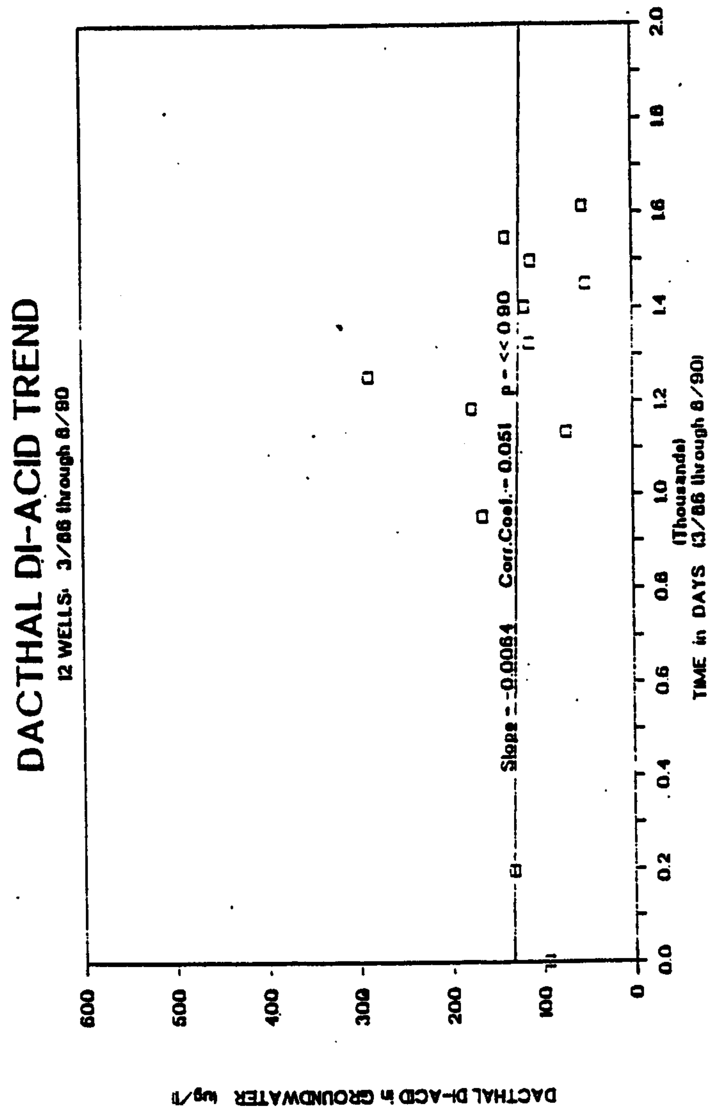

NORTHERN MALHEUR COUNTY GROUNDWATER
15 WELLS AVERAGED BY QUARTER
NO2+NO3 NITROGEN in GROUNDWATER mg/l
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Management Area Designation Level
JAN-MAR
APR-JUN
JUL-SEP
OCT-DEC
QUARTERLY AVERAGES (6/83 through 8/90)

FIGURE 6

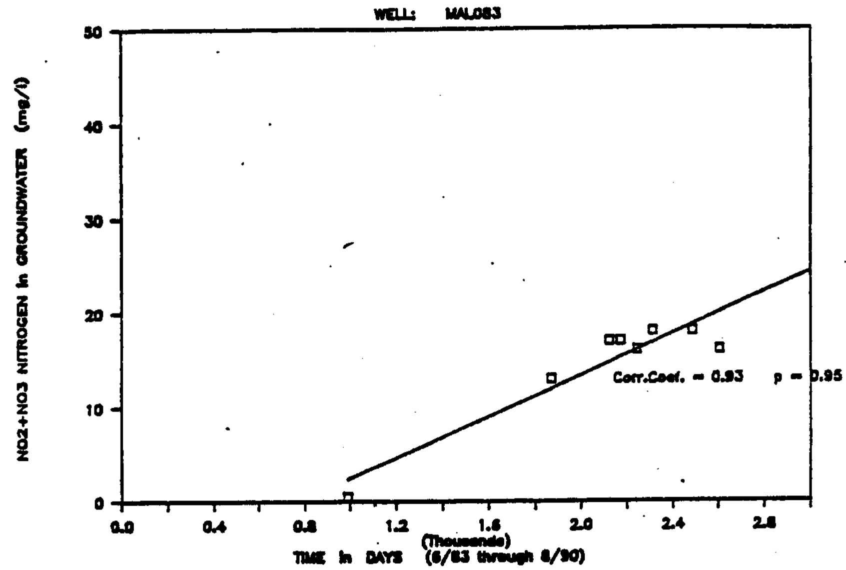


DACTHAL DI-ACID TREND
12 WELLS: 3/86 through 8/90
Slope = -0.0064   Corr.Coef. = 0.051   p = << 0.90
DACTHAL DI-ACID in GROUNDWATER (ug/l)
600
500
400
300
200
100
0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
(Thousands)
TIME in DAYS (3/86 through 8/90)

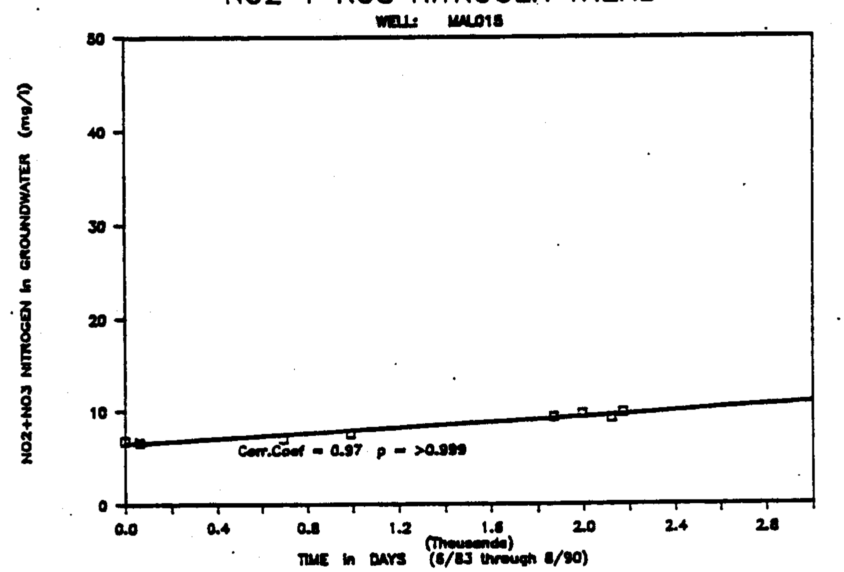
F-6

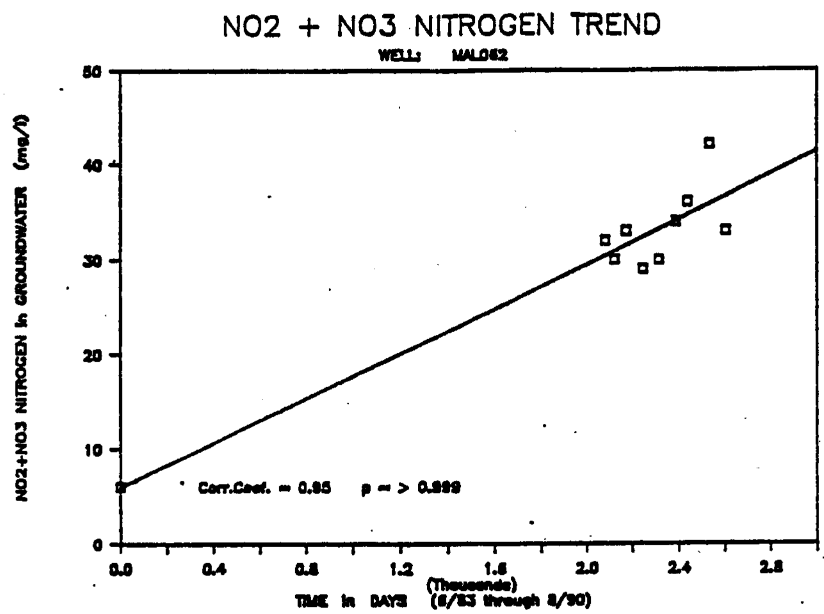
NITRATE/NITRITE–NITROGEN TRENDS
(Fifteen Individual Wells)

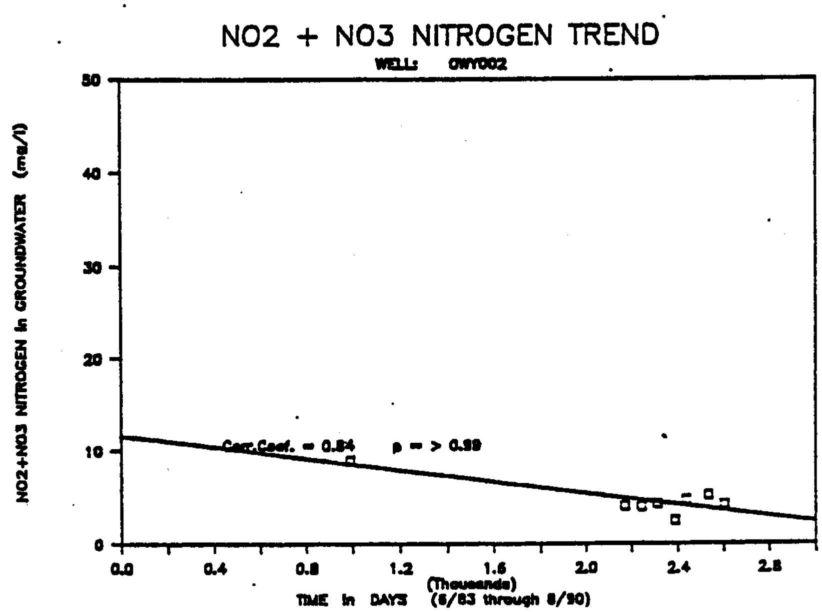
NO2 + NO3 NITROGEN TREND

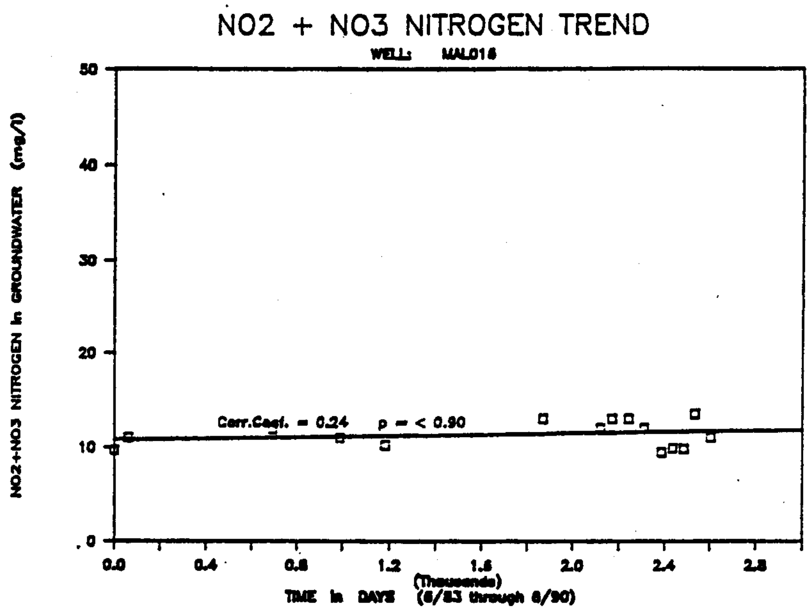


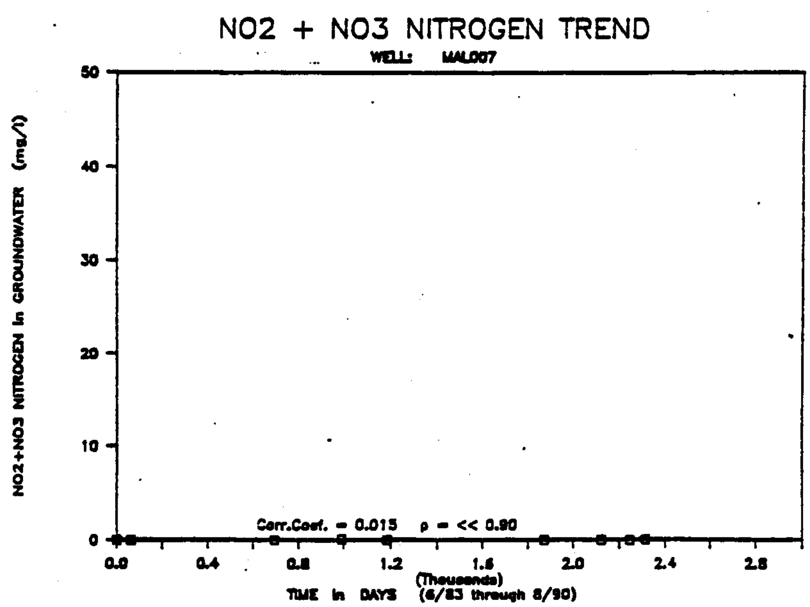
NO2 + NO3 NITROGEN TREND

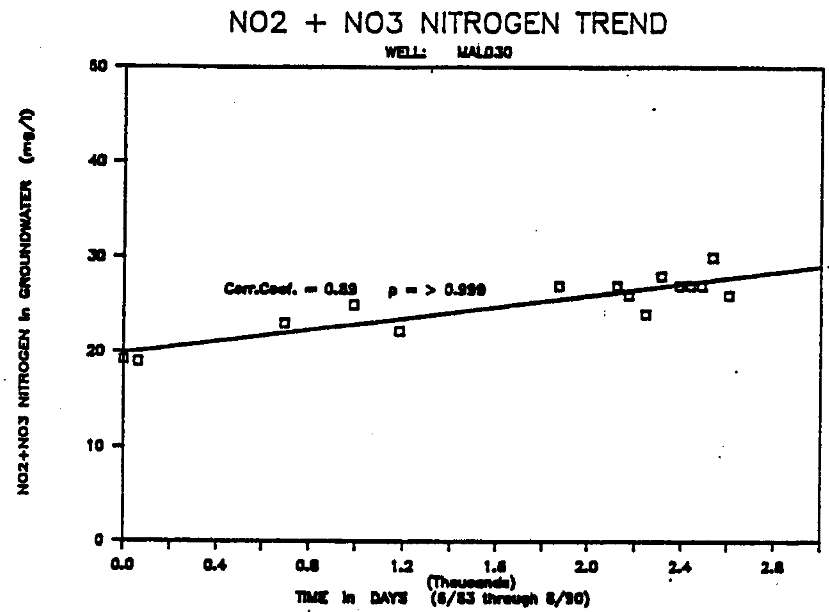


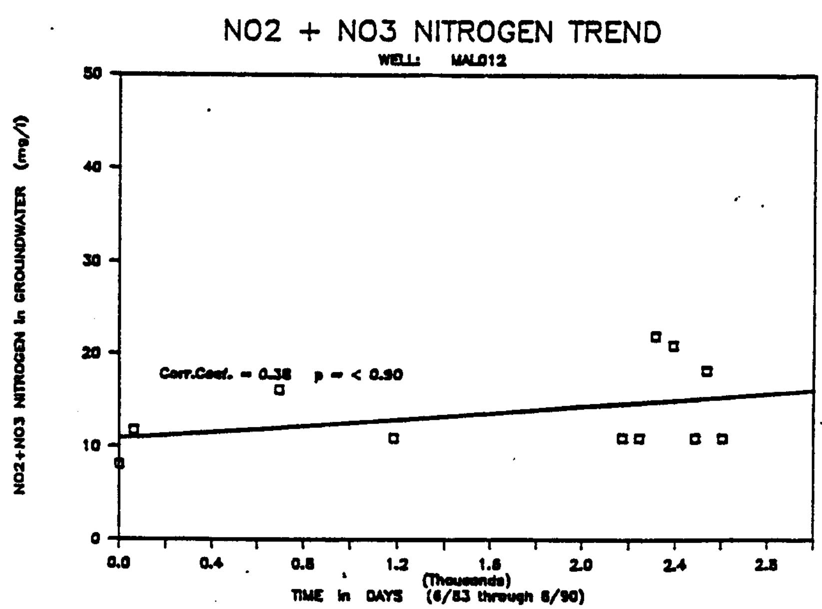

NO2 + NO3 NITROGEN TREND
WELL: MAL062
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
0
10
20
30
40
50
Corr.Coef. = 0.85 p => 0.999
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
(Thousands)
TIME in DAYS (5/83 through 8/90)

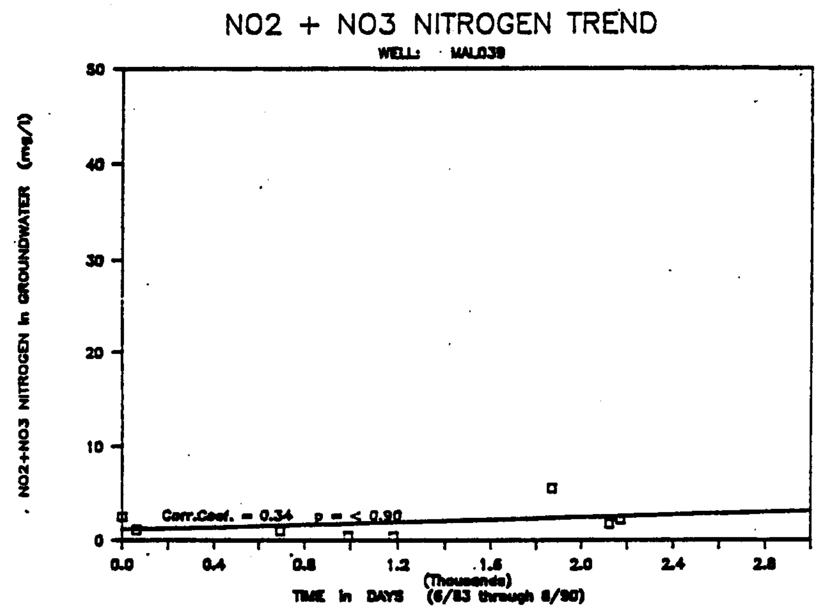

NO2 + NO3 NITROGEN TREND
WELL: GWY002
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
0
10
20
30
40
50
Corr.Coef. = 0.84 p => 0.99
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
(Thousands)
TIME in DAYS (5/83 through 8/90)

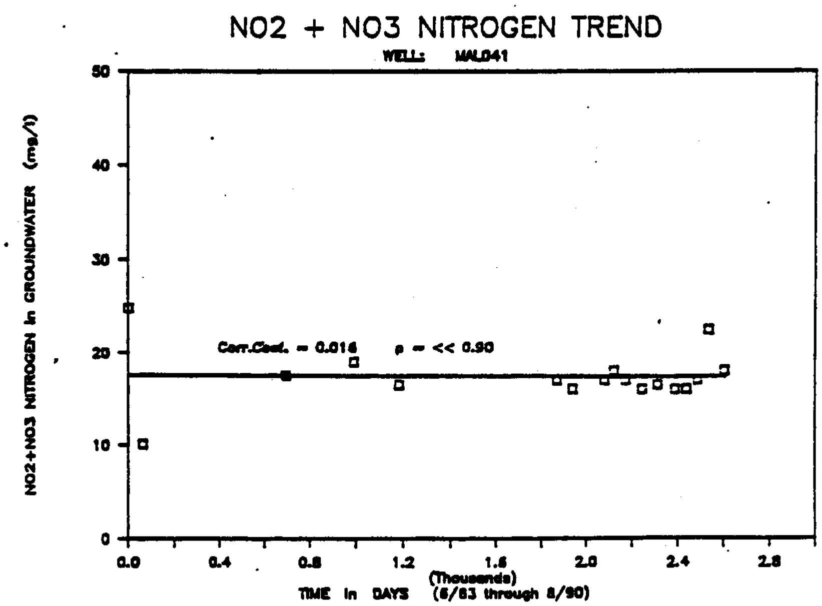

NO2 + NO3 NITROGEN TREND
WELL: MAL016
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
Corr.Coef. = 0.24 p = < 0.90
TIME in DAYS (6/83 through 8/90)
(Thousands)


NO2 + NO3 NITROGEN TREND
WELL: MAL007
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
Corr.Coef. = 0.015 p = << 0.90
TIME in DAYS (6/83 through 8/90)
(Thousands)


NO2 + NO3 NITROGEN TREND
WELL: MAL030
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
Corr.Coef. = 0.89 p = > 0.999
TIME in DAYS (Thousands) (6/83 through 8/90)

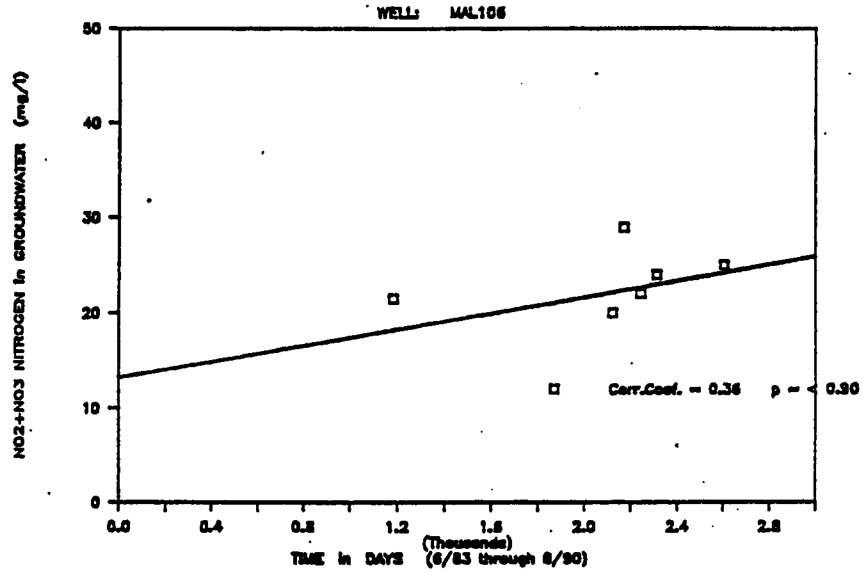

NO2 + NO3 NITROGEN TREND
WELL: MAL012
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
Corr.Coef. = 0.38 p = < 0.90
TIME in DAYS (Thousands) (6/83 through 8/90)


NO2 + NO3 NITROGEN TREND
WELL: MAL039
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
Corr.Coef. = 0.34 p = < 0.90
(Thousands)
TIME in DAYS (6/83 through 8/90)

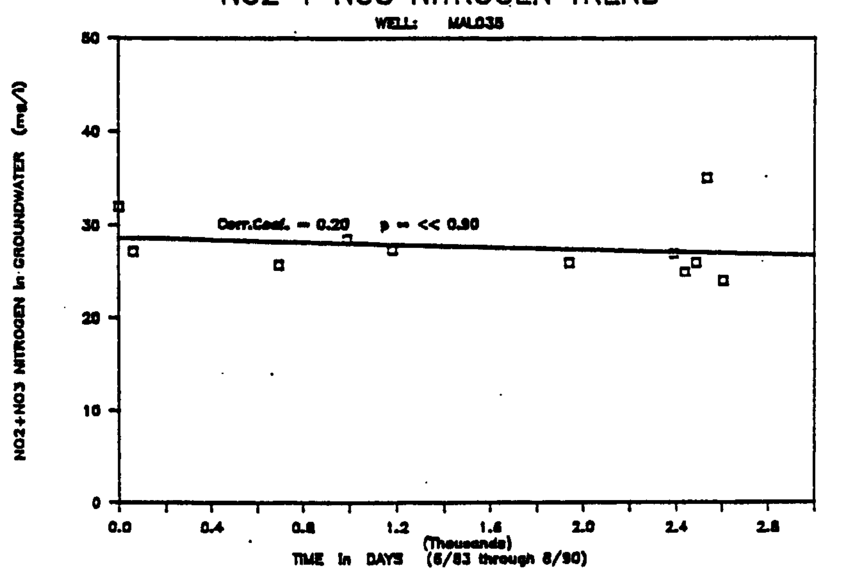

NO2 + NO3 NITROGEN TREND
WELL: MAL041
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
Corr.Coef. = 0.016 p = << 0.90
(Thousands)
TIME in DAYS (6/83 through 8/90)

F-11

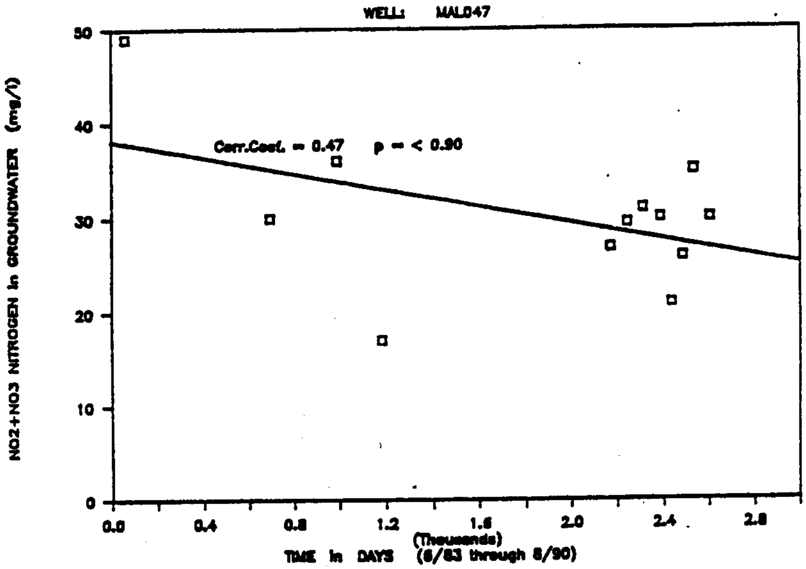
NO2 + NO3 NITROGEN TREND



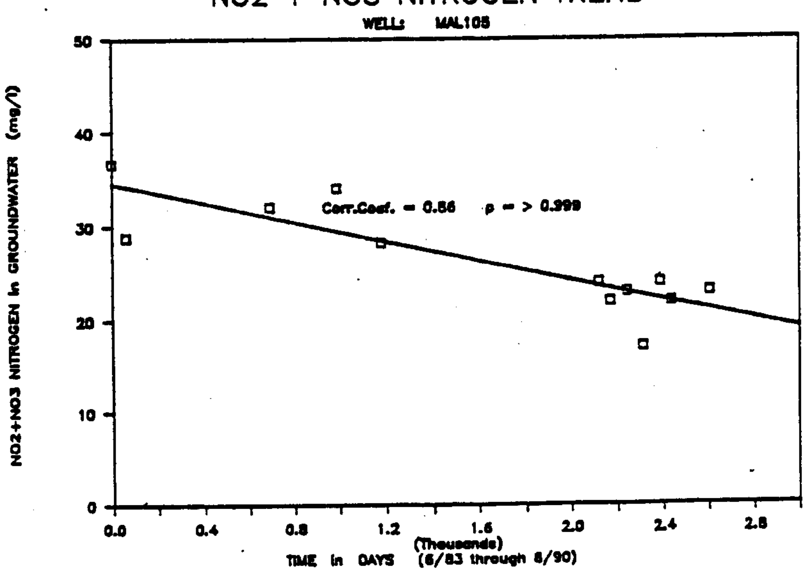
NO2 + NO3 NITROGEN TREND

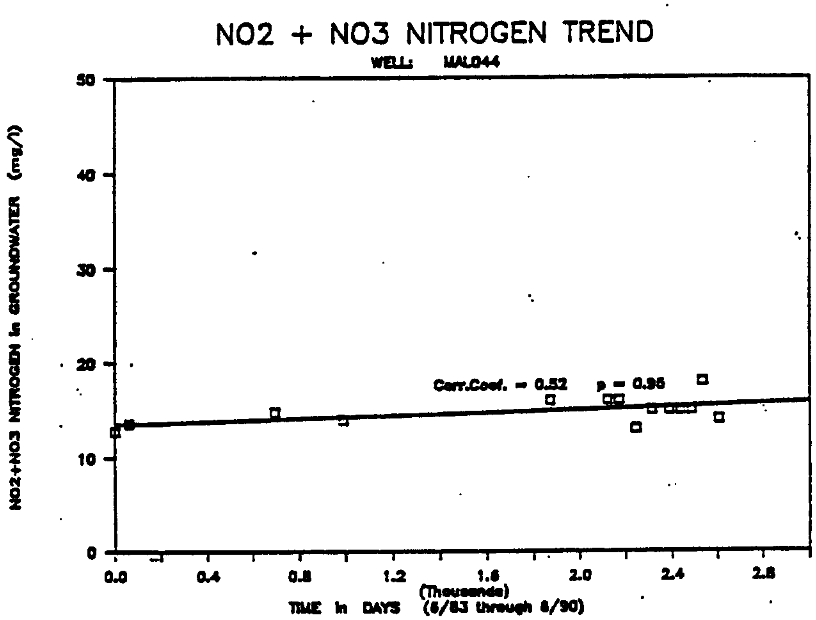


NO2 + NO3 NITROGEN TREND



NO2 + NO3 NITROGEN TREND





NO2 + NO3 NITROGEN TREND
WELL: MAL044
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
50
40
30
20
10
0
Corr.Coef. = 0.52
p = 0.95
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
(Thousands)
TIME in DAYS (6/83 through 8/90)

APPENDIX G

REEXAMINATION

OF

NITRATE TRENDS

Prepared By:

Department of Environmental Quality

Reexamination of Nitrate Trends

Northern Malheur County

Trend Evaluations Shared with SCS

February 12, 1991

APPENDIX G

REEXAMINATION OF NITRATE TRENDS

Fifteen wells were originallly selected for examination on the basis of:

1. Amount of data collected at the well.

2. Length of time over which data was collected.

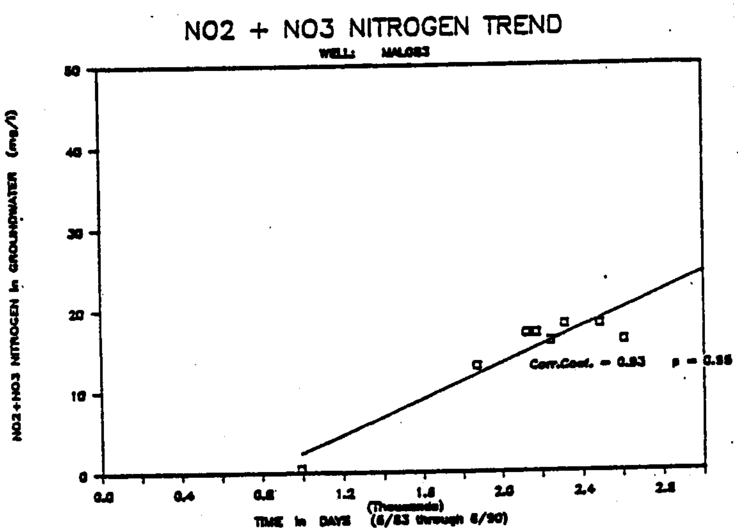
These wells were not necessarily part of the 20 primary, or 18 secondary, indicator wells (three of the 15 wells were not).

