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# QUINCY AGRICULTURAL CHEMICALS GROUND WATER QUALITY ASSESSMENT

by

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Finally, Dave Nash of the Washington State Department of Health reviewed all results for health implications and wrote Health Consults to all well owners explaining these implications.

# ABSTRACT

In May 1991, twenty-seven wells and two field drains near Quincy Washington were tested for 76 agricultural pesticides. One or more pesticides were detected in 26 of the wells and both drains. The compound 1,2-dichloropropane was detected most often (66 percent of sites) followed by ethylene dibromide (EDB) (62 percent of sites). The mean concentration of 1,2-dichloropropane was about 0.20 $\mu$g/L and that of EDB was about 0.017 $\mu$g/L. Dacthal (DCPAs) was detected at 55 percent of the sites during the initial sampling, but was not detected in the verification samples. EDB concentrations in nine wells and one drain exceeded the drinking water standard for public water supply systems.

EDB was detected throughout the study area (although not in all wells) with the two highest concentrations within one-mile of each other near the center of the study area. Dichloropropane was also detected throughout the study area, but again no pattern in the location of wells was apparent. Both pesticide products were found over the full range of well depths, from 44 to 110 feet.

Total organic carbon (TOC) and nitrate + nitrite as nitrogen (nitrate+nitrite-N) were also analyzed as potential indicator parameters. Concentrations of TOC were positively correlated with dacthal concentrations, and concentrations of nitrate+nitrite-N were positively correlated with 1,2-dichloropropane. Nitrate+nitrite-N concentrations in two wells exceeded the 10 mg/L standard for public water supply systems.

# INTRODUCTION

In 1991, twenty-seven wells and two field drains were sampled for agricultural pesticides. The wells and drains were located in an intensive agricultural area near Quincy, Washington, in northwestern Grant County (Figure 1). The study covered roughly 30 square miles including most of Township 20N Range 24E W.M. and the northern sections of Township 19N. Land use is primarily agriculture and the farms are relatively large with fields commonly exceeding several hundred acres. Predominant crops are potatoes, sweet and silage corn, and alfalfa. Many other crops are also grown on smaller acreages, including mint, peas, onions, carrots, and asparagus. The area is part of the Columbia Basin irrigation project and is irrigated by water from the Columbia River. This report presents the results of sampling for pesticides in this area.

## Background

The use of agricultural chemicals in Washington State is widespread. However, the effects of these chemicals, especially pesticides, on the state's ground water quality is largely unknown. In 1987, the Washington State Legislature directed the Department of Ecology to investigate whether normal agricultural use of pesticides was contaminating ground water. The project was designated the Washington State Agricultural Chemicals Pilot Study.

Initially, three geographically separated and agriculturally diverse study areas were sampled:

1. near Lynden in Whatcom County;
2. near Sunnyside in Yakima County; and
3. near Pasco in Franklin County.

Results from these areas were published by Erickson and Norton (1990). A fourth study was conducted near Gleed in Yakima County during 1990 (Erickson, 1992). The investigation of pesticides in ground water of the Quincy basin was proposed in the original pilot study, but not implemented. The Quincy study was initiated in April 1991.

## Objectives

Objectives of the Quincy study are:

- To provide information on the presence and concentration of pesticide residues in ground water of the Quincy basin resulting from normal pesticide applications; and

- to evaluate indicator parameters for identifying wells to test for pesticide.

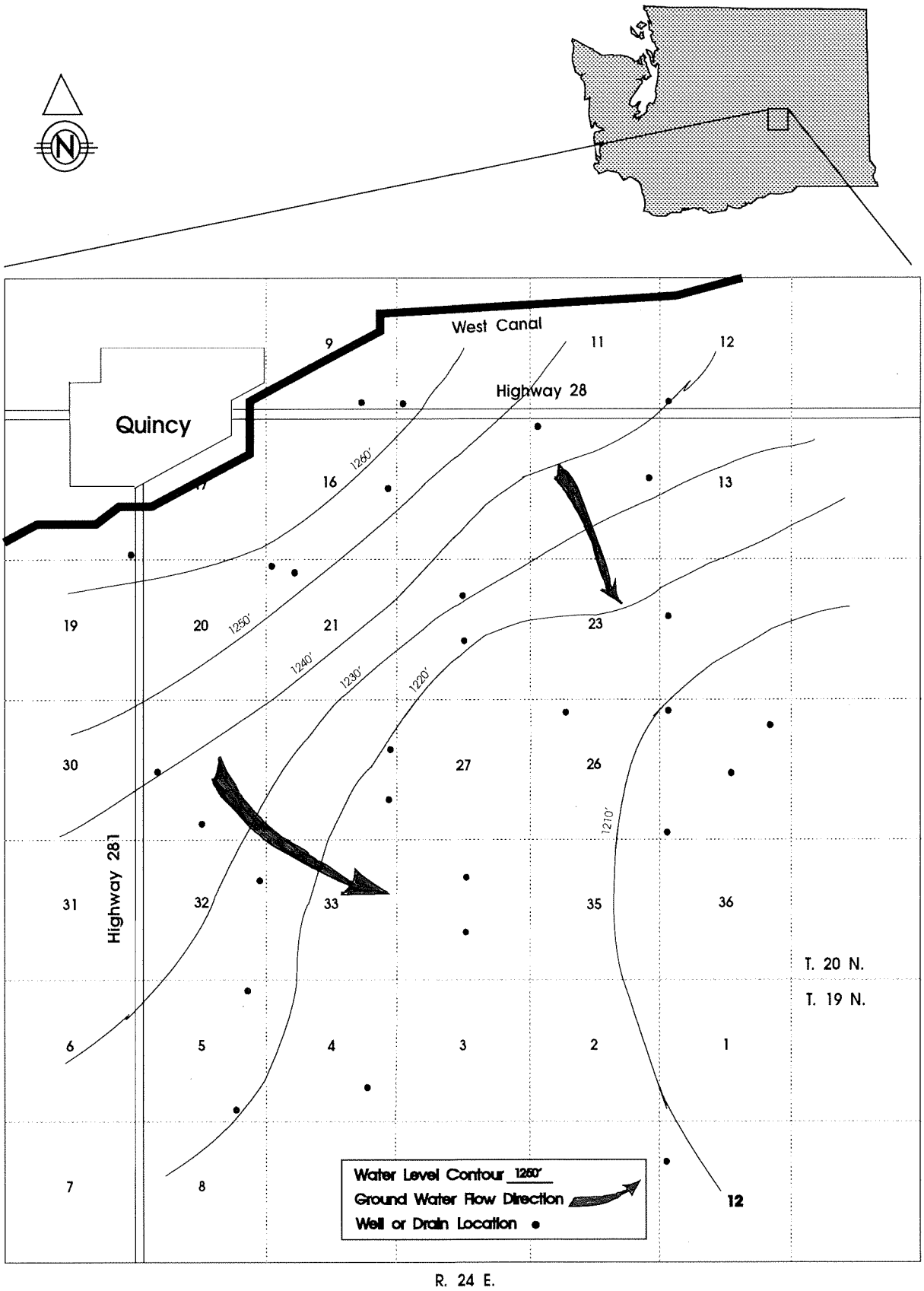


**Figure 1.** Quincy ground water study area showing sampling sites and ground water level contour elevations in feet.

## Soils and Hydrogeology

The major soils in the northern part of the study area are the Kennewick-Warden-Sagemoor soil types (Gentry, 1984). These soils consist predominately of silt loam and some fine sandy loam at depth. Quincy soils, consisting predominantly of fine sand, dominate the southern portion of the study area. All soils are deep and well to excessively drained.

Soils are underlain by unconsolidated and poorly consolidated deposits of fluvial and lacustrine sand and silt, some fluvial gravel, and basalt bedrock (Grolier and Bingham, 1971). The thickness of unconsolidated deposits ranges from about 50 to 100 feet. Caliche deposits within the unconsolidated deposits are common. The Yakima Basalt of the Columbia River Group underlies the unconsolidated deposits and is continuous beneath the study area. The land surface slopes from the northwest to the southeast with an average gradient less than 0.5 percent.

The uppermost aquifer consists of unconsolidated deposits and the upper portion of the underlying basalt. It is saturated to within 20 feet of the surface. The regional ground water flow of this surficial aquifer follows the land surface and is generally toward the south and southeast (Tanaka, *et al.*, 1974; Walters and Grolier, 1960).

