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EPA National Pesticide Survey

Update and Summary of Phase II Results

The U.S. Environmental Protection Agency (EPA) has completed the Phase II Report of its National Survey of Pesticides in Drinking Water Wells (NPS). This fact sheet provides an update on Survey activities and a summary of the Phase II results.

First National Survey of its Kind

The Survey is a joint project of EPA's Office of Ground Water and Drinking Water (OGWDW) and Office of Pesticide Programs (OPP). It is the first national study of pesticides, pesticide degradates, and nitrate in drinking water wells. EPA designed the Survey with two principal objectives. In Phase I, EPA developed national estimates of the frequency and concentration of the presence of pesticides and nitrate in drinking water wells. In Phase II, EPA carried out statistical analyses of the NPS data and pertinent data from non-NPS databases to improve EPA's understanding of how the presence of pesticides and nitrate in drinking water wells is associated with patterns of pesticide use and the sensitivity of ground water to contamination. After peer review of the report by the Scientific Advisory Panel established under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), EPA will use the findings to help implement pesticide registration and water protection programs.

Summary of Phase II Analyses

In Phase II, EPA studied how detections and concentrations of pesticides and nitrate in drinking water wells are affected by the sensitivity of ground water to contamination, use of fertilizers and pesticides, precipitation, irrigation, the chemical characteristics of pesticides, and the age, depth, construction, and location of drinking water wells.

No Single Factor Predominates

The Phase II analyses found associations that support several of the commonly accepted theories concerning the presence of chemicals in water from drinking water wells. In addition, some expected relationships were not found. The Survey identified statistical associations between the presence of pesticides and nitrate in drinking water wells and agricultural activity, the use of fertilizers, and livestock operations. The amount of a pesticide applied for non-agricultural purposes was linked to the chance of a nearby contaminated well. A number of factors affecting transport of chemicals to ground water, including precipitation, the presence of surface water close to the sampled well, and other wells operating near the sampled well, were found to be related to the presence of pesticides and nitrate in well water. Older wells and shallower wells were also found to be more likely to contain detectable amounts of pesticides and nitrate. The probability of detecting pesticides or nitrate was found to be greater in wells with low water temperature or pH. Pesticides with longer half-lives were more likely to be detected.

Everyone Must Help Address The Problem

Because of the many factors that can influence contamination of drinking water wells and ground water and because ground-water contamination is irreversible, an approach that concentrates on pollution prevention is the most effective means of protecting drinking water wells from contamination. Using the Phase II statistical analyses, EPA concluded that a variety of environmental conditions and human activities combine to affect the occurrence of pesticides and nitrate in drinking water

wells and that no single factor alone can explain the presence of pesticides or nitrates. Among the steps that need to be considered are appropriate reductions in the use of pesticides and fertilizers, site-specific assessments to accurately target vulnerable ground water, identification and protection of ground-water recharge areas and protection of wellhead areas; more careful use of flood irrigation; and continued efforts to identify problem pesticides and other materials and to establish more protective use requirements for them.

How EPA Conducted The Analysis

EPA used standard statistical procedures to evaluate the data gathered by the Survey. The data came from a broad range of sources. They included the records of detections of pesticides or nitrate in wells sampled by the Survey, and information from questionnaires such as pesticide and fertilizer use near wells; crops grown near wells; the age, depth, construction, and location of wells; and information about the location of lakes and rivers near the wells. EPA assessed ground-water pollution potential and obtained data from sources other than the Survey questionnaires to use in the analysis. For example, The National Oceanic and Atmospheric Administration (NOAA) provided information on rainfall from weather stations in the counties where wells were located that enabled EPA to develop data on precipitation for five years prior to the Survey. NOAA also provided an index of drought conditions that enabled EPA to investigate whether precipitation and drought affected the Survey results. EPA used data from the Department of Agriculture's Census of Agriculture, from Resources for the Future, and from the National Fertilizer and Environmental Research Center to investigate how agricultural activities, livestock production, pesticide sales, and fertilizer sales are related to detections of pesticides or nitrate in drinking water wells.