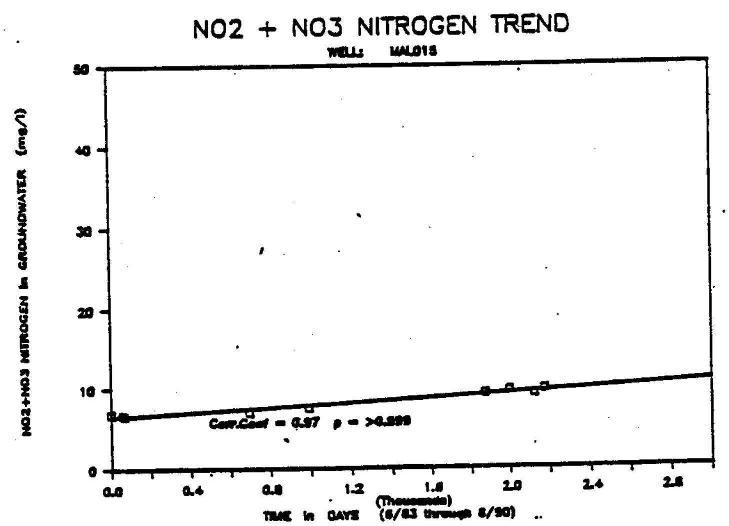
Wells were examined individually for trends. Approximate areal distribution of the wells is plotted. The location plot also indicates the type of trend noted at each well:

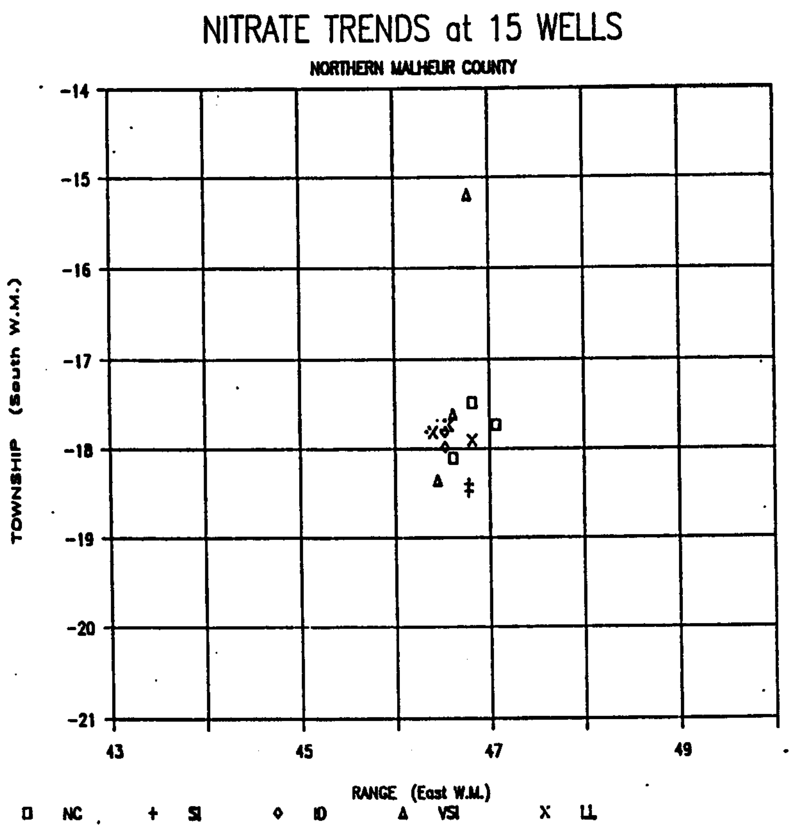
NC - No change
SI - Significant Increase
ID - Insignifcant Decrease
VSD - Very Significant Decrease
I.I. - Insignificant Increase
VSD - Very Significant Decrease

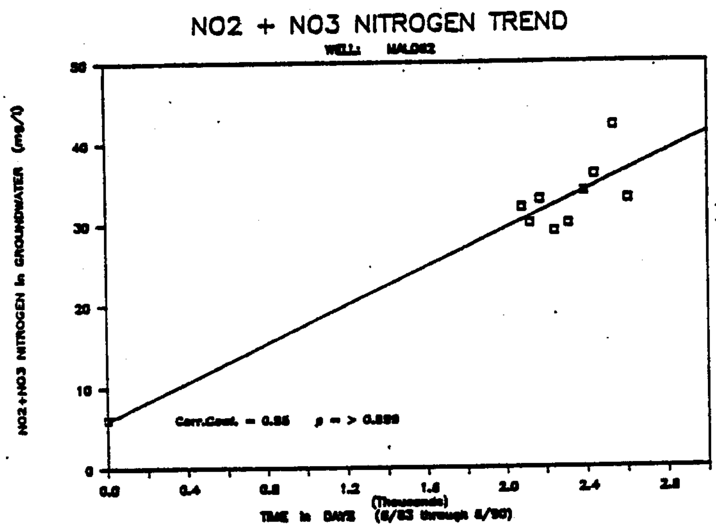
WELLS EXAMINED FOR NITRATE TRENDING - NORTHERN MALHEUR COUNTY

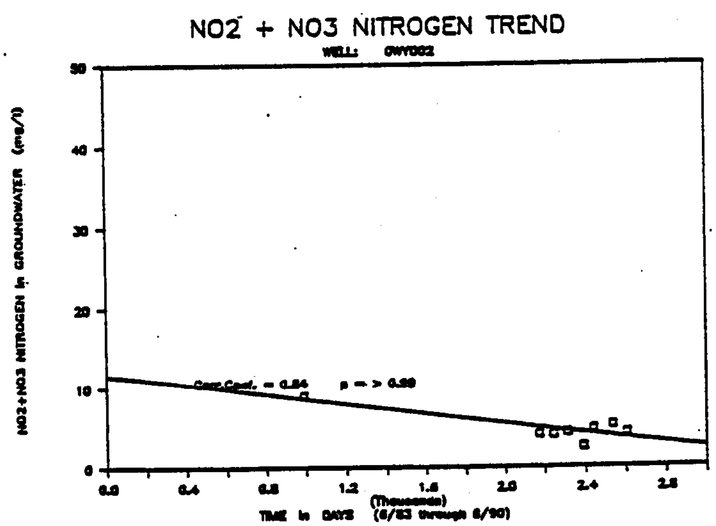
Well Designation	Location (W.M.)	Well Depth (feet)	Owner
MAL007	17S/47E-32Dd	98	Gary Edwards
MAL012	18S/46E-12Cd	59	Leon Price
MAL015	18S/46E-36Ab	150	Mushroom Plant
MAL016	18S/47E-10Bd	30	Lennie Minnick
MAL030	18S/47E- 6Dc	50	Shingo Wada
MAL035	18S/47E- 7Cc		Jim Nakano
MAL039	18S/47E-17Ad	65	Henry Gabiola
MAL041	18S/47E-19Db	61	Ray Winegar
MAL044	18S/47E-32Ac	86	John Wettstein
MAL047	18S/47E-18Cc	45	George Iieda
MAL062	15S/47E-29Ab	77	Herb Haun
MAL083	18S/47E-32Dc	55	Oliver Hines
MAL105	18S/46E-12Ad	39	Tom Butler
MAL106	18S/47E- 7Bd	43	Golf Course
OWY002	20S/45E-25Dd	43	James Langley

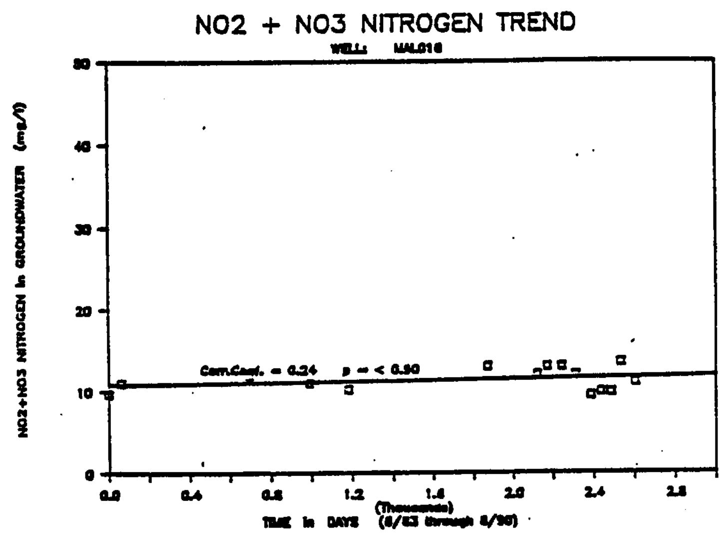

NO2 + NO3 NITROGEN TREND
WELL: MAL083
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
50
40
30
20
10
0
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
(Thousands)
TIME in DAYS (6/83 through 6/90)
Corr.Coef. = 0.93 p = 0.55

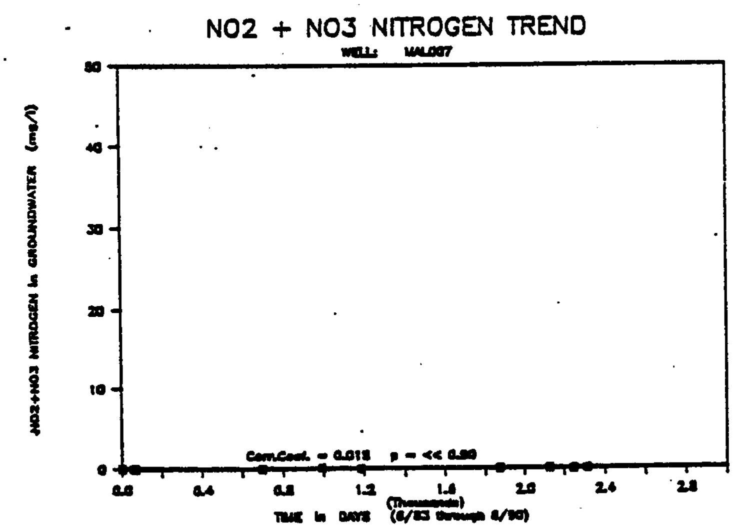

NO2 + NO3 NITROGEN TREND
WELL: MAL015
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
50
40
30
20
10
0
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
(Thousands)
TIME in DAYS (6/83 through 6/90)
Corr.Coef = 0.97 p = >0.999


NITRATE TRENDS at 15 WELLS
NORTHERN MALHEUR COUNTY
TOWNSHIP (South W.M.)
-14
-15
-16
-17
-18
-19
-20
-21
43
45
47
49
RANGE (East W.M.)
NC
SI
ID
VSI
LL

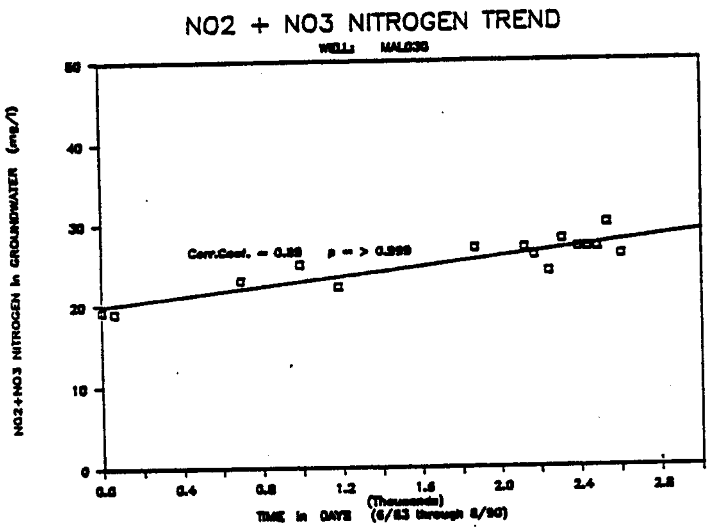

NO2 + NO3 NITROGEN TREND
WELL:
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
0
10
20
30
40
50
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
(Thousands)
TIME in DAYS

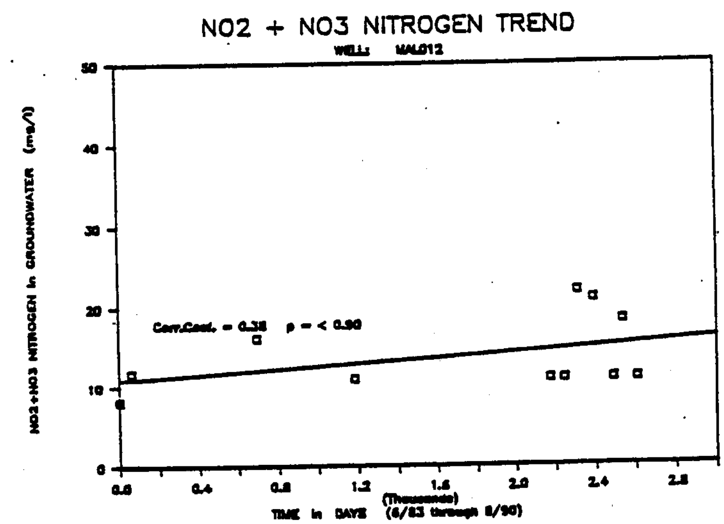

NO2 + NO3 NITROGEN TREND
WELL:
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
0
10
20
30
40
50
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
(Thousands)
TIME in DAYS

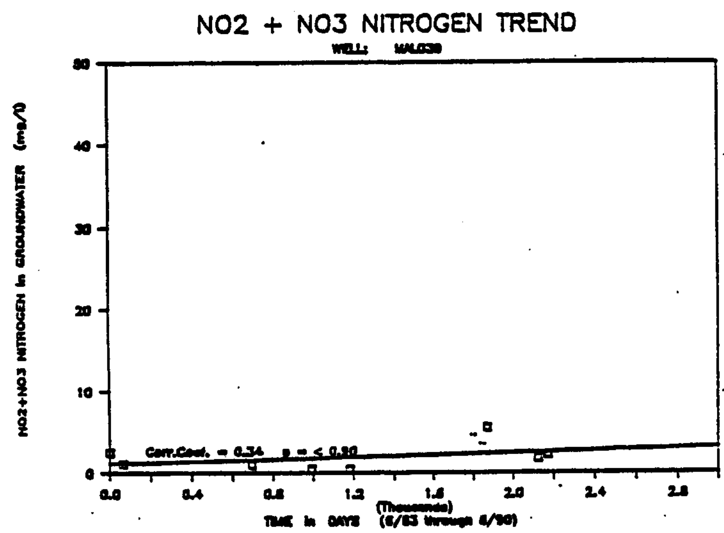

NO2 + NO3 NITROGEN TREND
WELL:
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
50
40
30
20
10
0
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
TIME in DAYS

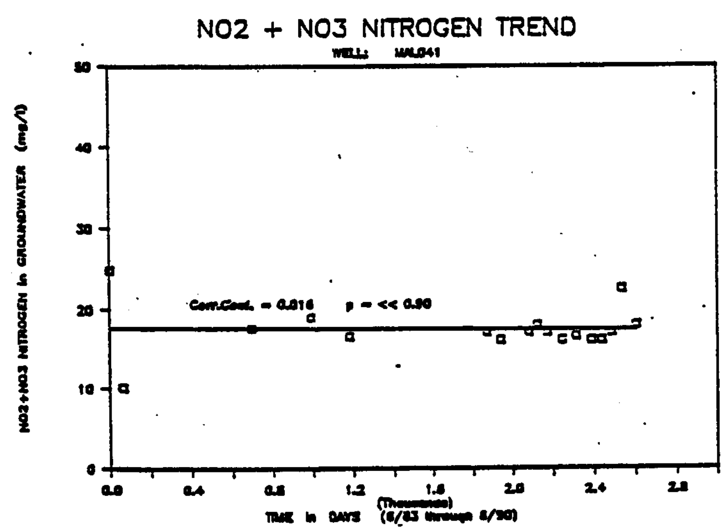

NO2 + NO3 NITROGEN TREND
WELL:
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
50
40
30
20
10
0
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
TIME in DAYS

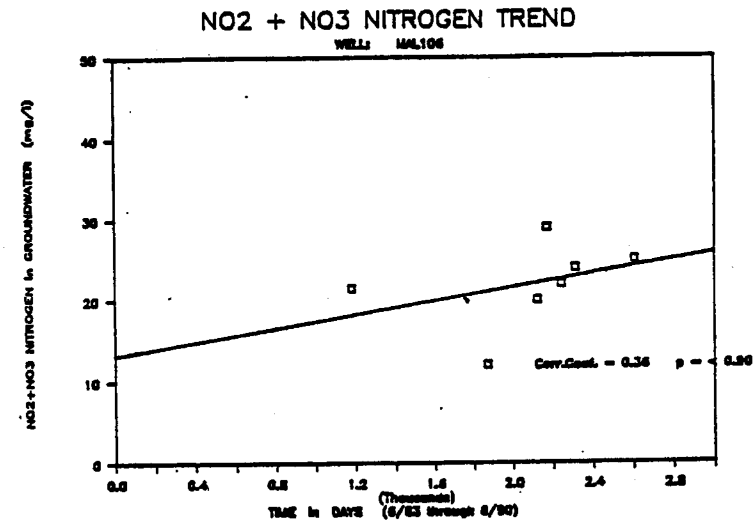
G-6

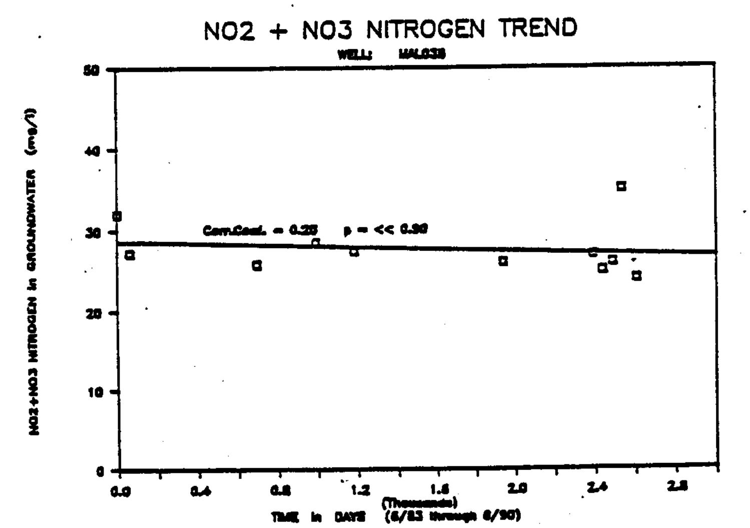

NO2 + NO3 NITROGEN TREND
WELL:
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
0
10
20
30
40
50
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
(Thousands)
TIME in DAYS (6/83 through 8/90)

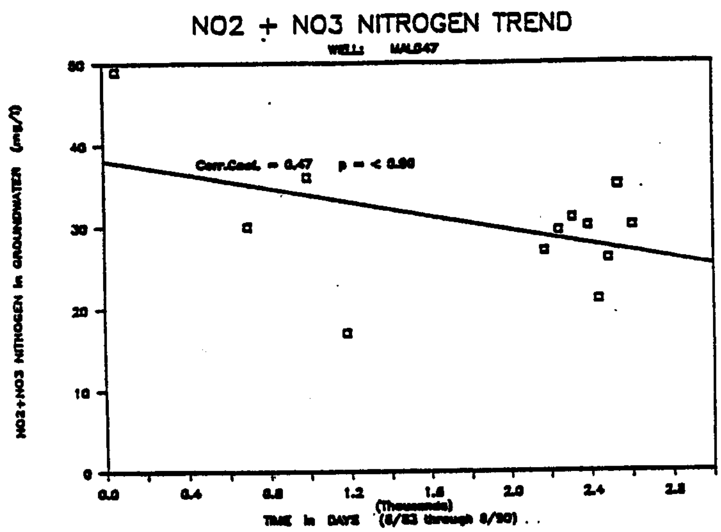

NO2 + NO3 NITROGEN TREND
WELL: MAL012
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
Corr.Coef. = 0.38 p = < 0.90
0
10
20
30
40
50
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
(Thousands)
TIME in DAYS (6/83 through 8/90)

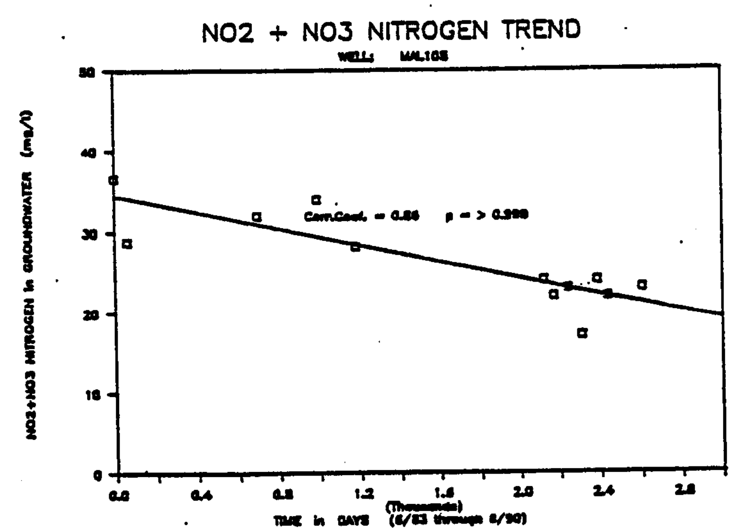

NO2 + NO3 NITROGEN TREND
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
Corr.Coef. = 0.34 p = < 0.90
TIME in DAYS

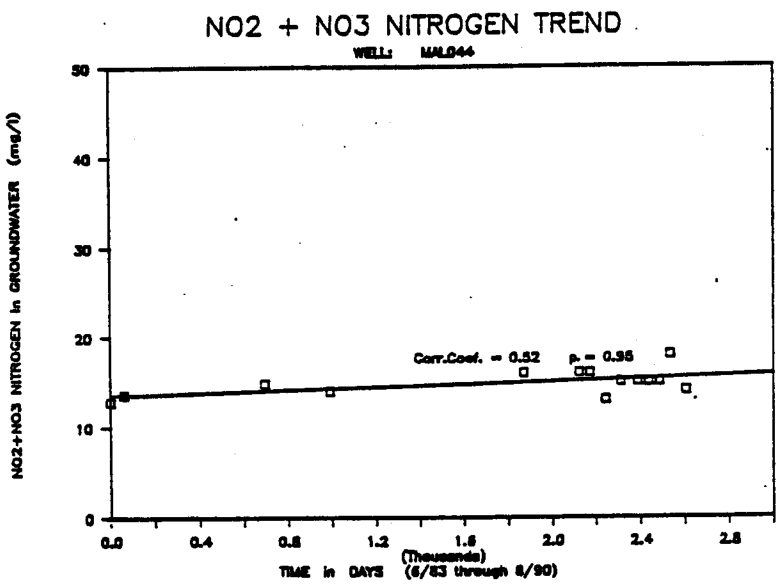

NO2 + NO3 NITROGEN TREND
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
Corr.Coef. = 0.016 p = << 0.90
TIME in DAYS


NO2 + NO3 NITROGEN TREND
WELL:
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
50
40
30
20
10
0
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
(Thousands)
TIME in DAYS


NO2 + NO3 NITROGEN TREND
WELL:
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
50
40
30
20
10
0
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
(Thousands)
TIME in DAYS


NO2 + NO3 NITROGEN TREND
WELL: MAL047
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
0
10
20
30
40
50
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
(Thousands)
TIME in DAYS (6/83 through 6/90)


NO2 + NO3 NITROGEN TREND
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
0
10
20
30
40
50
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
(Thousands)
TIME in DAYS (6/83 through 6/90)



Nitrate values from the fifteen wells were averaged by date.

> Use of a calculated mean in not unusual in statistical evaluation of data. We are, in this case, simply examining any change in the study area's average nitrate concentration.

Data from three sampling events (10/88, 12/88, and 3/89) were first discarded to avoid skewing the analysis since insufficient wells were represented during the event.

A significant increasing trend in nitrate concentration with time is noted. This is, essentially, the trend that was presented in the Basin Management Plan.

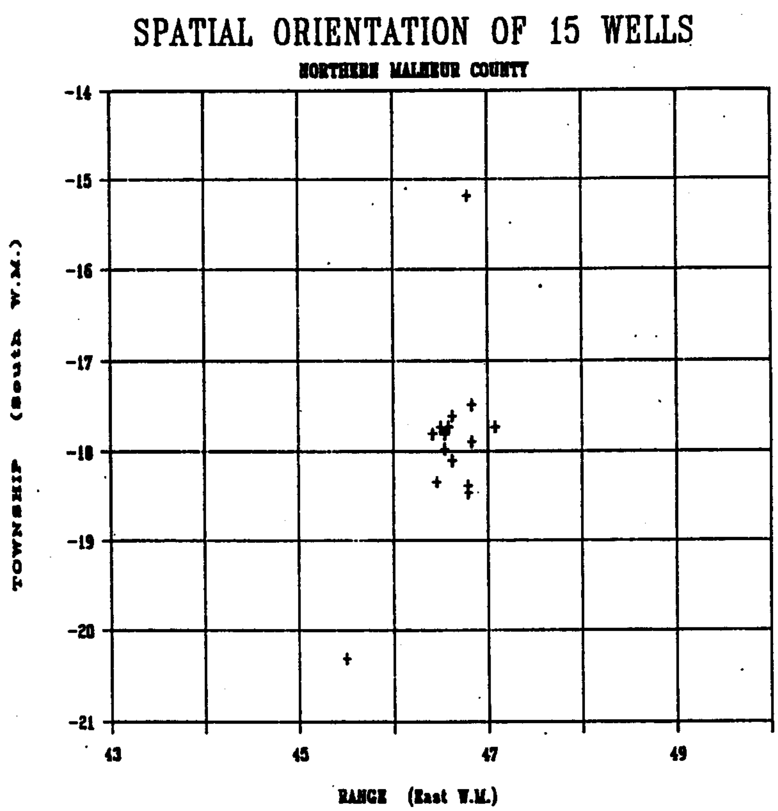
NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (6/83 - 8/90)

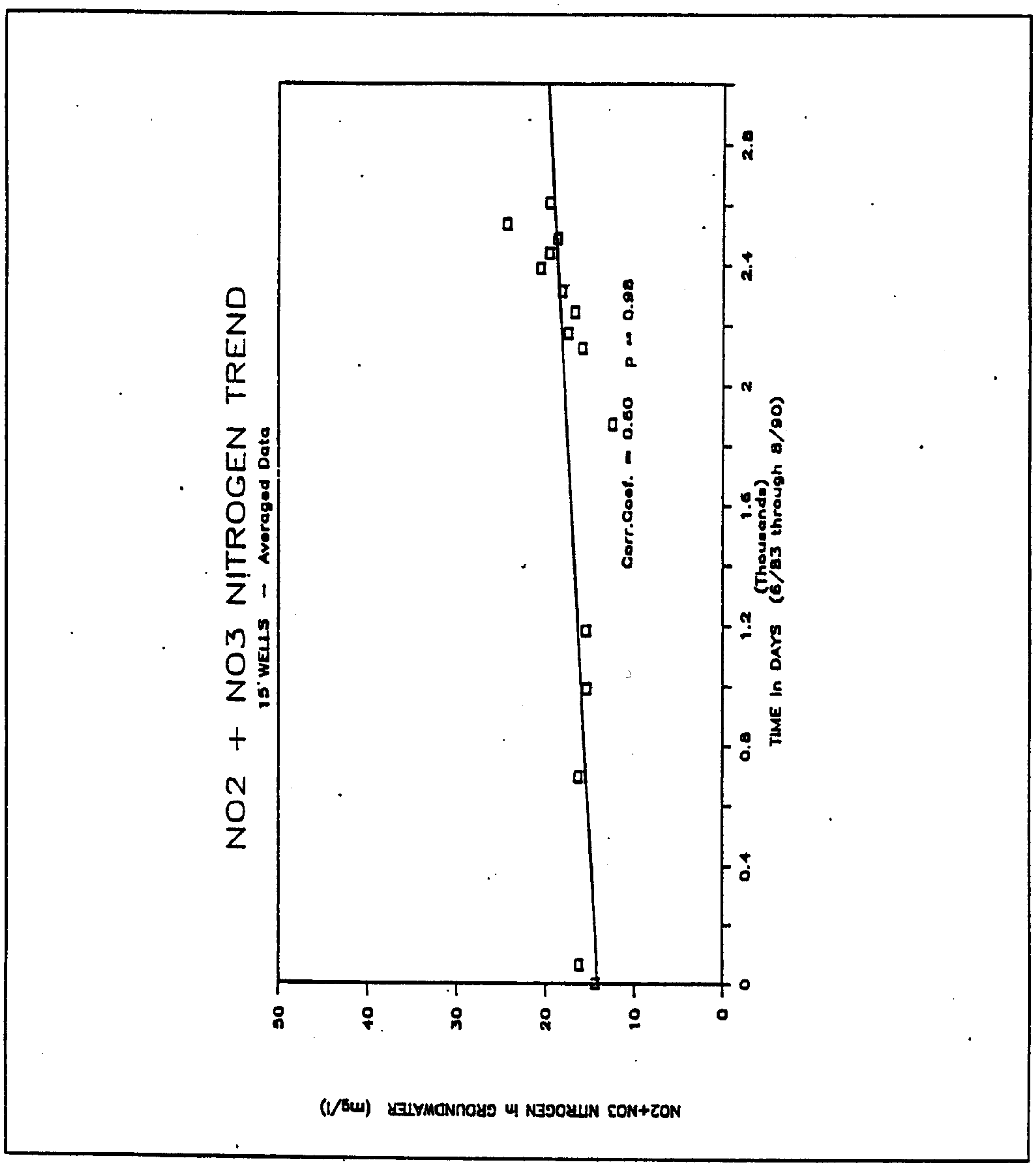
15 Wells:

NO2+NO3 ppm

DAY NUMBER	MAL007	MAL012	MAL015	MAL016	MAL030	MAL035	MAL039	MAL041	MAL044	MAL047	MAL062	MAL083	MAL105	MAL106	OUT002	NUMBER OF DATA POINTS	MEAN VALUE
1	0.015	8.1	4.8	9.7	19.2	32	2.5	24.8	12.8		6.00		34.60			11	14.41
64	0.0025	11.8	4.6	11	19	27.2	1.1	18.1	13.6	49			28.8			11	16.28
496	0.015	14.2	7	11.9	23	25.8	0.98	17.5	14.8	38			32			11	16.29
991	0.13		7.50	11	25.00	28.5	0.42	19.00	14.00	34		0.41	34		8.90	12	15.41
1184	0.015	11		10.2	22.2	27.4	0.36	16.5		17			28.2	21.5		10	15.46
1871	0.03		9.3	13	27		5.5	17	16			13		12		9	12.34
1941						26		16								2 *	21.00
1997			9.7													1 *	9.70
2082								17			32					2 *	24.50
2125	0.02		9.2	12	27		1.7	18	16		30	17	24	20		11	15.90
2175		11	9.8	13	26		2.2	17	16	27	33	17	22	29	4	13	17.46
2244	0.01	11		13	24			16	13	29.5	29	16	23	22	3.9	12	16.78
2313	0.02	22		12	28			14.5	15	31	30	18	17	28	4.2	12	18.14
2398		21		9.6	27	27		16	15	30	34		24		2.6	10	20.58
2439				9.9	27	25		16	15	21	36		22		4.6	9	19.61
2488		11		9.8	27	26		17	15	26		18				8	18.73
2536		10.3		13.5	30	35		22.5	18	35	42				5.1	9	24.38
2606		11		11	24	24		18	16	30	33	16	23	25	6.1	12	19.59
3000																	

* Data set dropped as unreprentative


SPATIAL ORIENTATION OF 15 WELLS
NORTHERN MALHEUR COUNTY
-14
-15
-16
-17
-18
-19
-20
-21
TOWNSHIP (South W.M.)
43
45
47
49
RANGE (East W.M.)


