# PESTICIDE AND NITRATE CONTAMINATION
# OF GROUND WATER NEAR ONTARIO, OREGON

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## ABSTRACT

Since 1983 the agricultural area south and west of Ontario, Oregon, has been investigated by the U.S. Environmental Protection Agency (EPA) in order to develop a better understanding of the high nitrate levels found in ground water there. The study has included samples from 50 wells, and nitrate levels as high as 49 mg/L nitrate-N have been found. In May 1985, 34 wells were resampled for nitrates, and seven of those samples were also analyzed for 13 pesticides and their common metabolites. These 13 compounds are known ground water leachers that are commonly used in the area. All seven samples were found to contain the pesticide DCPA in concentrations of between 0.11 and 290 ug/L. A second, March 1986, round of 25 samples contained DCPA concentrations of between 0.27 and 275 ug/L, thus confirming the previous findings and indicating widespread contamination throughout the study area.

In this area DCPA is used extensively on onions, which are planted in the well-drained, deep silt-loam soils of the Owyhee-Greenleaf series. The sampled wells penetrate an alluvial aquifer and are perforated at depths of between 20 and 70 feet from the surface. Because annual precipitation averages only about 12 inches per year, flood irrigation provides an additional 5 acre-feet per acre of supplemental water; thus, approximately 80 percent of the water available for ground water recharge is from diverted surface waters.

All wells sampled in this survey are drinking water supplies. The drinking water standard for nitrates is 10 mg/L as nitrate-N. In 1982 EPA established a drinking water draft health advisory for DCPA of 500 ug/L for longer-term exposure. At the present time, this has not been exceeded, and public reaction has been subdued. EPA is cooperating with agricultural, health, and environmental agencies on the state and local level in a comprehensive ground water quality investigation covering an area of approximately 10,000 acres. Preliminary results indicate that there is contamination over much of this area.

## Introduction



Between 1979 and 1983, routine monitoring of drinking water samples from small water supply wells in the Ontario, Oregon, area (Figure 1) indicated a persistent problem of high nitrate-Nitrogen (nitrate-N) levels. The drinking water standard for this contaminant is 10 mg/L (parts per million), and many of the samples from wells had levels ranging as high as 49 mg/L. U.S. Environmental Protection Agency (EPA) and state regulations, under the Safe Drinking Water Act, do not allow the distribution of water that exceeds these standards for human consumption. Several non-community water systems in the area have had great difficulty in achieving compliance with the standard, since the removal of nitrates by water treatment is both difficult and expensive. Due to their location, most of these systems could not readily connect with the nearest community water supply.

In an effort to better understand this problem, EPA began a limited ground water study aimed at determining if a specific nitrate source could be identified. Defining the problem would be the first step toward the goal of ensuring that residents of the area were drinking the safest water possible. Key to this study was the establishment of a ground water sampling program intended to both define the limits of the affected area and provide nitrate concentration data that would be useful in describing a subsurface plume of contamination.

## Area Hydrogeology

From the onset of this project, it was realized that a basic understanding of the hydrogeology in the area would be necessary. Efforts were made to obtain all available driller's well logs, along with any ground water investigations and reports. A review of these disclosed several limiting factors. The logs showed that the elevations of the well heads are not precisely known; thus, there is no accurate way to reference the water level measurements taken at any of the wells. Without this, the true water table depth beneath the area cannot be determined. Also, the geologic descriptions in the logs lacked accuracy, making subsurface correlations difficult.

The logs do provide some valuable information regarding the well construction. Each of the wells scheduled for sampling in the survey was originally sealed to the surface, and the point of the shallowest perforations in the well casings ranges from 20 to 70 feet from the surface. The logs also reveal that the geology of the saturated zone consists of interbedded gravel, sand, silt, and clay deposited as alluvial sediments.

A single U.S. Geological Survey observation well, completed to a depth of 135 feet, is located near the center of the study area. Water levels in this well have been measured since 1950 and are presented as a hydrograph in Figure 2. The data show a fairly constant ground water level of between 9 and 11 feet from the surface, with seasonal fluctuations as great as 7 feet. In a ground water report concerning the region, it was observed that, overall, water table levels are stable,

