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EPA Drinking Water and Ground Water Data Within the 305(b) Program

Preface

Many of the new initiatives in the Agency in the last couple of years and the requirements of the SDWA Amendments of 1996 require EPA and the States to use monitoring data for the support of various programs. These programs may benefit from the use of existing sources of monitoring data.

Monitoring data gathered by States under Section 106(e) of the Clean Water Act (CWA) are submitted to the Administrator in biennial State Water Quality Reports as required under Section 305(b) of this same act. The *National Water Quality Inventory Report to Congress* [305(b) Report] summarizes the water quality information submitted by the 58 States, American Indian Tribes, Territories, Interstate Water Commissions, and the District of Columbia in their water quality assessment report. This Report is the primary vehicle for informing Congress and the public about general water quality conditions in the United States. The Implementation and Assistance Division of the Office of Ground Water and Drinking Water has the responsibility for producing the drinking water and ground water portions of this report.

Since 1982, monitoring data related to drinking water quality and ground water quality have been included in these biennial submissions, yielding a wealth of data that has applications to many other programs and initiatives within the Environmental Protection Agency (EPA). The four reports included in this document analyze the types of data reported by States under the 305(b) program and the relationship of this data to other Office of Water programs and initiatives.

Contractor support was provided under Contract Number 68-C7-0056 with the Research Triangle Institute (RTI), Center for Environmental Analysis, Research Triangle Park, NC. Michael J. McCarthy, Program Manager and Mary T. Siedlecki and Susan B. Goldhaber, Task Leaders were the key contributors.

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September 15, 1998

Review and Analysis of the 305(b) Ground Water Data Base to Support the Index of Watershed Indicators (IWI) Project

Table of Contents

1.0 Introduction

The purpose of the Index of Watershed Indicators (IWI) Initiative is to develop a more complete descriptive technique for characterizing the condition and vulnerability of our Nation's water resources than has been available previously. The IWI is a compilation of data that characterizes the overall "health" of our Nation's water resources. Characterization is based on the use of 15 indicator parameters selected to describe whether rivers, lakes, streams, wetlands, and coastal areas are "well" or "ailing" and whether activities in the vicinity of our Nation's waters are placing the waters at risk. The indicator parameters were selected based on their appropriateness relative to project objectives, their relatively uniform availability across the Nation, and the ability to depict them at the defined scale. Seven of the indicators characterize the condition of our Nation's water resources, and eight characterize vulnerability. All 15 indicators are related to surface water resources. There are no indicator parameters to describe ground water condition or vulnerability. This is due, primarily, to the lack of a data source to support a ground water indicator.

The condition of our Nation's ground water resources is monitored and assessed under Section 106(e) of the Clean Water Act (CWA), which requests that each State monitor ground water quality and report the findings to Congress in their biennial 305(b) State Water Quality Reports. Ground water quality data, reported by States under the CWA, are compiled and maintained in a data base. The purpose of developing and maintaining these data is to develop an accurate representation of our Nation's ground water quality. This purpose is congruent with that of the IWI. Hence, the question has been raised whether the 305(b) ground water quality data base could be used to support development of an IWI indicator characterizing ground water vulnerability and/or condition.

This report analyzes the data collected under Section 305(b) of the CWA and assesses its appropriateness to support a ground water indicator under the IWI Initiative. This analysis will be approached as follows:

- Review the data elements requested in the 1996 Ground Water Guidelines to assess their appropriateness for application to the IWI Initiative;
- Review the data submitted by States in their 1996 305(b) State Water Quality Reports to determine if the data reported in the 1996 305(b) cycle is sufficient to develop a ground water indicator layer characterizing aquifer vulnerability and/or condition;
- Evaluate the potential of using State-supplied geographic information system (GIS) spatial datasets or databases in conjunction with 305(b) data;
- Evaluate the Safe Drinking Water Information System as a supplemental or alternate source of ground water quality data.

Because so much of this analysis depends on the data elements requested under Section 305(b) of the CWA, a brief history of the 305(b) ground water program development is included in this memorandum.

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that the Nation's ground water resources were "quite good." Similar conclusions were drawn in subsequent biennial reports.

Broad generalizations concerning the quality of State ground water resources failed to provide either a complete or an accurate representation of ambient ground water conditions (i.e., background or baseline water quality conditions). However, assessing the quality of our Nation's ground water resources is no easy task. An accurate and representative assessment of ambient ground water conditions ideally requires a well designed and well executed monitoring plan. Such plans are expensive and may not be compatible with State administrative, technical, and programmatic initiatives. As a consequence, EPA in partnership with interested States critiqued the existing guidelines and proposed changes to the guidelines that would improve assessment of ground water quality within the 305(b) program. The new guidelines were introduced to States as part of the 1996 305(b) reporting cycle.

3.0 1996 305(b) Guidelines for Assessing Ground Water Quality

In the 1996 Ground Water Guidelines, EPA requested that States report data for specific aquifers or hydrogeologic settings (e.g., watersheds) within the State. The focus on specific aquifers or hydrogeologic settings provides a more quantitative assessment of ground water quality than was possible prior to 1996. It is this focus on aquifers/hydrogeologic settings that make 305(b) ground water quality data suitable for use in supporting the IWI Initiative. Data related to aquifer vulnerability and condition were reported by States in 1996 using two table formats specified in the 1996 Guidelines.

3.1 Aquifer Vulnerability

States reported on the type and number of contamination sites per aquifer or hydrogeologic setting having the potential to adversely impact ground water quality using the form presented in Table 1 of this report. Specifically, States were asked to identify the type and number of contaminant source(s) present in the reporting area (e.g., NPL, LUST, RCRA, Superfund), the number of sites that are listed or have confirmed releases, and the number of sites with confirmed ground water contamination.

The data reported in Table 1 provide a measure of aquifer vulnerability analogous to several existing IWI indicators (e.g., Aquatic/Wetland Species at Risk) and could easily be translated into an IWI indicator of ground water vulnerability. One possible indicator might be the number of sites having the potential to affect ground water quality for a specified aquifer or hydrogeologic setting. Another potential indicator is the number of sites with confirmed ground water contamination for a specified aquifer or hydrogeologic setting. Thus, purely from a data element point of view, information currently being requested from States under the 305(b) program could be used to develop an IWI indicator representing ground water vulnerability.

3.2 Ground Water Condition

States reported ground water monitoring data for specified aquifers or hydrogeologic settings using the form presented in Table 2 of this report. States compared quantitative ground water monitoring data to water quality standards. Depending upon the results of the comparison, the data were summarized into major categories, including "not detected at or above the method detection limit (MDL)," "exceeding the MDL but less than the maximum contaminant level (MCL) defined under the Safe Drinking Water Act," and "exceeding the MCL." This type of data provides a measure of the condition of the aquifer and again is analogous to several existing IWI indicators (e.g., Ambient Water Quality Data — Four Toxic Pollutants).