NO2 + NO3 NITROGEN TREND
15' WELLS -- Averaged Data
Corr.Coef. = 0.60 p = 0.98
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
0
10
20
30
40
50
0
0.4
0.8
1.2
1.6
2
2.4
2.8
TIME in DAYS (Thousands)
(6/83 through 8/90)

Most of the 15 wells examined lie within, or near, the Cairo Junction area. So, the examination was refocused on that central valley agricultural area. Five wells were dropped from the evaluation:

MAL007	G.Edwards:	well is in Malheur River flood plane.
MAL016	L.Minnick:	well is in City of Ontario.
MAL039	H.Gabiola:	well is generally to the east of the area of concern. Nitrate contamination at this well is minimal. Suburban area.
MAL062	H.Haun:	well is in the Weiser area. Only well representing that area.
OWY002	J.Langley:	well is in Owyhee River basin. Only well representing that basin.

It is unlikely that single wells such as MAL062 and OWY002 can alone reasonably represent distinct groundwater areas.

Data from the 10/88, 12/88, and 3/89 sampling events were again dropped to avoid skewing the analysis (insufficient wells sampled during these sampling events).

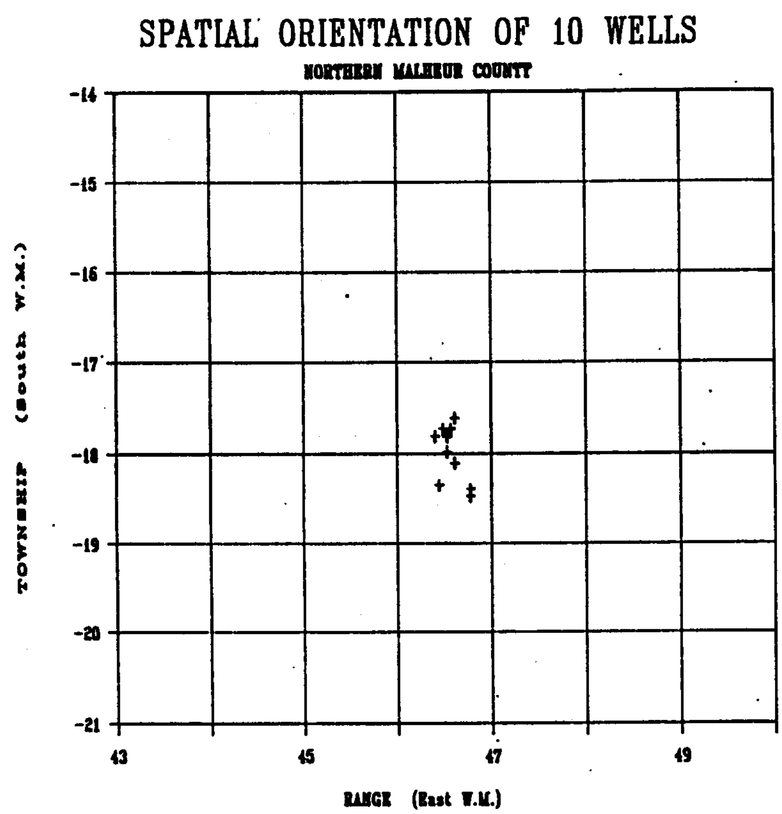
A slight, significant increasing trend is still noted (less pronounced than with the 15 wells).

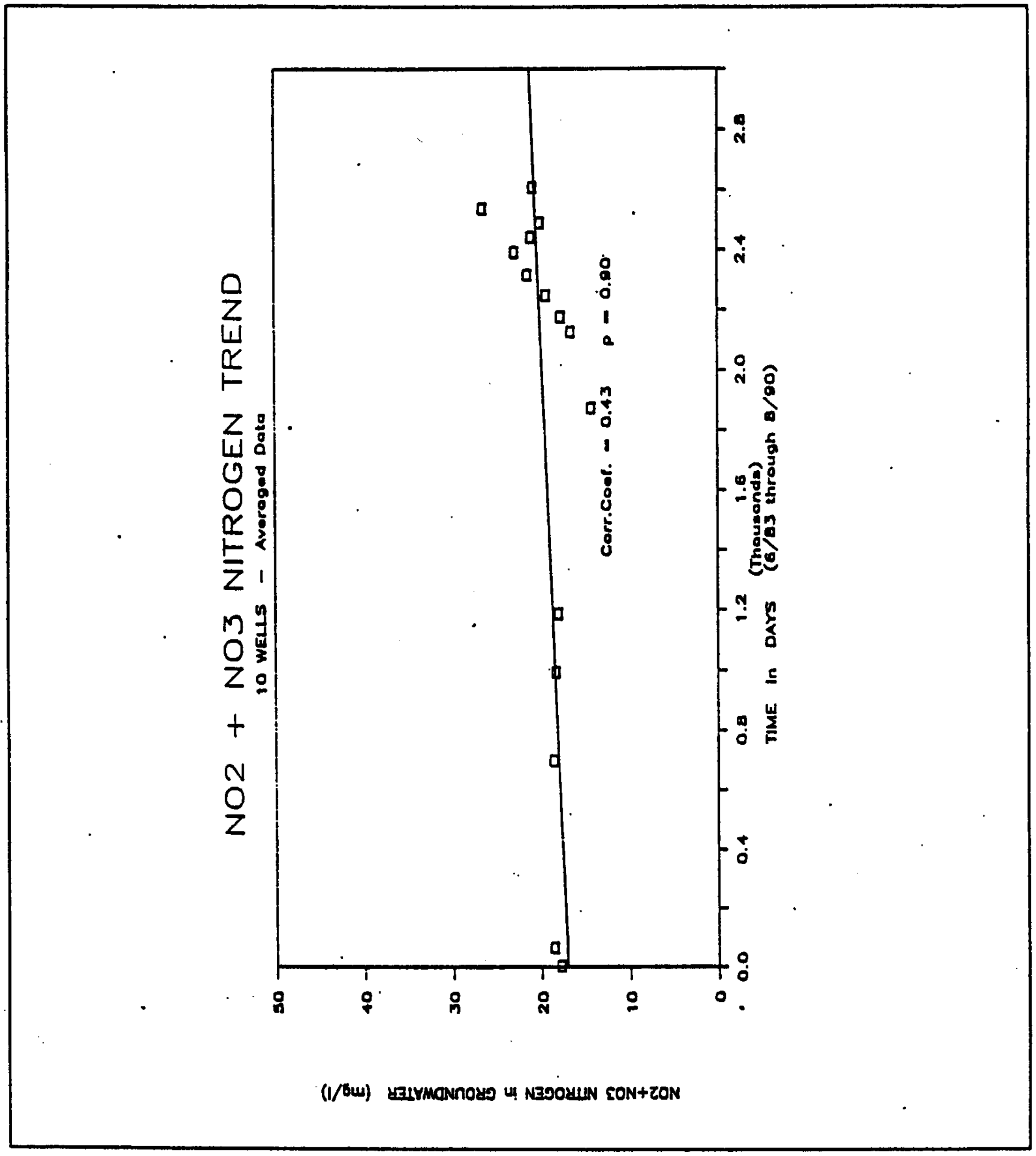
NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (6/83 - 8/90)

10 Wells:

DAY NUMBER	MAL012	MAL015	MAL030	MAL035	MAL041	MAL044	MAL047	MAL083	MAL105	MAL106	NUMBER OF DATA POINTS	MEAN VALUE
				NO2+NO3 ppm								
1	8.1	6.8	19.2	32	24.8	12.8			36.60		7	20.04
64	11.8	6.6	19	27.2	10.1	13.6	49		28.8		8	20.76
696	16.2	7	23	25.8	17.5	14.8	30		32		8	20.79
991		7.50	25.00	28.5	19.00	14.00	36	0.41	34		8	20.55
1186	11		22.2	27.4	16.5		17		28.2	21.5	7	20.54
1871		9.3	27		17	16		13		12	6	15.72
1961				26	16						2 *	21.00
1997		9.7									1 *	9.70
2082					17						1 *	17.00
2123		9.2	27		18	16		17	24	20	7	18.74
2173	11	9.8	26		17	16	27	17	22	29	9	19.42
2244	11		24		16	13	29.5	16	23	22	8	19.31
2313	22		28		14.5	15	31	18	17	24	8	21.44
2390	21		27	27	16	15	30		24		7	22.86
2439			27	25	16	15	21		22		6	21.00
2488	11		27	26	17	15	26	18			7	20.00
2536	18.3		30	35	22.5	18	35				6	26.47
2606	11		26	24	18	14	30	16	23	25	9	20.78
3000												

* Data set dropped as unreprentative


SPATIAL ORIENTATION OF 10 WELLS
NORTHERN MALHEUR COUNTY
-14
-15
-16
-17
-18
-19
-20
-21
TOWNSHIP (South W.M.)
43
45
47
49
RANGE (East W.M.)



NO2 + NO3 NITROGEN TREND
10 WELLS - Averaged Data
Corr.Coef. = 0.43 p = 0.90
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
TIME in DAYS (Thousands) (6/83 through 8/90)
0
10
20
30
40
50
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8

G-18

Two additional wells were then dropped:

MAL015 - Mushroom Plant
MAL106 - Shadow Butte Golf Course well.

No data are available for MAL015 after 6/89. No data are available for MAL106 prior to 9/86.

There was simply less data available for these two wells, so they were dropped.

Data from the 8/88, 10/88, 12/88, and 3/89 sampling events was also eliminated because too few wells were represented.

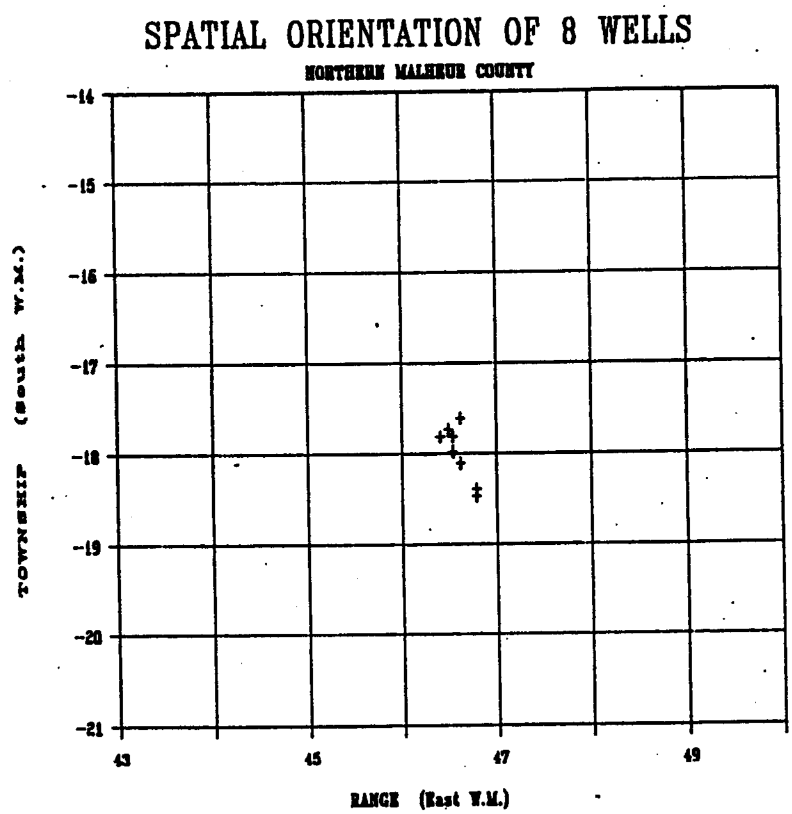
Resulting trend is slightly downward with time, though insignificant.

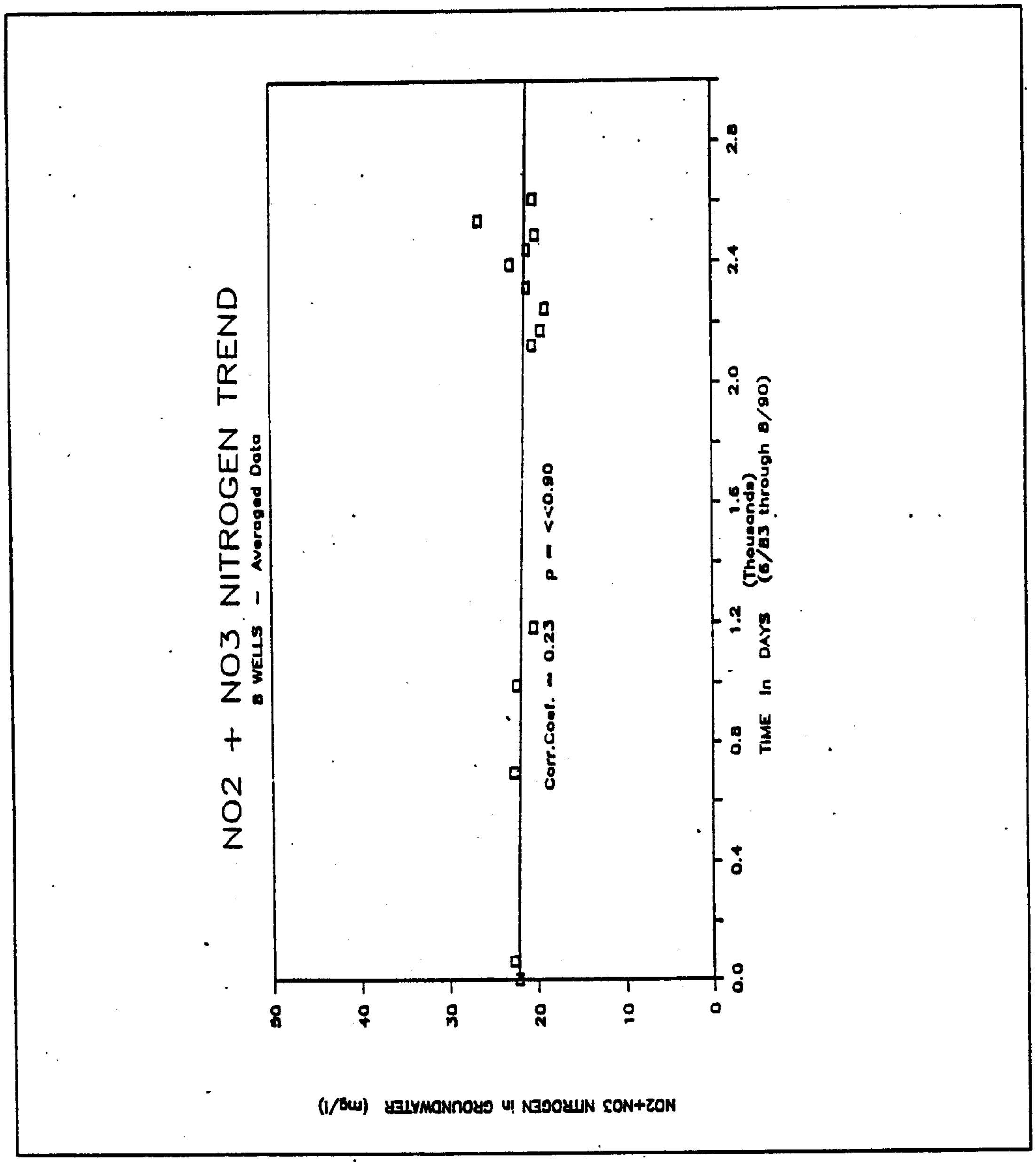
NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (6/83 - 8/90)

8 Wells:

DAY NUMBER	NO2+NO3 ppm MAL012	MAL030	MAL035	MAL041	MAL044	MAL047	MAL083	MAL105	NUMBER OF DATA POINTS	MEAN VALUE
1	8.1	19.2	32	24.8	12.8			36.60	6	22.25
64	11.8	19	27.2	10.1	13.6	49		28.8	7	22.79
696	16.2	23	25.8	17.5	14.8	30		32	7	22.76
991		25.00	28.5	19.00	14.00	36	0.41	34	7	22.42
1184	11	22.2	27.4	16.5		17		28.2	6	20.38
1871		27		17	16		13		4 *	18.25
1941			26	16					2 *	21.00
1997									0 *	
2082				17					1 *	17.00
2123		27		18	16		17	24	5	20.40
2173	11	26		17	16	27	17	22	7	19.43
2244	11	24		16	13	29.5	16	23	7	18.93
2313	22	28		14.5	15	31	18	17	7	21.07
2390	21	27	27	16	15	30		24	7	22.86
2439		27	25	16	15	21		22	6	21.00
2488	11	27	26	17	15	26	18		7	20.00
2536	18.3	30	35	22.5	18	35			6	26.47
2606	11	26	24	18	14	30	16	23	8	20.25
3000										

* Data set dropped as unreprentative


SPATIAL ORIENTATION OF 8 WELLS
NORTHERN MALHEUR COUNTY
-14
-15
-16
-17
-18
-19
-20
-21
TOWNSHIP (South W.M.)
43
45
47
49
RANGE (East W.M.)


NO2 + NO3 NITROGEN TREND
8 WELLS - Averaged Data
Corr.Coef. = 0.23 p = <<0.90
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
TIME In DAYS (Thousands)
(6/83 through 8/90)
50
40
30
20
10
0
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8

Finally, well MAL083 was dropped because there were fewer data available for it than the remaining 7 wells.

Data from sampling events from 8/88 through 4/89 were also discarded since so few wells were represented.

The result is a slight downward trend in nitrates, although not significant.

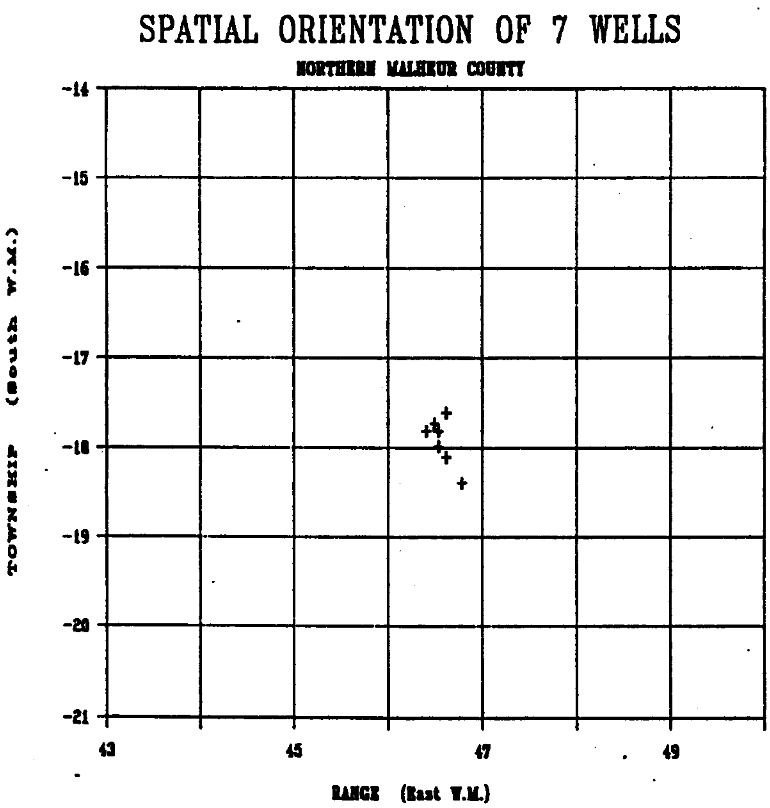
ONTARIO GROUNDWATER RESULTS - public water supplies

NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (6/83 - 8/90)

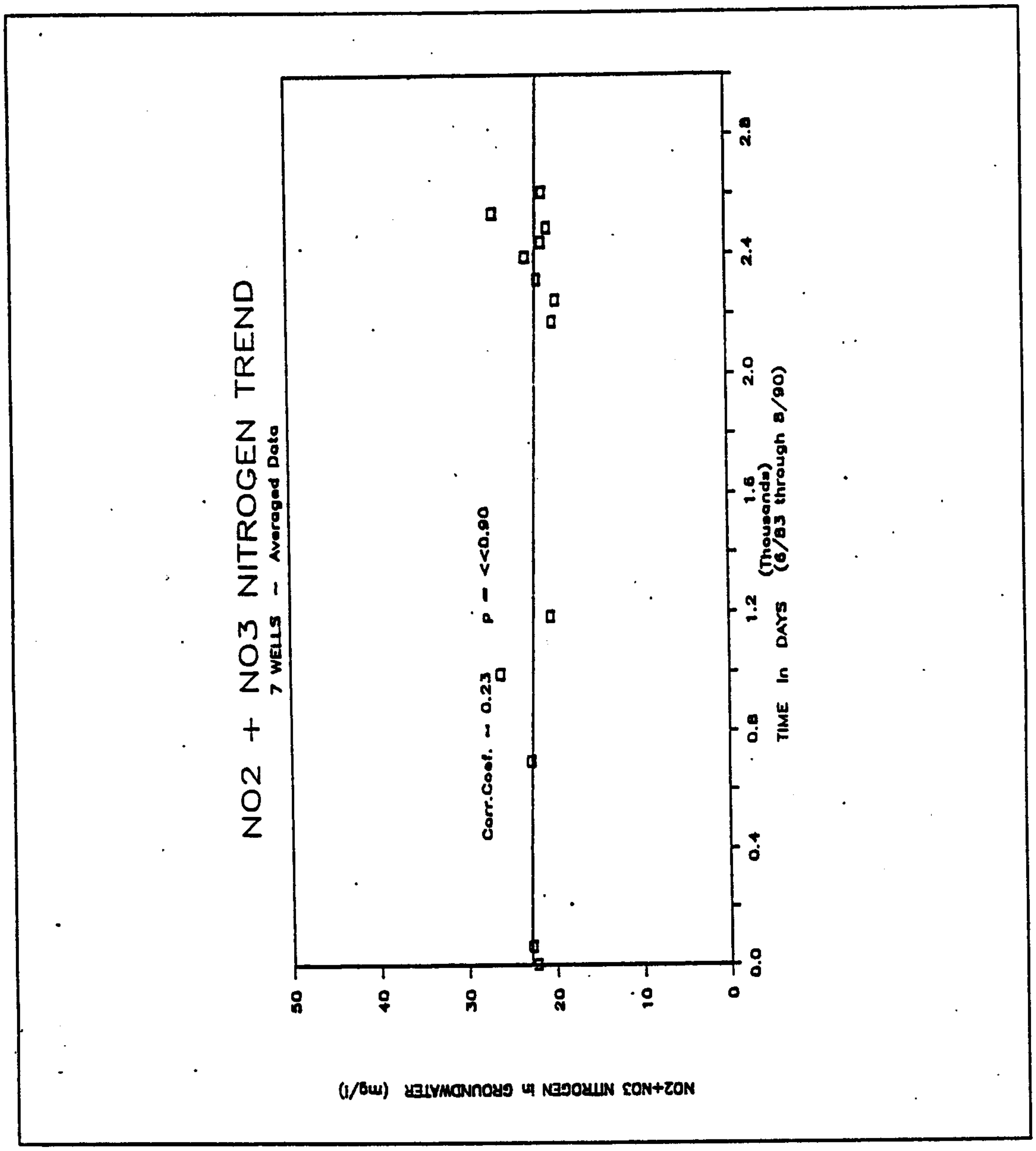
7 Wells — NO2+NO3 ppm

DAY NUMBER	MAL012	MAL030	MAL035	MAL041	MAL044	MAL047	MAL105	Number of Data Pts.	Mean Values
1	8.1	19.2	32	24.8	12.8		36.60	6	22.25
64	11.8	19	27.2	10.1	13.6	49	28.8	7	22.79
696	16.2	23	25.8	17.5	14.8	30	32	7	22.76
991		25.00	28.5	19.00	14.00	36	34	6	26.08
1184	11	22.2	27.4	16.5		17	28.2	6	20.38
1871		27		17	16			3 *	
1941			26	16				2 *	
1997								0 *	
2082				17				1 *	
2123		27		18	16		24	4 *	
2173	11	26		17	16	27	22	6	19.83
2244	11	24		16	13	29.5	23	6	19.42
2313	22	28		16.5	15	31	17	6	21.58
2390	21	27	27	16	15	30	24	7	22.86
2439		27	25	16	15	21	22	6	21.00
2488	11	27	26	17	15	26		6	20.33
2536	18.3	30	35	22.5	18	35		6	26.47
2606	11	26	24	18	14	30	23	7	20.86
3000									

*Disregard data sets because of limited data



SPATIAL ORIENTATION OF 7 WELLS
NORTHERN MALHEUR COUNTY
-14
-15
-16
-17
-18
-19
-20
-21
43
45
47
49
RANGE (East W.M.)
TOWNSHIP (South W.M.)


NO2 + NO3 NITROGEN TREND
7 WELLS -- Averaged Data
Corr.Coef. = 0.23 P = <<0.90
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
50
40
30
20
10
0
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
TIME In DAYS (Thousands)
(6/83 through 8/90)

FURTHER REVISIONS
(March 1, 1991)

During an informal meeting with Marty Bridges (SCS) on February 12, Marty suggested that early (prior to 1988) data for MAL062 and OWY002 may have been collected at different wells than those currently being monitored. The suggestion certainly seemed plausible:

> There has been longterm confusion about the numbering/location of well MAL062. It has previously also been identified as well MAL174. The well location has been described at various times as 15S/47E-29 and as 16S/47E-5.
>
> Marty suggested that OWY002 (James Langley, Sr.) was initially sampled exactly 1-mile to the west of the current location, at the farm of James Langley, Jr. After speaking with James Langley, Jr., on the morning of 2/12/91, this appears to be the case.