# METHODS

Twenty-seven existing wells and two field drains were sampled. Four of the wells were Bureau of Reclamation monitoring wells; the remainder were single domestic wells. The sampling density was about one well per square mile. Well selection was based on:

1. A distribution of well locations that represented ground water quality;
2. depth of the well (it must draw water from the surficial aquifer);
3. availability of well construction information; and
4. permission of the owner to sample.

The total number of wells sampled was limited by the budget for this study. Locations of study wells and drains are shown in Figure 1, the depth and type of well or drain are presented in Appendix A-1. Drain 1 drains a single field while drain 2 is a regional drain capturing water from several individual field drains.

Initial sampling occurred in late May and early June 1991. Pesticides detected in these samples were verified by resampling the respective wells and analyzing the new sample for the earlier detected pesticide. Thus, not all wells were resampled and only the prior detected pesticides were analyzed. Verification sampling occurred in February 1992.

## Sampling Procedures

Wells were purged before sampling until temperature, pH, and specific conductance had stabilized and at least three casing volumes of water had been removed. We purged and sampled domestic wells from existing faucets. Faucets were selected as near the well as possible, and before any pressure tanks where feasible. Monitoring wells were purged with either a centrifugal or peristaltic pump and sampled with a decontaminated teflon bailer. Decontamination consisted of a tap water and Liquinox® wash followed by sequential rinses with deionized water, 10% nitric acid, and acetone. Bailers were air-dried and wrapped in aluminum foil until used. We obtained grab samples from the two drains where they discharged to a waste canal.

## Pesticides

Ground water was analyzed for 76 pesticides or pesticide breakdown products (metabolites). Most of these pesticides were derived from the Environmental Protection Agency's (EPA) list of leachable pesticides which have properties conducive to migration through soil to ground water (Cohen, 1985). Target pesticides, test methods, and detection limits are listed in Appendix A-2. Initial samples were analyzed by Montgomery Laboratory in Pasadena, California, and verification samples by Ecology's Manchester Laboratory.

We estimated the mean, variance, and standard deviation of the detected pesticides using methods outlined by Newman *et al.* (1989). These methods use maximum likelihood and order statistics to estimate the mean and standard deviation of environmental samples with observations below the detection (or quantitation) limit (left censored data). Methods included iterative order, regression order, bias corrected, and Schneider one-step.

## Indicator Parameters

A secondary objective of this study was to evaluate indicator parameters that could be used to identify wells for pesticide testing. The ideal indicator parameter would have a strong positive correlation with pesticide occurrence, give repeatable and reliable results, and be inexpensive to monitor. We selected three indicator parameters for study: total organic carbon, nitrate/nitrite-N, and total dissolved solids. Analytical methods and detection limits for each indicator are listed in Appendix A-3.

We used two statistical methods to evaluate the usefulness of the indicator parameters; simple regression and the Mann-Whitney test (Zar, 1974). We regressed the concentration of the indicator against the concentration of each pesticide. Values reported as below the detection limit were assigned a value of one-half the detection limit for the regression. The significance of the regressions was tested at the 95% confidence level using analysis of variance and the F-statistic. The null hypothesis was that the slope of the regression line was equal to zero (no relationship between the indicator and the pesticide).

The Mann-Whitney test was applied at the two-tailed 95% confidence level. The null hypothesis for the Mann-Whitney test was that the concentrations of the indicator parameter in samples with detected pesticides were equal to the concentrations of the indicator parameter in samples without detected pesticides.

### General Chemistry and Field Parameters

In addition to pesticides and indicator parameters, we analyzed the general chemistry of water from six wells. This included the concentrations of the major cations - potassium, magnesium, calcium, and sodium; the anions - chloride, total sulfate, bicarbonate, and carbonate (both the latter as $CaCO_3$); total phosphorus; and selected metals and trace elements - iron, lead, manganese, mercury, nickel, arsenic, cadmium, chromium, copper, zinc, and selenium. Analytical methods and detection limits for general chemistry are listed in Appendix A-4.

We also field tested the water at each site for pH, specific conductance, and temperature. We used an Orion meter for pH and temperature, and a YSI meter for specific conductance.

## RESULTS

In this section, we present the hydrogeology based on data collected from the study wells. This is followed by a discussion of the detected pesticides, a limited discussion of health concerns related to the detected pesticides, a discussion of the statistical testing of the indicator parameters, and a brief discussion of the general ground water chemistry. In general, the quality of the data is good. Quality assurance results and discussion for pesticides and non-pesticide parameters are included as Appendix B.

### Hydrogeology

The uppermost aquifer consists of saturated unconsolidated materials and the upper portion of the underlying basalt. The top of the basalt is hydraulically connected with the unconsolidated deposits. Most domestic wells in the areas are completed in the upper portions of the basalt. The depths of the study wells averaged about 70 feet and ranged from 44 to 110 feet. The depth to ground water in the study wells averaged 13 feet and ranged between 3 and 38 feet. Bureau of Reclamation monitoring well records indicate the water level has risen between 40 and 50 feet since about 1950 in response to irrigation. Extensive networks of subsurface drains have been installed in many areas to control the rising water table. The drains consist of perforated pipe or clay tiles connected together by increasingly larger pipes which feed to open wasteway canals. In the Quincy area, perforated sections are installed at a depth of 8 to 10 feet.

Based on the elevation and water levels of the study wells, the ground water gradient across the study area is from the northwest to the east-southeast (Figure 1). The gradient is steepest in the northwest corner, about 0.4 percent, declining to about 0.1 percent in the southeast.

The steeper gradient in the northwest may be the result of leakage from a major irrigation canal that crosses this corner of the study area.

**Pesticides**

Five pesticides were detected in the initial sampling: ethylene dibromide (EDB), DCPAs (dacthal and metabolites), 1, 2-dichloropropane, (trans) 1,3-dichloropropene, and atrazine. The remaining 71 pesticides were not detected. The number of detections and the concentration range of detected pesticides are shown in Table 1. The concentrations of EDB, DCPAs, 1,2-dichloropropane, and (trans) 1,3-dichloropropene at individual sites are listed in Appendix C for both the initial and verification samples.

**Table 1.** Number of detections and range in detected concentrations ($\mu$g/L) of pesticides in the initial and verification sampling of Quincy ground water.

| | Initial (05/91) | | Verification (02/92) | |
|---|---|---|---|---|
| Pesticide | Detections | Range | Detections | Range |
| EDB | 18 | 0.01 - 0.26 | 10 | 0.01 - 0.33 |
| DCPAs | 16 | 0.20 - 8.30 | 2 | 0.06 - 0.14 |
| 1,2-Dichloropropane | 19 | 0.10 - 0.72 | 15 | 0.10 - 0.50 |
| (trans) 1,3-Dichloropropene | 3 | 0.10 - 0.11 | 0 | |
| Atrazine | 1 | 0.28 | 0 | |

We calculated the mean, variance, and standard deviation of EDB and 1,2-dichloropropane for the initial samples. Iterative order, regression order, and Schneider one-step were used to calculate statistics for EDB (Table 2). Maximum likelihood, bias corrected, iterative order, regression order, and Schneider one-step were used to calculate statistics for 1,2-dichloropropane (Table 3).

**EDB** was detected in 17 wells and Drain 2 at concentrations between 0.01 $\mu$g/L (detection limit) and 0.26 $\mu$g/L. However, verification sampling confirmed EDB in the water from only ten of these eighteen sites. We did not detect EDB in the verification sample from the remaining eight wells. EDB is a fumigant used to control nematodes, and most agricultural uses of EDB were cancelled by EPA in 1983 and 1984.

The estimated mean concentration of EDB in the initial samples, including the non-detections, ranged from 0.010 to 0.022 $\mu$g/L (Table 2). Estimates differ because of

**Table 2.** Statistics for EDB concentrations in the initial Quincy ground water samples ($\mu$g/L).

| Method | Mean | Variance | Standard Deviation |
|---|---|---|---|
| Iterative order | 0.022 | 0.008 | 0.087 |
| Regression order | 0.010 | 0.010 | 0.098 |
| Schneider one-step | 0.019 | 0.008 | 0.091 |

number of observations = 29
observations below the detection limit = 11

**Table 3.** Statistics for 1,2-Dichloropropane concentrations in the initial Quincy ground water samples ($\mu$g/L).

| Method | Mean | Variance | Standard Deviation |
|---|---|---|---|
| Max likelihood | 0.199 | 0.070 | 0.265 |
| Bias corrected | 0.201 | 0.072 | 0.269 |
| Iterative order | 0.198 | 0.073 | 0.270 |
| Regression order | 0.196 | 0.076 | 0.276 |
| Schneider one-step | 0.199 | 0.071 | 0.267 |

number of observations = 29
observations below the detection limit = 10

differences in underlying assumptions between methods. Which value is closest to the true mean is unknown. However, they are all lower than the mean of 0.069 $\mu$g/L calculated by simply averaging the 18 values that were above the detection limit.