Table 1. Ground Water Contamination Summary

Hydrogeologic Setting ____________________
Spatial Description (optional) ____________________
Map Available (optional) ____________________
Data Reporting Period ____________________

Source Type	Number of sites	Number of sites that are listed and/or have confirmed releases	Number of sites with confirmed ground water contamination	Contaminants	Number of site investigations (optional)	Number of sites that have been stabilized or have had the source removed (optional)	Number of sites with corrective action plans (optional)	Number of sites with active remediation (optional)	Number of sites with cleanup completed (optional)
NPL									
CERCLIS (non-NPL)									
DOD/DOE									
LUST									
RCRA Corrective Action									
Underground Injection									
State Sites									
Non-Point Sources									
Other (specify)									

NPL - National Priority List
CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOE - Department of Energy
DOD - Department of Defense
LUST - Leaking Underground Storage Tanks
RCRA - Resource Conservation and Recovery Act

Table 2. Aquifer Monitoring Data

Hydrogeologic Setting ______________________
Spatial Description (optional) ______________________
Map Available (optional) ______________________
Data Reporting Period ______________________

Monitoring Data Type	Total No. of Wells Used in the Assessment	Parameter Groups	Number of Wells								
			No detections of parameters above MDLs or background levels		Nitrate concentrations range from background levels to less than or equal to 5 mg/l No detections of parameters other than nitrate above MDLs or background levels and/or located in areas that are sensitive or vulnerable		Nitrate ranges from greater than 5 to less than or equal to 10 mg/l Other parameters are detected at concentrations exceeding the MDL but are less than or equal to the MCLs	Parameters are detected at concentrations exceeding the MCLs	Number of Wells Removed from service	Number of Wells Requiring Special Treatment	Background parameters exceed MCLs
			ND	Number of wells in sensitive or vulnerable areas (optional)	Nitrate ≤ 5mg/l VOC, SOC, and Other parameters not detected	Number of wells in sensitive or vulnerable areas (optional)					
Ambient Monitoring Network (Optional)		VOC									
		SOC									
		NO									
		Other									
Untreated Water Quality Data from Public Water Supply Wells		VOC									
		SOC									
		NO									
		Other									
Finished Water Quality Data from Public Water Supply Wells		VOC									
		SOC									
		NO									
		Other [16]									

The information requested using Table 2 under the 305(b) program can support development of an IWI indicator depicting ground water condition. One possible example of how this information could be used is the characterization of aquifers or hydrogeologic settings having constituent concentrations exceeding MCL values. An example using nitrate follows later in this report.

3.3 Conclusions Regarding the Data Elements Requested Under 305(b)

Information currently being requested from States under the 305(b) program can be used to develop IWI indicators representing both ground water vulnerability and condition. The data elements are

- appropriate relative to IWI objectives,
- uniformly available across the Nation, and
- can be depicted in a GIS format of an appropriate scale.

Furthermore, the 305(b) program has by necessity begun the task of developing a database to compile and maintain the large volume of ambient ground water quality data being collected by State agencies throughout the Nation. Data elements that can be used to describe aquifer vulnerability and ground water condition have been defined under the 305(b) program, and the framework for reporting ambient ground water data on a biennial basis is in place.

4.0 1996 305(b) Data Set

Given the suitability of the data elements used to assess ground water quality under the 305(b) program, the next logical question is whether the data set reported in 1996 can be used to develop ground water layers for GIS coverages. Specifically, is the existing 1996 305(b) data set sufficient to support development of an IWI ground water layer in terms of spatial display, national coverage, and data sources? The following sections investigate this question.

4.1 Spatial Display

For surface water data layers within the IWI Initiative, EPA's Office of Water emphasized the importance of organizing water quality improvement efforts on a consistent basis and selected the watershed approach for this purpose. The United States Geological Survey (USGS) developed a Hydrogeologic Unit Classification (HUC) System of watersheds at various scales and mapped these watersheds. The IWI is depicted at the "eight-digit scale — the smallest nationally consistent set of watersheds in the HUC system."

Only one of the States reporting ground water quality data for the 1996 305(b) cycle reported data on a watershed basis. All other reporting entities utilized other reporting units (e.g., aquifers, hydrogeologic subareas, ground water basins, counties). Although an inconsistency exists between the units used to report ground water quality and surface water quality data, this inconsistency does not negate the use of the 305(b) data for developing an IWI ground water layer.

Due to the disparity between ground water flow systems and watersheds, a methodology is needed to permit ground water quality data to be spatially displayed jointly with watershed data under the existing HUC system. A separate and unique data layer must be developed for the ground water quality data. The ground water data layer must be linked to the HUC system, such that when a HUC code is selected, the ground water data associated with the selected HUC code is also displayed. Two options for developing the ground water quality data layer are suggested here.

One possible option is to use existing digitized maps. One such map is the *Nationwide Map of Principal Aquifers*, developed by the USGS. This map depicts the shallowest principal aquifers in the United States and can provide a solid basis for spatial displays of ground water quality data. This option requires that map scales and projections used by the USGS be correlated to those used in the HUC system.

A second possible option is to use the units reported by States in their 305(b) State Water Quality Reports. Ground water quality data reported by States under the 305(b) program are directly correlated to the reporting unit. Although map scales and projections used by the States will need to be correlated to those used in the HUC system, reported ground water quality data are directly linked to the reporting unit, thus requiring little interpretation and reducing the potential for error. For example, States most frequently identified the location of their reporting units in 1996 by providing a paper map in conjunction with a written description of the unit. The use of these maps infers that the boundaries of the aquifers within the State have been mapped and that the ground water monitoring data have been reviewed and assimilated to conform to the mapped boundaries. Maps, along with the corresponding data, could be digitized to form a ground water layer and used in a GIS format. Using state-supplied information, an example is provided to better illustrate the development of an IWI ground water layer using this option.

Idaho currently uses a GIS dataset and displays the data spatially. The State of Idaho supplied coverages in the form of hydrogeologic subareas, major aquifer flow systems, and statewide monitoring well locations. Each of these coverages is presented in Figures 1 through 3.

Nitrate concentrations measured in 1995 and 1996 in monitoring wells comprising the State monitoring network were also supplied by Idaho. The concentration measured in each of the wells is presented graphically in Figure 4. This same information was then summarized in Figure 5 according to the number of wells in an aquifer having a certain percentage of nitrate concentrations exceeding background levels. The USGS HUC system was superimposed on the data presented in Figure 5 to illustrate how an aquifer flow system could be displayed within the HUC system (Figure 6).

As shown, it is possible to develop a ground water layer on a State-by-State basis given that the individual States can provide aquifer coverages and data in a GIS format. If such an approach were taken, it would be necessary to make inquiries to determine how many States are using GIS-based systems in their ground water management efforts and to obtain those coverages to display data in the IWI format. Cooperation between EPA and the States in construction of each ground water quality layer would provide the highest degree of accuracy and precision.

4.2 National Coverage

Reporting ground water quality data on an aquifer-specific basis was new to the 305(b) program in 1996. To ease the reporting burden, EPA purposely developed the Guidelines with sufficient flexibility to encourage all States to respond. Although it was thought important that the first few 305(b) reporting cycles following release of the new Guidelines be characterized by a great deal of flexibility, that same flexibility resulted in wide variations in reported data. Variations were noted in the diversity of the reporting units and the extent of State coverage.

Thirty-three States reported data summarizing ground water quality. Of these 33 States, 16 States reported data for specific or differentiated hydrogeologic units. Figure 7 presents an overview of the states that were able to provide ground water quality data for specific or differentiated hydrogeologic units within the State.