## LOCATION MAP

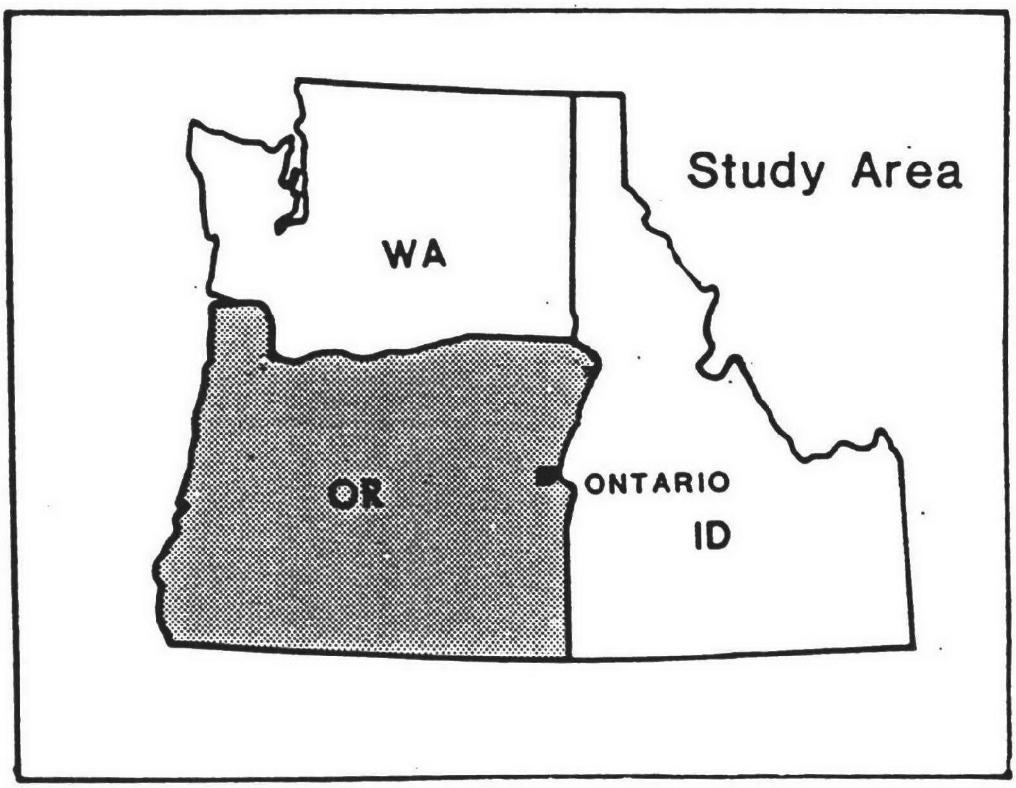


Figure 1

## Hydrograph of USGS Observation Well

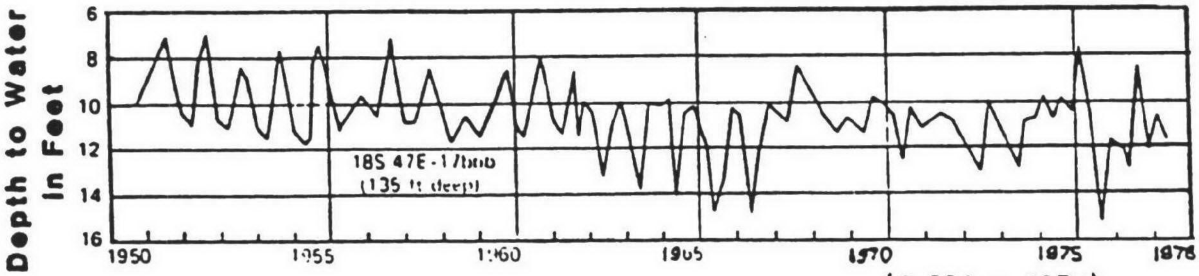


Figure 2

(Collins, 1978)

indicating that ground water recharge and discharge are generally in balance (Collins, 1979). 

The combination of limited published data and variable well log information makes the important task of estimating ground water flow largely speculative. In the absence of more reliable data, it seems reasonable to presume that ground water flow generally conforms to the area's surface topography. In the Ontario study area, this implies a regional flow tending northward toward the Malheur and Snake River flood plains, where it eventually parallels and then joins the respective flow gradients of the rivers (Figure 3).