EPA used this broad range of information to determine whether individual factors were associated with pesticide and nitrate occurrence in drinking water wells. EPA used the results of these initial tests to investigate how the combined factors influence the detections and concentrations of pesticides and nitrate.

Major Findings

EPA tested first for associations between detections and individual factors considered one at a time. Significant results were frequently from community water system (CWS) wells with nitrate detections. The relatively large number of associations involving nitrate detections is related to a significantly larger number of nitrate detections than pesticide detections were obtained. Because most of the detections were for nitrate in CWS wells, most of the statistically significant associations apply to that group. The Survey analysis concluded that the complex phenomena and interactions examined in the NPS are not easily described by simple, aggregated measures.

Site-specific assessment needed for pollution potential of well water

EPA used the Agricultural DRASTIC system to evaluate the pollution potential of ground water in different counties and sub-county areas. DRASTIC scores are based on seven factors: depth to ground water, recharge, aquifer media, soil media, topography, impact of the unsaturated zone, and hydraulic conductivity. In the Phase II analysis, EPA investigated whether overall DRASTIC scores or any of the seven subscores, either for counties or for sub-county areas, were associated with detections of pesticides or nitrate in drinking water wells. EPA concluded that DRASTIC, as it was used by the Survey, generally had not identified drinking water wells with a greater likelihood of detections. Localized or site-specific assessments appear to be necessary to obtain adequate evaluations of the sensitivity of drinking water wells to contamination.

Certain measures of agricultural activity, pesticide use, and fertilizer sales shown to be associated with detections

The Survey used several different sources of data on pesticide and nitrate use near sampled wells. EPA collected information on agricultural crops in counties across the country and pesticide sales to identify locations where pesticide use was likely. Survey personnel also collected information on crops grown and pesticides and fertilizer used near the wells from county agricultural extension agents, well owners, and community water system operators. EPA also obtained data from other sources on pesticide sales, nitrogen fertilizer sales, and agricultural activities to provide indirect measures of pesticide and nitrate use.

The indirect measures of pesticide and nitrate use showed strong associations between use and detections. The market value of crops was highly related to pesticide detections in rural domestic wells. Pesticide detections were less likely for areas with fertilized pasture and rangeland and less likely to be associated with numbers of beef cattle. Data on use of pesticides by urban applicators and golf courses showed a relation between detections of DCPA acid metabolites and the rate of DCPA application. DCPA acid metabolites were the most frequently detected pesticide analytes and result from the degradation of the pesticide DCPA. The market value of livestock was related to nitrate detections. The amount of fertilizer sold in a county was found to be associated with concentrations of nitrate in wells in that county.

Pesticide use data from Survey did not show strong associations with detections

The Survey's questionnaire data provided direct measures of agricultural pesticide use near the sampled wells. The pesticide use data from the questionnaires did not show the same strong associations with detections. Pesticides were detected where they were not reported as used, and reported as used where they were not detected. The data collected about each of the sampled wells did not show that pesticide detections could be linked to misuse of the pesticide (accidental spills or leaks, or mixing or disposal in an improper location). In considering how detections might occur without reports of use of that pesticide, EPA concluded that the time period (three or five years) about which it asked for use information might not have been long enough, that the geographic area about which it asked for information might not have included the area of recharge for the ground water that was the source for the well, or that respondents' information might sometimes be mistaken or inaccurate.

Moist conditions associated with fewer detections and lower concentrations of nitrates

The Phase II analysis obtained information from the National Oceanic and Atmospheric Administration (NOAA) about precipitation in the counties where wells had been sampled. NOAA also provided an index of moist and drought conditions (the Palmer Draught Index) for those counties. EPA concluded that detections were less likely in areas with increased precipitation. The analysis of the Palmer Drought Index data showed that fewer nitrate detections and lower concentrations of nitrate occurred in moist areas, at least in CWS wells.