**Dacthal** or its metabolites (DCPAs) were detected in 16 of the initial samples. Dacthal is a pre-emergent herbicide used to control annual grasses and broadleaf weeds in turf, ornamental, and food crops. With the test method used, we did not distinguish dacthal from its degradation products monomethyl tetrachloroterephthalate and tetrachloroterephthalic acid. All are included as DCPAs. Concentrations ranged from the detection limit (0.20 $\mu$g/L) to 8.30 $\mu$g/L. However, DCPAs were detected in only two of the verification samples. In these two samples, DCPAs were positively identified but were not quantifiable. Because of uncertainty in the results, we did not calculate a mean for DCPAs, although we did test DCPAs against the indicator parameters. The cause of the disparity between the initial sampling results and the verification results is unknown. It may be related to the different sampling seasons or the different lab used for the verification samples.

In the initial sampling, we detected **1,2-dichloropropane** in 17 of the wells and both drains. The verification sampling confirmed dichloropropane in 14 of the 17 wells and Drain 2. Although no longer used, 1,2-dichloropropane is a contaminant in the manufacture of dichloropropene, a soil fumigant. Concentrations ranged from 0.10 (the detection limit) to 0.72 $\mu$g/L. The mean concentration of the initial samples, including the non-detections, was about 0.20 $\mu$g/L (Table 3). This is a better estimate than the 0.35 $\mu$g/L average of the 19 values above the detection limit.

We detected **(trans) 1,3-dichloropropene** in three of the initial samples. Concentrations were near the 0.10 $\mu$g/L detection limit and ranged from 0.10 to 0.11 $\mu$g/L. We did not detect this pesticide in verification samples.

We detected **atrazine**, a widely used selective herbicide, at a concentration of 0.28 $\mu$g/L in one sample (QN22G1); the detection limit was 0.20 $\mu$g/L. It was not detected in the verification sample. Neither EDB nor DCPAs were found at this site, however, we detected a low concentration of 1,3-dichloropropene.

**Health Concerns**

EPA has set the maximum contaminant level (MCL) for EDB in drinking water for public supply systems at 0.05 $\mu$g/L. In the initial sampling, EDB concentrations in 9 wells and Drain 2 equaled or exceeded the drinking water standard. Concentrations in verification samples from 6 of these 9 wells also equaled or exceeded 0.05 $\mu$g/L. EDB in the verification sample for Drain 2 was less than the MCL.

Detections of other pesticides did not exceed health criteria. Specifically the MCL for 1,2-dichloropropane set at 5.00 $\mu$g/L; the Lifetime Health Advisory Level for dacthal set at 3500 $\mu$g/L for drinking water; and the Lifetime Health Advisory Level for atrazine in drinking water set at 3.00 $\mu$g/L (US EPA, 1991).

**Indicator Parameters**

The indicator parameters, total dissolved solids, total organic carbon, and nitrate+nitrite-N, were detected at all sites. The average concentration of total dissolved solids was 414 mg/L with concentrations ranging from 224 to 583 mg/L. The average concentration of total organic carbon was 10.6 mg/L with concentrations ranging from 2.2 to 19.9 mg/L. Nitrate+nitrite as N ranged from 1.0 mg/L to 13.6 mg/L with an average concentration of 6.1 mg/L. Nitrate concentrations exceeded the 10.0 mg/L maximum contaminant level for drinking water in two wells and one drain. Concentrations of indicator parameters for each sample site are listed in Appendix D.

Using two methods, regression analysis and the Mann-Whitney test, we tested for a relationship between the three indicator parameters and three of the 76 pesticides: EDB, DCPAs, and 1,2-dichloropropane. These were the only pesticides detected in enough samples to make statistical testing useful. The correlation coefficients for the regression analyses are presented in Table 4. Of the nine tests, two were significant at the 95% confidence level. We found a significant positive correlation between total organic carbon and DCPAs and between nitrate+nitrite-N and 1,2-dichloropropane.

The results of the Mann-Whitney tests, presented in Table 5, are in agreement with the regression results. The null hypothesis was rejected in two of the nine tests. The total organic carbon concentration in samples without DCPAs differed significantly at the 95% confidence level from the concentration in samples with DCPAs. Likewise, the concentration of nitrate+nitrite-N in samples without 1,2-dichloropropane was significantly different than the concentration in samples with 1,2-dichloropropane.

**Table 4.** Correlation coefficients for the regression of total dissolved solids (TDS), total organic carbon (TOC), and nitrate+nitrite-N ($NO_3+NO_2$-N) with ethylene dibromide (EDB), DCPAs, and 1,2-dichloropropane (1,2-D).

| | EDB | DCPAs | 1,2-D |
|---|---|---|---|
| TDS | -0.10 | 0.05 | -0.07 |
| TOC | -0.19 | 0.54[1] | -0.11 |
| $NO_3+NO_2$-N | 0.24 | -0.08 | 0.60[1] |

[1] significant at the 95% confidence level.

**Table 5.** Results of the Mann-Whitney test for total dissolved solids (TDS), total organic carbon (TOC), and nitrate+nitrite-N ($NO_3+NO_2$-N) tested against ethylene dibromide (EDB), DCPAs, and 1,2-dichloropropane (1,2-D). Null hypothesis = concentrations of the indicator parameter in samples with detected pesticides are equal to concentrations of the indicator parameter in samples without detected pesticides.

| | EDB | DCPAs | 1,2-D |
|---|---|---|---|
| TDS | No | No | No |
| TOC | No | Yes[1] | No |
| $NO_3+NO_2$-N | No | No | Yes[1] |

No = do not reject null hypothesis,
Yes = reject null hypothesis.
[1] significant at the 95% confidence level.

## General Chemistry and Field Parameters

The pH of Quincy ground water was slightly basic. The average pH was 7.97 and the range was 7.41 to 8.39. Specific conductance ranged from 255 to 600 $\mu$mhos/cm and averaged 436 $\mu$mhos/cm. The average water temperature was 14.8 °C with a range of 12.5 to 16.8 °C. The major cations in Quincy ground water are calcium, magnesium, and sodium. The major anion is bicarbonate. The average concentration and the range of these parameters are presented in Table 6. The individual values for pH, temperature, and specific conductance, measured at all wells, are listed in Appendix E. The individual values for the remaining analytes, measured at only six sites, are listed in Appendix F.

Arsenic was detected in each of the six wells sampled at concentrations ranging from an estimated 1.7 $\mu$g/L to 7.9 $\mu$g/L, with a mean of 5.7 $\mu$g/L. All arsenic concentrations exceeded the ground water quality standard for Washington (WAC 173-200). The 5.7 $\mu$g/L average concentration was 100 times the 0.05 $\mu$g/L standard. However, concentrations were 10 times lower than the 50 $\mu$g/L maximum contaminant level (MCL) for drinking water.

**Table 6.** Temperature (°C), pH, specific conductance (μmhos/cm), and concentrations of major cations, anions, and trace metals in Quincy ground water samples.

| Parameter | Average | Range |
|---|---|---|
| Temperature | 14.8 | 12.5 - 16.8 |
| pH | 7.97 | 7.41 - 8.39 |
| Conductance | 436 | 255 - 600 |
| Analyte | (mg/L) | (mg/L) |
| Calcium | 47.4 | 34.1 - 75.6 |
| Magnesium | 29.5 | 24.6 - 38.3 |
| Potassium | 3.1 | 1.7 - 4.4 |
| Sodium | 29.4 | 18.8 - 36.0 |
| Chloride | 19.6 | 7.1 - 27.8 |
| Carbonate[1] | <1 | all <1 |
| Bicarbonate[1] | 177 | 135 - 231 |
| Total Sulfate | 66.5 | 29.3 - 117.0 |
| Total Phosphorus | 0.029 | 0.010 - 0.205 |
| Analyte | (μg/L) | (μg/L) |
| Iron | 15.9[2] | 5.0 - 19,300 |
| Lead | <1.0 | <1.0 - 1.5 |
| Manganese | <1.0 | <1.0 - 136 |
| Mercury | <0.04 | all <0.04 |
| Nickel | <10.0 | all <10.0 |
| Arsenic | 5.7 | 1.7 - 7.9 |
| Cadmium | <2.0 | <2.0 - 2.3 |
| Chromium | <5.0 | all <5.0 |
| Copper | <3.0 | all <3.0 |
| Zinc | 8.6 | 4.0 - 14.0 |
| Selenium | <2.0 | all <2.0 |

[1] as $CaCO_3$
[2] average does not include the maximum concentration.