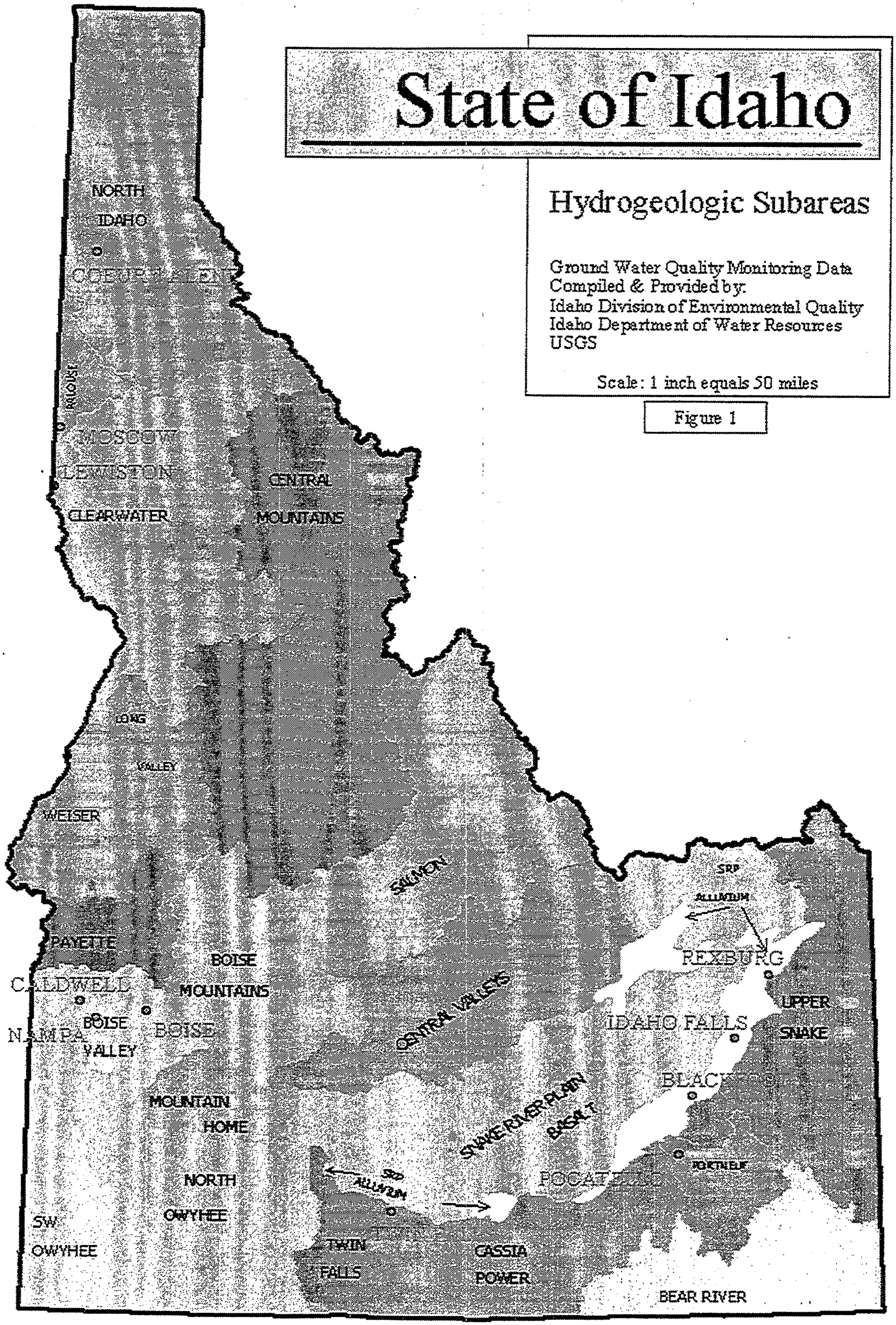
State of Idaho

Hydrogeologic Subareas

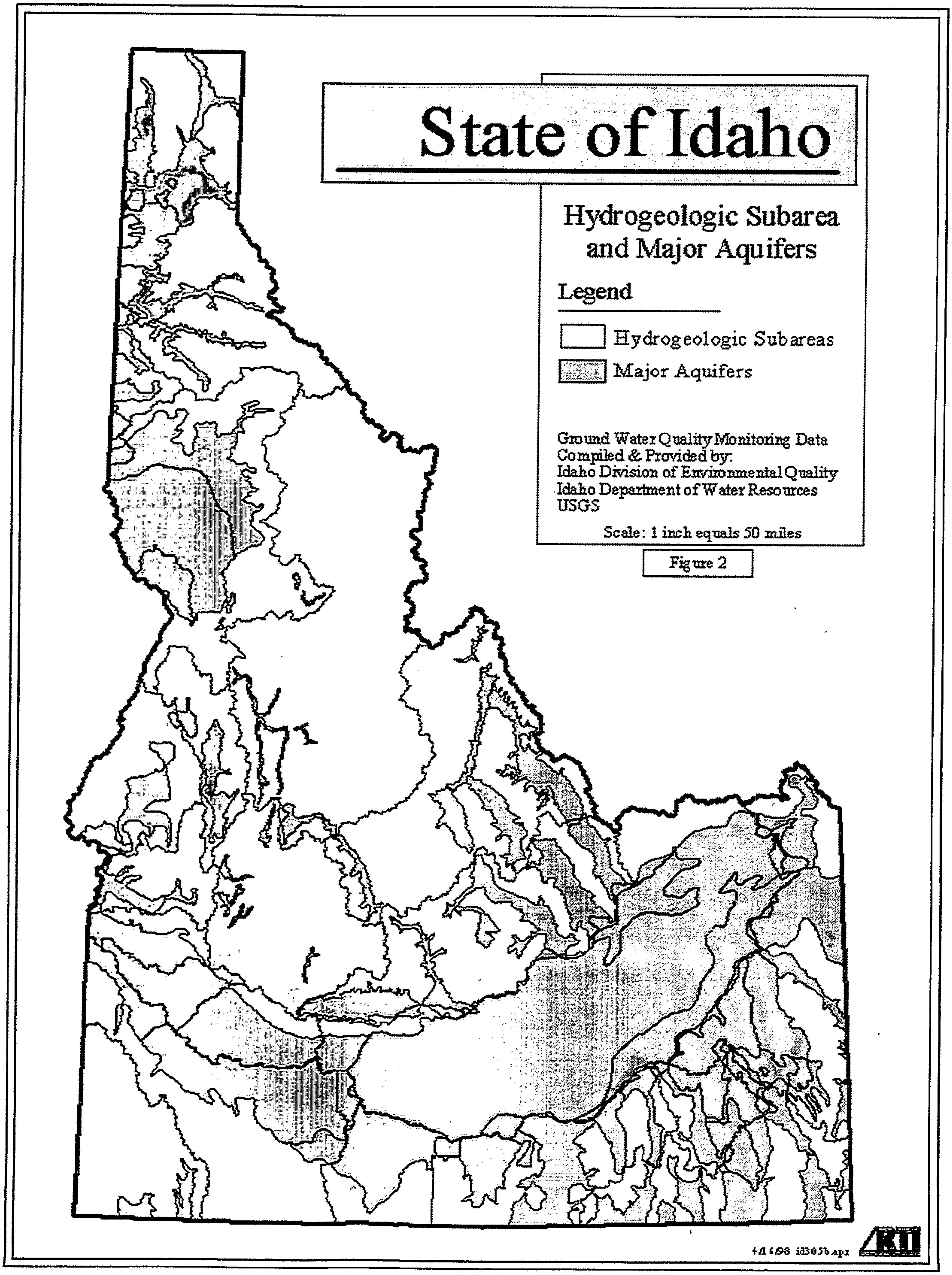
Ground Water Quality Monitoring Data
Compiled & Provided by:
Idaho Division of Environmental Quality
Idaho Department of Water Resources
USGS