## Land Elevations and Estimated Ground Water Flow

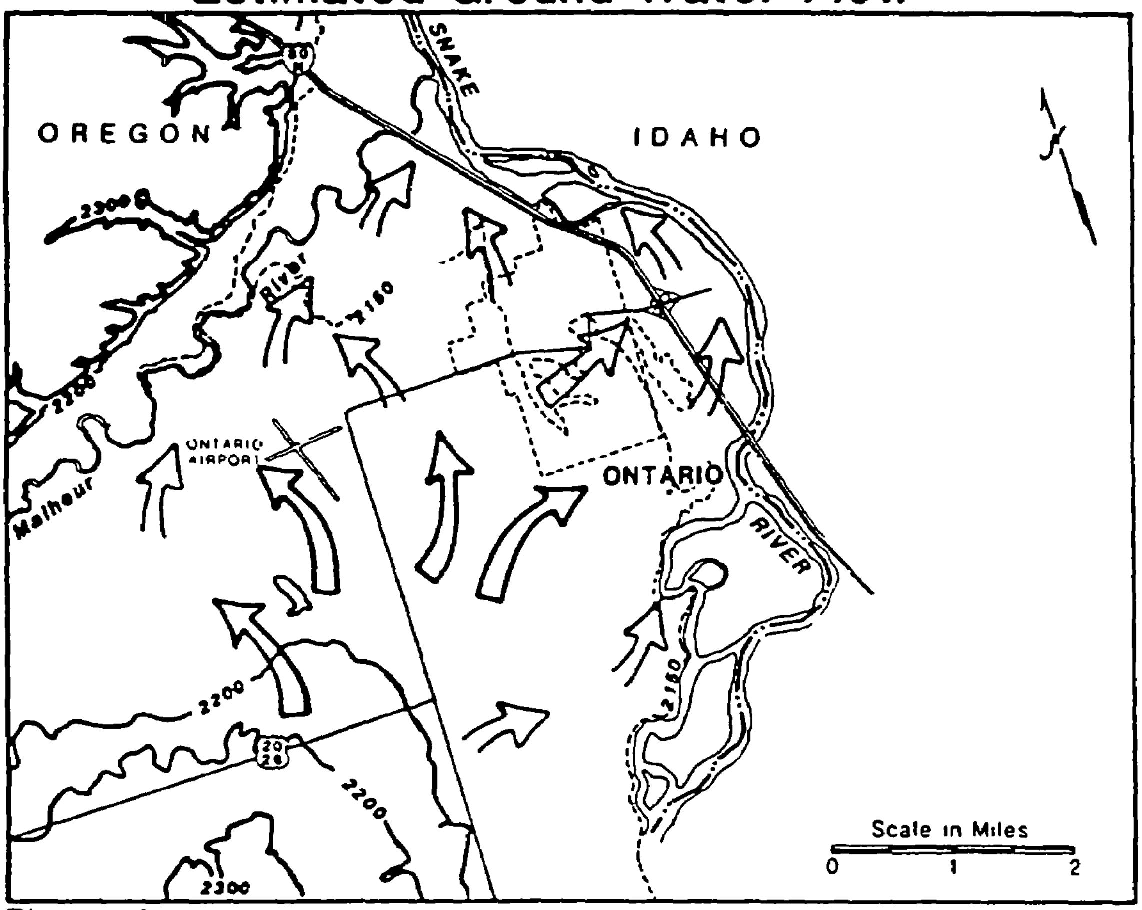

Figure 3

Obviously, there are many factors directly affecting ground water flow that cannot be accounted for given the limited resources of this investigation. The area is crossed by unlined irrigation canals and ditches. Most parts of the study area have relatively low slopes of 2 percent or less, and there are many fields that receive intensive irrigation. These factors could cause localized ground water mounding in the water table and add greatly to the difficulty of estimating ground water flow.

## Nitrate Sampling and Results

In June 1983, EPA, in cooperation with Malheur County Sanitarian's Office, collected the initial round of 45 samples for nitrate-N analysis. The results showed concentrations ranging from 0 to 39.2 mg/L, and the nitrate concentrations did not correlate with the depth of well perforations. The concentration data are plotted in Figure 4, which shows contoured nitrate-N values in 10 mg/L intervals over the study area. The results from these samples show that there is not a well-defined plume that would be characteristic of a single contaminant source; instead, there appear to be broad areas with higher and lower concentrations, indicating the existence of several different sources of nitrate-N. In addition, it is apparent that there are fairly large quantities of the contaminant present throughout the area.

As part of the ongoing monitoring program, a second round of 35 samples was collected in August 1983. Nitrate-N concentrations detected in these samples ranged from 0 to 49 mg/L, and the results are plotted in Figure 5. A contour pattern somewhat similar to that in the June 1983 data emerges. The areas of higher concentration have shifted to some degree, but once again a distinctive flow pattern or plume does not become readily apparent.

## Pesticides

Resource limitations precluded sampling during 1984, but a third round of sampling was scheduled for the spring of 1985.

With this third round of samples, it was decided to expand the scope of the investigation in order to determine if any of the pesticides commonly used in the area might also be affecting the ground water quality.

The method used to establish which pesticides to look for in the ground water samples consisted of comparing a list of pesticides known to leach into ground water with a list of those commonly used in the area. The overlap of these two became the final list of 13 target compounds requested for laboratory analysis (Table 1). In the face of limited lab resources, it was agreed that only seven samples could be afforded a complete pesticide scan.