## CONCLUSIONS

1. One or more pesticides were detected in 26 of 27 wells and in two field drains - over 95 percent of the sampling sites. We detected one pesticide at eight sites, two pesticides at 12 sites, three pesticides at seven sites, and four pesticides at one site. We detected no pesticides at one site (QN14D1).

   Of the 76 pesticides tested, 1,2-dichloropropane was detected most often (66 percent of sites) followed by EDB (62 percent of sites). The mean concentration of 1,2-dichloropropane was about 0.20 $\mu$g/L and that of EDB was about 0.017 $\mu$g/L. Dacthal was detected at 55 percent of the sites during the initial sampling, but was not detected in the verification samples. The cause of the disparity between DCPAs results for initial and verification sampling is unknown, but may be related to the different sampling seasons.

2. EDB concentrations in nine wells and one drain exceeded the drinking water standard for public water supply systems. Concentrations of other pesticides did not exceed existing standards or criteria. Arsenic concentrations exceeded the criteria of the ground water quality standard (0.05 $\mu$g/L) at the six wells where arsenic was tested, but did not exceed the 50 $\mu$g/L MCL for drinking water.

3. We detected EDB throughout the study area (although not in all wells) with the two highest concentrations within one-mile of each other near the center of the study area. We also detected dichloropropane throughout the study area. The two sites with the greatest concentrations were located at opposite sides of the study area.

   There is no apparent relationship between EDB or 1,2-dichloropropane detections and well depth. We detected both pesticides in the deepest well at 110 feet and in the shallowest well at 44 feet. We found the two highest EDB concentrations in wells 60 and 86 feet deep, and the two highest 1,2-dichloropropane concentrations in an 85 feet deep well and Drain 2.

   Because pesticides were detected throughout the study area, we believe that a single source does not exist for the pesticides detected, but rather their detection is a result of long-term historic applications of these pesticides over wide portions of the study area. Because the study area is similar to other areas in the Columbia Basin, and because the study area is not confined by any hydrologic boundaries (that is, water flows into the area from the northwest and out of the area to the southeast), we believe the detected pesticides would also be detected outside the bounds of the present study area.

4. We found a statistically significant relationship between indicator parameters and pesticide detections in two of the nine relationships tested. Concentrations of TOC were positively correlated with dacthal concentrations and concentrations of nitrate+nitrite-N

were positively correlated with 1,2-dichloropropane. However, the correlation coefficients were low and the reliability of either indicator to predict the presence or absence of these pesticides at a specific site is limited.

5. Nitrate+nitrite-N was found in all samples, with an average concentration of 6.1 mg/L. The nitrate+nitrite-N concentration in two wells and one field drain exceeded the 10 mg/L standard for public water supply systems.

6. Pesticides, specifically EDB, have adversely affected the use of ground water for drinking. Health advisories, prepared by the Washington State Department of Health, were sent to affected well owners.

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# APPENDICES

**Appendix A-1.** Type, depth and elevation of sample sites.

| Site ID | Type | Depth to Water (ft.) | Total Depth (ft.) | Ground Elevation (ft.) |
|---|---|---|---|---|
| QN04Q1 | DW | NM | 60 | 1234 |
| QN05A1 | DW | 14 | 60 | 1241 |
| QN05Q1 | DW | 21 | 110 | 1242 |
| QN09Q1 | MW | 7 | 73 | 1278 |
| QN10N1 | MW | 10 | 51 | 1270 |
| QN12D1 | DW | 3 | 60 | 1215 |
| QN12N2 | MW | 9 | 51 | 1252 |
| QN13Q1 | DW | 15 | 100 | 1234 |
| QN14D1 | DW | 14 | 60 | 1260 |
| QN16J1 | DW | 10 | 65 | 1265 |
| QN18R1 | MW | 11 | 51 | 1279 |
| QN21D1 | DW | 9 | 68 | 1264 |
| QN22G1 | DW | 11 | 80 | 1247 |
| QN22K1 | DW | 18 | 86 | 1239 |
| QN24E1 | DW | NM | 80 | 1237 |
| QN25A1 | DW | NM | 70 | 1215 |
| QN25D1 | DW | NM | 85 | 1229 |
| QN25G2 | DW | 15 | 85 | 1220 |
| QN25N1 | DW | NM | 60 | 1215 |
| QN26C1 | DW | 13 | 80 | 1230 |
| QN28H1 | DW | 11 | 60 | 1232 |
| QN28J1 | DW | 18 | 61 | 1234 |
| QN29E1 | DW | 25 | 66 | 1255 |
| QN29Q1 | DW | 35 | 98 | 1265 |
| QN32H1 | DW | 24 | 72 | 1255 |
| QN34B1 | DW | 6 | 60 | 1225 |
| QN34K1 | DW | 16 | 44 | 1232 |
| QNDrain1 | Drain | NA | 15 | 1242 |
| QNDrain2 | Drain | NA | 5 | 1264 |

DW = Domestic well
MW = USBR Monitoring well
NM = Not measured
NA = Not applicable

**Appendix A-2.** Pesticides, test methods, and reporting limits for Quincy ground water samples.

| Pesticide | Test Method* | Estimated Reporting Limit ($\mu$g/L) |
|---|---|---|
| Acifluorfen | NPS 3 | 0.2 |
| Alachlor | NPS 1 | 1 |
| Aldicarb | NPS 5 & EPA 531 | 1.5 |
| Aldicarb Sulfone | NPS 5 & EPA 531 | 1 |
| Aldicarb Sulfoxide | NPS 5 & EPA 531 | 1 |
| Ametryn | NPS 1 | 0.3 |
| Atraton | NPS1 | 0.3 |
| Atrazine | NPS 1 | 0.2 |
| Baygon (Propoxure) | EPA 632 | 1.1 |
| Bentazon | NPS 3 | 0.5 |
| Bromacil | NPS 1 | 2.2 |
| Butachlor | NPS1 | 1.5 |
| Butylate | NPS 1 | 5.0 |
| Carbaryl | EPA 632 | 5 |
| Carbofuran | NPS 4 & EPA 632 | 0.5 |
| Carboxin | NPS 1 | 1 |
| Chloramben | NPS 3 | 0.5 |
| Chlorpropham | NPS 1 | 0.7 |
| Cyanazine | NPS 4 & EPA 632 | 0.8 |
| Cycloate | NPS 1 | 0.4 |
| Dalapon | NPS 3 | 5 |
| Diazinon | NPS 1 | 0.1 |
| Dibromochloropropane | EPA 504 (Modified) | 0.01 |
| DCPAs (Dacthal and metabolites) | NPS 3 | 0.2 |
| Dicamba | NPS 3 | 0.2 |
| Dichloroprop | NPS 3 | 0.5 |
| Dichlorvos | NPS 1 | 0.2 |
| Dinoseb | NPS 3 | 2.5 |