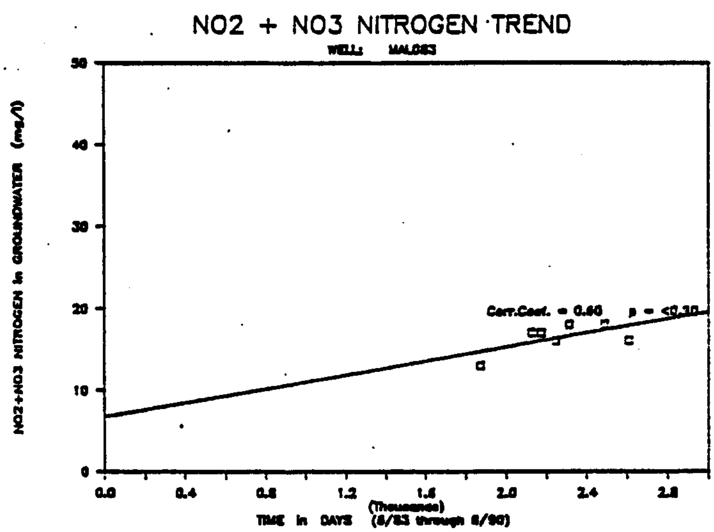
Sampling site description for MAL083 during the initial sampling event is somewhat ambiguous. Data may initially have been collected at a well directly across Arcadia Blvd. (to the west) from the current monitoring site.

Since some confusion exists, early (pre-1988) data from these wells were discarded, and trends reexamined.

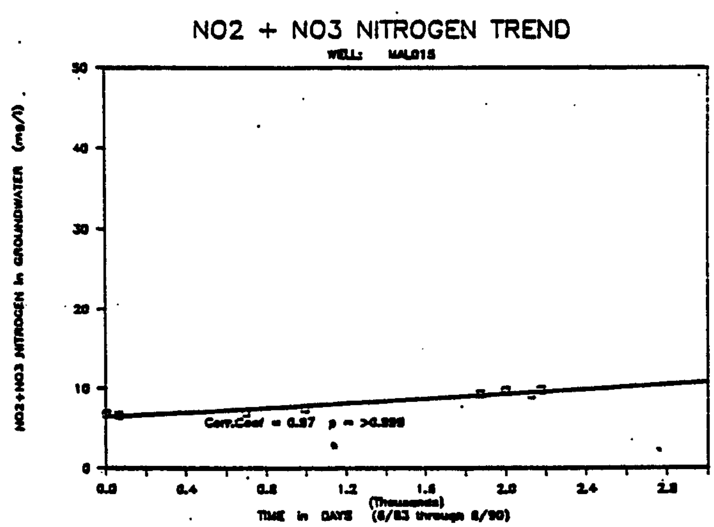
Upon reexamination, MAL083 still shows a dramatic upward trend in nitrate contamination, although it is no longer significant. Early data that are questioned might have been collected from this well.

Revised trend line for MAL062 is essentially unchanged, although the trend is no longer as significant. It is most likely that early data were collected from the same well.

By eliminating the first data set for well OWY002, a highly significant downward trend in nitrates becomes an insignificant upward trend. It appears quite likely that the samples for the first data set designated OWY002 was collected at another well.

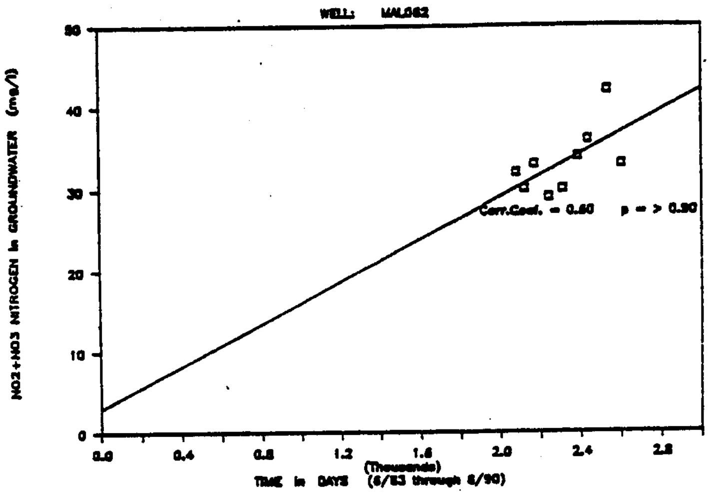


NO2 + NO3 NITROGEN TREND
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
(Thousands)
TIME in DAYS (6/83 through 6/90)

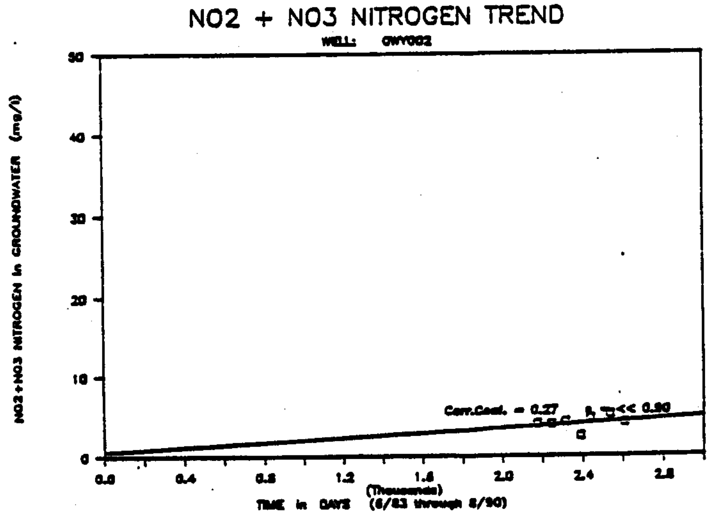


NO2 + NO3 NITROGEN TREND
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
(Thousands)
TIME in DAYS (6/83 through 6/90)

NO2 + NO3 NITROGEN TREND



NO2 + NO3 NITROGEN TREND



With the elimination of the previously described questionable data, nitrate trends were reexamined at the same 15, 10, and 8 wells.

Probability of the upward nitrate trend at the 15 wells drops from 0.98 to 0.95.

For the 10 wells previously examined, a significant upward trend in nitrates ($p = 0.90$) becomes insignificant ($p = <0.90$).

For the 8 wells, the insignificant downward trend is still insignificant.

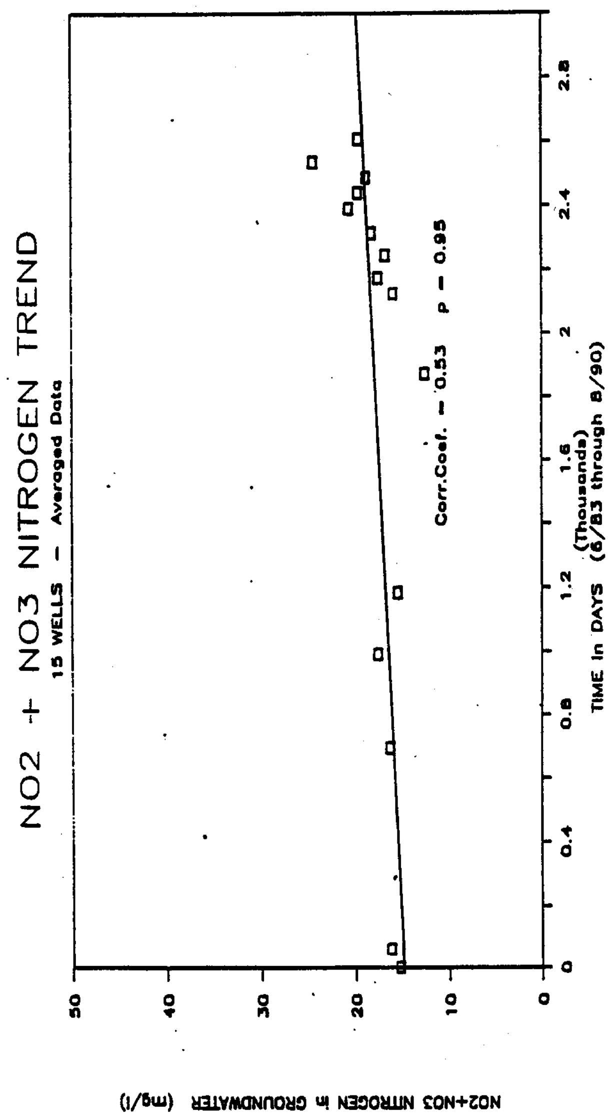
NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (4/83 - 8/90)

15 Wells:

NO2+NO3 ppm

DAY NUMBER	MAL007	MAL012	MAL015	MAL016	MAL030	MAL035	MAL039	MAL041	MAL044	MAL047	MAL062	MAL083	MAL105	MAL106	OWY002	NUMBER OF DATA POINTS	MEAN VALUE
1	0.015	0.1	6.0	9.7	19.2	32	2.5	24.8	12.8		•		34.60			10	15.25
64	0.0025	11.0	4.6	11	19	27.2	1.1	18.1	13.6	49			28.0			11	16.20
696	0.015	16.2	7	11.9	23	25.8	0.98	17.5	14.8	30			32			11	16.29
991	0.13		7.50	11	25.00	28.5	0.42	19.00	14.00	34		•	34		•	10	17.54
1106	0.015	11		10.2	22.2	27.4	0.36	16.5		17			20.2	21.5		10	15.44
1871	0.03		9.3	13	27		5.5	17	16			13		12		9	12.56
2125	0.02		9.2	12	27		1.7	18	16		30	17	24	20		11	15.90
2173		11	9.0	13	26		2.2	17	16	27	33	17	22	29	4	13	17.46
2266	0.01	11		13	26			16	13	29.5	29	16	23	22	3.9	12	16.78
2313	0.02	22		12	28			16.5	15	31	30	18	17	24	4.2	12	18.14
2390		21		9.4	27	27		16	15	30	34		24		2.6	10	20.58
2439				9.9	27	25		16	15	21	34		22		4.6	9	19.61
2488		11		9.8	27	24		17	15	24		18				8	18.73
2536		10.3		13.5	30	35		22.5	18	35	42				5.1	9	24.38
2606		11		11	26	24		18	14	30	33	14	23	25	4.1	12	19.59
3000																	

• Data points dropped - early data may have been from a different well

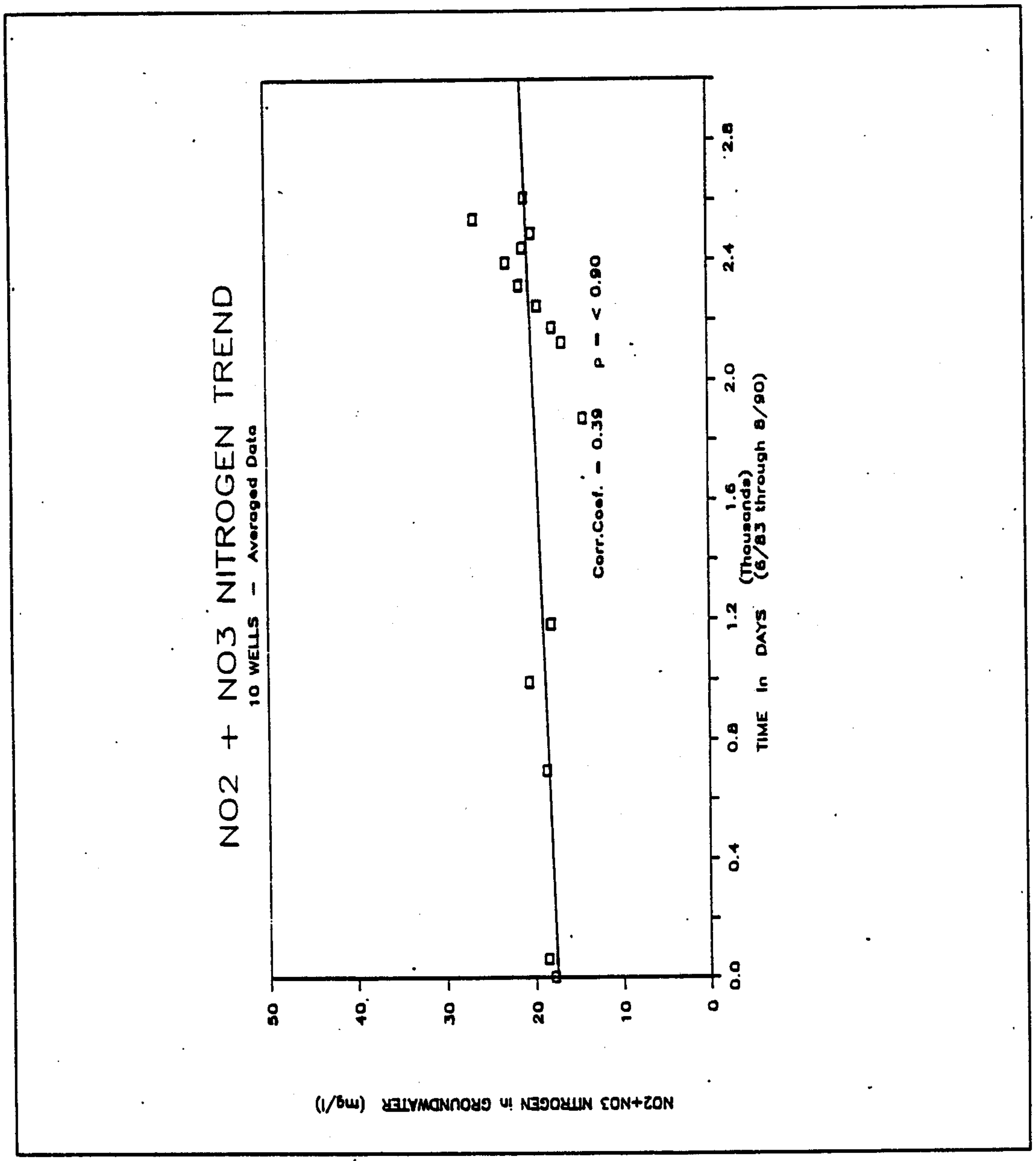

NO2 + NO3 NITROGEN TREND
15 WELLS – Averaged Data
Corr.Coef. = 0.53 p = 0.95
TIME in DAYS (Thousands) (6/83 through 8/90)
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
0
0.4
0.8
1.2
1.6
2
2.4
2.8
0
10
20
30
40
50

NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (6/83 - 8/90)

10 Wells:

DAY NUMBER	NO2+NO3 ppm											NUMBER OF DATA POINTS	MEAN VALUE
	MAL012	MAL015	MAL030	MAL035	MAL039	MAL041	MAL044	MAL047	MAL083	MAL105	MAL106		
1	8.1	6.8	19.2	32	2.5	24.8	12.8			36.60		8	17.85
64	11.8	6.6	19	27.2	1.1	10.1	13.6	49		28.8		9	18.58
696	16.2	7	23	25.8	0.98	17.5	14.8	38		32		9	18.59
991		7.50	25.00	28.5	0.42	19.00	14.00	36	*	34		7	20.55
1184	11		22.2	27.4	0.36	16.5		17		28.2	21.5	8	18.02
1871		9.3	27		5.5	17	16		13		12	7	14.26
2123		9.2	27		1.7	18	16		17	24	20	8	16.61
2173	11	9.8	26		2.2	17	16	27	17	22	29	10	17.70
2244	11		26			16	13	29.5	16	23	22	8	19.31
2313	22		28			16.5	15	31	18	17	24	8	21.44
2390	21		27	27		16	15	30		24		7	22.86
2439			27	25		16	15	21		22		6	21.00
2488	11		27	26		17	15	26	18			7	20.00
2536	10.3		30	35		22.5	18	35				6	26.47
2606	11		26	24		18	16	38	16	23	25	9	20.78
3000													

*. Data point dropped - early data may have been from a different well


NO2 + NO3 NITROGEN TREND
10 WELLS — Averaged Data
Corr.Coef. = 0.39   p = < 0.90
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
50
40
30
20
10
0
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
TIME in DAYS (Thousands)
(6/83 through 8/90)

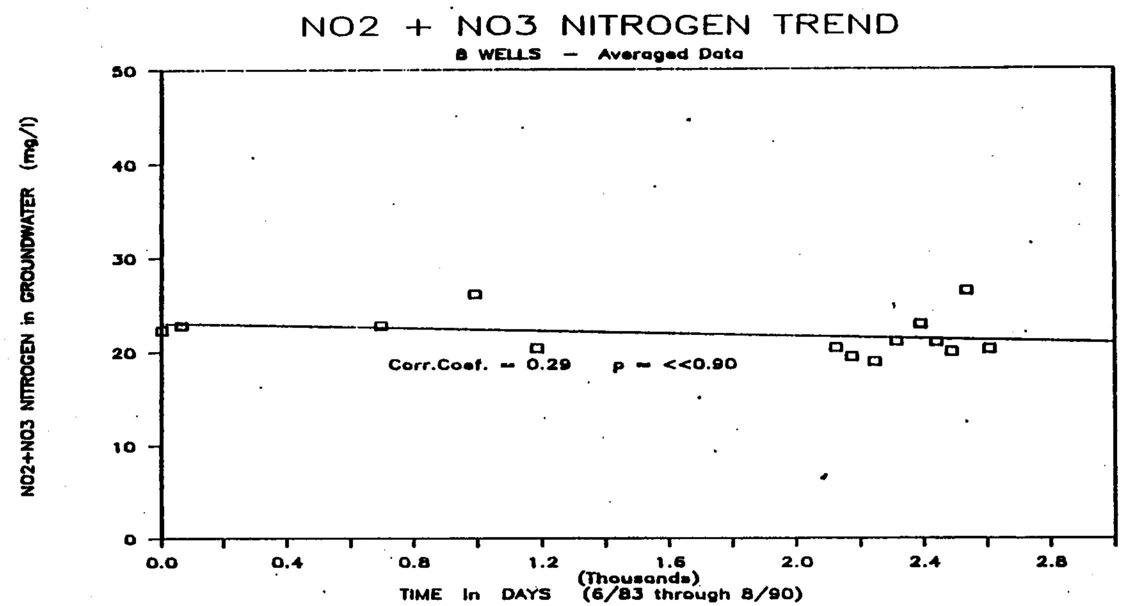
NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (6/83 - 8/90)

8 Wells:

NO2+NO3 ppm

DAY NUMBER	MAL012	MAL030	MAL035	MAL041	MAL044	MAL047	MAL083	MAL105	NUMBER OF DATA POINTS	MEAN VALUE
1	8.1	19.2	32	24.8	12.8			36.60	6	22.25
64	11.8	19	27.2	10.1	13.6	49		28.8	7	22.79
696	16.2	23	25.8	17.5	14.8	30		32	7	22.76
991		25.00	28.5	19.00	14.00	36	•	34	6	26.08
1184	11	22.2	27.4	16.5		17		28.2	6	20.38
2123		27		18	16		17	24	5	20.40
2173	11	26		17	16	27	17	22	7	19.43
2244	11	24		16	13	29.5	16	23	7	18.93
2313	22	28		16.5	15	31	18	17	7	21.07
2390	21	27	27	16	15	30		24	7	22.86
2439		27	25	16	15	21		22	6	21.00
2488	11	27	26	17	15	26	18		7	20.00
2536	18.3	30	35	22.5	18	35			6	26.47
2606	11	26	24	18	14	30	16	23	8	20.25
3000										

• Data point dropped - early data may have been from a different well



Since future evaluations of groundwater nitrates in northern Malheur County will be based on data from the Indicator Wells specified by John Cardwell, initial data evaluations should more-properly be based on those same Indicator Wells. The following evaluations are based only on Indicator Wells.

Nitrate trend when examining averages based on the 20 Primary Indicator Wells plus the 18 Secondary Indicator Wells.

A highly significant downward trend (p between 0.99 and 0.999).

NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (4/83 - 8/90)

20 Primary and 18 Secondary Indicator Wells

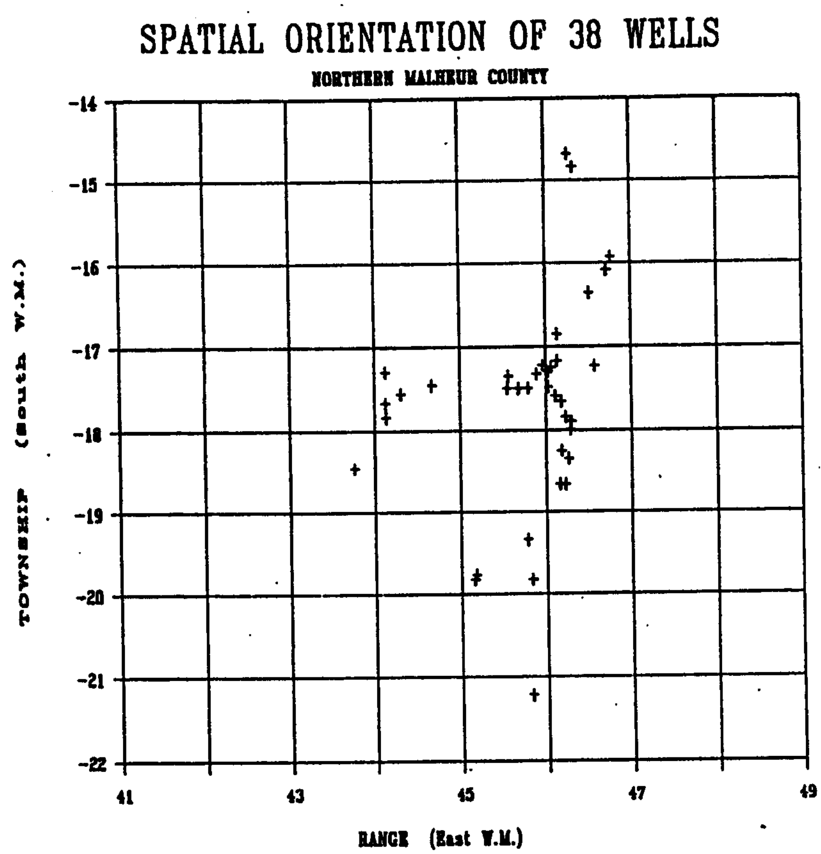
NO2+NO3
ppm

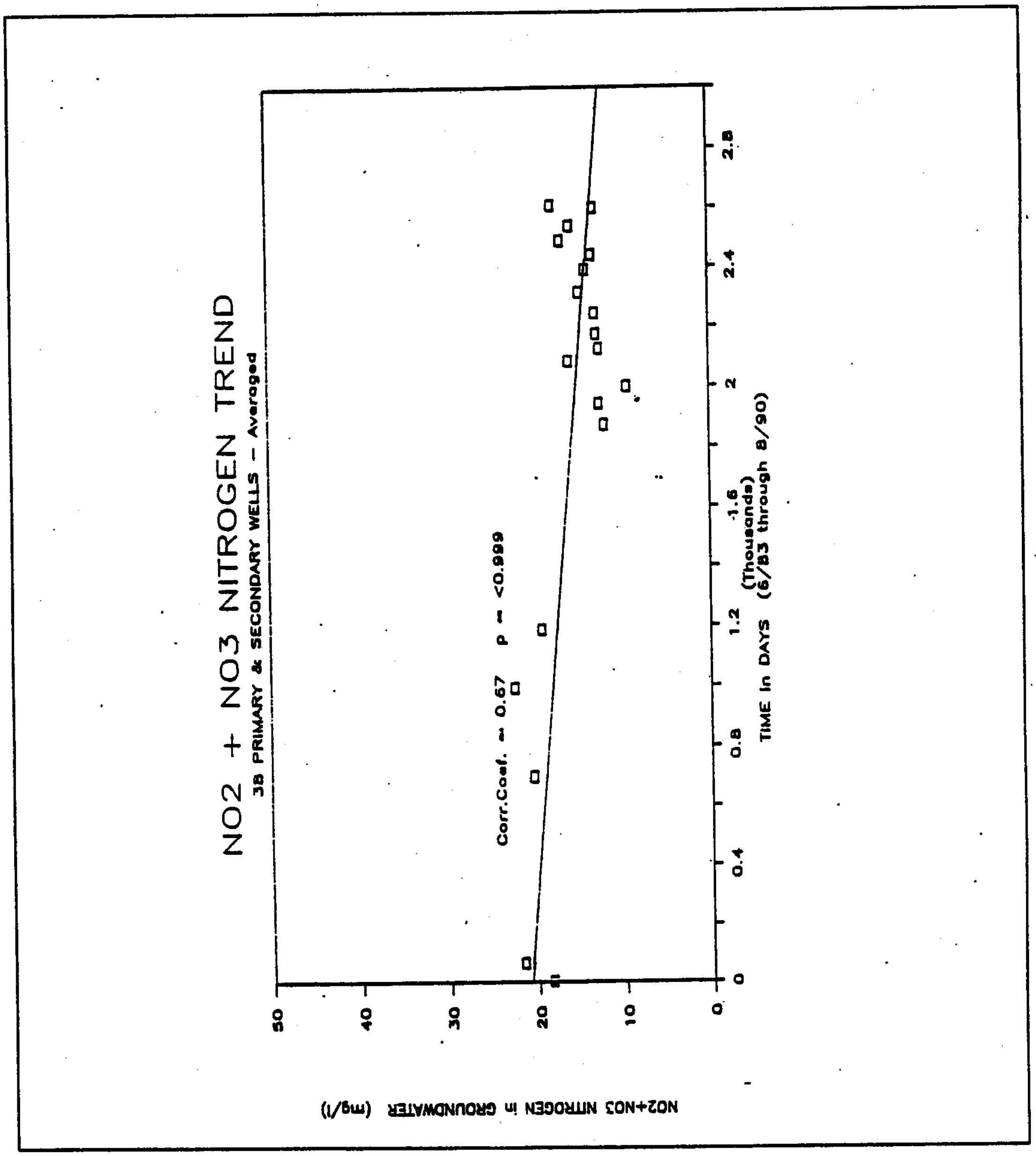
DAY NUMBER	DATE	MAL005	MAL012	MAL016	MAL030	MAL035	MAL041	MAL044	MAL047	MAL042	MAL046	MAL075	MAL078	MAL079	MAL083	MAL101	MAL105	MAL106
1	830427	3.8	8.1	9.7	19.2	32	24.8	12.8									36.40	
64	830629		11.8	11	19	27.2	18.1	13.6	49								28.8	24.2
696	850522	4.2	16.2	11.9	23	25.8	17.5	14.8	30								32	28
991	860313			11	25.00	28.5	19.00	16.00	36		19.00	19.00		12.00			34	29.5
1185	860923		11	10.2	22.2	27.4	16.5		17								28.2	21.5
1871	880809	8.3		13	27		17	16					<0.02		13	1.7		12
1941	881018						16											
1997	881213	8.3												0.105		0.95		
2083	890309						17			32								
2123	890418			12	27		18	16		30	6.2				17	1.5	24	30
2173	890607		11	13	26		17	16	27	33				13	17	1.9	22	29
2243	890816		11	13	26		18	13	29.5	29					16	7.3	23	22
2313	891025		22	12	28	26	16.5	15	31	30					18	7.1	17	24
2390	900110		21	9.4	27	27	16	15	30	34						2	24	
2439	900228			9.9	27	25	16	15	21	36						1	22	
2488	900418		11	9.8	27	26	17	15	26			12	30		18			
2537	900606		16.3	13.5	30	35	22.5	10	35	42	7.9							
2599	900807		11	11				14		33			14	11	14			
2644	900816				26	24	18		30		18						23	25
3000																		
Data Points:		4	11	15	15	11	17	14	12	9	4	2	3	4	7	8	12	10

DAY NUMBER	DATE	MAL100	MAL116	MAL119	MAL121	MAL123	MAL125	MAL126	MAL129	MAL134
1	830627									
64	830829									
696	850522									
991	860313									
1185	860923									
1871	880809			12	14	14			7.7	12
1941	881018		2				12	20		
1997	881213			15	13	18			6.5	13
2083	890309									
2123	890418	1.2	5	11	14		8.3	11	7.7	
2173	890607	2.3	5.3	13	12	14	7.7	6.5	7.2	
2243	890816	2.25	3.3	13	13	12	9.3	7.6		
2313	891025	0.37	5.5	14	13	14	9	8.8		
2390	900110			15	13	14		9.3		12
2439	900228	0.6	8	13	12	12				
2488	900418			13	12					
2537	900606	3.4	4	17.5	14.5	14	15	5.3		
2599	900807	3.2	4	15						
2606	900814				13		11			13
3000										
Data Points:		7	8	11	11	8	7	7	4	4

DAY NUMBER	DATE	MAL147	MAL152	MAL164	MAL172	MAL175	MAL180	MAL189	MAL211
1	830627								
64	830829								
696	850522								
991	860313								
1185	860923								
1871	880809								
1941	881018								
1997	881213								
2083	890309	0.02		20	9.35	17			
2123	890418	0.04			11	17			
2173	890607	0.03	20	13	11	7.5	4		
2243	890816	0.09	27	8.6	7.45	15	4.3		
2313	891025	0.02	21		5.5	14		11	
2390	900110	0.02		7.9	5.9			9.8	
2439	900228	0.05		12	7.8	13		8.9	
2488	900418	0.01	22	13	12			10	44
2537	900606	0.5	28	14.5	8.2	14.5		10.3	
2599	900807			11	6.1	13			48
2606	900814	0.04	22					7.7	
3000									
Data Points:		10	6	8	10	8	2	4	2

DAY NUMBER	DATE	MAL213	OW002	OW009	OW101	NUMBER OF DATA POINTS	MEAN VALUE
1	830627					8	18.38
64	830829					9	21.63
696	850522					10	20.34
991	860313					11	22.45
1185	860923					8	19.25
1871	880809					14	11.98
1941	881018					4	12.50
1997	881213					8	9.36
2083	890309					6	15.90
2123	890418			3.7		21	12.46
2173	890607		4	4.4		28	12.78
2243	890816		3.9	4.5		26	12.88
2313	891025		4.2			25	14.68
2390	900110		2.4	3.4	8.75	22	13.95
2439	900228		4.6			20	13.24
2488	900418	6.7			8.4	20	16.75
2537	900606		5.1	3	10	25	15.68
2599	900807	7.3	4.1	6	8.5	18	13.01
2606	900814					13	17.75
3000							
Data Points:		2	7	6	4		19


SPATIAL ORIENTATION OF 38 WELLS
NORTHERN MALHEUR COUNTY
TOWNSHIP (South W.M.)
-14
-15
-16
-17
-18
-19
-20
-21
-22
41
43
45
47
49
RANGE (East W.M.)