# N03-N ONTARIO, OREGON June, 1983

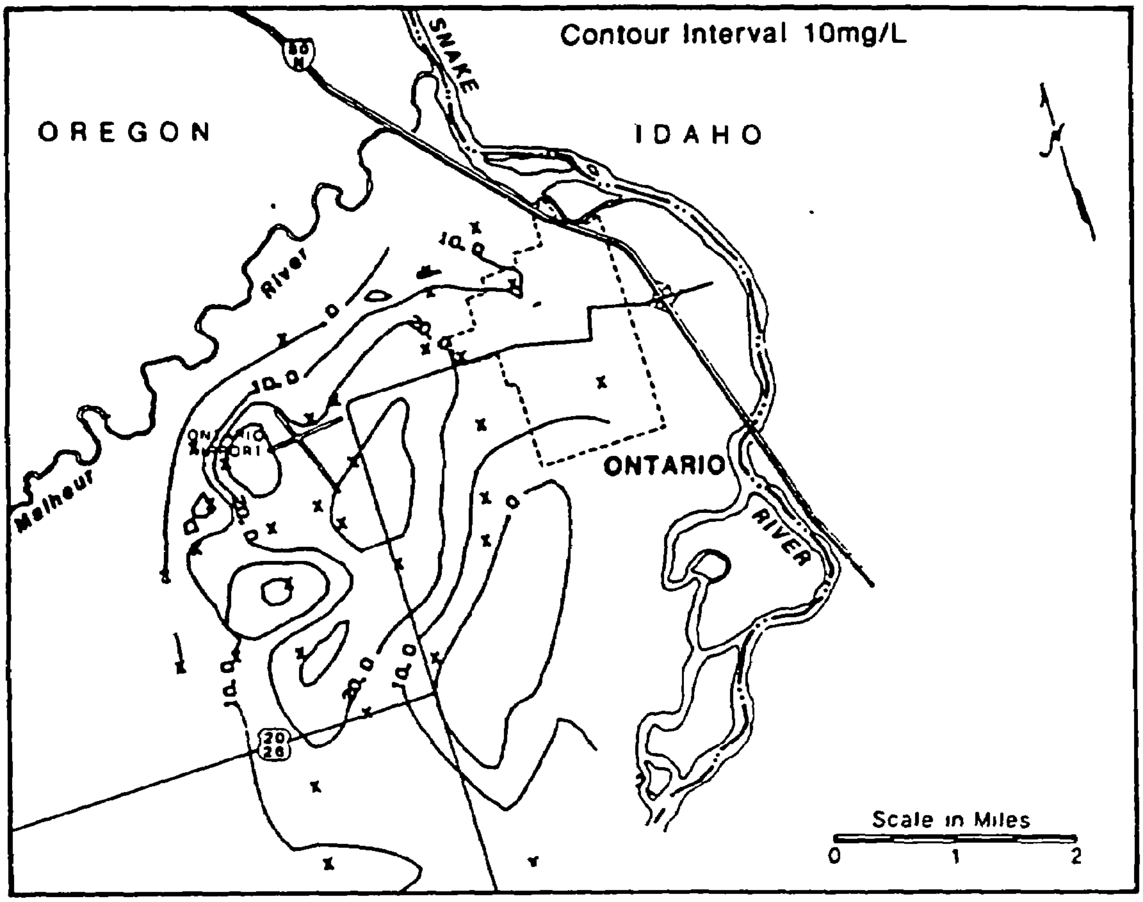


Figure 4

# N03-N ONTARIO, OREGON August, 1983

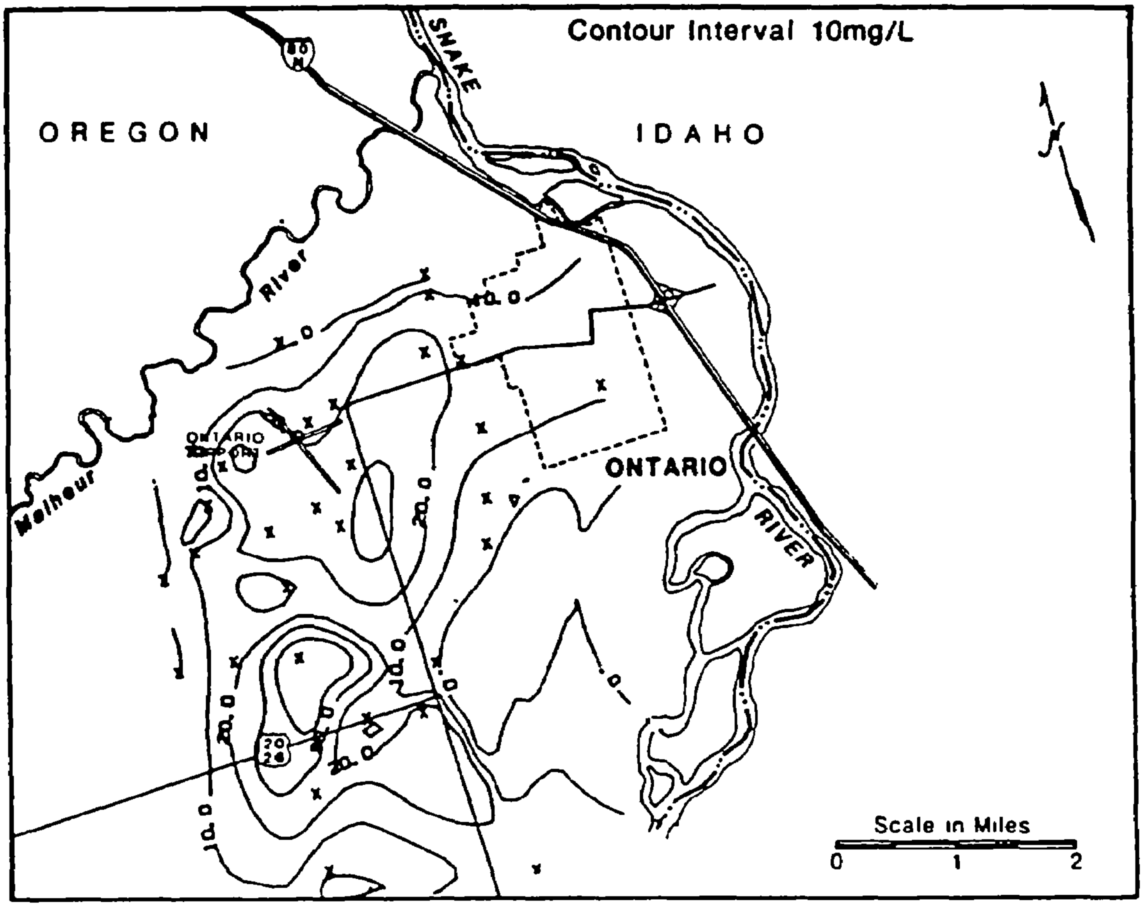


Figure 5

TABLE 1

List of Pesticides for Analysis in
Ontario Ground Water Samples
May 1985

| Common Name |
|---|
| Alachlor |
| Carbofuran |
| Cyanazine |
| DCPA |
| Dinoseb |
| Dichloropropane/propene |
| EDB |
| Fonofos |
| Hexazinone |
| Metribuzin |
| Simazine |
| 2,4-D |
| 2,4-DB |

In May 1985, 34 ground water samples were collected for nitrate-N analysis; seven of these were chosen for the more detailed pesticide scans. The results of this third round of nitrate-N sampling are plotted in Figure 6. A pattern somewhat similar to that of the previous two rounds emerges. It is significant to note that in essence, there appears to have been little change in the nitrate situation over a two-year period.