Scale: 1 inch equals 50 miles

Figure 1



4/16/98 id305b.apx


State of Idaho
Hydrogeologic Subarea
and Major Aquifers
Legend
Hydrogeologic Subareas
Major Aquifers
Ground Water Quality Monitoring Data
Compiled & Provided by:
Idaho Division of Environmental Quality
Idaho Department of Water Resources
USGS
Scale: 1 inch equals 50 miles
Figure 2

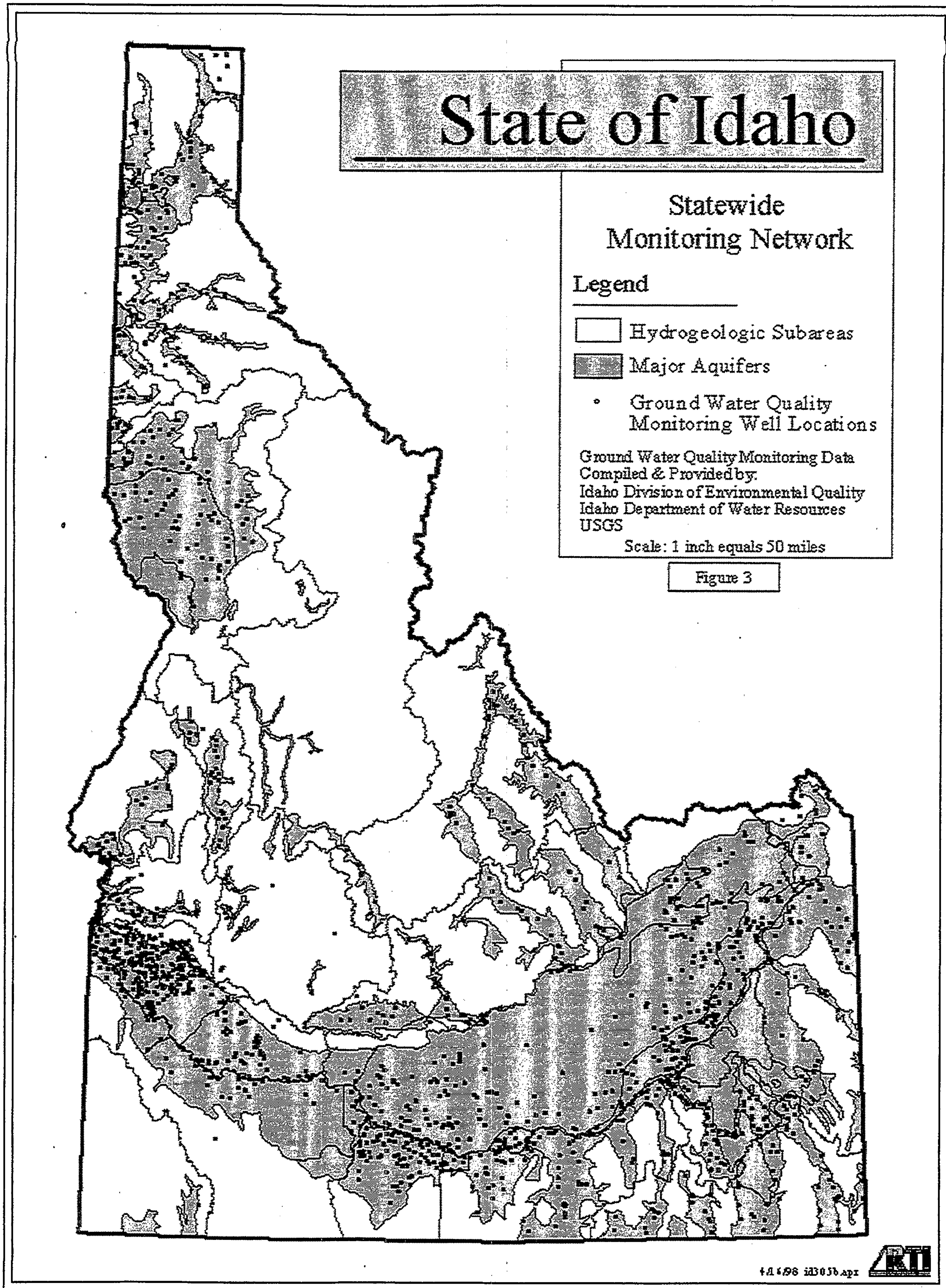
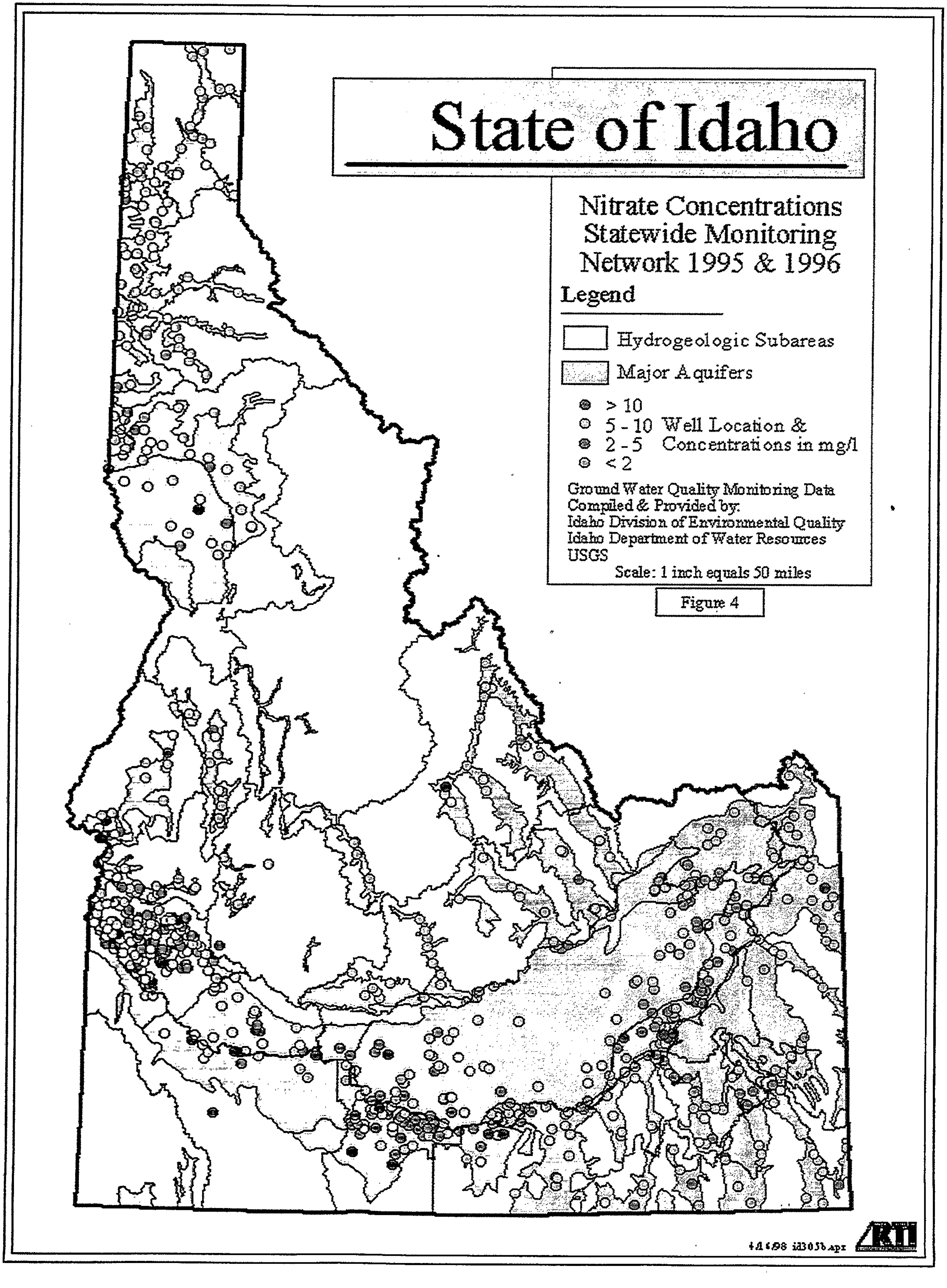