NO2 + NO3 NITROGEN TREND
38 PRIMARY & SECONDARY WELLS - Averaged
Corr.Coef. = 0.67   p = <0.999
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
50
40
30
20
10
0
0
0.4
0.8
1.2
1.6
2
2.4
2.8
(Thousands)
TIME in DAYS (6/83 through 8/90)

Nitrate trend when examining averages based on the 20 Primary Indicator Wells alone.

Data from 10/88 and 12/88 sampling events were eliminated as being unrepresentative (too few wells represented).

A highly significant downward trend (p = 0.98).

NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (6/83 - 8/90)

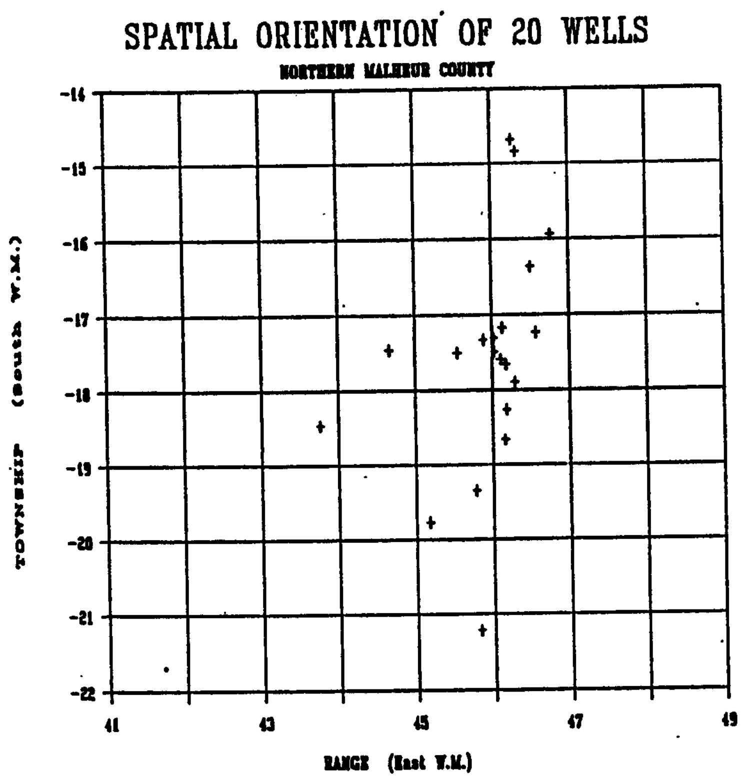
20 Primary Indicator Wells

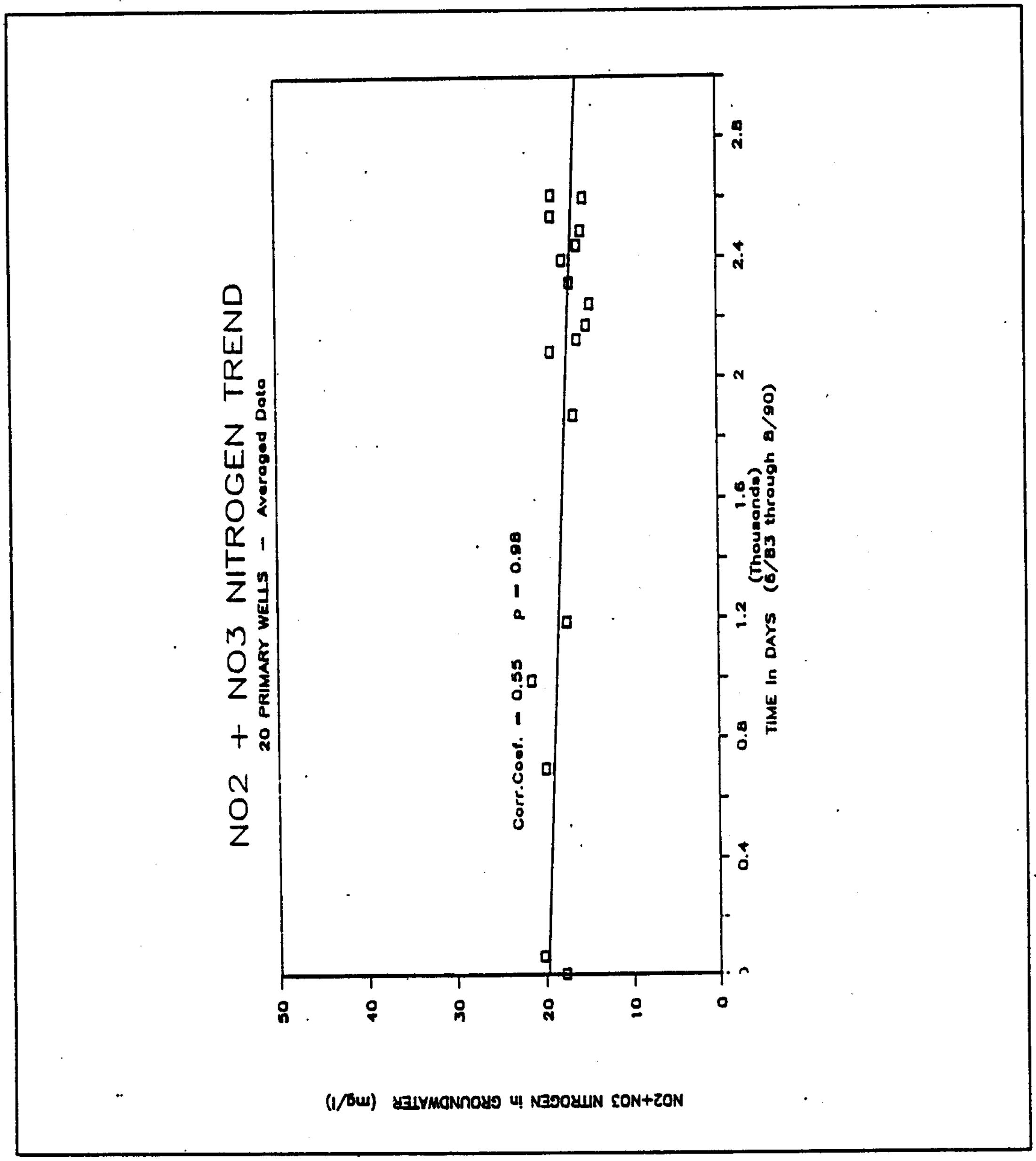
NO2+NO3
ppm

DAY NUMBER	MAL012	MAL016	MAL030	MAL035	MAL041	MAL044	MAL047	MAL062	MAL064	MAL075	MAL108	MAL119	MAL121	MAL125	MAL164	MAL172	MAL175
1	8.1	9.7	19.2	32	26.8	12.8											
64	11.8	11	19	27.2	18.1	13.6	49										
696	16.2	11.9	23	25.8	17.5	14.8	38										
990		11	25.00	28.5	19.00	14.00	36		19.00	19.00							
1185	11	10.2	22.2	27.4	14.5		17										
1871		13	27		17	16						12	14				
1942					16									12			
1997												15	13				
2083					17			32							20	9.35	17
2126		12	27		18	16		30	6.2		1.2	11	14	8.3		11	17
2175	11	13	26		17	16	27	33			2.3	13	12	7.7	13	11	7.5
2243	11	13	26		16	13	29.5	29			2.25	13	13	9.5	8.6	7.45	15
2313	22	12	28	26	14.5	15	31	30			0.37	14	13	9		5.5	14
2390	21	9.4	27	27	16	15	30	34				15	13		7.9	5.9	
2439		8.9	27	25	16	15	21	34			0.6	13	12		12	7.8	13
2488	11	9.8	27	26	17	15	26			12		13	12		13	12	
2534	10.3	13.5	30	35	22.5	18	35	42	7.9		3.4	17.5	14.5	15	14.5	8.2	14.5
2599		11				14		33			3.2	13			11	6.1	13
2606	11		26	24	18		30		18				13	11			
3000																	

DAY NUMBER	HAL211	HAL213	OWY101	NUMBER OF DATA POINTS		MEAN VALUE
1				6		17.77
64				7		20.24
696				7		19.89
990				8		21.44
1185				6		17.38
1871				6		16.50
1942				2	*	14.00
1997				2	*	14.00
2083				5		19.07
2124	46	6.7		14		16.03
2173				14		14.96
2263				14		14.58
2313				14		16.88
2390			8.75	13		17.69
2439				13		16.02
2488			8.4	13		15.55
2536			10	17		18.93
2599	48	7.3	8.5	11		15.28
2606				8		18.88
3000						

* Data sets dropped as unrepresentative


SPATIAL ORIENTATION OF 20 WELLS
NORTHERN MALHEUR COUNTY
TOWNSHIP (South W.M.)
RANGE (East W.M.)
-14
-15
-16
-17
-18
-19
-20
-21
-22
41
43
45
47
49


NO2 + NO3 NITROGEN TREND
20 PRIMARY WELLS — Averaged Data
Corr.Coef. = 0.55 P = 0.98
50
40
30
20
10
0
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
0.4
0.8
1.2
1.6
2
2.4
2.8
(Thousands)
TIME In DAYS (6/83 through 8/90)

Data gathered prior to 4/89 from the 20 Primary Indicator Wells are eliminated since these data are mainly representative of only 7 wells.

The result is an insignificant upward trend.

NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (4/83 - 8/90)

20 Primary Indicator Wells:

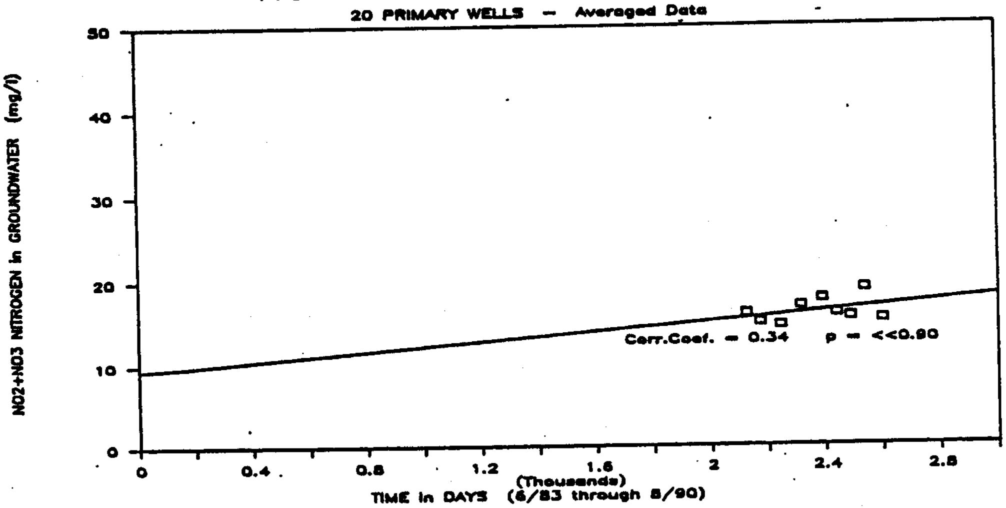
NO2+NO3
ppm

DAY NUMBER	MAL012	MAL016	MAL030	MAL035	MAL041	MAL044	MAL047	MAL062	MAL064	MAL075	MAL100	MAL119	MAL121	MAL125	MAL164	MAL172	MAL175
1																	
64																	
696																	
990																	
1185																	
1871																	
2043																	
2126		12	27		18	16		30	6.2		1.2	11	14	8.3		11	17
2173	11	13	26		17	16	27	33			2.3	13	12	7.7	13	11	7.5
2243	11	13	26		16	13	29.5	29			2.25	13	13	9.3	8.6	7.45	15
2313	22	12	28	26	16.5	15	31	30			0.37	14	13	9		5.5	16
2390	21	9.4	27	27	16	15	30	34				15	13		7.9	5.9	
2439		9.9	27	25	16	15	21	34			0.6	13	12		12	7.8	13
2488	11	9.8	27	26	17	15	26			12		13	12		13	12	
2536	10.3	13.5	30	35	22.5	10	35	42	7.9		3.4	17.5	14.5	15	14.5	8.2	16.5
2599		11				16		33			3.2	13			11	6.1	13
2606																	
3008																	

DAY NUMBER	NAL211	NAL213	GMY101	NUMBER OF DATA POINTS	MEAN VALUE
1					
64					
696					
990					
1185					
1871					
2083					
2124	46	6.7		14	16.03
2173				14	14.96
2243				14	14.58
2313				14	16.88
2390			8.75	13	17.69
2439				13	16.02
2488			8.6	13	15.55
2536			10	17	18.93
2599	48	7.3	8.5	11	15.28
2606					
3000					

NO2 + NO3 NITROGEN TREND

20 PRIMARY WELLS — Averaged Data



Examining 7 of the 20 Primary Indicator Wells from which early data are most plentiful.

Data sets from the 3/89 and 8/90 sampling events are discarded since they represent too few wells.

The result is a slight, though insignificant, upward trend in nitrates.

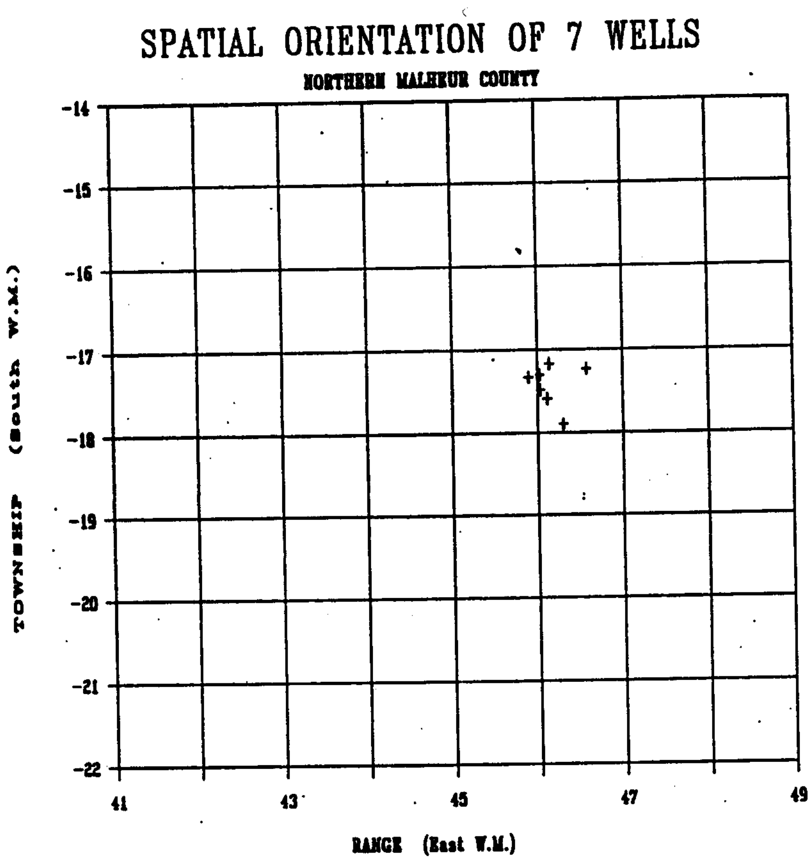
These wells, incidentally, are all located within a 3-mile radius.

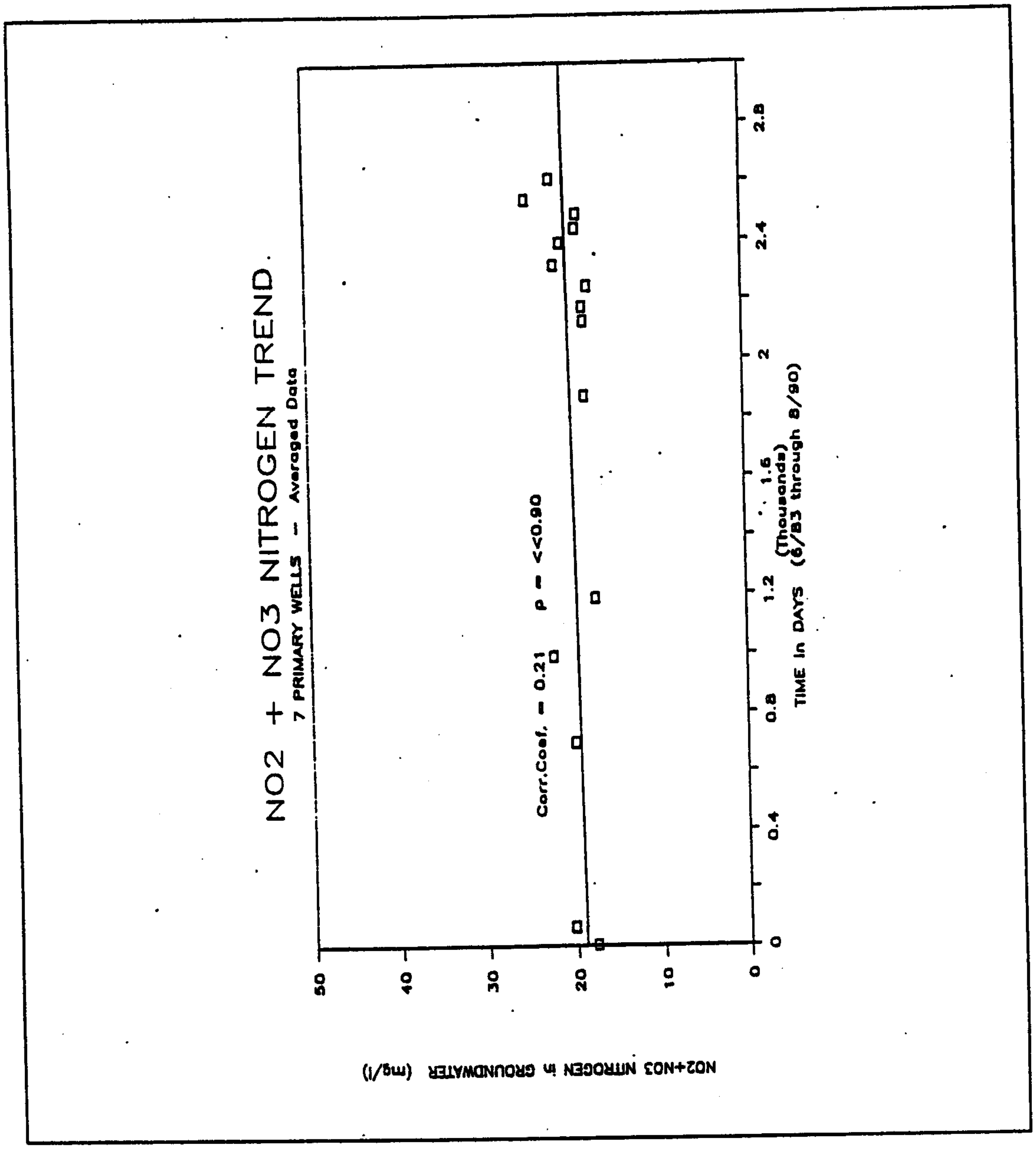
NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (6/83 - 8/90)

7 of the 20 Primary Indicator Wells:

DAY NUMBER	NO2+NO3 ppm							NUMBER OF DATA POINTS		MEAN VALUE
	MAL012	MAL016	MAL030	MAL035	MAL041	MAL044	MAL047			
1	8.1	9.7	19.2	32	24.8	12.8		6		17.77
64	11.8	11	19	27.2	10.1	13.6	49	7		20.24
496	16.2	11.9	23	25.8	17.5	14.8	30	7		19.89
990		11	25.00	28.5	19.00	14.00	36	6		22.25
1185	11	10.2	22.2	27.4	14.5		17	6		17.38
1871		13	27		17	16		4		18.25
2083					17			1	*	17.00
2124		12	27		18	16		4		18.25
2173	11	13	26		17	16	27	6		18.33
2263	11	13	24		16	13	29.5	6		17.75
2313	22	12	28	26	14.5	15	31	7		21.50
2390	21	9.4	27	27	16	15	30	7		20.77
2439		9.9	27	25	16	15	21	6		18.98
2488	11	9.8	27	26	17	15	26	7		18.83
2536	18.3	13.5	30	35	22.5	18	35	7		24.61
2599		11				14		2	*	12.50
2606	11		26	24	18		30	5		21.80
3000										

* Data sets dropped as unrepresentative


SPATIAL ORIENTATION OF 7 WELLS
NORTHERN MALHEUR COUNTY
TOWNSHIP (South W.M.)
RANGE (East W.M.)
-14
-15
-16
-17
-18
-19
-20
-21
-22
41
43
45
47
49


NO2 + NO3 NITROGEN TREND
7 PRIMARY WELLS -- Averaged Data
Corr.Coef. = 0.21 p = <<0.90
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
50
40
30
20
10
0
0
0.4
0.8
1.2
1.6
2
2.4
2.8
(Thousands)
TIME in DAYS (6/83 through 8/90)

Returning to the 20 Primary and 18 Secondary Indicator Wells, wells with limited nitrates data are dropped. Those wells dropped include:

MAL005
MAL064
MAL075
MAL078
MAL079
MAL129
MAL136
MAL180
MAL211
MAL213
OWY101

Two sampling events, 10/88 and 12/88, are dropped from the data for the remaining 27 wells (15 Primary and 12 Secondary) because they represent too few wells.

The result is a significant downward nitrate trend ($p > 0.999$).

NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (6/83 - 8/90)

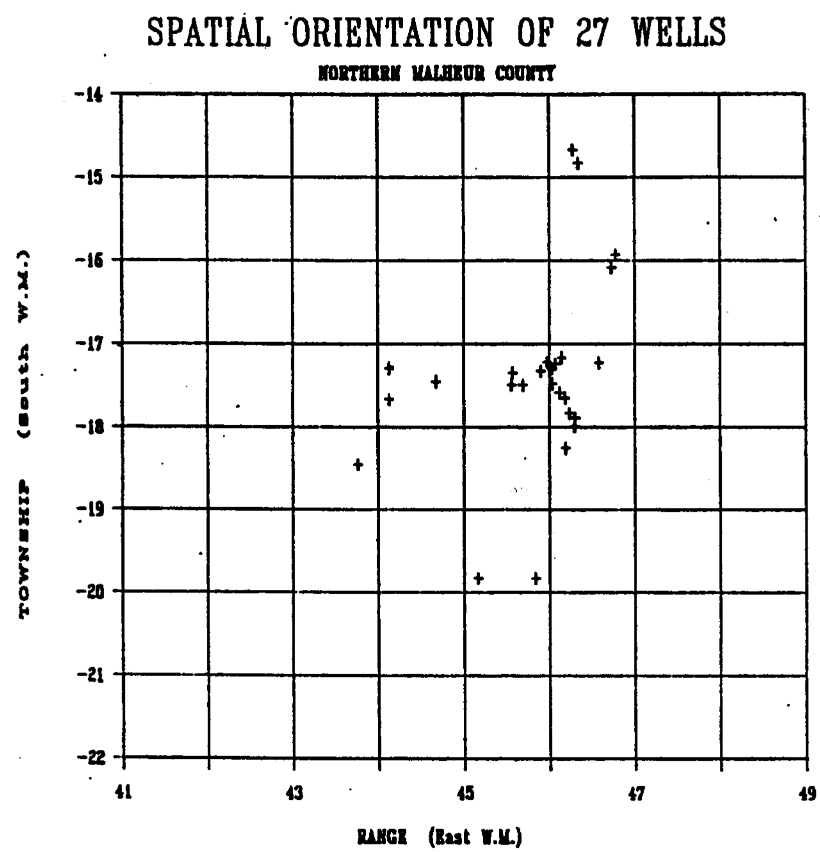
15 Primary and 12 Secondary Indicator Wells:

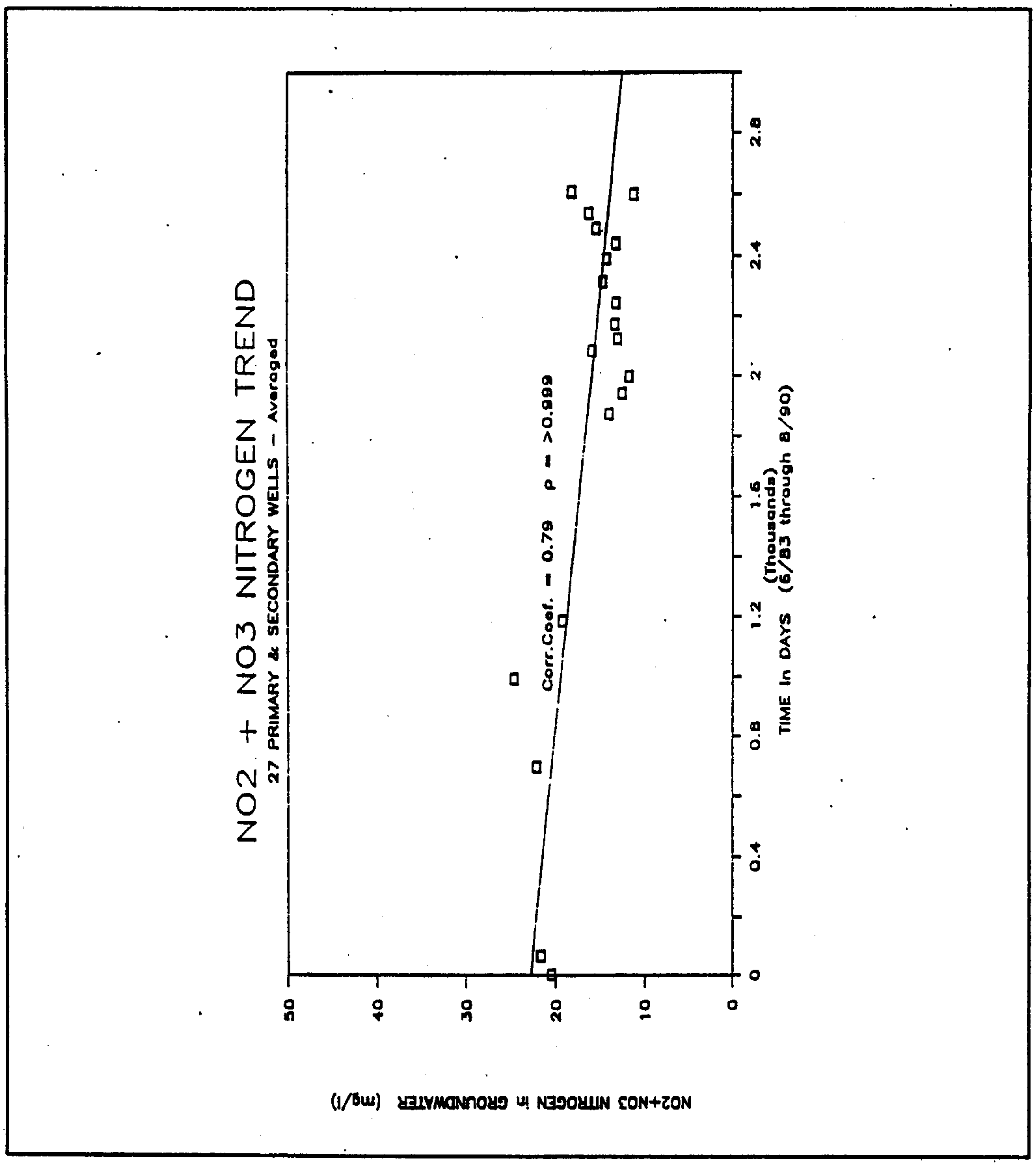
NO2+NO3 ppm

DAY NUMBER	DATE	MAL012	MAL016	MAL030	MAL035	MAL041	MAL044	MAL047	MAL062	MAL083	MAL101	MAL105	MAL106	MAL108	MAL116	MAL119	MAL121	MAL123
1	830427	8.1	9.7	19.2	32	24.8	12.8					36.60						
64	830829	11.8	11	19	27.2	10.1	13.6	49				28.8	24.2					
696	850522	14.2	11.9	23	25.8	17.5	14.8	30				32	28					
991	860313		11	25.00	28.5	19.00	14.00	34				34	29.5					
1185	860923	11	10.2	22.2	27.4	14.5		17				28.2	21.5					
1871	880809		13	27		17	14			13	1.7		12			12	14	16
1941	881018					14									2			
1997	881213										0.95					15	13	18
2083	890309					17			32									
2123	890418		12	27		18	14		30	17	1.5	24	20	1.2	5	11	14	
2173	890607	11	13	24		17	16	27	33	17	1.9	22	29	2.3	5.3	13	12	14
2243	890816	11	13	24		14	13	29.5	29	16	7.3	23	22	2.25	3.3	13	13	12
2313	891025	22	12	28	24	14.5	15	31	30	18	7.1	17	24	0.37	5.5	14	13	14
2390	900110	21	9.4	27	27	14	15	30	34		2	24				15	13	14
2439	900228		9.9	27	25	16	15	21	34		1	22		0.6	8	13	12	12
2488	900418	11	9.8	27	26	17	15	26		18						13	12	
2537	900606	10.3	13.5	30	35	22.5	18	35	42					3.4	6	17.5	14.5	14
2599	900807	11	11				14		33	16				3.2	4	13		
2606	900816			26	24	18		30				23	25				13	
3000																		
Data Points:		11	15	15	11	17	14	12	9	7	8	12	10	7	8	11	11	8