| Pesticide | Test Method* | Estimated Reporting Limit ($\mu$g/L) |
|---|---|---|
| Diphenamide | NPS 1 | 0.4 |
| Disulfoton | NPS 1 | 0.3 |
| Disulfutone Sulfone | NPS 1 | 0.3 |
| Disulfotone Sulfoxide | NPS 1 | 0.3 |
| Ethylene Dibromide | EPA 504 (Modified) | 0.01 |
| EPTC | NPS1 | 0.3 |
| Ethoprop | NPS1 | 0.1 |
| Fenamiphos | NPS 1 | 0.3 |
| Fenarimol | NPS1 | 0.4 |
| Fluridone | NPS 1 | 1.8 |
| Hexazinone | NPS 1 | 0.3 |
| Merphos | NPS 1 | 0.4 |
| Methiocarb | EPA 632 | 5 |
| Methomyl | NPS 4 & EPA 632 | 0.5 |
| Methyl paraoxon | NPS1 | 0.3 |
| Metolachlor | NPS 1 | 1.5 |
| Metribuzin | NPS 1 | 0.4 |
| Mevinphos | NPS 1 | 0.3 |
| MGK264 | NPS 1 | 2 |
| Molinate | NPS 1 | 0.4 |
| Napropamide | NPS 1 | 0.4 |
| Norflurazon | NPS 1 | 0.4 |
| Oxamyl | NPS 4 & EPA 632 | 0.6 |
| Pebulate | NPS 1 | 0.4 |
| Pentachlorophenol | NPS 3 | 0.2 |
| Picloram | NPS 3 | 1 |
| Prometon | NPS 1 | 0.3 |
| Prometryn | NPS 1 | 0.2 |
| Propazine | NPS 1 | 0.2 |
| Silvex | NPS 3 | 0.2 |

| Pesticide | Test Method* | Estimated Reporting Limit ($\mu$g/L) |
|---|---|---|
| Simazine | NPS 1 | 0.8 |
| Simetryn | NPS 1 | 0.1 |
| Stirofos | NPS 1 | 0.4 |
| Tebuthiuron | NPS 1 | 0.4 |
| Terbacil | NPS 1 | 3.5 |
| Terbutryn | NPS 1 | 0.3 |
| Triademefon | NPS 1 | 0.3 |
| Tricyclazole | NPS 1 | 1.2 |
| Vernolate | NPS 1 | 0.4 |
| 1,2-Dichloropropane | EPA 501 | 0.2 |
| cis-1,3-Dichoropropene<br>trans-1,3-Dichoropropene | EPA 501 | 0.2 |
| 2,4,5-Trichlorophenoxy-acetic Acid | NPS 3 | 0.2 |
| 2,4-D | NPS 3 | 0.5 |
| 2,4-DB | NPS 3 | 2 |
| 3,5-Dichlorobenzoic Acid | NPS 3 | 0.6 |
| 4-Nitrophenol | NPS 3 | 5 |
| 5-Hydroxy Dicamba | NPS 3 | 0.2 |

* NPS 1- Determination of N and P-containing pesticides by GC with N detector.
NPS 3- Determination of chlorinated acids by GC with electron detector.
NPS 4- Determination of pesticides in water by HPLC with UV detector.
NPS 5- Measurement of N-Methyl Carbomoyloximes and N-Methyl Carbamates by direct aqueous injection HPLC with post column derivitization.
NPS= National Pesticide Survey
EPA = Environmental Protection Agency method
Sources = US EPA, 1984 and 1987

**Appendix A-3.** Analytical methods and detection limits (mg/L) for indicator parameters in Quincy ground water samples.

| Indicator Parameter | Method [1] | Detection Limit |
|---|---|---|
| Total Organic Carbon (TOC) | EPA 415.1 | 1.0 |
| Total Dissolved Solids (TDS) | EPA 160.1 | 1.0 |
| Nitrate+Nitrite - N | EPA 353.2 | 0.01 |

[1] U.S. EPA, 1979.

**Appendix A-4.** Analytical methods and detection limits for cations, anions, and trace metals in Quincy ground water samples.

| Analyte | Method[1] | Detection Limit (mg/L) |
|---|---|---|
| Potassium | EPA 200.7 | 0.40 |
| Magnesium | EPA 200.7 | 0.01 |
| Calcium | EPA 200.7 | 0.01 |
| Sodium | EPA 200.7 | 0.10 |
| Chloride | EPA 330.0 | 0.10 |
| Total Sulfate | STD M 429 | 0.50 |
| Bicarbonate as $CaCO_3$ | EPA 310.1 | 1.0 |
| Carbonate as $CaCO_3$ | EPA 310.1 | 1.0 |
| ---------- | | ($\mu$g/L) |
| Total phosphorus | EPA 365.3 | 10.0 |
| Iron | EPA 600 | 20.0 |
| Lead | EPA 600 | 1.0 |
| Manganese | EPA 600 | 1.0 |
| Mercury | EPA 600 | 0.04 |
| Nickel | EPA600 | 10.0 |
| Arsenic | EPA 600 | 1.5 |
| Cadmium | EPA 600 | 2.0 |
| Chromium | EPA 600 | 5.0 |
| Copper | EPA 600 | 3.0 |
| Zinc | EPA 600 | 4.0 |
| Selenium | EPA 600 | 2.0 |

[1] U.S. EPA, 1979, except Standard Method 429.

## Appendix B. Quality Assurance

In general, the quality of the data is good. Quality assurance results for pesticides and non-pesticide parameters are discussed separately.

### Pesticides

All data are acceptable for use except as qualified below. The qualitative and quantitative accuracy, validity, and usefulness of data from Montgomery Laboratory were independently reviewed by Stuart Magoon of the Ecology/EPA Manchester Laboratory. The quality assurance packages consisted of copies of the extraction logs, analytical run logs, surrogate recovery forms, laboratory control sample recovery forms, calibration curves, data worksheets, and chromatograms. The initial sampling matrix spike recoveries (66 and 61 percent) did not meet QC limits (75-125%) for dacthal, therefore, all dacthal concentrations are considered estimates. For the verification round, all 1,2-dichloropropane concentrations were below the quantitation limit and are considered estimates.

In addition to laboratory QC samples, field quality assurance (QA) samples were also tested. Field QA samples consisted of duplicates, replicates, transport blanks, and transfer blanks. Duplicate samples consisted of identical samples that were submitted to the laboratory with different sample identifications. A replicate sample was obtained from the same well using the identical sampling procedures but sampled at a different time. A transport blank consisted of organic-free water in unopened sample bottles that were carried during the sampling event. A transfer blank was obtained by rinsing a decontaminated bailer with organic-free water and placing the rinsate in sample bottles.

The field QA results for pesticides are shown in Table B-1 (initial sampling) and Table B-2 (verification sampling).

No pesticides were detected in the transport or transfer blanks.

DCPAs, 1,2-dichloropropane, and EDB were detected in duplicate and replicate samples for the initial sampling. The results are summarized in Table B-3. Relative percent differences (RPDs), the ratio of the difference and the mean of duplicate (or replicate) samples expressed as a percentage, are also shown in the table. RPDs can be used to estimate analytical precision. The lower the RPD the higher the analytical precision. For the initial sampling the RPDs for DCPAs, 1,2-dichloropropane and EDB were 18 to 44 percent, 17 to 36 percent, and 0 to 4 percent, respectively. For verification sampling, DCPAs were not detected in the field duplicate and replicate samples. RPDs for an EDB duplicate and replicate were three and five percent (Table B-2). One duplicate set for 1,2-dichloropropane had an RPD of zero percent. However, in another duplicate set, 1,2-dichloropropane was detected in one sample (0.1 $\mu$g/L) but not in the other.

## Non-Pesticide Parameters

Randy Knox of the Manchester Laboratory reviewed the adequacy of the metals results. The results are presented in Table B-4. All analyses with the exception of total dissolved solids (TDS) were completed within specified holding times. Fifteen TDS samples were not done before holding times expired. All results that exceeded holding times are qualified with an "H." One instrument calibration standard for cadmium and potassium was outside control limits of (+/- 10 percent) therefore all cadmium and potassium results are flagged as estimates. Method blanks showed detectable levels of calcium (0.4 mg/L) and sodium (0.09 mg/L) but no qualification of the data was necessary because all measured concentrations were substantially greater than the blank concentrations. All results with concentrations less than the quantitation limit (less than 5 to 10 times the detection limit) are qualified with a "J". All matrix spike recoveries ranged from 93 to 105 percent and were within acceptable limits (75 to 125 percent)

Lead was detected in the transport blank at a concentration of 1.2 $\mu$g/L and one sample is qualified with a "B". Manganese was detected in the transport blank at concentration of 69 $\mu$g/L. Therefore, all manganese results are rejected. RPDs for duplicate and replicate samples for the major cations and anions, indicator parameters, and trace metals were low ranging from 0 to 15 percent. Two exceptions were total organic carbon (88 percent and 31 percent) and zinc (34 and 16 percent).