State of Idaho
Statewide
Monitoring Network
Legend
Hydrogeologic Subareas
Major Aquifers
Ground Water Quality
Monitoring Well Locations
Ground Water Quality Monitoring Data
Compiled & Provided by:
Idaho Division of Environmental Quality
Idaho Department of Water Resources
USGS
Scale: 1 inch equals 50 miles

Figure 3


State of Idaho
Nitrate Concentrations
Statewide Monitoring
Network 1995 & 1996
Legend
Hydrogeologic Subareas
Major Aquifers
> 10
5 - 10 Well Location &
2 - 5 Concentrations in mg/l
< 2
Ground Water Quality Monitoring Data
Compiled & Provided by:
Idaho Division of Environmental Quality
Idaho Department of Water Resources
USGS
Scale: 1 inch equals 50 miles
Figure 4

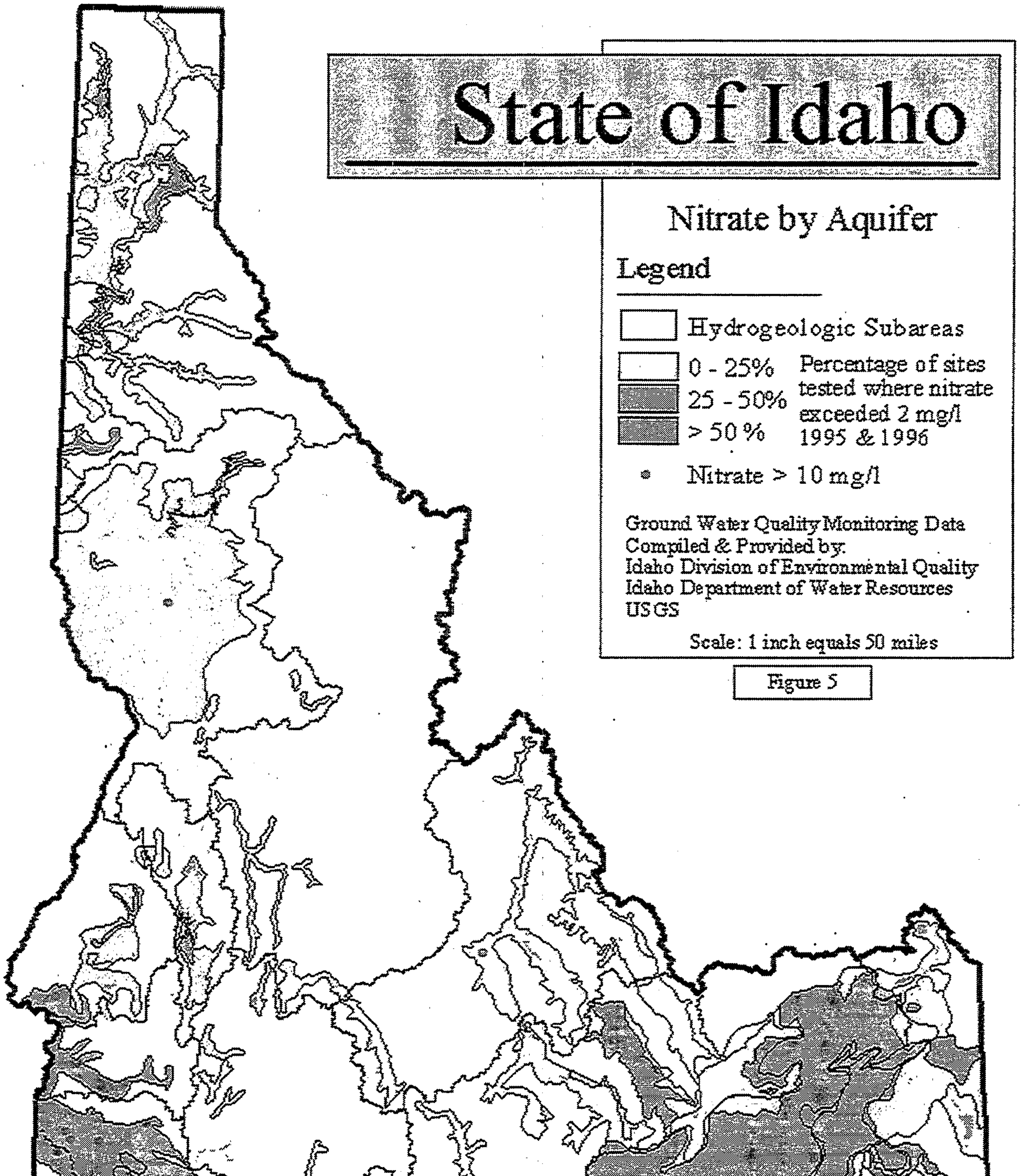


Figure 5

4/16/98 id305b.apx

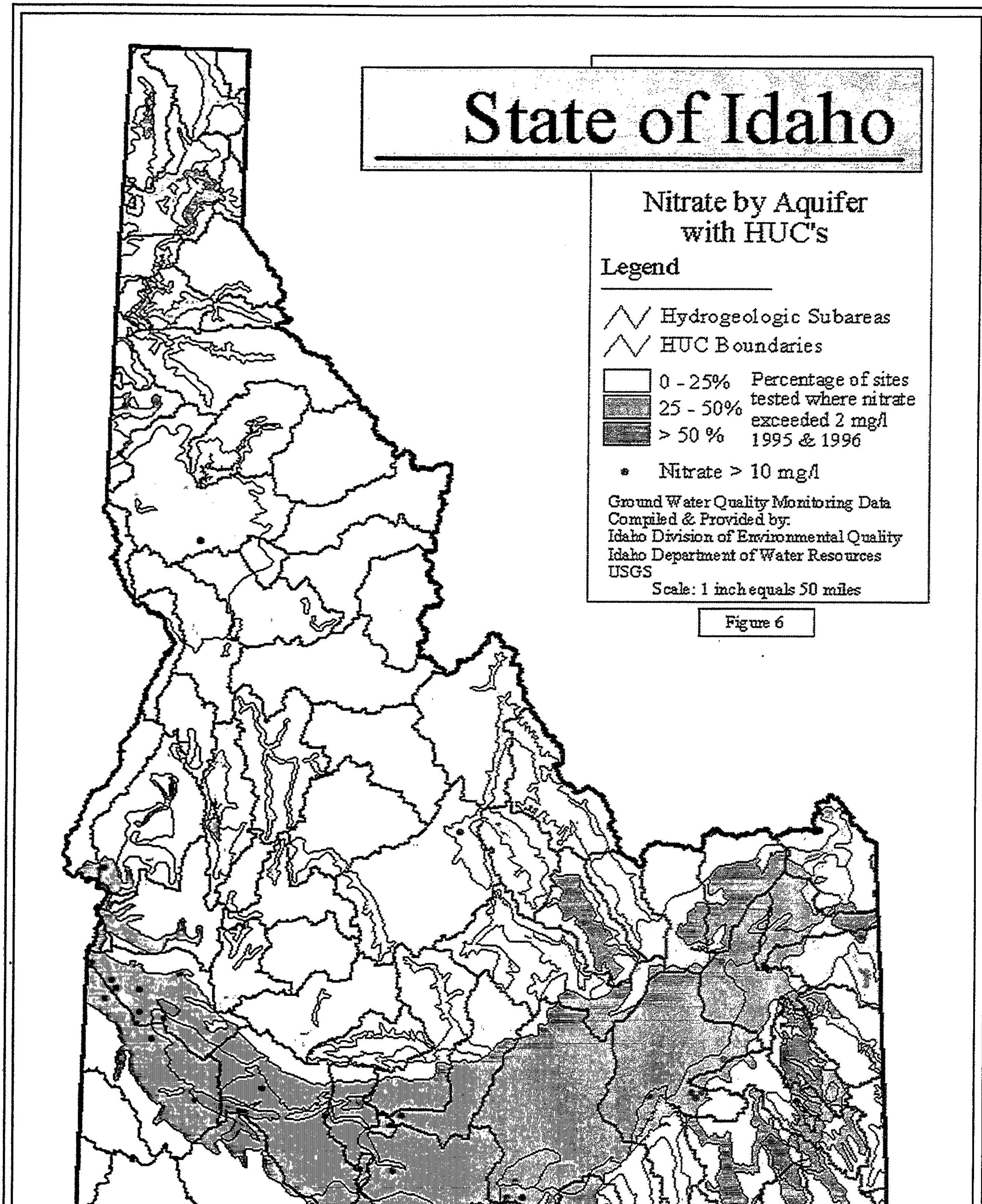
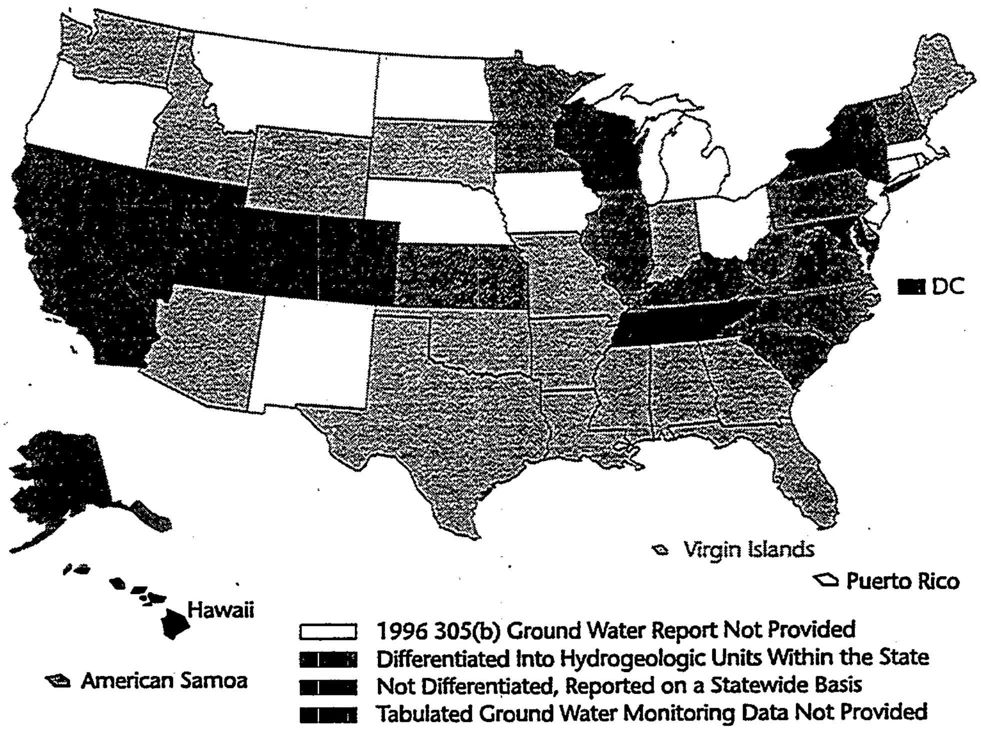

State of Idaho
Nitrate by Aquifer with HUC's
Legend
Hydrogeologic Subareas
HUC Boundaries
0 - 25%
25 - 50%
> 50 %
Percentage of sites tested where nitrate exceeded 2 mg/l 1995 & 1996
Nitrate > 10 mg/l
Ground Water Quality Monitoring Data Compiled & Provided by:
Idaho Division of Environmental Quality
Idaho Department of Water Resources
USGS
Scale: 1 inch equals 50 miles
RTI

Figure 6

Figure 7. Overview of Reporting Units



Hydrogeologic units were defined by the individual State ground water management programs and included aquifers, hydrogeologic subareas, ground water basins, monitoring areas, counties, and watersheds. Although the reporting units used by States to organize and manage ground water quality data vary across the Nation, it is not expected that this would create a problem in the development of a ground water layer to support the IWI Initiative because the individual units would not be displayed, but would rather underlie the HUC system.