DAY NUMBER	DATE	HAL125	HAL126	HAL147	HAL152	HAL164	HAL172	HAL175	HAL189	OWY002	OWY009	NUMBER OF DATA POINTS	MEAN VALUE
1	830627											7	20.46
64	830829											9	21.63
696	850522											9	22.13
991	860313											8	24.63
1185	860923											8	19.25
1871	880809											10	13.97
1941	881018	12	20									4 *	12.50
1997	881213											4 *	11.74
2083	890309			0.02		20	9.35	17				6	15.90
2123	890418	8.3	11	0.04			11	17			3.7	19	13.04
2173	890607	7.7	6.5	0.03	20	13	11	7.5		4	4.4	25	13.35
2243	890816	9.3	7.4	0.09	27	8.6	7.45	15		3.9	4.5	25	13.22
2313	891025	9	8.8	0.02	21		5.5	14	11	4.2		25	14.68
2390	900110		9.3	0.02		7.9	5.9		9.8	2.4	3.4	20	14.31
2439	900228			0.05		12	7.8	13	8.9	4.6		20	13.24
2488	900418			0.01	22	13	12		10			15	15.45
2537	900606	15	5.3	0.5	28	14.5	8.2	16.5	10.3	5.1	3	23	16.27
2599	900807					11	6.1	13		4.1	6	13	11.10
2606	900814	11		0.04	22				7.7			11	10.16
3000													
Data Points:		7	7	10	6	8	10	8	6	7	6		19

* Data set dropped as unrepresentative


SPATIAL ORIENTATION OF 27 WELLS
NORTHERN MALHEUR COUNTY
TOWNSHIP (South W.M.)
RANGE (East W.M.)
-14
-15
-16
-17
-18
-19
-20
-21
-22
41
43
45
47
49


NO2 + NO3 NITROGEN TREND
27 PRIMARY & SECONDARY WELLS - Averaged
Corr.Coef. = 0.79 p = >0.999
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
50
40
30
20
10
0
0
0.4
0.8
1.2
1.6
2
2.4
2.8
(Thousands)
TIME in DAYS (6/83 through 8/90)

NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (4/83 - 8/90)

20 Primary and Secondary Wells in Central Valley

NO2+NO3
ppm

DAY NUMBER	DATE	MAL012	MAL016	MAL030	MAL035	MAL041	MAL044	MAL047	MAL078	MAL079	MAL083	MAL101	MAL105	MAL106	MAL108	MAL119	MAL121	MAL123
1	830427	8.1	9.7	10.2	32	26.8	12.8						36.60					
64	830629	11.0	11	19	27.2	10.1	13.6	49					28.8	26.2				
696	850522	16.2	11.9	23	25.8	17.5	14.8	30					32	28				
991	860313		11	25.00	28.5	19.00	16.00	36		12.00			34	29.5				
1185	860923	11	10.2	22.2	27.4	14.5		17					28.2	21.5				
1671	880809		13	27		17	16		<0.02		13	1.7		12		12	14	14
1961	881018					16												
1997	881213									0.105		0.95				15	13	18
2083	890309					17												
2123	890418		12	27		18	16				17	1.5	26	20	1.2	11	14	
2173	890607	11	13	26		17	16	27		13	17	1.9	22	29	2.3	13	12	14
2243	890816	11	13	24		16	13	29.5			16	7.3	23	22	2.25	13	13	12
2313	891025	22	12	28	26	14.5	15	31			18	7.1	17	26	0.37	14	13	14
2390	900110	21	9.6	27	27	16	15	30				2	26			15	13	16
2439	900228		9.9	27	25	16	15	21				1	22		0.6	13	12	12
2488	900418	11	9.8	27	26	17	15	26	30		18					13	12	
2537	900606	10.3	13.5	30	35	22.5	18	35							3.4	17.5	14.5	16
2599	900807	11	11				14		14	11	16				3.2	13		
2604	900816			26	26	18		30					23	25			13	
3000																		
Data Points:		11	15	15	11	17	14	12	* 3	* 4	7	8	12	10	7	11	11	8

G-52

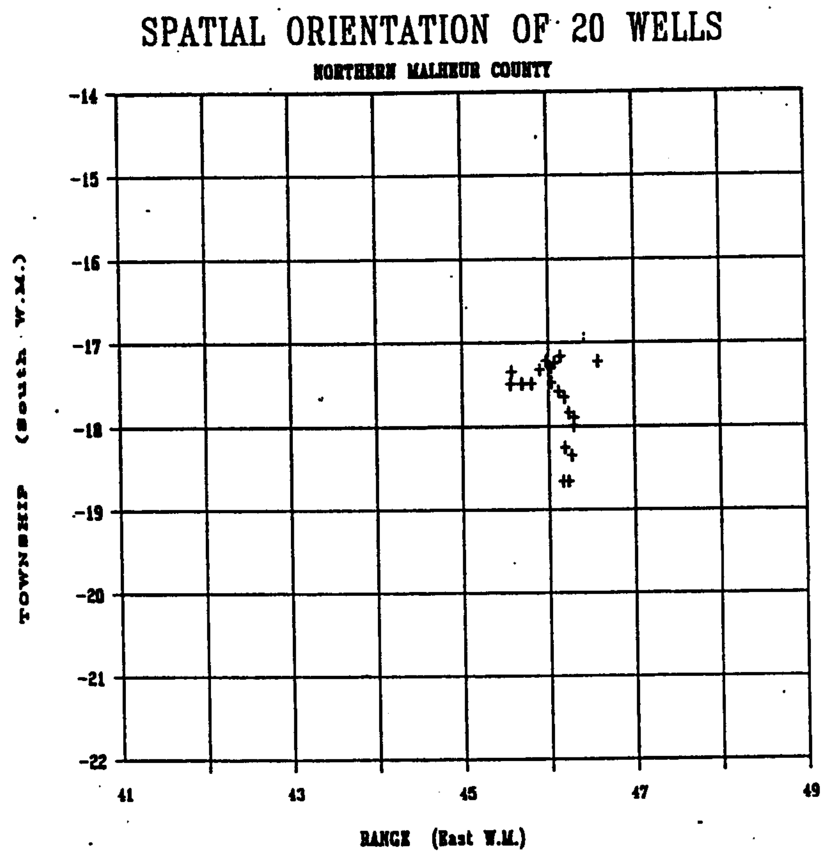
Trends in nitrate contamination that are based on data from multiple groundwater formations may be misleading. So, data from the 38 Primary and Secondary Indicator Wells were subdivided to represent smaller groundwater regions.

Twenty wells were initially selected (from the 38 Indicator Wells) to represent the agricultural area southwest of Ontario, and extending south toward Nyssa. Of these 20 wells, data from four wells were discarded since these wells were sampled only infrequently.

Averaged nitrate data from the remaining 16 wells exhibits a significant downward trend (p = 0.99).

DAY NUMBER	DATE	HAL136	HAL189	HAL211	NUMBER OF DATA POINTS	MEAN VALUE
1	830627				7	20.46
64	830829				9	21.63
696	850522				9	22.13
991	860313				9	23.22
1185	860923				8	19.25
1871	880809	12			12	12.64
1941	881018				1 *	16.00
1997	881213	13			6	10.01
2083	890309				1 *	17.00
2123	890418				11	14.70
2173	890607				15	15.61
2243	890816				14	15.36
2313	891025		11		16	16.81
2390	900110	12	9.8		14	16.80
2439	900228		8.9		13	14.11
2488	900418		10	46	13	20.06
2537	900606		10.3		12	19.33
2599	900807			48	9	15.69
2606	900814	13	7.7		9	19.97
3000						
.Data Points:		* 4	6	* 2		19

* Data sets to drop because of insufficient data


SPATIAL ORIENTATION OF 20 WELLS
NORTHERN MALHEUR COUNTY
-14
-15
-16
-17
-18
-19
-20
-21
-22
TOWNSHIP (South W.M.)
41
43
45
47
49
RANGE (East W.M.)

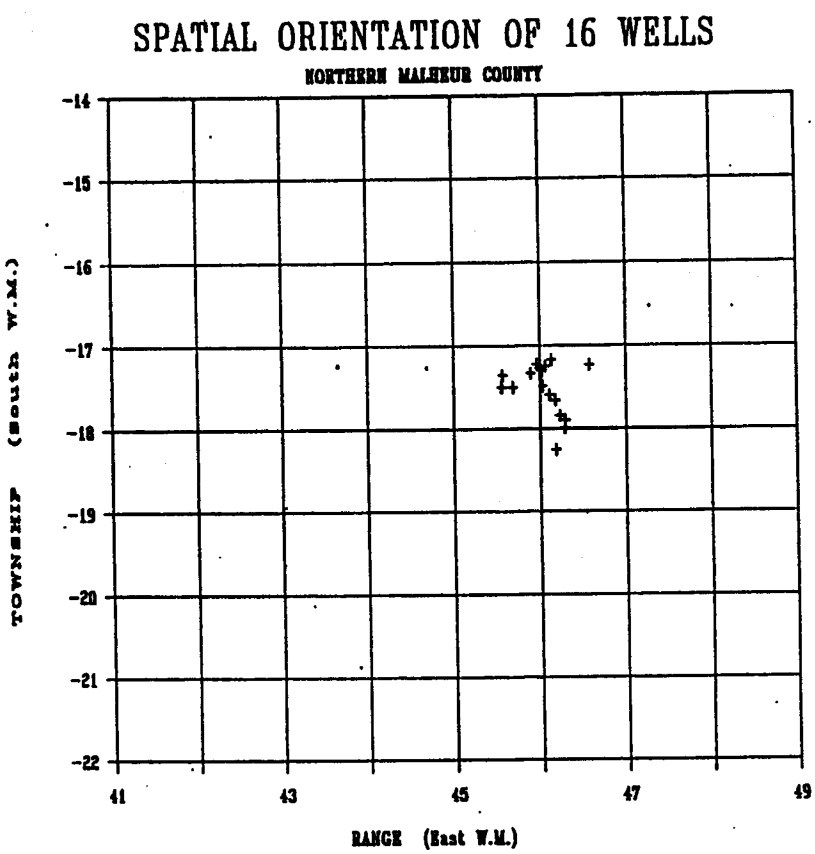
NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (6/83 - 8/90)

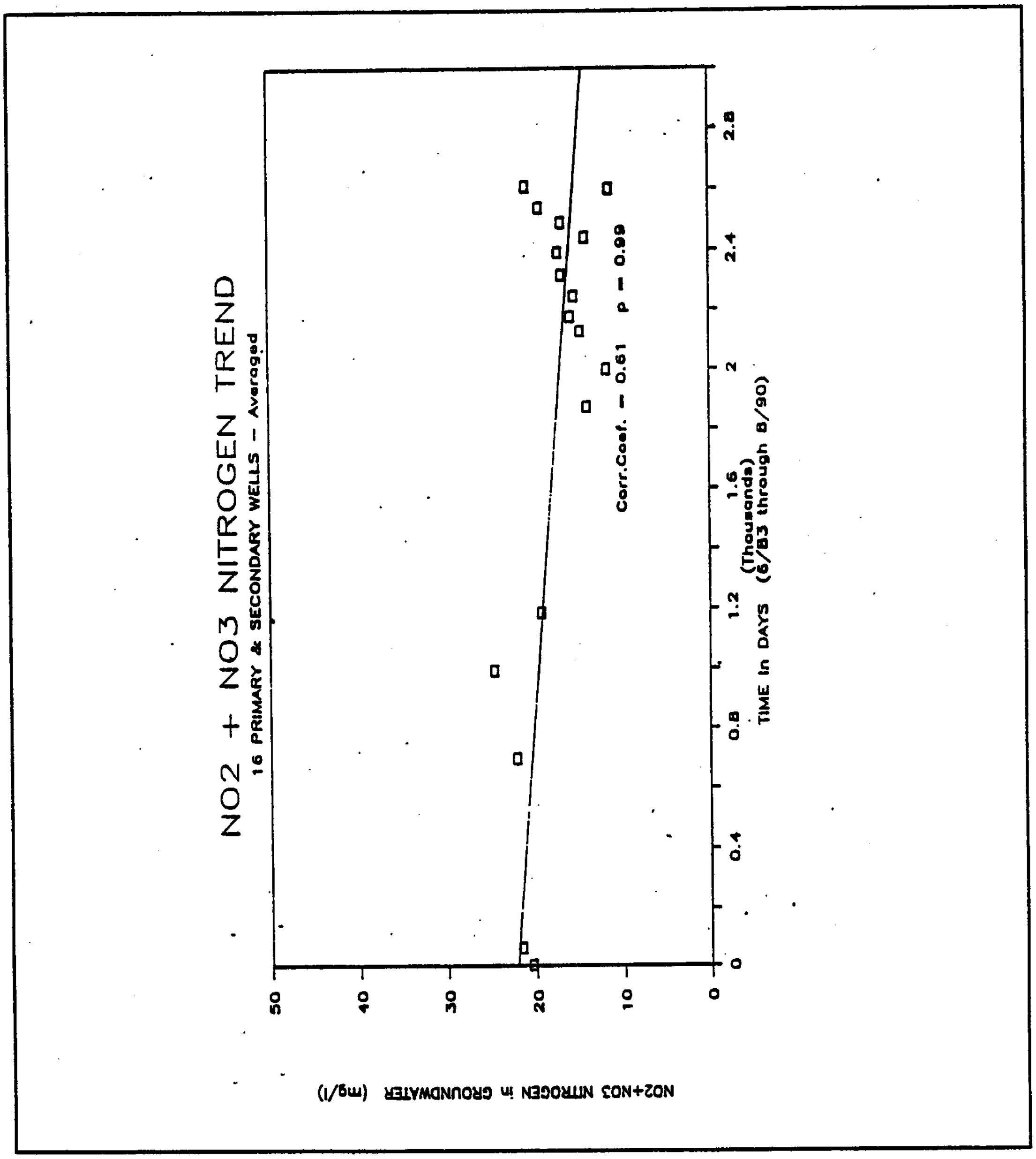
Remaining 16 Primary and Secondary Wells in Central Valley

NO2+NO3
ppm

DAY NUMBER	DATE	MAL012	MAL016	MAL030	MAL035	MAL041	MAL044	MAL047	MAL083	MAL101	MAL105	MAL106	MAL108	MAL119	MAL121	MAL123	MAL189
1	830427	8.1	9.7	10.2	32	24.8	12.8				36.60						
64	830829	11.6	11	19	27.2	10.1	13.6	49			28.8	24.2					
696	850522	14.2	11.9	23	25.8	17.5	14.8	30			32	28					
991	840313		11	25.00	28.5	19.00	14.00	36			34	29.5					
1185	840923	11	10.2	22.2	27.4	14.5		17			28.2	21.5					
1871	880809		13	27		17	16		13	1.7		12		12	14	14	
1997	881213									0.95				15	13	18	
2123	890418		12	27		18	16		17	1.5	26	20	1.2	11	14		
2173	890607	11	13	26		17	14	27	17	1.9	22	29	2.3	13	12	14	
2243	890816	11	13	24		16	13	29.5	16	7.3	23	22	2.25	13	13	12	
2313	891025	22	12	28	26	16.5	15	31	18	7.1	17	24	0.37	14	13	14	11
2390	900110	21	9.4	27	27	16	15	30		2	24			15	13	14	9.8
2439	900228		9.9	27	25	16	15	21		1	22		0.6	13	12	12	8.9
2488	900418	11	9.8	27	24	17	15	26	18					13	12		10
2537	900606	10.3	13.5	30	35	22.5	18	35					3.4	17.5	14.5	14	10.3
2599	900807	11	11				14		16				3.2	13			
2606	900814			26	24	18		30			23	25			13		7.7
3000																	
Data Points:		11	15	15	11	17	14	12	7	8	12	10	7	11	11	8	6

DAY NUMBER	DATE	NUMBER OF DATA POINTS	MEAN VALUE
1	830427	7	20.46
64	830829	9	21.63
696	850522	9	22.13
991	840313	8	24.63
1185	840923	8	19.25
1871	880809	10	13.97
1997	881213	4	11.74
2123	890418	11	14.70
2173	890607	14	15.80
2243	890816	14	15.36
2313	891025	16	16.81
2390	900110	13	17.17
2439	900228	13	14.11
2488	900418	11	16.80
2537	900606	12	19.33
2599	900807	6	11.37
2606	900814	8	20.84
3000			
Data Points:			19


SPATIAL ORIENTATION OF 16 WELLS
NORTHERN MALHEUR COUNTY
TOWNSHIP (South W.M.)
RANGE (East W.M.)
-14
-15
-16
-17
-18
-19
-20
-21
-22
41
43
45
47
49


NO2 + NO3 NITROGEN TREND
16 PRIMARY & SECONDARY WELLS -- Averaged
Corr.Coef. = 0.61 ρ = 0.99
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
0
10
20
30
40
50
0
0.4
0.8
1.2
1.6
2
2.4
2.8
TIME in DAYS (Thousands)
(6/83 through 8/90)

G-57

This region was further subdivided into a subregion in the area near, and north of, Cairo Junction, and a separate subregion to the south of Cairo Junction.

The area north and west from Cairo Junction is represented by 8 wells. The nitrate trend for this area is downward, but insignificant.

The area south of Cairo Junction is represented by 5 wells. The nitrate trend here is also downward and insignificant.

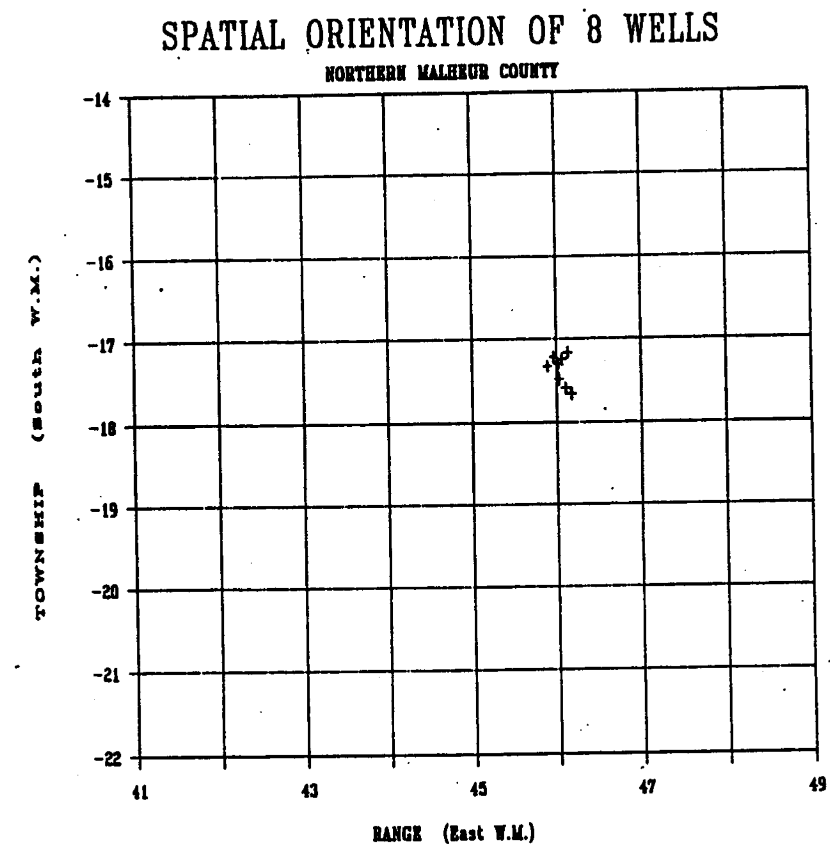
ONTARIO GROUNDWATER RESULTS - public water supplies

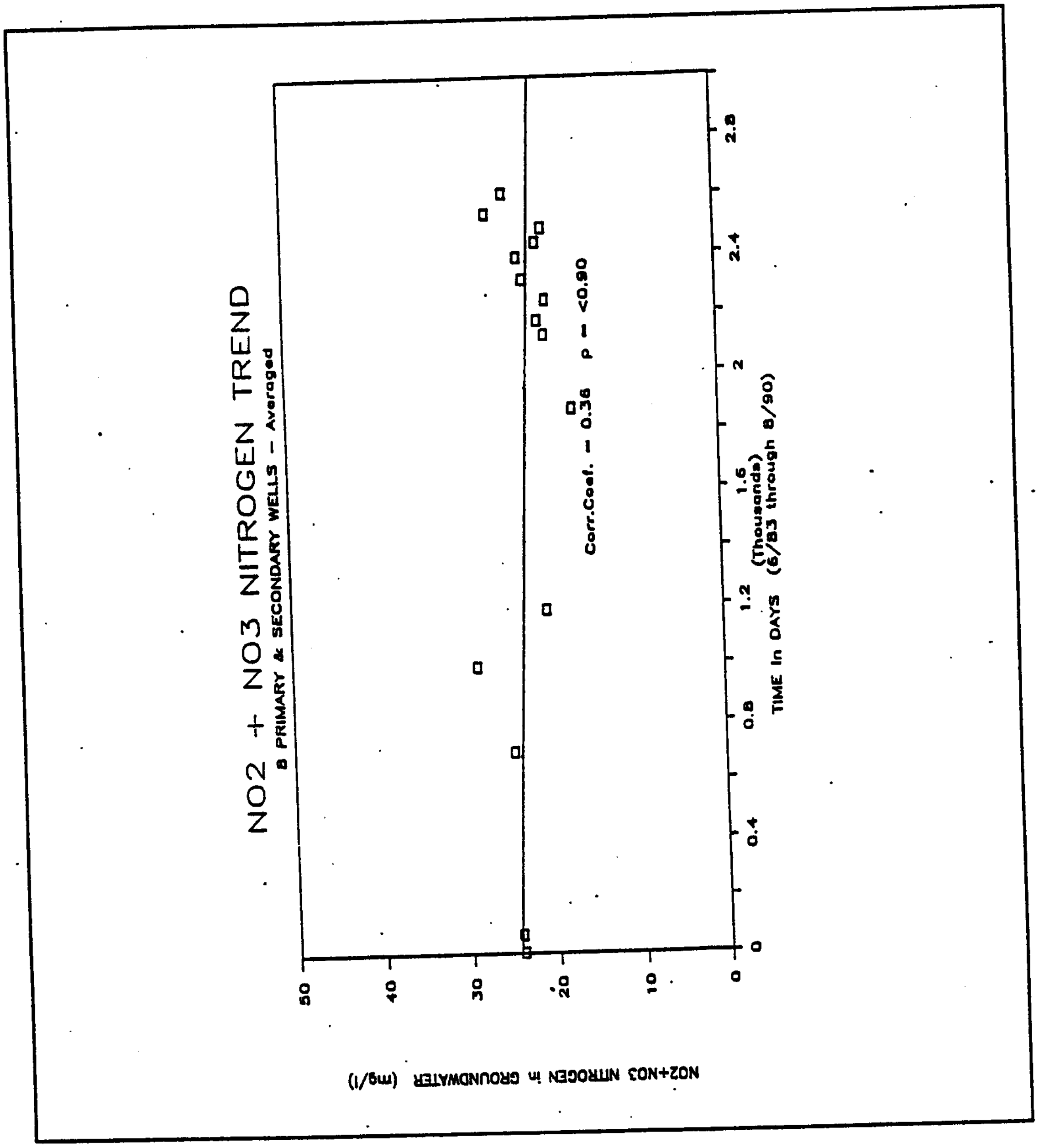
NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (6/83 - 8/90)

8 Wells in Cairo Junction/North Area:

DAY NUMBER	DATE	MAL012	MAL030	MAL035	MAL041	MAL047	MAL105	MAL106	MAL119	NUMBER OF DATA POINTS	MEAN VALUE
1	830627	8.1	19.2	32	24.8		36.60			5	24.14
64	830829	11.8	19	27.2	10.1	49	28.8	24.2		7	24.30
696	850522	16.2	23	25.8	17.5	30	32	28		7	24.64
991	860313		25.00	28.5	19.00	36	34	29.5		6	28.67
1185	860923	11	22.2	27.4	14.5	17	28.2	21.5		7	20.54
1871	880809		27		17			12	12	4	17.00
1997	881213								15	1 *	15.00
2123	890418		27		18		24	20	11	5	20.00
2173	890607	11	26		17	27	22	29	13	7	20.71
2243	890816	11	24		16	29.5	23	22	13	7	19.79
2313	891025	22	28	24	14.5	31	17	24	14	8	22.31
2390	900110	21	27	27	16	30	24		15	7	22.86
2439	900228		27	25	16	21	22		13	6	20.67
2488	900418	11	27	26	17	26			13	6	20.00
2537	900606	18.3	30	35	22.5	35			17.5	6	26.38
2599	900807	11							13	2 *	12.00
2604	900814		26	24	18	30	23	25		6	24.33
3000											
Data Points:		11	15	11	15	12	12	10	11		17

* Data sets dropped as unrepresentative


SPATIAL ORIENTATION OF 8 WELLS
NORTHERN MALHEUR COUNTY
TOWNSHIP (South W.M.)
-14
-15
-16
-17
-18
-19
-20
-21
-22
41
43
45
47
49
RANGE (East W.M.)


NO2 + NO3 NITROGEN TREND
B PRIMARY & SECONDARY WELLS - Averaged
Corr.Coef. = 0.36 p = <0.90
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
0
10
20
30
40
50
TIME in DAYS (Thousands) (6/83 through 8/90)
0
0.4
0.8
1.2
1.6
2
2.4
2.8

NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (6/83 - 8/90)

7 Wells in Valley South of Cairo Junction

DAY NUMBER	DATE	NO2+NO3 ppm HAL044	HAL078	HAL079	HAL083	HAL108	HAL119	HAL123	NUMBER OF DATA POINTS	MEAN VALUE
1	830627	12.8							1 *	12.80
64	830829	13.6							1 *	13.60
696	850522	14.8							1 *	14.80
991	860313	14.00		12.00					2 *	13.00
1185	860923								0 *	
1871	880809	16	<0.02		13		12	14	5	11.00
1941	881018								0 *	
1997	881213			0.105			15	18	3	11.04
2083	890309								0 *	
2123	890418	16			17	1.2	11		4	11.30
2173	890607	16		13	17	2.3	13	14	6	12.55
2243	890816	13			16	2.25	13	12	5	11.25
2313	891025	15			18	0.37	14	14	5	12.27
2390	900110	15					15	14	3	14.67
2439	900228	15				0.6	13	12	4	10.15
2488	900418	15	30		18		13		4	19.00
2537	900606	18				3.4	17.5	14	4	13.23
2599	900807	14	14	11	16	3.2	13		6	11.87
2606	900814								0 *	
3000										
			*	*						
Data Points:		14	3	4	7	7	11	8		15