## Table B-1. Quality Assurance Results for Pesticides, Quincy Study Area, Inital Sampling (ι

| Analyte | Test Method | 18-8234 Dup | 18-8235 Dup | 18-8239 Dup | 18-8240 Dup | 18-8243 Rep | 18-8241 Matrix Spikes (% Recov.) | 18-8242 Matrix Spikes (% Recov.) | 18-8260 Transport | 18-8261 Transfer |
|---|---|---|---|---|---|---|---|---|---|---|
| Alachlor | NPS-1 | 1.0 U | 1.0 U | 1.0 U | 1.0 U | 1.0 U | 88 | 81 | 1.0 U | 1.0 U |
| Ametryn | NPS-1 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | | | 0.3 U | 0.3 U |
| Atraton | NPS-1 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | | | 0.3 U | 0.3 U |
| Atrazine | NPS-1 | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 92 | 79 | 0.2 U | 0.2 U |
| Bromacil | NPS-1 | 2.2 U | 2.2 U | 2.2 U | 2.2 U | 2.2 U | | | 2.2 U | 2.2 U |
| Butachlor | NPS-1 | 1.5 U | 1.5 U | 1.5 U | 1.5 U | 1.5 U | | | 1.5 U | 1.5 U |
| Butylate | NPS-1 | 1.0 U | 1.0 U | 1.0 U | 1.0 U | 1.0 U | 71 | 68 | 1.0 U | 1.0 U |
| Carboxin | NPS-1 | 1.0 U | 1.0 U | 1.0 U | 1.0 U | 1.0 U | | | 1.0 U | 1.0 U |
| Chlorpropham | NPS-1 | 0.7 U | 0.7 U | 0.7 U | 0.7 U | 0.7 U | | | 0.7 U | 0.7 U |
| Cyanazine | NPS-1 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | | | 0.5 U | 0.5 U |
| Cycloate | NPS-1 | 0.4 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U | | | 0.4 U | 0.4 U |
| Diazinon | NPS-1 | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | | | 0.1 U | 0.1 U |
| Dichlorvos | NPS-1 | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | | | 0.2 U | 0.2 U |
| Diphenamide | NPS-1 | 0.4 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U | | | 0.4 U | 0.4 U |
| Disulfoton | NPS-1 | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | | | 0.2 U | 0.2 U |
| Disulfoton Sulfone | NPS-1 | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | | | 0.2 U | 0.2 U |
| Disulfoton Sulfoxide | NPS-1 | 0.4 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U | | | 0.4 U | 0.4 U |
| EPTC | NPS-1 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | | | 0.3 U | 0.3 U |
| Ethoprop | NPS-1 | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 90 | 86 | 0.1 U | 0.1 U |
| Fenamiphos | NPS-1 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 79 | 50 | 0.3 U | 0.3 U |
| Fenarimol | NPS-1 | 0.4 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U | | | 0.4 U | 0.4 U |
| Fluridone | NPS-1 | 1.8 U | 1.8 U | 1.8 U | 1.8 U | 1.8 U | | | 1.8 U | 1.8 U |
| Hexazinone | NPS-1 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | | | 0.3 U | 0.3 U |
| Merphos | NPS-1 | 0.4 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U | | | 0.4 U | 0.4 U |
| Methyl paraoxon | NPS-1 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 91 | 73 | 0.3 U | 0.3 U |
| Metolachlor | NPS-1 | 1.5 U | 1.5 U | 1.5 U | 1.5 U | 1.5 U | | | 1.5 U | 1.5 U |
| Metribuzin | NPS-1 | 0.4 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U | | | 0.4 U | 0.4 U |
| Mevinphos | NPS-1 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | | | 0.3 U | 0.3 U |
| MGK264 | NPS-1 | 2.0 U | 2.0 U | 2.0 U | 2.0 U | 2.0 U | 83 | 65 | 2.0 U | 2.0 U |

## Table B-1. Continued.

| Analyte | Test Method | 18-8234 Dup | 18-8235 Dup | 18-8239 Dup | 18-8240 Dup | 18-8243 Rep | 18-8241 Matrix Spikes (% Recov.) | 18-8242 Matrix Spikes (% Recov.) | 18-8260 Transport | 18-8261 Transfer |
|---|---|---|---|---|---|---|---|---|---|---|
| Molinate | NPS-1 | 0.4 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U | | | 0.4 U | 0.4 U |
| Napropamide | NPS-1 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | | | 0.5 U | 0.5 U |
| Norflurazon | NPS-1 | 0.4 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U | | | 0.4 U | 0.4 U |
| Pebulate | NPS-1 | 0.4 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U | | | 0.4 U | 0.4 U |
| Prometon | NPS-1 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | | | 0.3 U | 0.3 U |
| Prometryn | NPS-1 | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | | | 0.2 U | 0.2 U |
| Propazine | NPS-1 | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | | | 0.2 U | 0.2 U |
| Simazine | NPS-1 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | | | 0.5 U | 0.5 U |
| Simetryn | NPS-1 | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | | | 0.1 U | 0.1 U |
| Stirofos | NPS-1 | 0.4 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U | 89 | 68 | 0.4 U | 0.4 U |
| Tebuthiuron | NPS-1 | 0.4 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U | | | 0.4 U | 0.4 U |
| Terbacil | NPS-1 | 3.5 U | 3.5 U | 3.5 U | 3.5 U | 3.5 U | | | 3.5 U | 3.5 U |
| Terbutryn | NPS-1 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 75 | 76 | 0.3 U | 0.3 U |
| Triademefon | NPS-1 | 0.3 U | 0.3 U | 0.3 U | 0.3 U | 0.3 U | | | 0.3 U | 0.3 U |
| Tricyclazole | NPS-1 | 1.2 U | 1.2 U | 1.2 U | 1.2 U | 1.2 U | | | 1.2 U | 1.2 U |
| Vernolate | NPS-1 | 0.4 U | 0.4 U | 0.4 U | 0.4 U | 0.4 U | | | 0.4 U | 0.4 U |
| | | | | | | | | | | |
| Acifluorfen | NPS-3 | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | | | 0.2 U | 0.2 U |
| Bentazon | NPS-3 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | | | 0.5 U | 0.5 U |
| Chloramben | NPS-3 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | | | 0.5 U | 0.5 U |
| 2,4-D | NPS-3 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 83 | 79 | 0.5 U | 0.5 U |
| 2,4-DB | NPS-3 | 2.0 U | 2.0 U | 2.0 U | 2.0 U | 2.0 U | | | 2.0 U | 2.0 U |
| DCPAs | NPS-3 | 0.56 | 0.42 | 0.30 | 0.25 | 0.43 | 66 | 61 | 0.2 U | 0.2 U |
| Dalapon | NPS-3 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | | | 5.0 U | 5.0 U |
| Dicamba | NPS-3 | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | | | 0.2 U | 0.2 U |
| 3,5-Dichlorobenzoic A | NPS-3 | 0.6 U | 0.6 U | 0.6 U | 0.6 U | 0.6 U | | | 0.6 U | 0.6 U |
| Dichloroprop | NPS-3 | 0.5 U | 0.5 U | 0.5 U | 0.5 U | 0.5 U | | | 0.5 U | 0.5 U |
| Dinoseb | NPS-3 | 2.5 U | 2.5 U | 2.5 U | 2.5 U | 2.5 U | | | 2.5 U | 2.5 U |
| 5-Hydroxy Dicamba | NPS-3 | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | | | 0.2 U | 0.2 U |
| 4-Nitrophenol | NPS-3 | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | | | 5.0 U | 5.0 U |