Shallower wells and older wells associated with detections

Many details of well construction and condition were obtained from the Survey's questionnaires and analyzed in Phase II. Shallower wells were shown to be associated with more frequent detections. The analysis showed that wells located near surface bodies of water such as lakes and rivers were less likely to have

pesticides or nitrate detected in them. Weaker results also indicated that older wells were associated with more frequent detections.

Results for Combinations of Factors

In addition to analyzing single factors, EPA also studied whether combinations of variables are good predictors of the occurrence of pesticides and nitrate. The following table shows that several factors, when analyzed together, are statistically related.

TABLE 1: LEADING FACTORS ASSOCIATED WITH CONTAMINATION OF DRINKING WATER WELLS*

CWS Wells		Rural Domestic Wells	
Pesticide Detections	**Nitrate Detections**	**Pesticide Detections**	**Nitrate Detections**
• Fertilized Pasture and Rangeland • Well Depth • Other operating wells	• Fertilized Pasture and Rangeland • Monthly Precipitation • Well Water pH • Property Farmed	• Market Value of Crops • Number of Beef Cows	• Well Age • Monthly Precipitation • Well Water pH • Drainage Ditch Within ½ Mile • Fertilized Pasture and Rangeland
	Nitrate Concentrations		**Nitrate Concentrations**
	• Monthly Precipitation • Well Water Conductivity • Total Nitrogen Fertilizer Sales • Well Depth • Palmer Drought Index Score • Market Value of Crops		• Well Depth • Market Value of Crops • Surface Water Within ½ Mile • DRASTIC Topography Score • Total Nitrogen Fertilizer Sales

* The NPS Phase II Report gives a complete description of the relative importance and direction of associations.

Exposure Assessment

Estimates of potential health effects remain low

EPA used the data generated by the Survey to estimate national concentration distributions for the two chemicals detected most frequently: nitrate and DCPA acid metabolites. Such estimates also had been prepared in Phase I using only

concentrations that exceeded minimum reporting levels. Due to possible occurrence below the minimum reporting limits, the Phase II estimates indicate that the frequency of occurrence of these chemicals is somewhat greater than indicated by the estimates reported in Phase I. Approximately 10.4 million people in the United States are served by CWS wells or rural domestic wells that contain DCPA acid metabolites, but none are expected to be exposed above the Lifetime Health Advisory Level (HAL) of 4,000 parts per billion (ppb). About 4.5 million people in the U.S., including 66,000 infants under one year of age, are served by CWS wells or rural domestic wells that exceed the maximum contaminant level (MCL) for nitrate of 10 parts per million (ppm). Persons with high levels of nitrate in their private wells should consult their pediatricians and may wish to obtain water from alternate sources that have less than 10 mg/L of nitrate to help protect infants from the risk of methemoglobinemia (blue-baby syndrome). Physicians are usually well informed about the risks to infants of high levels of nitrate in drinking water and are able to provide medical treatment. Public water supplies that violate the maximum contaminant level of 10 mg/L for nitrate are required to notify their customers about the violation, and the adverse health effects caused by nitrate. Systems that apply for variances or exemptions while in violation of the standard may be required by the state to provide bottled water or point-of-use or point-of-entry devices to avoid unreasonable risks to health. Local and state health authorities are the best source of information concerning alternate sources of drinking water for infants.