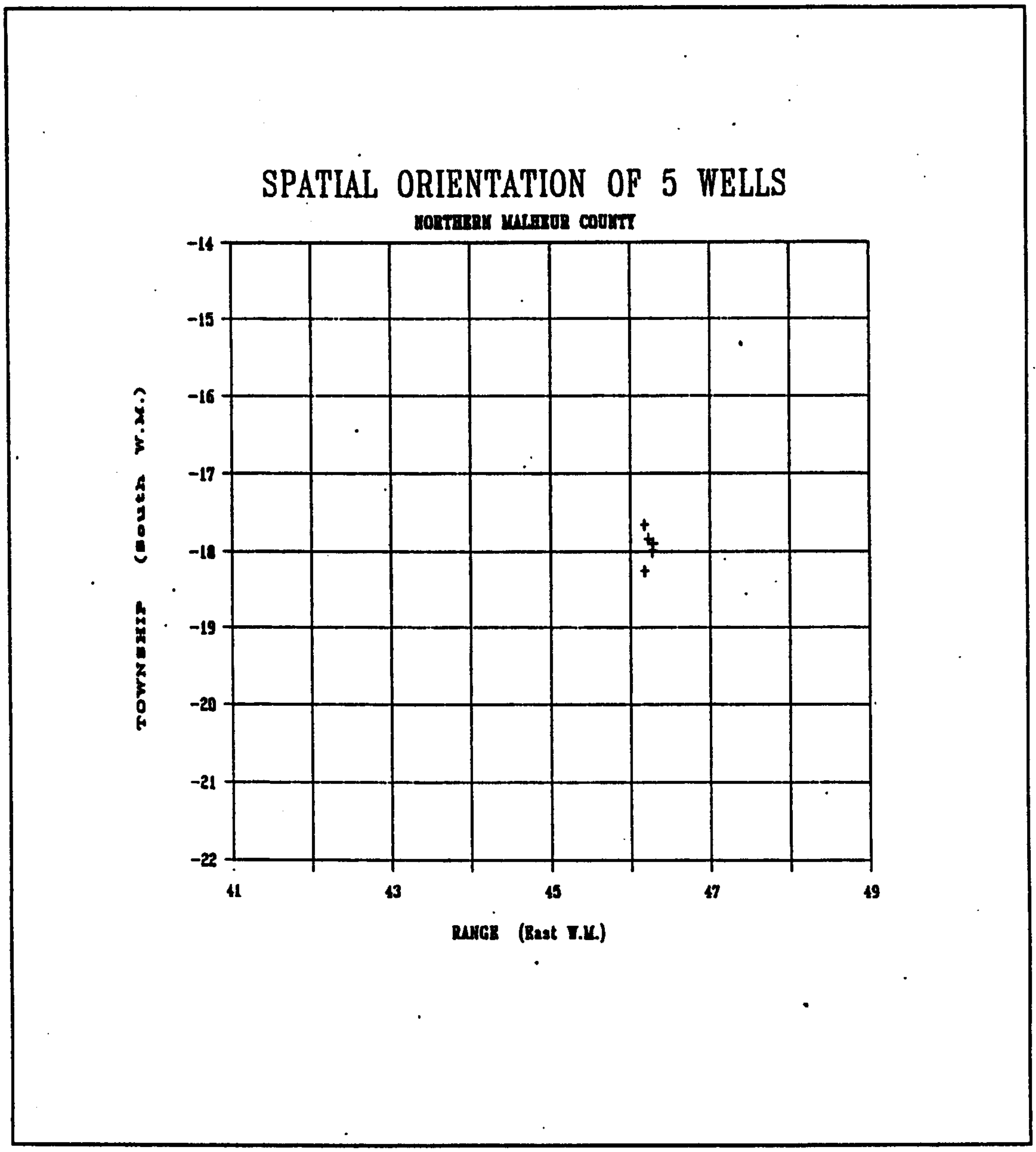
* Data sets to drop as unrepresentative

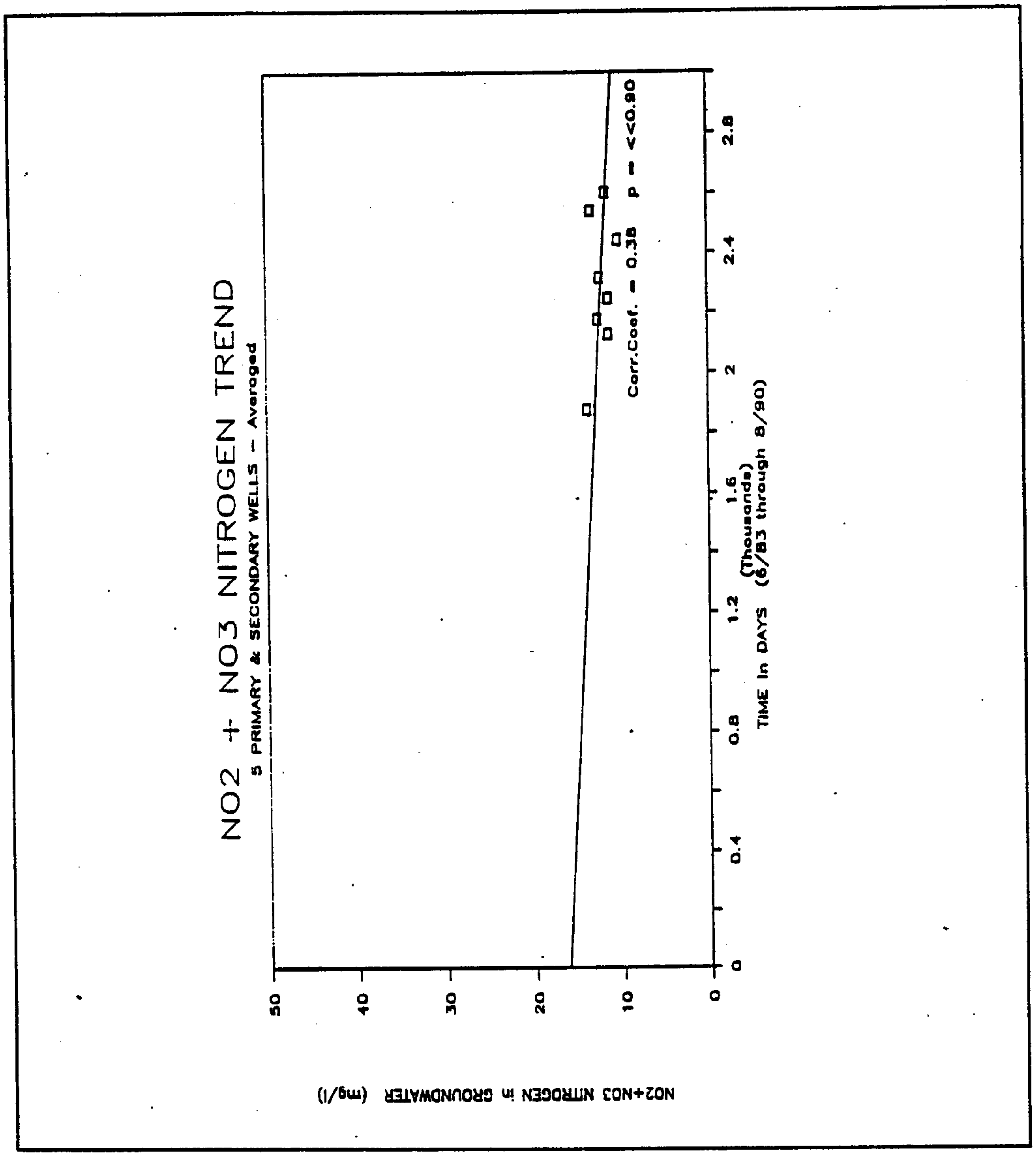
NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (6/83 - 8/90)

5 Remaining wells in Valley South of Cairo Junction

DAY NUMBER	DATE	NO2+NO3 ppm HAL044	HAL083	HAL108	HAL119	HAL123	NUMBER OF DATA POINTS	MEAN VALUE
1871	880809	16	13		12	14	4	13.75
1997	881213				15	18	2 *	16.50
2123	890418	16	17	1.2	11		4	11.30
2173	890607	16	17	2.3	13	14	5	12.46
2243	890816	13	16	2.25	13	12	5	11.25
2313	891025	15	18	0.37	14	14	5	12.27
2390	900110	15			15	14	3 *	14.67
2439	900228	15		0.6	13	12	4	10.15
2488	900418	15	18		13		3 *	15.33
2537	900606	18		3.4	17.5	14	4	13.23
2599	900807	14	16	3.2	13		4	11.55
3000								
Data Points:		10	7	7	11	8		11

* Data set dropped as unrepresentative


SPATIAL ORIENTATION OF 5 WELLS
NORTHERN MALHEUR COUNTY
-14
-15
-16
-17
-18
-19
-20
-21
-22
41
43
45
47
49
TOWNSHIP (South W.M.)
RANGE (East W.M.)


NO2 + NO3 NITROGEN TREND
5 PRIMARY & SECONDARY WELLS - Averaged
Corr.Coef. = 0.38 p = <<0.90
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
0
10
20
30
40
50
0
0.4
0.8
1.2
1.6
2
2.4
2.8
(Thousands)
TIME in DAYS (6/83 through 8/90)

The region to the east of the Oregon Slope (Weiser/Dead Ox Flat) is represented by 6 wells. One of the wells has only limited data (MAL064), so it was dropped from the analysis. The remaining 5 wells are represented only since 3/89.

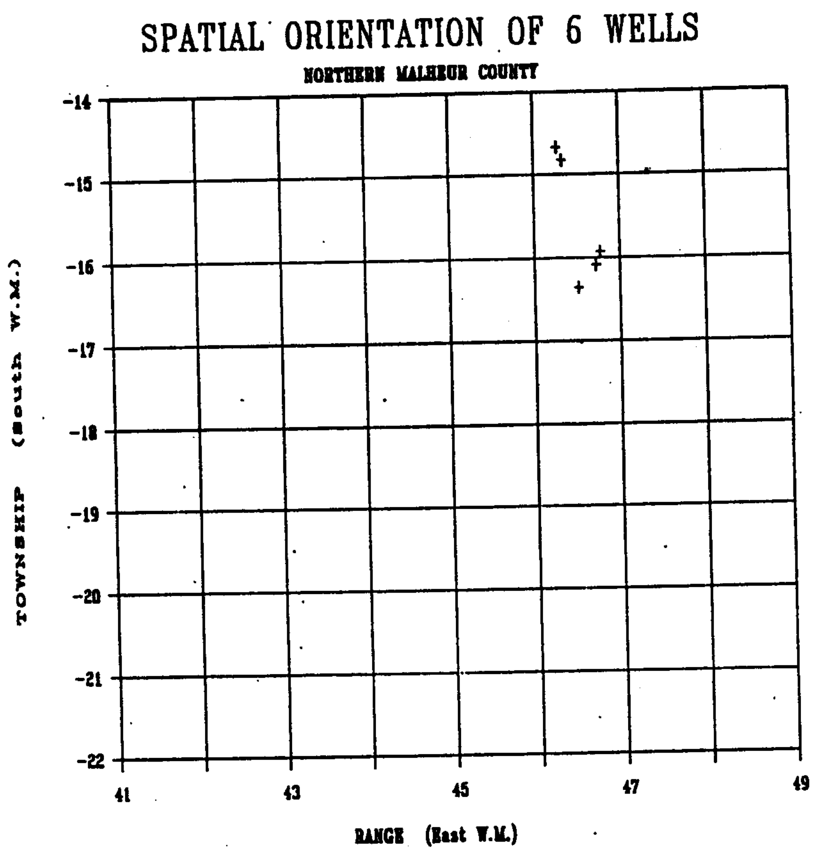
The 5 wells have an upward trend in nitrates that is almost significant.

NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (6/83 - 8/90)

6 Wells along Oregon Slope (Primary and Secondary Indicator Wells)

DAY NUMBER	DATE	NO2+NO3 ppm MAL062	MAL064	MAL147	MAL152	MAL172	MAL175	NUMBER OF DATA POINTS	MEAN VALUE
1	830627							0 *	
64	830829							0 *	
696	850522							0 *	
991	860313		19.00					1 *	19.00
1185	860923							0 *	
1871	880809							0 *	
1941	881018							0 *	
1997	881213							0 *	
2083	890309	32		0.02		9.35	17	4	14.59
2123	890418	30	6.2	0.04		11	17	5	12.85
2173	890607	33		0.03	20	11	7.5	5	14.31
2243	890816	29		0.09	27	7.45	15	5	15.71
2313	891025	30		0.02	21	5.5	14	5	16.10
2390	900110	34		0.02		5.9		3 *	13.31
2439	900228	36		0.05		7.8	13	4	14.21
2488	900418			0.01	22	12		3 *	11.34
2537	900606	42	7.9	0.5	28	8.2	16.5	6	17.18
2599	900807	33				6.1	13	3 *	17.37
2606	900814		18	0.04	22			3 *	13.35
3000									
Data Points:		9	4 *	10	6	10	8	19	12

* Data sets dropped - insufficient data



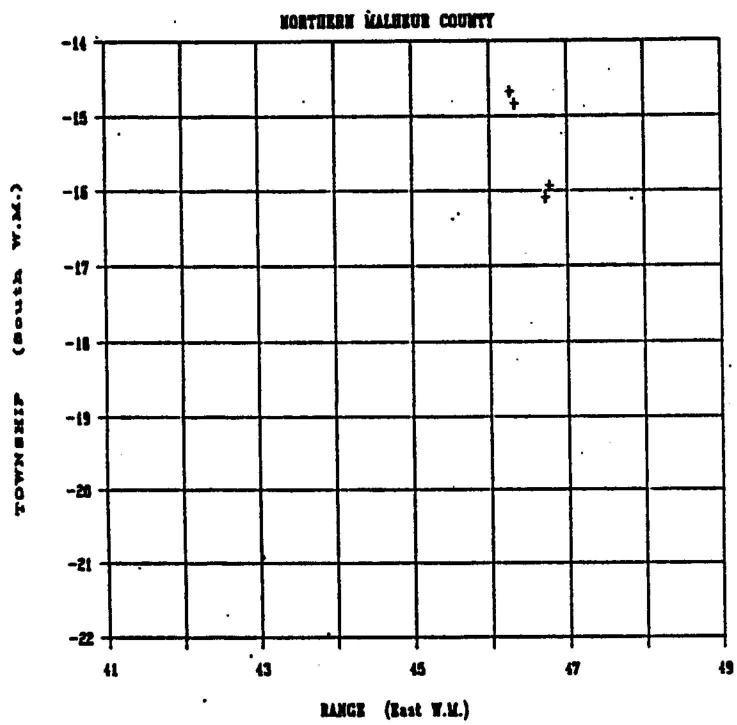
SPATIAL ORIENTATION OF 6 WELLS
NORTHERN MALHEUR COUNTY
TOWNSHIP (South W.M.)
-14
-15
-16
-17
-18
-19
-20
-21
-22
41
43
45
47
49
RANGE (East W.M.)

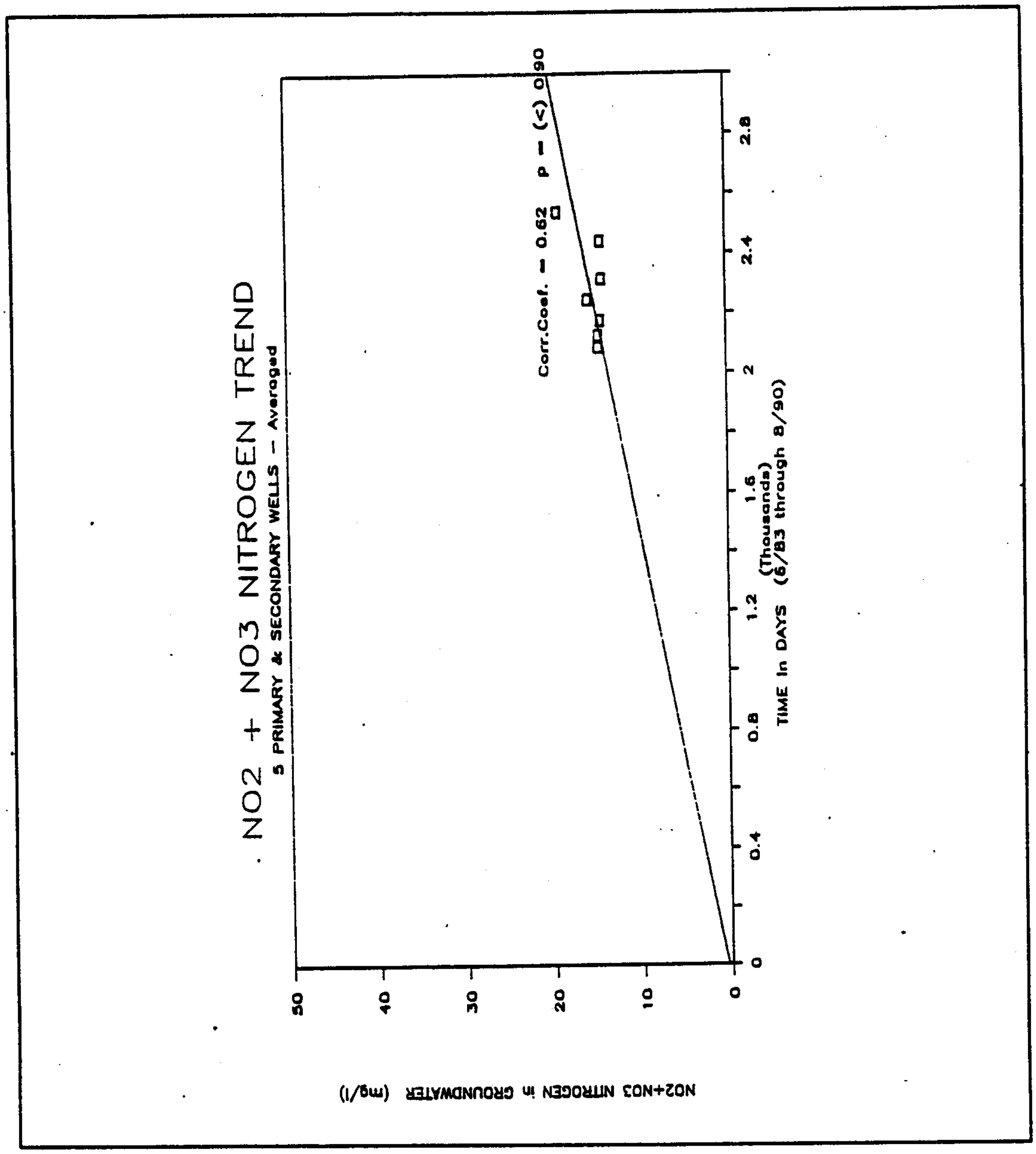
NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (6/83 - 8/90)

5 Wells along Oregon Slope (Primary and Secondary Indicator Wells)

DAY NUMBER	DATE	NO2+NO3 ppm					NUMBER OF DATA POINTS	MEAN VALUE
		NAL062	NAL147	NAL152	NAL172	NAL175		
1								
2083	890309	32	0.02		9.35	17	4	14.59
2123	890418	30	0.04		11	17	4	14.51
2173	890607	33	0.03	20	11	7.5	5	14.31
2263	890816	29	0.09	27	7.45	15	5	15.71
2313	891025	30	0.02	21	5.5	14	5	14.10
2439	900228	34	0.05		7.8	13	4	14.21
2537	900606	42	0.5	28	8.2	16.5	5	19.04
3000								
Data Points:		7	7	4	7	7		7

SPATIAL ORIENTATION OF 5 WELLS




NO2 + NO3 NITROGEN TREND
5 PRIMARY & SECONDARY WELLS -- Averaged
Corr.Coef. = 0.62 p = (<) 0.90
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
0
10
20
30
40
50
TIME In DAYS (6/83 through 8/90)
(Thousands)
0
0.4
0.8
1.2
1.6
2
2.4
2.8

The Weiser/Dead Ox Flat region was further subdivided into two subregions: Weiser (represented by two wells) and Dead Ox Flat (represented by three wells).

The nitrate trend in the Weiser area is upward, though not significant.

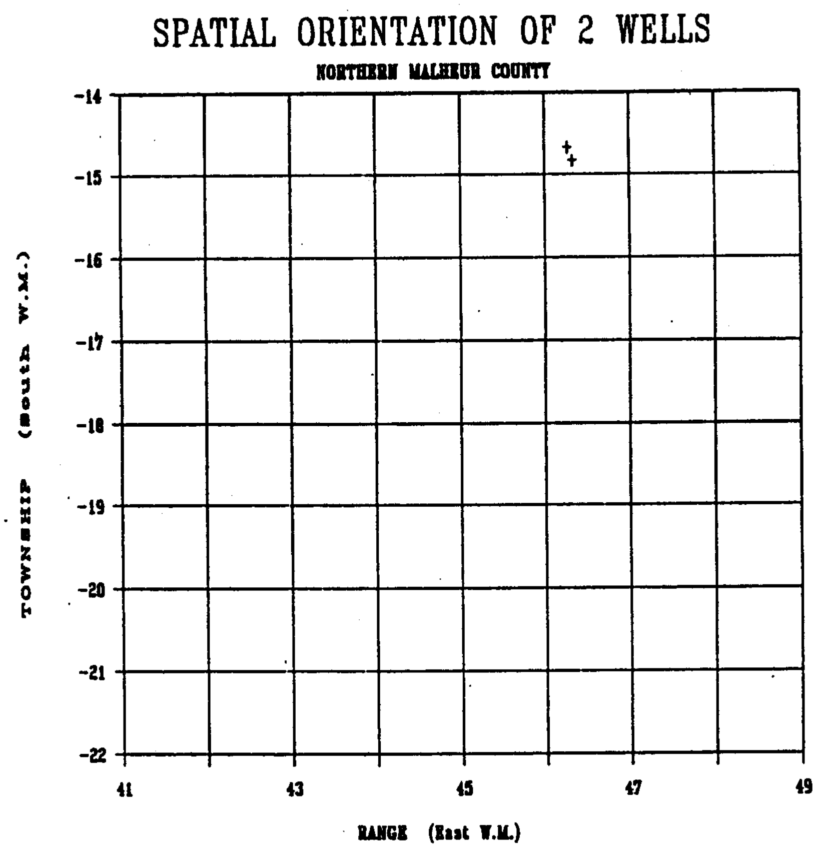
The trend in the Dead Ox Flat area is also upward and insignificant.

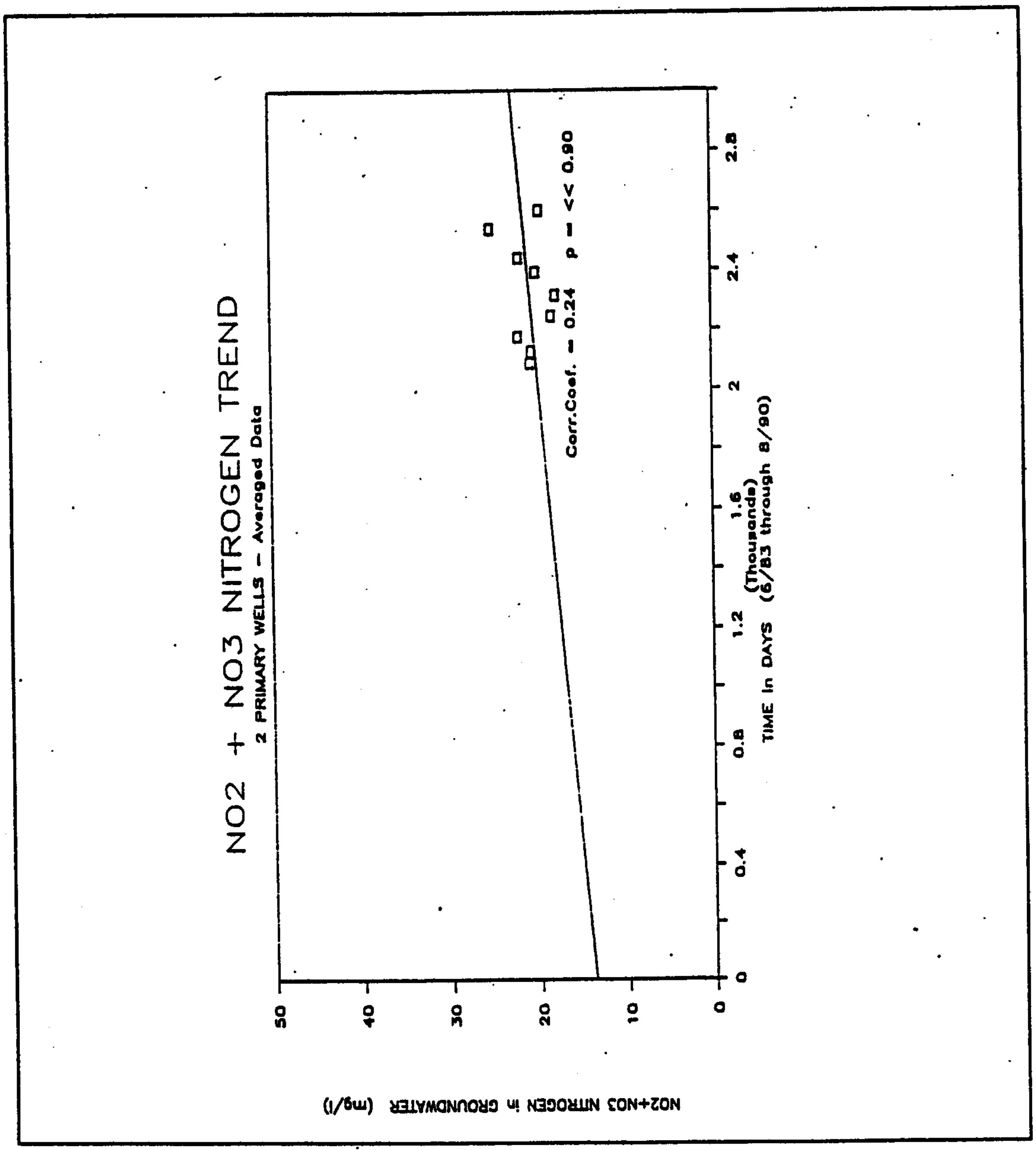
NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (6/83 - 8/9

2 Primary Indicator Wells - Weiser Area:

DAY NUMBER	DATE	MAL062	MAL172	NUMBER OF DATA POINTS	MEAN VALUE
1	830627			0 *	
64	830829			0 *	
696	850522			0 *	
991	860313			0 *	
1185	860923			0 *	
1871	880809			0 *	
1941	881018			0 *	
1997	881213			0 *	
2083	890309	32	9.35	2	20.68
2123	890418	30	11	2	20.50
2173	890607	33	11	2	22.00
2243	890816	29	7.45	2	18.23
2313	891025	30	5.5	2	17.75
2390	900110	34	5.9	2	19.95
2439	900228	36	7.8	2	21.90
2488	900418		12	1 *	12.00
2537	900606	42	8.2	2	25.10
2599	900807	33	6.1	2	19.55
2606	900814			0 *	
3000					
Data Points:		9	10		10

* Insufficient data


SPATIAL ORIENTATION OF 2 WELLS
NORTHERN MALHEUR COUNTY
-14
-15
-16
-17
-18
-19
-20
-21
-22
41
43
45
47
49
RANGE (East W.M.)
TOWNSHIP (South W.M.)

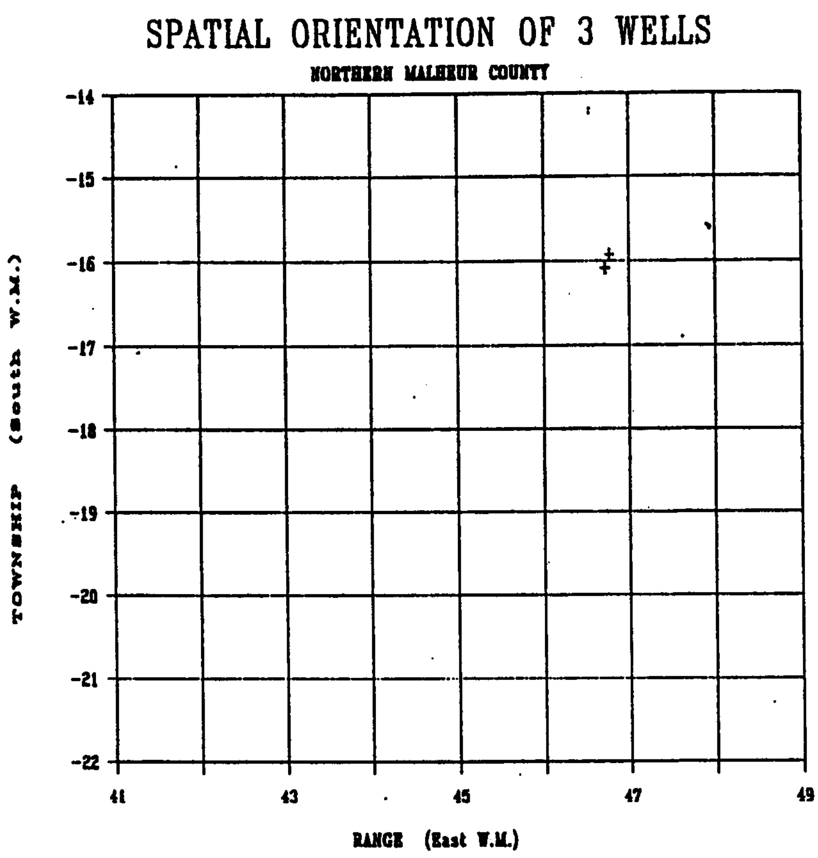

NO2 + NO3 NITROGEN TREND
2 PRIMARY WELLS – Averaged Data
Corr.Coef. = 0.24 p = << 0.90
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
0
10
20
30
40
50
0
0.4
0.8
1.2
1.6
2
2.4
2.8
(Thousands)
TIME in DAYS (6/83 through 8/90)

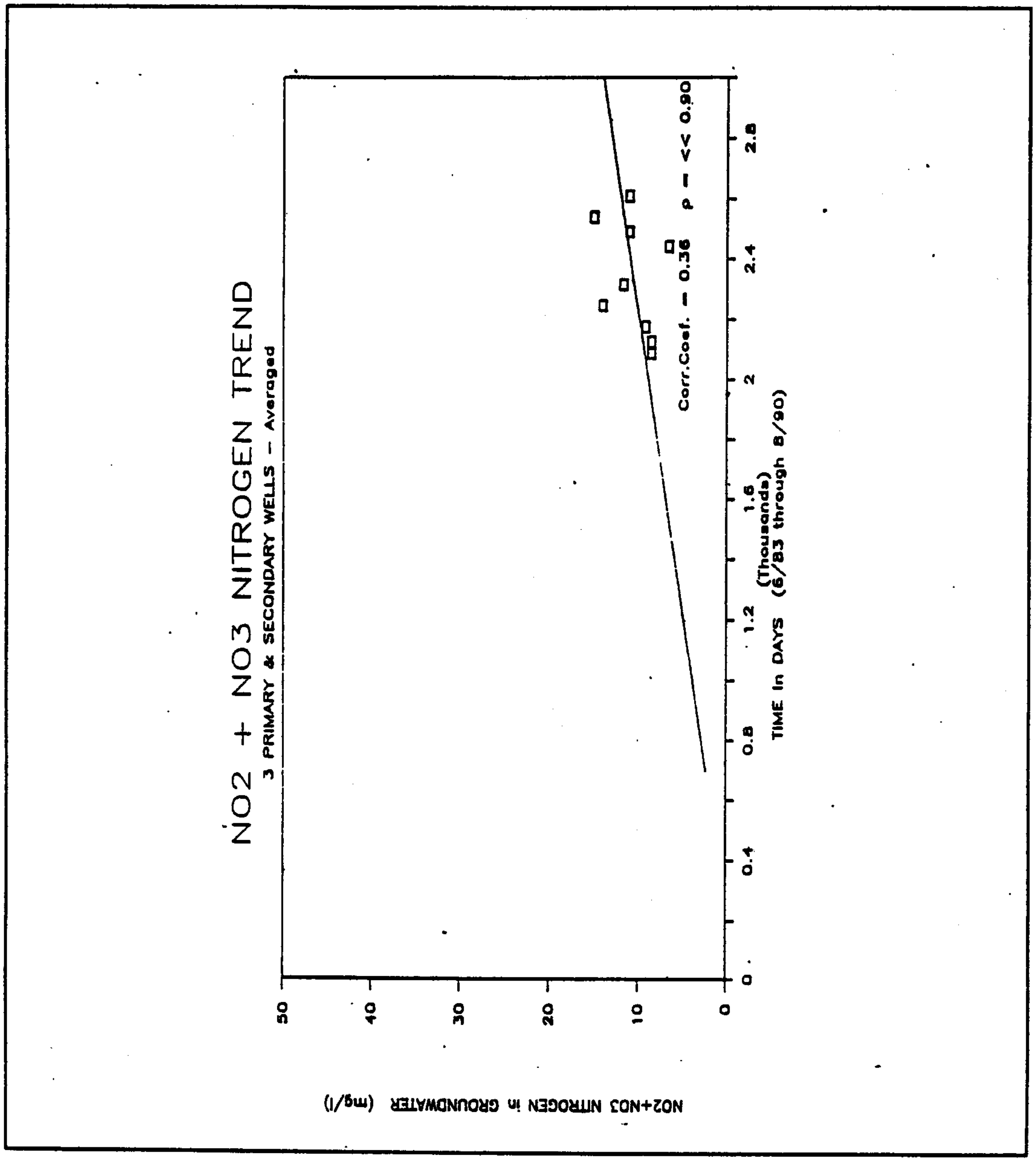
NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (6/83 - 8/90)

3 Primary and Secondary Wells along Southern End of Oregon Slope:

DAY NUMBER	DATE	MAL147	MAL152	MAL175	NUMBER OF DATA POINTS	MEAN VALUE
1	830627				0 *	
64	830829				0 *	
696	850522				0 *	
991	860313				0 *	
1185	860923				0 *	
1871	880809				0 *	
1941	881018				0 *	
1997	881213				0 *	
2083	890309	0.02		17	2	8.51
2123	890418	0.04		17	2	8.52
2173	890607	0.03	20	7.5	3	9.18
2243	890816	0.09	27	15	3	14.03
2313	891025	0.02	21	14	3	11.67
2390	900110	0.02			1 *	0.02
2439	900228	0.05		13	2	6.53
2488	900418	0.01	22		2	11.01
2537	900606	0.5	28	16.5	3	15.00
2599	900807			13	1 *	13.00
2606	900814	0.04	22		2	11.02
3000						
Data Points:		10	6	8		11

* Insufficient Data


SPATIAL ORIENTATION OF 3 WELLS
NORTHERN MALHEUR COUNTY
-14
-15
-16
-17
-18
-19
-20
-21
-22
TOWNSHIP (South W.M.)
41
43
45
47
49
RANGE (East W.M.)