## Table B-1. Continued.

| Analyte | Test Method | 18-8234 Dup | 18-8235 Dup | 18-8239 Dup | 18-8240 Dup | 18-8243 Rep | 18-8241 Matrix Spikes (% Recov.) | 18-8242 Matrix Spikes (% Recov.) | 18-8260 Transport | 18-8261 Transfer |
|---|---|---|---|---|---|---|---|---|---|---|
| Pentachlorophenol | NPS-3 | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 87 | 75 | 0.2 U | 0.2 U |
| Picloram | NPS-3 | 1.0 U | 1.0 U | 1.0 U | 1.0 U | 1.0 U | | | 1.0 U | 1.0 U |
| Silvex | NPS-3 | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | | | 0.2 U | 0.2 U |
| 2,4,5-Trichlorophenoxy acetic Acid | NPS-3 | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 0.2 U | 80 | 75 | 0.2 U | 0.2 U |
| EDB | | 0.05 | 0.05 | 0.26 | 0.25 | 0.25 | | | 0.01 U | 0.01 U |
| DBCP | | 0.01 U | 0.01 U | 0.01 U | 0.01 U | 0.01 U | | | 0.01 U | 0.01 U |
| 1,2-Dichlorpropane | | 0.36 | 0.29 | 0.46 | 0.32 | 0.33 | 93 | 105 | 0.1 U | 0.1 U |
| cis-1,3-Dichlorpropene | | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 95 | 108 | 0.1 U | 0.1 U |
| trans-1,3-Dichlorpropene | | 0.11 | 0.1 U | 0.1 U | 0.1 U | 0.1 U | 93 | 100 | 0.1 U | 0.1 U |
| Aldicarb | | 2.0 U | 2.0 U | 2.0 U | 2.0 U | 2.0 U | 115 | 112 | 2.0 U | 2.0 U |
| Aldicarb sulfone | | 2.0 U | 2.0 U | 2.0 U | 2.0 U | 2.0 U | 113 | 111 | 2.0 U | 2.0 U |
| Aldicarb sulfoxide | | 2.0 U | 2.0 U | 2.0 U | 2.0 U | 2.0 U | 118 | 115 | 2.0 U | 2.0 U |
| Baygon | | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 112 | 111 | 5.0 U | 5.0 U |
| Carbaryl | | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 113 | 112 | 5.0 U | 5.0 U |
| Carbofuran | | 10 U | 10 U | 10 U | 10 U | 10 U | 102 | 105 | 10 U | 10 U |
| Methiocarb | | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 106 | 106 | 5.0 U | 5.0 U |
| Methomyl | | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 122 | 118 | 5.0 U | 5.0 U |
| Oxamyl (Vydate) | | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 5.0 U | 108 | 105 | 5.0 U | 5.0 U |

NPS= National Pesticide Survey Test Method

NT= Not Tested

U= Analyte not detected above the reported concentration.

J= Estimated concentration.

Table B–2. Verification Sampling Pesticide Quality Assurance Results, Quincy Study Area.

| Sample No. | | EDB | Atrazine | DCPAs | 1,2-Dichloro-propane | Trans 1,3-Di-chloropropene |
|---|---|---|---|---|---|---|
| 09-8231 | Dup | 0.01 U | NT | 0.028 U | 0.1 J | 1 U |
| 09-8232 | Dup | 0.01 U | NT | 0.031 U | 0.1 J | 1 U |
| | RPD(%) | -- | -- | -- | 0 | -- |
| 09-8240 | Dup | 0.31 | NT | 0.015 U | 1 U | 1 U |
| 09-8241 | Dup | 0.32 | NT | 0.014 U | 0.2 J | 1 U |
| | RPD(%) | 3 | -- | -- | -- | -- |
| 09-8242 | Rep | 0.33 | NT | 0.014 U | 0.2 J | 1 U |
| | RPD(%) | 5 | -- | -- | -- | -- |
| 09-8249 | Dup | NT | 0.24 U | NT | 1 U | 1 U |
| 09-8250 | Dup | NT | 0.24 U | NT | 1 U | 1 U |
| 09-8257 | Matrix Spike | 100 | 133 | 97 | NT | NT |
| 09-8258 | Matrix Spike | 100 | 125 | 88 | NT | NT |
| 09-8260 | Transport | 0.01 U | 0.25 U | 0.015 U | 1 U | 1 U |
| 09-8261 | Transfer | NT | NT | 0.014 U | NT | NT |

NT= Not tested.

U= Analyte not detected above listed concentration.

J= Estimated value.

UJ= Analyte was not detected at or above the estimated concentration.

Table B–3. Summary of Pesticide Quality Assurance Results, Initial Sampling (ug/L).

| Sample Type | | DCPAs | EDB | 1,2–DCP |
|---|---|---|---|---|
| Duplicate | | 0.56 | 0.05 | 0.36 |
| Duplicate | | 0.42 | 0.05 | 0.29 |
| | RPD(%)= | 29 | 0 | 22 |
| Duplicate | | 0.30 | 0.26 | 0.46 |
| Duplicate | | 0.25 | 0.25 | 0.32 |
| | RPD(%)= | 18 | 4 | 36 |
| Replicate | | 0.43 | 0.25 | 0.33 |
| | RPD(%)= | 44 | 2 | 17 |

RPD= Relative Percent Difference.

**Appendix C.** Detected pesticide concentrations ($\mu$g/L) in Quincy ground water samples for both the initial (05/91) and the verification (02/92) sampling.

| Site ID | EDB (05/91) | EDB (02/92) | DCPAs (05/91) | DCPAs (02/92) | 1,2-DPA[3] (05/91) | 1,2-DPA[3] (02/92) | 1,3-DPE[4] (05/91) | 1,3-DPE[4] (02/92) |
|---|---|---|---|---|---|---|---|---|
| QNO4Q1 | 0.05 | <0.01 | 0.42/0.56[1] | <0.20 | 0.29/0.36[1] | 0.10J | 0.11 | <0.10 |
| QN05A1 | 0.04 | <0.01 | <0.20 | na | 0.48 | 0.30J | <0.10 | na |
| QN05Q1 | 0.02 | <0.01 | 8.30 | <0.20 | 0.24 | 0.10J | <0.10 | na |
| QN09Q1 | <0.01 | na | 0.82 | <0.20 | <0.10 | na | <0.10 | na |
| QN10N1 | <0.01 | na | 0.40 | <0.20 | <0.10 | na | <0.10 | na |
| QN12D1 | 0.05 | <0.01 | <0.20 | na | 0.35 | 0.20J | <0.10 | na |
| QN12N2 | <0.01 | na | 0.30 | <0.20 | <0.10 | na | <0.10 | na |
| QN13Q1 | <0.01 | na | 0.53 | <0.20 | <0.10 | na | <0.10 | na |
| QN14D1 | <0.01 | na | <0.20 | na | <0.10 | na | <0.10 | na |
| QN16J1 | <0.01 | na | 2.10 | <0.20 | <0.10 | na | <0.10 | na |
| QN18R1 | 0.10 | 0.099 | 0.32 | <0.20 | <0.10 | na | <0.10 | na |
| QN21D1 | 0.06 | 0.059 | 0.80 | <0.20 | 0.17 | <0.10 | <0.10 | na |
| QN22G1 | <0.01 | na | <0.20 | na | <0.10 | na | 0.11 | <0.10 |
| QN22K1 | 0.21 | 0.340 | <0.20 | na | 0.48 | 0.30J | 0.10 | <0.10 |
| QN24E1 | 0.05 | 0.067 | 0.48 | <0.20 | <0.10 | na | <0.10 | na |
| QN25A1 | 0.01 | 0.013 | <0.20 | na | <0.10 | na | <0.10 | na |
| QN25D1 | 0.04 | <0.01 | <0.20 | na | 0.72 | 0.50J | <0.10 | na |
| QN25G2 | 0.04 | 0.014 | <0.20 | na | 0.18 | 0.20J | <0.10 | na |
| QN25N1 | <0.01 | na | <0.20 | na | 0.23 | 0.10J | <0.10 | na |
| QN26C1 | 0.03 | <0.01 | <0.20 | na | 0.52 | 0.40J | <0.10 | na |
| QN28H1 | 0.25/0.26[1] | 0.31-0.33[2] | 0.25-0.43[2] | 0.14UJ | 0.32-0.46[2] | 0.20J | <0.10 | na |
| QN28J1 | <0.01 | na | <0.20 | na | 0.15 | 0.04J | <0.10 | na |
| QN29E1 | 0.01 | 0.010 | 1.10 | 0.06UJ | 0.12 | <0.10 | <0.10 | na |
| QN29Q1 | <0.01 | na | 0.90 | <0.20 | 0.25 | <0.10 | <0.10 | na |
| QN32H1 | 0.07 | 0.096 | 1.10 | <0.20 | 0.53 | 0.40J | <0.10 | na |
| QN34B1 | 0.13 | <0.01 | 1.10 | <0.20 | 0.37 | 0.20J | <0.10 | na |
| QN34K1 | 0.01 | <0.01 | <0.20 | na | 0.19 | 0.06J | <0.10 | na |
| QNDrain1 | <0.01 | na | 5.70 | <0.20 | 0.18 | <0.10 | <0.10 | na |
| QNDrain2 | 0.06 | 0.010 | <0.20 | na | 0.72 | 0.40J | <0.10 | na |

na = not analyzed
[1] = Duplicate samples
[2] = Range of duplicate and replicate
[3] = 1,2-dichloropropane
[4] = (trans) 1,3-dichloropropene
UJ = not detected at or above the estimated concentration shown
J = above the detection limit but below the quantitation limit, estimate