The results from these pesticide scans indicated the presence of a hydrolized form of the herbicide DCPA (Dimethyl tetrachloroterephthalate) in all seven of the samples, which were collected from widely-spaced wells. The concentrations detected in the samples ranged from 0.1 to 290 ug/L (parts per billion).

## Public Health Implications

In 1982 EPA established a drinking water draft Health Advisory of 500 ug/L DCPA (and metabolites) for longer-term exposure. Since all of the samples collected in this study were from drinking water wells and the levels found were greater than one half of the advisory value, it was immediately realized that there was a potential for endangerment of public health.

In light of these concerns, EPA, Oregon State Health Division, and Malheur County Sanitarian's Office jointly decided that the local or county sanitarian's office should publicly release the preliminary pesticide results. A press release was drafted and issued to the local newspapers.

# N03-N ONTARIO, OREGON May, 1985

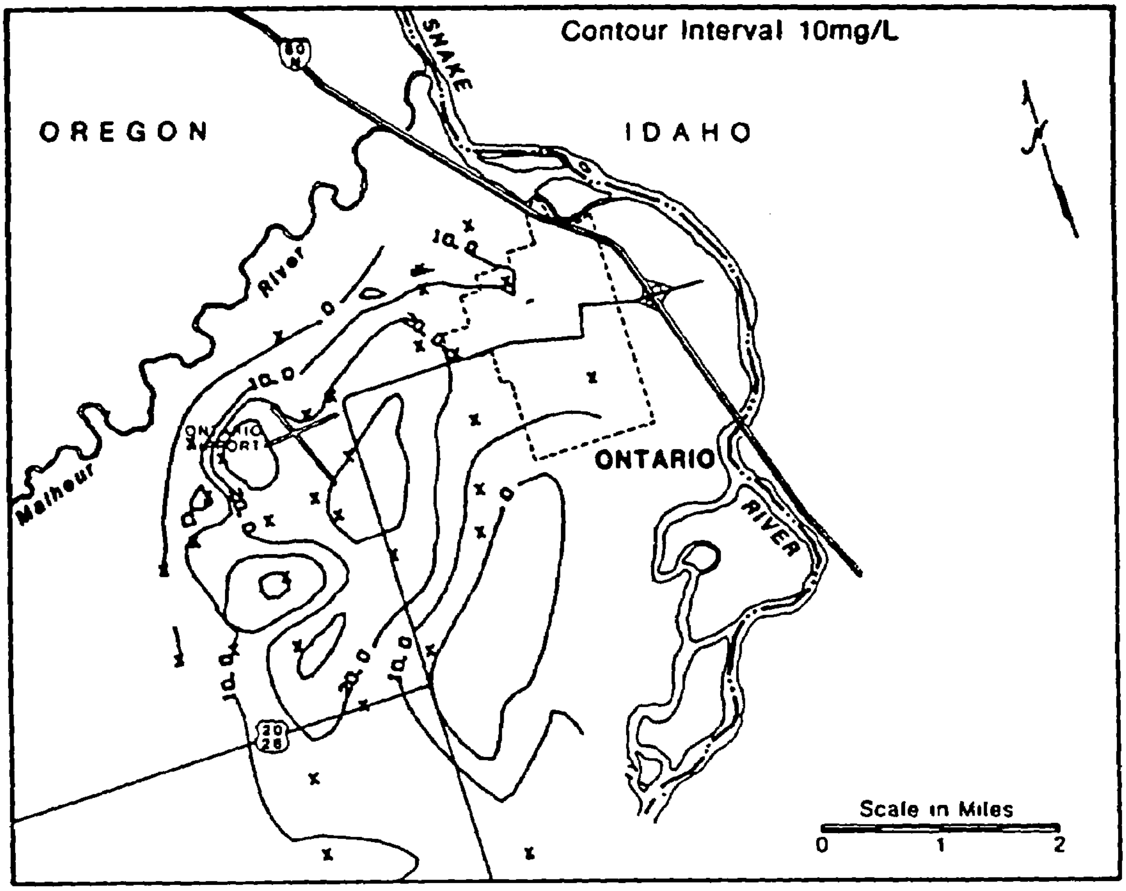


Figure 6

Public reaction to the sample results was generally subdued, and the subsequent newspaper and television reports tended not to sensationalize the problem.

Before deciding on the next course of action, EPA met with a diverse group of state and local agencies representing agricultural, health, and environmental concerns. During this meeting all of the agency representatives agreed that the sampling effort should be greatly expanded and that their respective agencies should participate in the sampling and follow-up activities.