In addition to variations in the reporting units, Statewide coverages were not achieved in the 1996 305(b) reporting cycle. The concept of reporting information for specific aquifers within a State was new in 1996. To ease the State burden, EPA recommended that ground water quality be assessed incrementally. As a consequence, State-wide coverages were the exception rather than the norm for the 1996 data set. Most frequently, coverages ranged from specific monitoring areas of local interest to a small percentage of the State. EPA recognized this would be the case and welcomed the reporting of more specific information on a larger scale as opposed to the reporting of general information on a statewide basis as had been done in past 305(b) reporting cycles.

The lack of Statewide coverages presents a challenge in developing National coverage using the 1996 305(b) dataset. Ground water quality cannot be inferred on a National basis from the limited data reported for specific aquifers or hydrogeologic settings in 1996. Portions of the

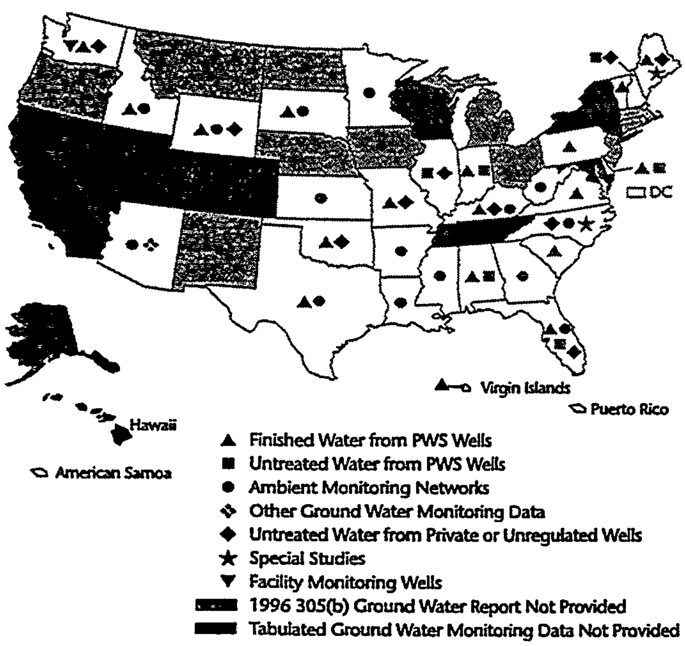
State for which no data are reported would have to be identified as "having insufficient data to make an assessment." This procedure is consistent with the methodology already employed to depict surface water indicators for IWI. The visual identification of areas within a State having insufficient data to develop a ground water layer may be useful in developing plans for future monitoring efforts. Implementation of these plans would naturally increase State coverage with each successive 305(b) reporting cycle, thus benefitting both the 305(b) and the IWI programs.