NO2 + NO3 NITROGEN TREND
3 PRIMARY & SECONDARY WELLS - Averaged
Corr.Coef. = 0.36
p = << 0.90
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
TIME in DAYS (Thousands) (6/83 through 8/90)
0
10
20
30
40
50
0
0.4
0.8
1.2
1.6
2
2.4
2.8

Six wells were grouped to represent a western region near Vale. The wells are individually located in the Malheur River basin, and in the Willow Creek subbasin. The grouping was artificial simply for convenience. Only 3 of the 6 wells provide a reasonable data base: MAL116, MAL125, and MAL126.

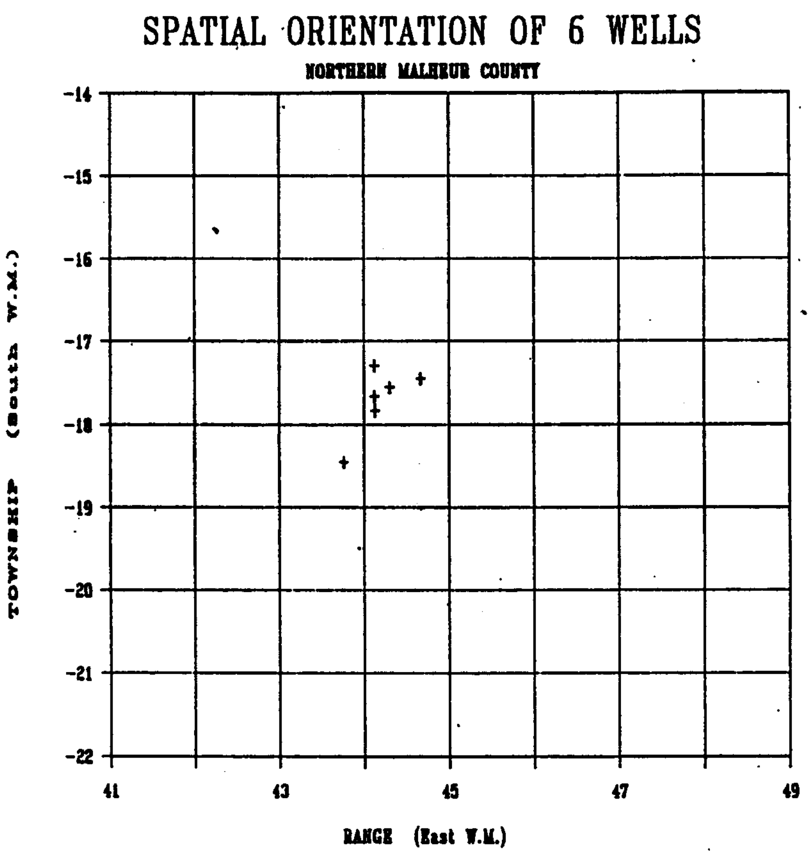
These wells were sampled consistently only between 10/88 and 6/90. Nitrates trend downward, but the trend is not significant.

NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (6/83 - 8/90)

6 Primary and Secondary Indicator Wells: Vale Area

DAY NUMBER	DATE	NO2+NO3 ppm						NUMBER OF DATA POINTS	MEAN VALUE
		MAL116	MAL125	MAL126	MAL129	MAL164	MAL180		
1	830427							0 *	
44	830829							0 *	
696	850522							0 *	
991	860313							0 *	
1185	860923							0 *	
1871	880809				7.7			1 *	7.70
1941	881018	2	12	20				3	11.33
1997	881213				6.5			1 *	6.50
2083	890309					20		1 *	20.00
2123	890418	5	8.3	11	7.7			4	8.00
2173	890607	5.3	7.7	6.5	7.2	13	4	6	7.28
2243	890816	3.3	9.3	7.4		8.6	4.3	5	6.58
2313	891025	5.5	9	8.8				3	7.77
2390	900110			9.3		7.9		2 *	8.60
2439	900228	8				12		2 *	10.00
2488	900418					13		1 *	13.00
2537	900606	4	15	5.3		14.5		4	9.70
2599	900807	4				11		2 *	7.50
2606	900814		11					1 *	11.00
3000									
Data Points:		8	7	7	* 4	8	* 2		14

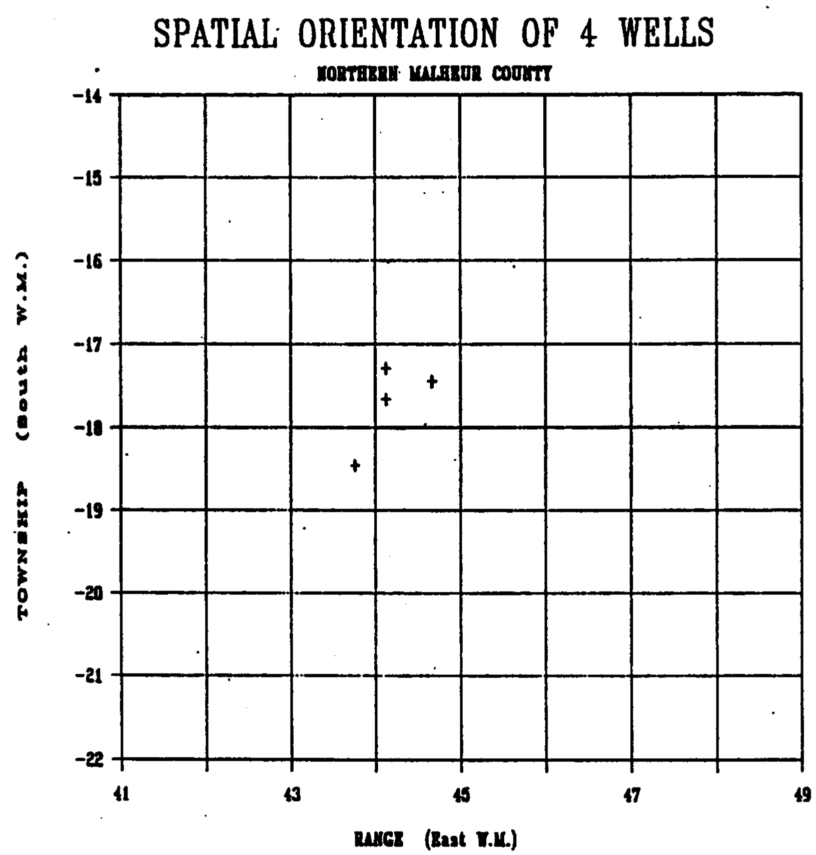
* Dropped - Insufficient Data


SPATIAL ORIENTATION OF 6 WELLS
NORTHERN MALHEUR COUNTY
TOWNSHIP (South W.M.)
-14
-15
-16
-17
-18
-19
-20
-21
-22
41
43
45
47
49
RANGE (East W.M.)

NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (6/83 - 8/90)

4 Primary and Secondary Indicator Wells: Vale Area

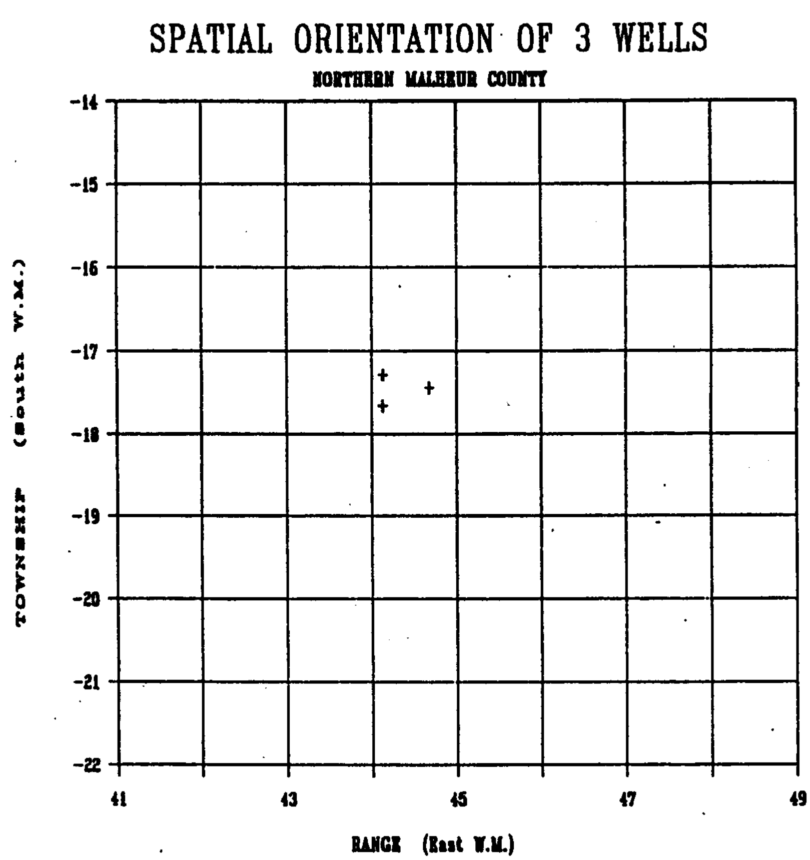
DAY NUMBER	DATE	MAL116	MAL125	MAL126	MAL164	NUMBER OF DATA POINTS	MEAN VALUE
1							
1941	881018	2	12	20		3	11.33
2123	890418	5	8.3	11		3	8.10
2173	890607	5.3	7.7	6.5	13	4	8.13
2243	890816	3.3	9.3	7.4	8.6	4	7.15
2313	891025	5.5	9	8.8		3	7.77
2537	900606	4	15	5.3	14.5	4	9.70
3000							
Data Points:		6	6	6	3		6


SPATIAL ORIENTATION OF 4 WELLS
NORTHERN MALHEUR COUNTY
-14
-15
-16
-17
-18
-19
-20
-21
-22
TOWNSHIP (South W.M.)
41
43
45
47
49
RANGE (East W.M.)

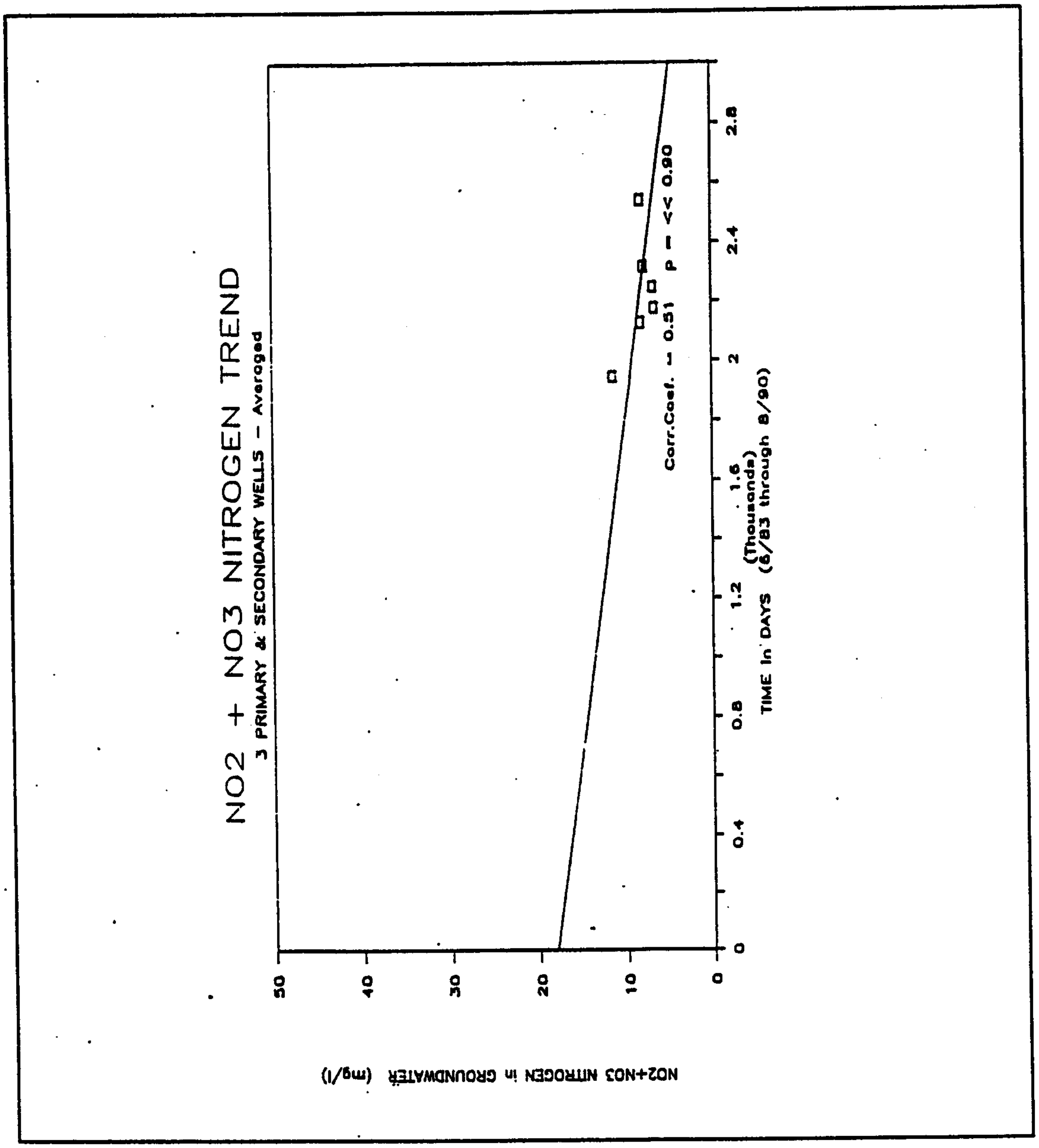
NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (6/83 - 8/90)

3 Primary and Secondary Indicator Wells: Vale Area

DAY NUMBER	DATE	MAL116	MAL125	MAL126	NUMBER OF DATA POINTS	MEAN VALUE
1						
1941	881018	2	12	20	3	11.33
2123	890418	5	8.3	11	3	8.10
2173	890607	5.3	7.7	6.5	3	6.50
2243	890816	3.3	9.3	7.4	3	6.67
2313	891025	5.5	9	8.8	3	7.77
2537	900606	4	15	5.3	3	8.10
3000						
Data Points:		6	6	6		6



SPATIAL ORIENTATION OF 3 WELLS
NORTHERN MALHEUR COUNTY
TOWNSHIP (South W.M.)
-14
-15
-16
-17
-18
-19
-20
-21
-22
41
43
45
47
49
RANGE (East W.M.)



NO2 + NO3 NITROGEN TREND
3 PRIMARY & SECONDARY WELLS – Averaged
Corr.Coef. = 0.51 p = << 0.90
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
TIME In DAYS (Thousands) (6/83 through 8/90)
0
0.4
0.8
1.2
1.6
2
2.4
2.8
0
10
20
30
40
50

The wells south of Nyssa are scattered into a number of groundwater subregions. The only subregion that might reasonably be examined is represented by three wells immediatly north of the Owyhee River. The area extends from the town of Owyhee west toward Cow Hollow/Fletcher Gulch.

Consistent data is available only between 6/89 and 8/90.

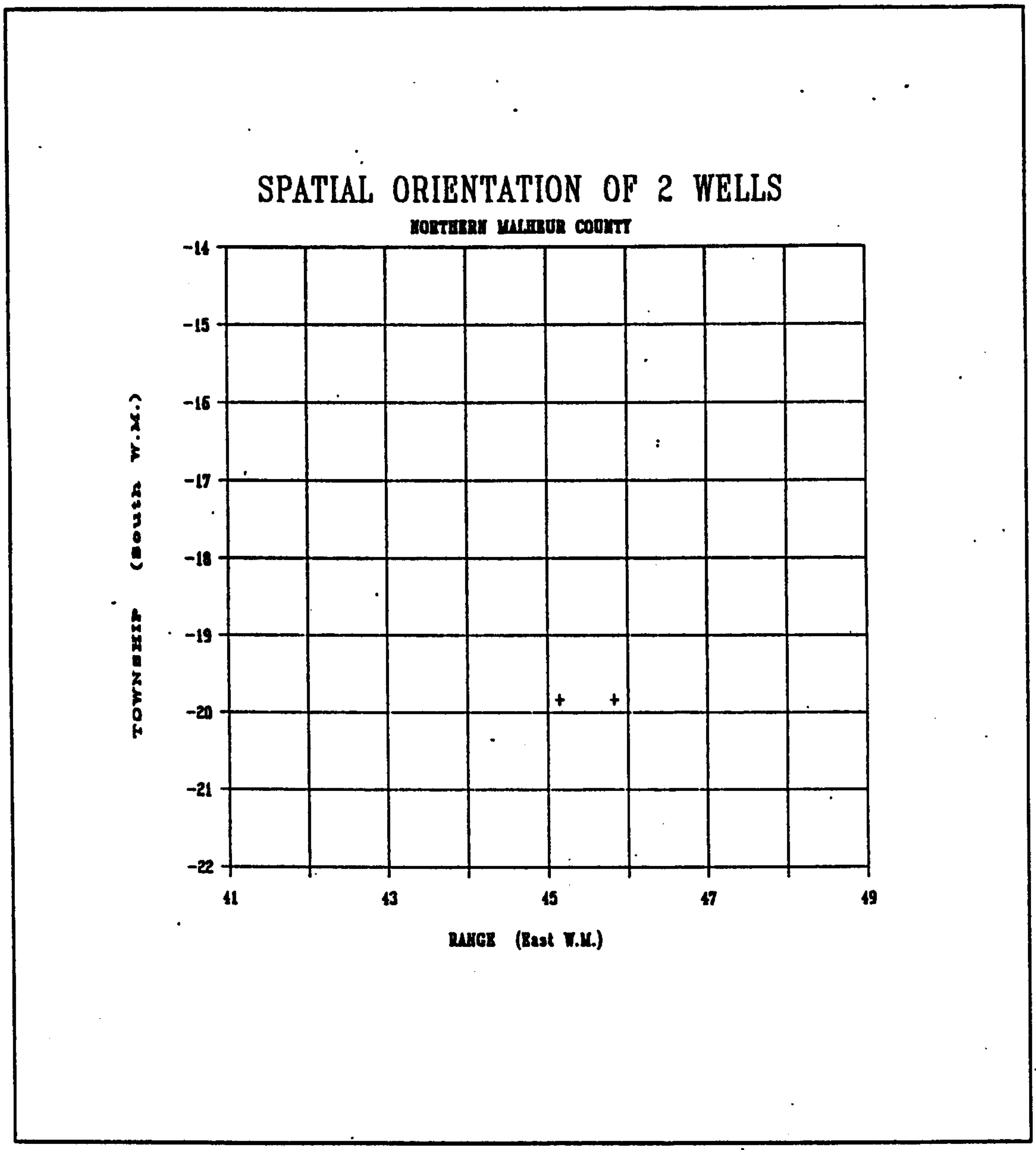
Nitrate concentrations, although relatively low, seem to trend upward. The trend is, however, insignificant.

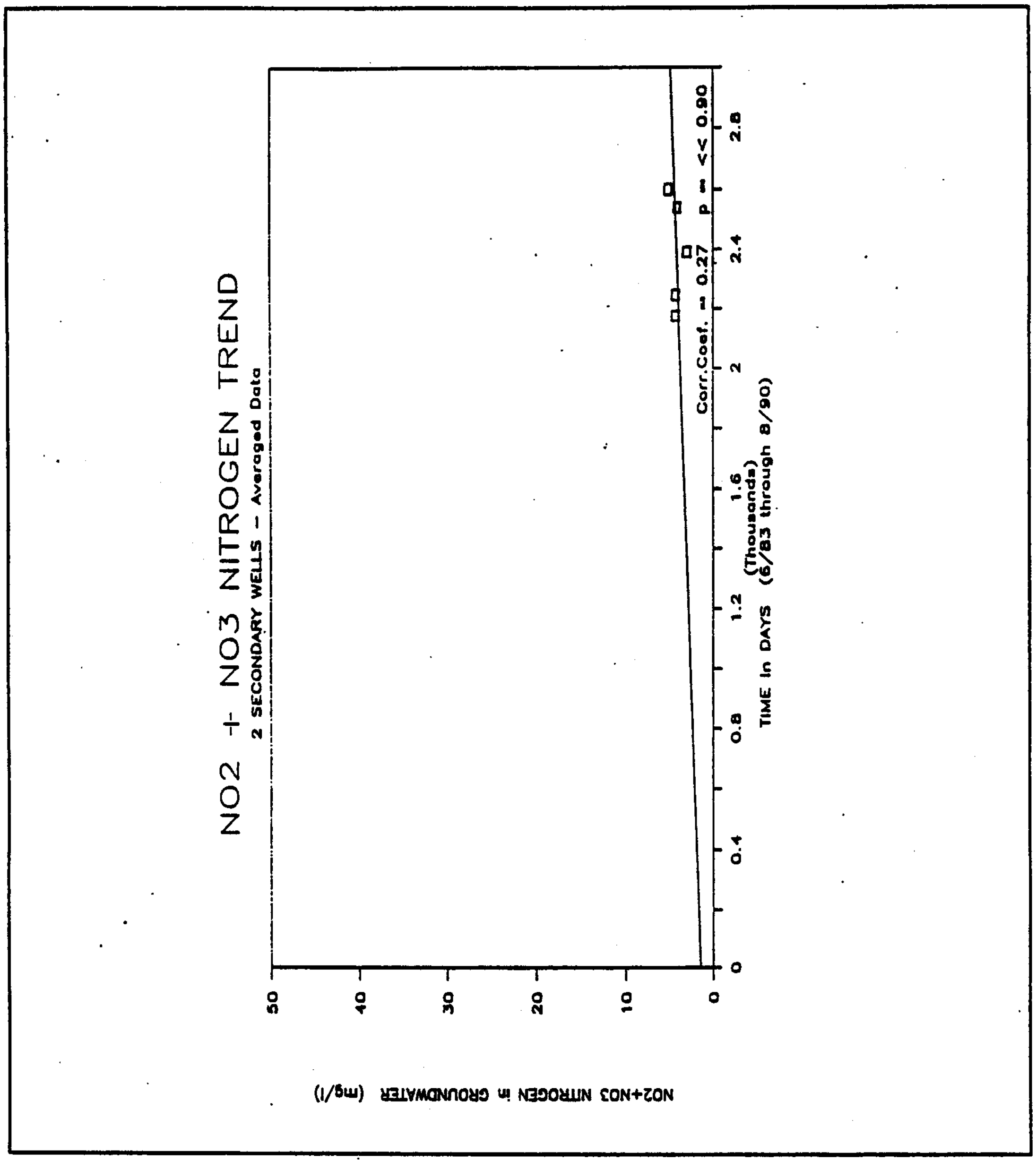
NORTHERN MALHEUR COUNTY
Nitrate Values by Well and Day Number (6/83 - 8/9

2 Secondary Wells - Owyhee Basin

DAY NUMBER	DATE	OWY002	OWY009	NUMBER OF DATA POINTS		MEAN VALUE
1	830627			0	*	
64	830829			0	*	
696	850522			0	*	
991	860313			0	*	
1185	860923			0	*	
1871	880809			0	*	
1941	881018			0	*	
1997	881213			0	*	
2083	890309			0	*	
2123	890418		3.7	1	*	3.70
2173	890607	4	4.4	2		4.20
2243	890816	3.9	4.5	2		4.20
2313	891025	4.2		1	*	4.20
2390	900110	2.4	3.4	2		2.90
2439	900228	4.6		1	*	4.60
2488	900418			0	*	
2537	900606	5.1	3	2		4.05
2599	900807	4.1	6	2		5.05
2606	900814			0	*	
3000						
Data Points:		7	6			8

* Insuficient Data


SPATIAL ORIENTATION OF 2 WELLS
NORTHERN MALHEUR COUNTY
-14
-15
-16
-17
-18
-19
-20
-21
-22
TOWNSHIP (South W.M.)
41
43
45
47
49
RANGE (East W.M.)


NO2 + NO3 NITROGEN TREND
2 SECONDARY WELLS - Averaged Data
Corr.Coef. = 0.27 p = << 0.90
NO2+NO3 NITROGEN in GROUNDWATER (mg/l)
0
10
20
30
40
50
TIME in DAYS (Thousands) (6/83 through 8/90)
0
0.4
0.8
1.2
1.6
2
2.4
2.8

G-83

APPENDIX H

NATURE OF DACTHAL

Source Material:

PESTICIDES ON ONIONS

AS IT AFFECTS GROUNDWATER

Prepared By:

Oregon State University
Malheur County Extension Service

NATURE OF DACTHAL*

The herbicide *Dacthal* is used on onions. A metabolite of Dacthal, known as *Dacthal di-acid* has been found in Malheur County groundwater. The herbicide itself is very insoluble in water, but is broken down by soil micro-organisms to a soluble metabolite which is easily leached into the groundwater. The health advisory for *Dacthal* is 4000 ppb, far above the highest concentrations found. The chemistry of *Dacthal* and *Dachtal di-acid* is shown in Figure 1.

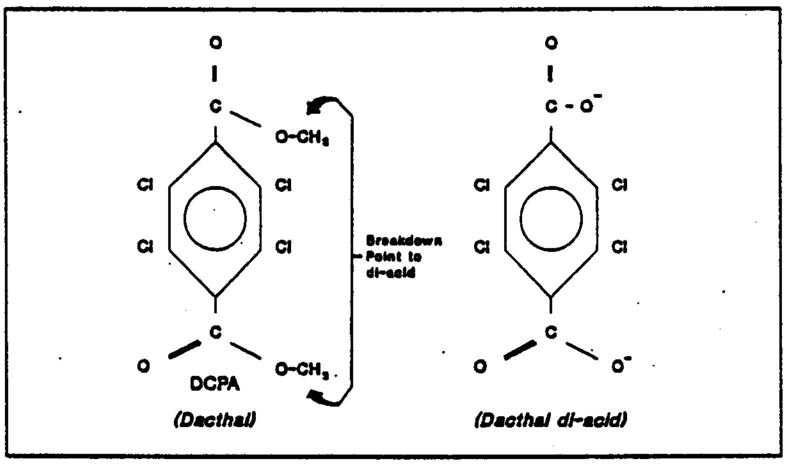


FIGURE 1

Chemistry of Dacthal

* Information in Appendix H taken from "Pesticides on Onions as It Affects Groundwater," 1990, Lynn Jensen, Malheur County Extension Service.

The *di-acid* that forms as a metabolite is very stable and not easily broken down further by micro-organisms. The solution to *Dacthal di-acid* contamination is not easy. There is no currently registered herbicide to replace Dacthal. There is a possibility that *Ramrod* (propachlor) may receive EPA registration, which would solve the problem, but registration status is tenuous at best. Tests should be conducted to determine the effects of using only postemergence treatments on onions or finding a substitute. Fortunately, there is time to work on this problem as the contamination is well below the health advisory level. This is a long-term project that will take a minimum of 5 years to find the right herbicides or combinations of herbicides and run the necessary tests to determine that they are safe and effective.

Herbicides for onions are economically essential as described in the University of California publication, "Onion Production" (Table 1).

TABLE 1

Cost of Onion Weed Control

Hours Weeding/Acre		Weeding Cost/Acre
Without Herbicides	= 200 x 4.75/Hr.	$ 950.00
With Dacthal	= 44 x 4.75/Hr.	$ 209.00
With Dacthal + Brominal	= 15 x 4.75/Hr.	$ 71.00

- Without Herbicides 6% of the plants were lost to hoeing injury.
- With Herbicides only 0.3% were lost.
- With Herbicides yields increased by 50% over hand hoed only trials.

NOTE:

Material in this Appendix is condensed from a paper, "Pesticides on Onions as It Affects Groundwater"; prepared by Lynn Jensen, Malheur County Extension agent.