Two immediate objectives were identified: (1) to determine the size of the affected area, and (2) to see if even higher levels were present in unsampled areas. In order to meet these objectives, the following recommendations were incorporated into a comprehensive sampling plan:

1. The agricultural agencies should proceed to determine what additional areas should be sampled, while the health and environmental agencies should determine the most suitable well sites and field conditions for sample collection.

2. The samples should be collected in the middle of March, before the widespread application of agricultural chemicals begins for the growing season.

3. Samples should be collected from those areas in the region where onions had been grown because onion crops characteristically receive 6 lbs/acre active DCPA as a pre-emergent herbicide. Onion producers constitute the largest users of DCPA in the region.

4. Aldicarb is commonly used in the area and has serious health implications. Thus, EPA laboratory capabilities should be expanded in order to analyze ten samples for that compound as well.

5. Between 90 and 100 samples should be collected over an agricultural area totaling approximately 10,000 acres in the northern half of Malheur County.

6. The samples should be divided between different laboratories in order to maintain quality assurance. A three-way division between EPA, Oregon State University, and a major producer of the herbicide was decided upon.

Sample collection for this second follow-up effort was completed in March 1986, when five sampling teams collected 96 samples.

As of this writing, results from all three laboratories are not yet available. However, those samples from the Ontario portion of the study area are available, since they were analyzed by the EPA laboratory. The nitrate-N values in these samples range from 0.4 to 36 mg/L and are plotted in a contour pattern somewhat similar to that of the previous nitrate-N data (Figure 7). DCPA was again detected in the samples in concentrations ranging from 0 to 275 ug/L. A contour plot of the DCPA results is shown in Figure 8. Several of the samples collected from