4.3 Data Sources

A single data source to describe ground water quality does not exist, and for purposes of the 1996 305(b) program, States were encouraged to use available data that best reflect the quality of the ground water resource. The exact source(s) of data used by States to assess ground water quality in 1996 depended on data availability and the judgment of the ground water professionals. Ambient water quality data from dedicated monitoring wells or networks were the preferred source of data. However, in the absence of dedicated ground water monitoring wells or networks, States resorted to using data collected from public water supply systems (PWSs) as these data are routinely collected under the Safe Drinking Water Act (SDWA) and would not necessitate a separate and unique monitoring effort.

Analysis of the 1996 data reported by States revealed that a variety of data sources were used to assess ground water quality. Although there was a strong reliance on finished water quality data from PWSs, these data were frequently reported in conjunction with other sources of data. Figure 8 illustrates the variety in reported data.

Figure 8. Sources of Ground Water Data



Given the variety of data sources, ground water quality data most closely approximating actual ground water conditions (i.e., untreated ground water) were given special consideration in the *1996 Report to Congress*. It is assumed that these same data types would be favored in producing a ground water layer for the IWI Initiative.

Ten States reported ambient monitoring data for selected aquifers or hydrogeologic settings in 1996. Admittedly, data from ten States is not sufficient to develop a National ground water layer. However, it is expected that the number of States reporting ambient monitoring data for selected aquifers/hydrogeologic settings will increase with each successive 305(b) cycle.

The primary basis for assessing ground water quality in the 305(b) program is the comparison of chemical concentrations measured in ground water to water quality standards. Because it was not possible for States to sample and analyze ground water for every known constituent, EPA suggested that ground water quality data be summarized into parameter groups: volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs). In addition to these two parameter groups, nitrate was given special consideration in the 1996 Ground Water Guidelines. These two groups and nitrate were suggested as they are generally indicative of contamination originating as a result of human activities, and thus, provide excellent indicators of ground water degradation. It is probable that any ground water layer developed for IWI would likely use similar indicators.

Using available data sources, States provided a wealth of data for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and nitrate. In addition to these three categories, States also reported data for pesticides and metals (both of which are indicators of anthropogenic impacts). For 1996, States reported the number of wells for which a parameter or parameter group was "not detected at or above the MDL," "exceeded the MDL but was less than the MCL" or "exceeded the MCL." This type of data provides a excellent measure of the condition of the aquifer and again is analogous to several existing IWI indicators (e.g., Ambient Water Quality Data — Four Toxic Pollutants).

Data reported in 1996 is representative of the type of data needed to develop an IWI ground water layer. It is both well suited and relevant to evaluating the condition of our Nation's ground water resources. Still, the fact remains that national coverage was not attained in 1996. Furthermore, although nitrate data was reported by 32 States, only 15 States reported nitrate data for ambient monitoring networks. The same holds true for VOCs, SVOCs, pesticides, and metals.

4.4 Conclusions Regarding the Use of the 1996 305(b) Data Set

The data elements currently requested under the existing 305(b) program are well suited to provide the necessary information to characterize ground water condition and vulnerability on a National basis. However, the ground water quality data reported by States in 1996 are too sparse to be used for this purpose at this time. Still, a framework for reporting ambient ground water quality data on a biennial basis has been developed under the 305(b) program, and it is expected that the amount of data reported will increase with each successive 305(b) cycle as the direction and focus of the program become clearer to both States and EPA. Thus, with additional

305(b) reporting cycles, the data set will achieve the maturity needed to support the IWI Initiative.

5.0 Potential Alternatives

Given the present immaturity of the 1996 305(b) ground water data set, the possibility of using alternative data sources was explored. One data source that was considered was the Federal Safe Drinking Water Information System (SDWIS/FED).

Under the SDWA, EPA is responsible for regulating more than 170,000 distinct public water supply systems and the water they supply. In order to best manage these water systems and their widely different local conditions, the majority of States supervise water systems within their borders. To do this, States and the systems test for and monitor contaminants in the finished (treated) water of each water system. The monitoring data are compiled into State computer systems and a copy of these data is then downloaded to SDWIS/FED on a quarterly basis.

SDWIS/FED contains a wealth of information related to PWS systems and their compliance with drinking water standards. A series of queries were designed to evaluate whether SDWIS/FED could be used to develop a ground water layer for the IWI Initiative. Specific queries included:

- How many States report to SDWIS/FED
- Are ground water data included in the SDWIS/FED database
- If ground water data are included, are samples analyzed *prior* to treatment
- Are sample data linked to location
- Are sample data linked to aquifer systems or watersheds.

All States and Territories report data to SDWIS/FED. Sixty-six entities have water systems data reported in SDWIS/FED. The population of individuals served by water systems in SDWIS/FED is high and accounts for a large portion of the population of the United States.

Ground water data are included in the SDWIS/FED database. However, this would be indicated as a source whether it is from a surface water source or a ground water source as "water type." In addition, it would be difficult to definitively determine whether a sample received treatment prior to analysis because this type of information is not currently requested under SDWIS/FED. Revised reporting requirements for treatment data, however, require that the PWS report a fuller description of treatment practices, and location of sample in relation to the treatment. Hence, it is likely that this type of information may be available in the future.

Other ground water information necessary for collection of source data are linked to location. Although States are capable of linking ground water sample results to location, at the Headquarters level, SDWIS/FED does not require this level of detail. Still, the option exists and States may provide this information. Furthermore, there is an attribute in SDWIS/FED of the HUC code, but few States have populated this data element. The latitude and longitude coordinates are another way to get this locational information, but again, many systems do not have the locational coordinates input to SDWIS/FED. This condition will greatly improve with the revised inventory reporting requirements issued in July 1998.

In conclusion, SDWIS/FED consists of a framework that States use to report data related to PWS systems and their compliance with drinking water standards. SDWIS/FED contains a wealth of data reported by States and Territories in the Nation, thereby achieving National coverage. However, the use of this data to develop a National ground water layer for the IWI Initiative is questionable primarily due to the difficulties associated with determining "water type," "treatment," and location to aquifers/watersheds.

6.0 Conclusions

The condition of our Nation's ground water resources is monitored and assessed under Section 106(e) of the Clean Water Act (CWA), which requests that each State monitor ground water quality and report the findings to Congress in their biennial 305(b) State Water Quality Reports. Data reported by States are used to assess the quality of our Nation's ground water resources. Assessment of ground water quality on a National basis is congruent with the objectives defined under the IWI Initiative.

Recognizing the overlap in data needs between the 305(b) program and the IWI Initiative, ground water quality data collected under the 305(b) program were assessed to determine their appropriateness for use in developing an IWI GIS layer characterizing ground water vulnerability and/or condition. In addition to assessing the data collected under the 305(b) program, alternative sources of data were evaluated for this same purpose. Following are the conclusions of this assessment.

- IWI indicators representing both ground water vulnerability and condition can be developed using the data elements currently requested in the 1996 Ground Water Guidelines. Specifically, the data elements are appropriate relative to IWI objectives, uniformly available across the Nation, and can be depicted in a GIS format of an appropriate scale. Little-to-no modifications of the 1996 Guidelines would be required.