**Appendix D.** Concentrations (mg/L) of total dissolved solids (TDS), total organic carbon (TOC), total phosphorus (TP) and nitrate+nitrite-N ($NO_3$-N) in Quincy ground water samples.

| Site ID | TDS | TOC | TP | $NO_3$-N |
|---|---|---|---|---|
| QN04Q1 | 358H | 5.4 | 0.016 | 7.7 |
| QN05A1 | 387H | 11.5 | 0.014 | 7.7 |
| QN05Q1 | 361H | 19.9 | 0.013 | 6.0 |
| QN09Q1 | 559 | 12.8 | 0.024 | 8.2 |
| QN10N1 | 403 | 6.4 | 0.024 | 4.3 |
| QN12D1 | 367H | 2.9 | 0.017 | 6.7 |
| QN12N2 | 528 | 13.3 | 0.037 | 1.9 |
| QN13Q1 | 498 | 13.0 | 0.016 | 3.8 |
| QN14D1 | 481 | 9.8 | 0.020 | 7.5 |
| QN16J1 | 532 | 14.0 | 0.022 | 7.5 |
| QN18R1 | 330 | 9.3 | 0.042 | 2.3 |
| QN21D1 | 424 | 9.6 | 0.022 | 4.6 |
| QN22G1 | 224H | 6.5 | 0.010 | 1.0 |
| QN22K1 | 371H | 2.2 | 0.016 | 5.8 |
| QN24E1 | 474 | 7.4 | 0.013 | 3.8 |
| QN25A1 | 406 | 5.3 | 0.012 | 3.7 |
| QN25D1 | 463 | 15.6 | 0.018 | 10.7 |
| QN25G2 | 347 | 13.7 | 0.018 | 13.6 |
| QN25N1 | 371 | 11.1 | 0.020 | 6.1 |
| QN26C1 | 507 | 6.0 | 0.020 | 8.8 |
| QN28H1 | 437H | 14.3 | 0.019 | 9.5 |
| QN28J1 | 336H | 8.3 | 0.018 | 3.1 |
| QN29E1 | 364 | 16.1 | 0.025 | 5.1 |
| QN29Q1 | 337H | 11.7 | 0.012 | 5.2 |
| QN32H1 | 404H | 15.0 | 0.013 | 7.2 |
| QN34B1 | 321H | 8.8 | 0.012 | 6.1 |
| QN34K1 | 351H | 15.8 | 0.017 | 3.2 |
| QNDrain1 | 502 | 16.8 | 0.205 | 4.2 |
| QNDrain2 | 583 | 3.4 | 0.123 | 11.2 |

H = exceeded holding time

**Appendix E.** Temperature (Temp), pH, and specific conductance (SC) of Quincy ground water samples.

| Site ID | Temp (°C) | pH | SC (μmhos/cm) |
|---|---|---|---|
| QN04Q1 | 14.4 | 8.10 | 390 |
| QN05A1 | 14.9 | 8.00 | 432 |
| QN05Q1 | 13.9 | 8.12 | 385 |
| QN09Q1 | 14.7 | 7.85 | 600 |
| QN10N1 | 13.6 | 7.93 | 435 |
| QN12D1 | 14.3 | 8.30 | 378 |
| QN12N2 | 15.1 | 8.20 | 580 |
| QN13Q1 | 14.5 | 7.82 | 495 |
| QN14D1 | 16.4 | 8.11 | 500 |
| QN16J1 | 15.1 | 8.16 | 520 |
| QN18R1 | 15.4 | 7.99 | 350 |
| QN21D1 | 12.7 | 8.31 | 448 |
| QN22G1 | 16.8 | 8.06 | 255 |
| QN22K1 | 14.5 | 8.11 | 430 |
| QN24E1 | 16.0 | 7.74 | 510 |
| QN25A1 | 16.0 | 7.98 | 442 |
| QN25D1 | 15.1 | 7.93 | 520 |
| QN25G2 | 15.1 | 8.39 | 385 |
| QN25N1 | 15.1 | 8.07 | 430 |
| QN26C1 | 15.6 | 7.97 | 500 |
| QN28H1 | 14.4 | 7.41 | 450 |
| QN28J1 | 15.1 | 7.41 | 385 |
| QN29E1 | 14.5 | 7.98 | 400 |
| QN29Q1 | 15.0 | 8.09 | 382 |
| QN32H1 | 14.2 | 7.89 | 443 |
| QN34B1 | 12.5 | 7.63 | 332 |
| QN34K1 | 15.0 | 7.56 | 408 |

**Appendix F.** General chemistry of Quincy ground water.

| | QN04Q1 | QN04Q1 Duplicate | QN09Q1 | QN14D1 | QN25A1 | QN28H1 | QN28H1 Duplicate | QN28H1 Replicate | QN34B1 |
|---|---|---|---|---|---|---|---|---|---|
| ---------- mg/L ---------- | | | | | | | | | |
| Ca | 36.3 | 35.6 | 75.6 | 55.9 | 42.3 | 40.7 | 40.1 | 40.6 | 34.1 |
| Mg | 30.7 | 30.0 | 38.3 | 24.6 | 25.5 | 31.7 | 31.4 | 31.5 | 26.5 |
| K | 3.4J | 3.4J | 4.4J | 3.6J | 3.2J | 2.4J | 2.2J | 2.8J | 1.7J |
| Na | 26.3 | 25.7 | 32.4 | 36.0 | 31.0 | 32.1 | 31.8 | 31.8 | 18.8 |
| $CO_3$ | 1U | 1U | 1U | 1U | 1U | 1U | 1U | 1U | 1U |
| $HCO_3$ | 179 | 178 | 231 | 163 | 135 | 183 | 182 | 183 | 174 |
| $SO_4$ | 40.1 | 40.0 | 117 | 105 | 54.9 | 52.3 | 52.3 | 52.7 | 29.3 |
| Cl | 18.8 | 18.4 | 25.7 | 27.8 | 16.5 | 21.8 | 22.2 | 22.2 | 7.1 |
| ---------- μg/L ---------- | | | | | | | | | |
| Fe | 5.2J | 2.0U | 19300 | 16J | 36.4 | 5.0 | 2.0U | 7.1J | 16J |
| Pb | 1.0U | 1.0U | 1.5JB | 1.0U | 1.0U | 1.0U | 1.0U | 1.0U | 1.0U |
| Mn[1] | 1.0U | 1.0U | 136B | 10.6B | 1.0U | 1.0U | 1.0U | 1.4JB | 1.0U |
| Hg | 0.04U | 0.04U | 0.04U | 0.04U | 0.04U | 0.04U | 0.04U | 0.04U | 0.04U |
| Ni | 10U | 10U | 10U | 10U | 10U | 10U | 10U | 10U | 10U |
| As | 6.2 | 5.7 | 1.7J | 2.8J | 4.0J | 6.2 | 5.8 | 5.7 | 7.9 |
| Cd | 2.0UJ | 2.0UJ | 2.0UJ | 2.0UJ | 2.0UJ | 2.3J | 2.0UJ | 2.0UJ | 2.0UJ |
| Cr | 5.0U | 5.0U | 5.0U | 5.0U | 5.0U | 5.0U | 5.0U | 5.0U | 5.0U |
| Cu | 3.0U | 3.0U | 3.0U | 3.0U | 3.0U | 3.0U | 3.0U | 3.0U | 3.0U |
| Zn | 11J | 14J | 8.8J | 11J | 4.0U | 8.5J | 12J | 12J | 4.3J |
| Se | 2.0U | 2.0U | 2.0U | 2.0U | 2.0U | 2.0U | 2.0U | 2.0U | 2.0U |

U = The analyte was not detected at or above the reported result.
UJ = The analyte was not detected at or above the reported estimated result.
J = The analyte was positively identified, the reported numerical result is an estimate.
B = The analyte was found in the blank.
[1] = Mn contamination found in the blank, all Mn results rejected.