# N03-N ONTARIO, OREGON March, 1986

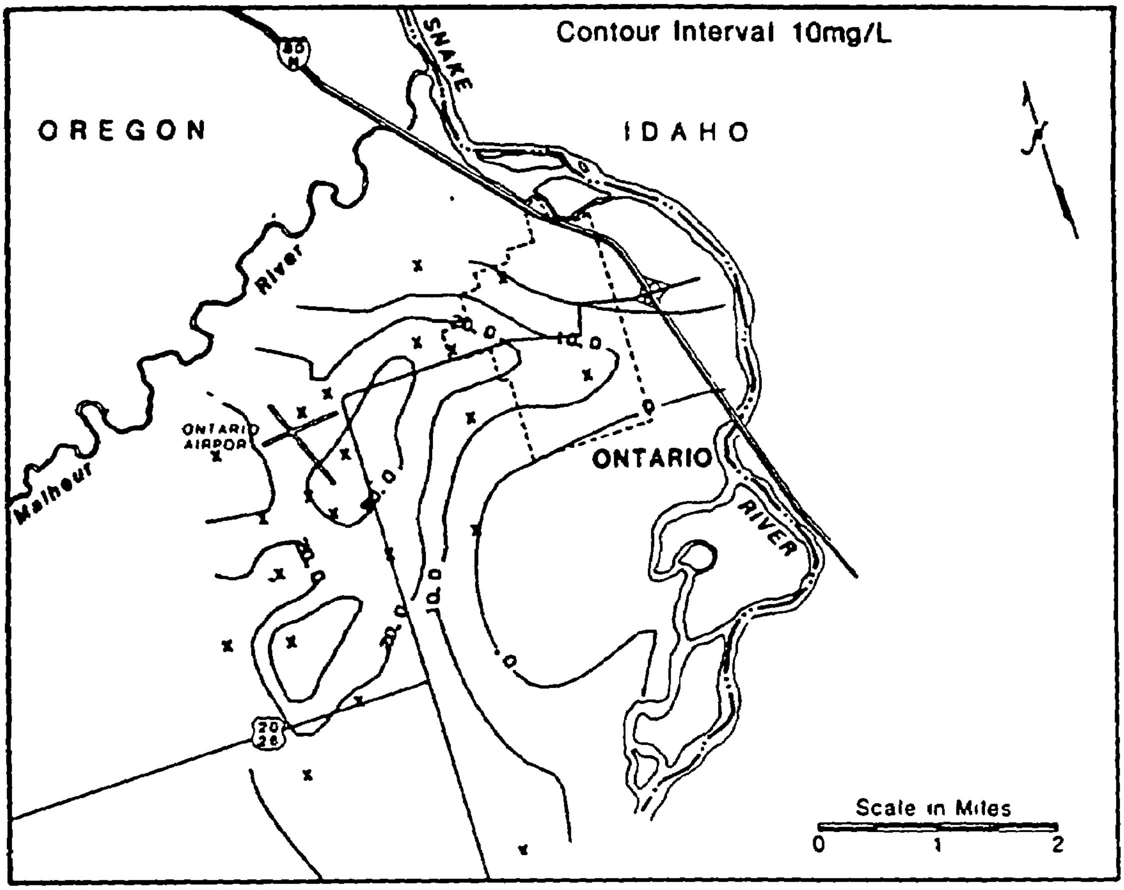


Figure 7

# DCPA ONTARIO, OREGON March, 1986

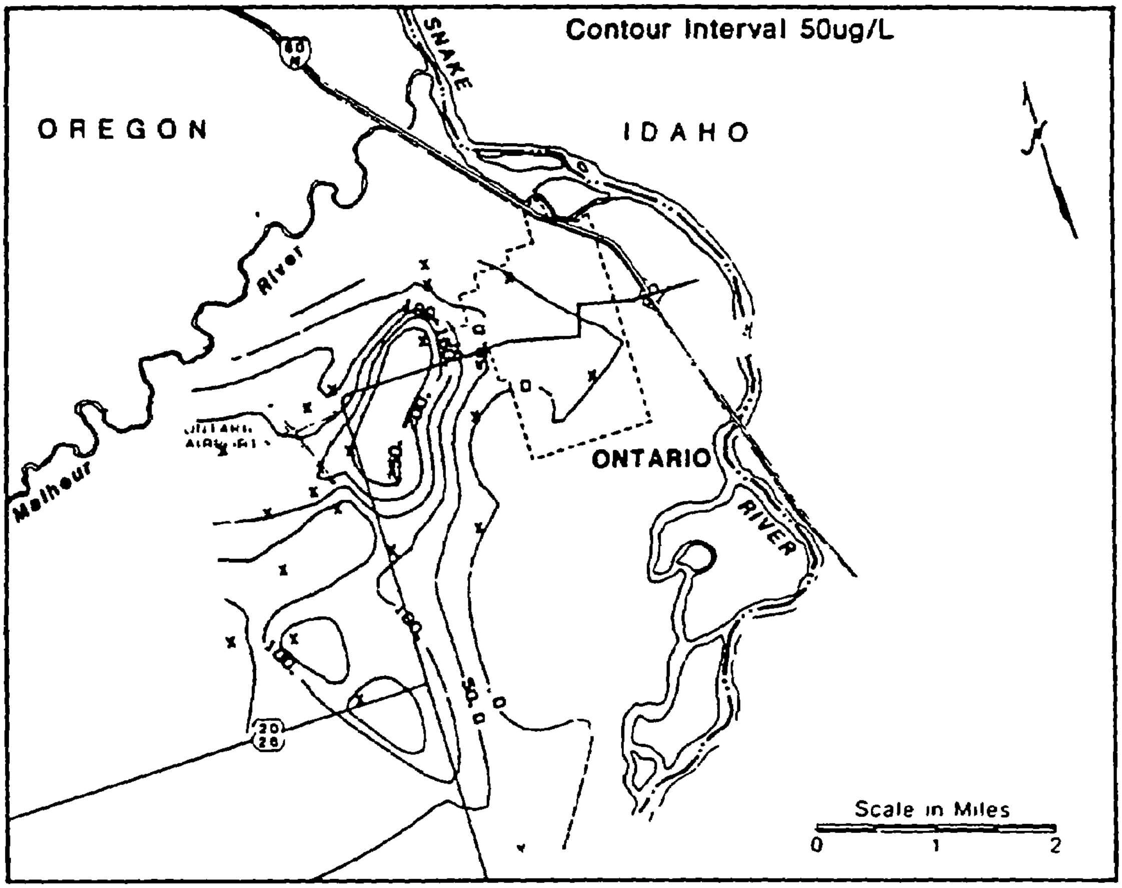


Figure 8

outside the Ontario area were found to contain DCPA as well, thus indicating a more widespread problem. Results from the ten aldicarb analyses were all negative. 

## Implications for the Regional Agricultural Economy

DCPA is presently the only effective pre-emergent herbicide registered for use on onions in Malheur County. Onions rank second, behind cattle production, in terms of the county's agricultural income. Most farmers in the area would prefer to use the more effective herbicide propachlor either alone or with lower amounts of DCPA. The use of propachlor on onions in Oregon was permitted from 1982 to 1984 through section 18, emergency registrations, which were issued annually. In 1985, issuance was denied because the registrant had failed to make adequate progress in pursuing a section 3 or "normal" registration to allow for its use on onions.

Optimistic projections indicate that the data requirements for propachlor registration (section 3) for existing crops could be met by 1988. Unless that data contains adequate information regarding use on onions, the chemical will still remain unavailable to growers in Malheur County. It is these problems with propachlor's registration that have resulted in the extensive use of the less effective DCPA.

## Agriculture and Ground Water in the Ontario Area

In an EPA contract study, W. M. Mack provided a comprehensive analysis of aerial photographs of the Ontario area (1983). The photos cover the time period from 1946 to 1983; throughout that time the area was predominantly crop land. No waste disposal sites or industrial sources of water pollution could be identified. The report concluded by stating that agricultural practices were the most likely source of nitrate contamination of ground water.

Data from the present study further supports such a conclusion. The role of agriculture appears to be significant for many reasons. Farming is the major land use in the affected area. Irrigation records show that the average cultivated field receives about 5 acre-feet per year of diverted surface water, and the local soils consist of the Owyhee-Greenleaf series, an alkaline, well-drained deep silt-loam occurring on slopes of 0 to 2 percent. All of these factors combine to create a high potential for ground water recharge from cultivated fields. The dispersed patterns of nitrate-N and the widespread presence of the herbicide DCPA in the ground water further highlight the contribution of agriculture.