EPA estimates that about 10.4 percent of CWS wells and 4.2 percent of rural domestic wells contain detectable levels of one or more pesticides. The Phase II study estimated the chance that a well that contains one or more pesticides also exceeds the MCL or HAL for those chemicals for which an MCL or HAL has been established. Although the Survey did not identify any CWS wells exceeding health based limits for pesticides. EPA estimates that no more than 7.3 percent of the 10.4 percent of CWS wells that contain one or more pesticides could exceed an MCL or health advisory. Similarly, no more than 28.3 percent of the 4.2 percent of rural domestic wells that contain detectable levels of one or more pesticides are also expected to exceed a health based limit. In summary, about 1 percent of all drinking water wells in the U.S. are estimated to exceed a health based limit. EPA concluded that the overall chance of a given well exceeding a level of concern for a pesticide is low. If a well contains a detectable amount of one or more pesticides, it has a slightly higher risk of also exceeding a health based limit. EPA recommends that well owners that know or suspect that their well is affected by pesticides have the water tested to ensure that any pesticides are present at levels below the MCLs or health advisories.

Recommendations for Design of Future Studies

The NPS was the first survey of the presence of pesticides and nitrate in public and private drinking water wells throughout the United States. Its results provide several useful lessons for the design of future studies. The Survey design functioned effectively to produce the data upon which the Phase I national population estimates were based. To provide the best data for complex statistical analysis of survey results, EPA recommends that future studies carefully consider the following points.

- Survey designs should only call for sampling a higher proportion of wells in areas that meet certain previously specified criteria (such as areas of high pesticide use or high ground-water sensitivity) in cases when it is known that the selected criteria have a proven and measurable influence and the characteristics of those areas can be defined and measured with accuracy.
- Pilot studies should be conducted that test statistical analytic approaches as well as planned laboratory and survey data collection procedures.
- Specifications for survey size and precision and the limits established in chemical analytic procedures for reporting detections (such as minimum reporting limits) should be chosen to ensure that a sufficient number of

detections are likely to be obtained to support planned statistical procedures. All laboratory results should be reported and all detections should be confirmed by the appropriate chemical analytic methods.

- Site-specific data on pesticide use and ground-water sensitivity should be obtained. In addition to determining the sensitivity of ground water, data on the recharge patterns for particular wells is also desirable. Detailed, publicly accessible, data on actual pesticide use should include non-farm as well as farm pesticides, and data should also be gathered on both farm and non-farm uses of fertilizers.
- Pesticide metabolites should be included in sample analysis.

Further Studies Needed

The Survey analysis identified a number of additional topics for future study. They include studies of seasonal and temporal effects on contamination, analysis of links between surface and ground-water contamination, and collection and evaluation of site-specific data on soil characteristics and recharge and their association with contamination patterns in wells.

Access to Databases

The data collected by the Survey, documented computer files, and records of the analyses carried out to prepare the Phase I and Phase II results will be available. Contact the EPA Office of Pesticide Programs Docket for access to the data, documentation, and records.

Where to Go for More Information

This fact sheet is part of a series of NPS outreach materials, fact sheets and reports. The following additional NPS fact sheets are available through EPA's Safe Drinking Water Hotline, 1-800-426-4791):

Survey Design	***Analytical Methods***	***Summary Results***
Survey Analytes		***Glossary***
Fact Sheet for each detected analyte	***How EPA Will Use The NPS Results***	***Quality Assurance/ Quality Control***

Additional information on the Survey and on pesticides in general can be obtained from the following sources:

U.S. EPA Safe Drinking Water Hotline 1-800-426-4791 (In Washington, DC -- 382-5533) Monday-Friday, 8:30 am to 4:30 pm Eastern Time	Information on regulation of pesticides in drinking water
National Pesticide Telecommunications Network 1-800-858-7378 24 hours a day	Information on health effects and safe handling of pesticides
U.S. EPA Office of Pesticide Programs (OPP) Docket Public Information Branch (H-7506 C) 401 M Street, SW Room NEG004 Washington, DC 20460 (703) 557-2805	Background documents for Survey and documented databases (available for review)
National Technical Information Service (NTIS) 5285 Port Royal Road Springfield, VA 22161 (703) 487-4650 or 1-800-336-4700	Copies of the NPS Phase I Report (NTIS #PB91-125765) and NPS Phase II Report (NTIS #PB92-120831) (available 1992)