## Nitrate-Pesticide Relationship

In recent years, it has been implied that the presence of nitrates in ground water may connote pesticide contamination. As a test of this hypothesis, an x-y plot of nitrate-N versus DCPA for the March 1986

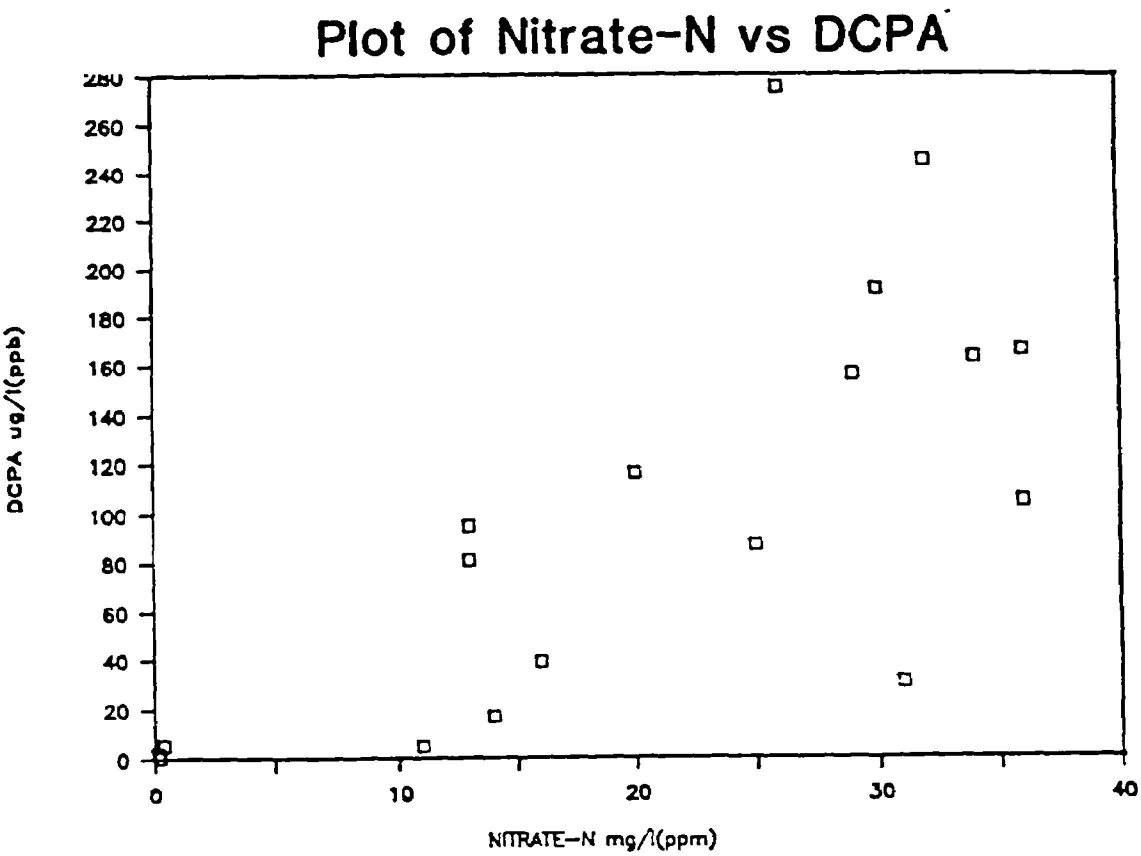
Plot of Nitrate-N vs DCPA
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
DCPA ug/l(ppb)
0
10
20
30
40
NITRATE-N mg/l(ppm)

Figure 9

sample data is presented in Figure 9. The correlation coefficient for this data is approximately 0.7. If such a correlation can be validated through further studies, routine, low cost nitrate sample results could be used as preliminary indicators of potential pesticide contamination.



## Conclusions

This study has been conducted under constraints that will not allow absolute determinations of the direct causes of nitrate and pesticide contamination. However, the data do indicate a significant contribution from agricultural activities.

More information about the hydrogeology of the area is necessary, since this will play a vital role in understanding the contamination problems and any subsequent decision making.

Nitrate contamination of ground water is widespread throughout the study area, with levels commonly exceeding the drinking water standard by two or three times. Since the data indicate that agricultural practices are a major contributor of nitrates here, the need for a careful re-evaluation of nitrogen fertilizer use is apparent.

DCPA contamination of ground water is also widespread in the area, with levels greater than one half the present health advisory. The health implications of these high levels may at some point force the agricultural, environmental, and health agencies to place limitations on DCPA in the area. Before such decisions are made, the possible economic impacts on the agricultural community that would result from such restrictions must be carefully weighed.

At the time of writing, EPA drinking water and pesticide programs, along with their state counterparts, are exploring options that may mitigate these problems. Presently a continuing, long-term monitoring program is being implemented, and the propachlor registration issues are being carefully examined. Hopefully, reasonable and intelligent actions can be taken before the ground water situation worsens.

## REFERENCES CITED

Collins, C.A. 1979. Ground-Water Data in the Baker County-Northern Malheur County Area. U.S.G.S. Open File Report 79-695. 28 pp.

Mack, W.M. 1983. Aerial Photographic Analysis for Groundwater Contamination, Ontario, Oregon. Environmental Monitoring Systems Laboratory, U.S. EPA, Las Vegas, Nevada. 31 pp.