- Data elements used to describe aquifer vulnerability and ground water condition have been defined under the 305(b) program. Data reported by States in their 1996 305(b) Water Quality Reports have been compiled into a database, establishing a functional framework for reporting, compiling, and managing ambient ground water data on a National basis.

- Although the data elements currently requested under the existing 305(b) program are well suited to characterize ground water condition and vulnerability on a National basis, the data reported by States in 1996 is too sparse to be used for this purpose at this time. Still, a framework for reporting ambient ground water quality data on a biennial basis has been developed under the 305(b) program, and it is expected that data density will increase with each successive 305(b) cycle. Thus, with additional 305(b) reporting cycles, the data set will achieve the maturity needed to support the IWI Initiative.

- SDWIS/FED consists of a framework that States use to report data related to PWS systems and their compliance with drinking water standards. SDWIS/FED contains a wealth of data reported by States and Territories in the Nation, thereby achieving National coverage. However, the use of this data to develop a National ground water layer for the IWI Initiative is questionable primarily due to the difficulties associated with determining "water type," "treatment," and location to aquifers/watersheds.

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September 15, 1998

Relationship of State Source Water Assessment and Protection Program Guidance to 305(b) Process

Table of Contents

1.0 Introduction

This report examines EPA's guidance for the Source Water Assessment Program (SWAP), under the 1996 Safe Drinking Water Act Amendments, and discusses its relationship with EPA's Clean Water Act's Section 305(b) program. The purpose of this report is to examine whether data being collected for the 305(b) program may be useful for States in preparing SWAPs.

2.0 Source Water Assessment Program

The Safe Drinking Water Act Amendments of 1996 emphasize pollution prevention to ensure safe drinking water, focusing on the protection of water sources. Section 1453 of the Safe Drinking Water Act Amendments requires that all States establish SWAPs which will

- set forth the State's strategic approach to conducting assessments
- delineate the boundaries of areas providing source waters for public water supplies
- identify, to the extent practical, the origins of regulated and certain unregulated contaminants in the delineated area to determine susceptibility of public water supplies to such contaminants.

States with Public Water Supply Supervision program primacy must submit SWAPs to EPA for approval no later than February, 1999. A State program is automatically approved 9 months after submittal to EPA unless EPA disapproves the program. The States have up to two years after EPA program approval, or with an approved time extension, up to no more than three and one half years, to complete the source water assessments. This timetable means that most States will be submitting data from the SWAPs beginning in the year 2001.

EPA has set two goals under the Government Performance and Results Act (GPRA) that emphasize pollution prevention strategies in the office of Ground Water and Drinking Water. By the year 2005, the following goals to protect drinking water sources are to be met:

(1) Sixty percent of the population served by community water systems will receive their water from systems with source water protection programs in place under both wellhead protection and watershed protection programs.
(2) Increase by 50 percent the waters that meet the drinking water use that States designate under the Clean Water Act [305(b)] Report to Congress.

2.1 State Source Water Assessment And Protection Programs Guidance

EPA published the "State Source Water Assessment and Protection Programs Guidance" in August 1997 to help States develop SWAP submittals. This guidance describes the required content of a SWAP submittal, federal funds available for completion of the assessments, requirements of public participation, and linkages to other federal programs.

The guidance states that one of the first steps in any SWAP needs to be a review of relevant, available sources of existing data (including susceptibility determinations) at the Federal, State, and Local levels. Furthermore, States are encouraged to assemble, review, and use appropriate information from existing sources of information.

In order to gain EPA approval of its SWAP program, States need to include in their submittal:

- A description of the level of exactness and detail that each assessment will achieve once it is considered by the State to have been completed. A "completed" assessment for a public water supply must include:
  - › A delineation of the source water protection area
  - › A contamination source inventory for that source water protection area, and
  - › A determination of the public water supply's susceptibility to contamination by sources inventoried within the source water protection area.
- A description of how each assessment will protect and benefit the public water systems in the State.

The guidance does not outline a specific approach for State preparation of SWAPs. It presents guidelines for delineation of source water protection areas for ground water and surface water systems, addresses what contaminants should be considered of concern, and discusses approaches for determining which types of sources of contamination are significant.

In regard to the requirement that the assessment will be "for the protection and benefit of the public water systems" in the State, the guidance states that this description needs to include the linkage of the SWAP to ongoing or future source water protection effects, and how a SWAP will link with existing programs such as the Wellhead Protection Program.

3.0 Clean Water Act, National Water Quality Inventory Program [305(b)]

The Clean Water Act, Section 305(b) specifies that States develop and report information concerning the quality of the nation's water resources to EPA and the U.S. Congress. Each State must develop a program to monitor the quality of its ground and surface waters and prepare a report every two years describing the status of water quality. The States assess their water quality and its ability to meet various designated uses, including supporting aquatic life, fish consumption, shellfishing, swimming, and drinking water.

3.1 Drinking Water

EPA developed guidelines for use in assessing drinking water use support as part of the 1996 305(b) reporting cycle. Specifically, States were asked to use ambient water quality data, finished water quality data, and drinking water use restrictions to assess use support for each waterbody. The guidelines for drinking water use support for the 1998 305(b) cycle were revised in order to provide more flexibility to the States. These guidelines emphasize that States may consider prioritizing their water resources and performing drinking water use support assessments for a limited percentage of their water resources. States are then encouraged to expand their drinking water assessment efforts to include additional waters each subsequent reporting cycle.

Limited drinking water data were provided by the States in the 1996 305(b) reporting cycle. The States rarely addressed the considerations from the guidelines (see above). When most States addressed one of these issues, it was very brief and did not present enough detail to be meaningful. For most States, it was not possible to determine their data sources, data quality, and the linkage of the data to its source area.

However, several States provided much more detail on drinking water in the 1998 305(b) cycle. A review of the 1998 305(b) reports that have currently been received (ten States or territories) showed

- Three States had separate drinking water sections providing detailed information on monitoring results and their criteria for classification of drinking water use
- Three States did not have a separate drinking water section, but discussed drinking water as a designated use
- Four States did not discuss drinking water in their reports.

The following summarizes the key information provided by the three States with separate drinking water sections:

- **ARKANSAS**: Arkansas presented data on analysis from 133 ambient water quality sampling stations. Elevated levels of some pesticides were found, but none exceeded the maximum contaminant levels (MCLs). The three pesticides with the highest occurrences above the detection level were atrazine, metolachlor, and molinate. None of these levels exceeded the MCLs. Monthly data for nitrate and minerals (chlorides, sulfates, total dissolved solids) were compared to the MCLs. Of more than 8,500 miles assessed for drinking water use support, 77.7 miles were not meeting the use and there was concern for an additional 38.1 miles. Many of the exceedances were from nitrate values greater than 10 mg/L.

- **HAWAII:** Hawaii summarized the length of streams used for drinking water and presented the list of contaminants being monitored: all current MCLs including bacteriological, organics, inorganics, and pesticides. All streams were found to be fully supporting drinking water use, but did not present the monitoring results. A summary table was provided and reported the lengths of streams (in miles) used for drinking water and it was noted that all streams are considered fully supporting drinking water use.

- **MASSACHUSETTS:** Massachusetts provided a very detailed drinking water section. Of 231 public water sources (groundwater) closed, 136 were contaminated by volatile organic chemicals (VOCs), 63 by inorganics, synthetic organic chemicals (SOCs) or natural causes, and 18 by two or more chemicals. Fifteen sources reported nitrate detections above the MCL, several had problems with lead and copper action levels, and several had sodium above Massachusett's recommended guideline level. For surfacewater, 96% were in full compliance, 28% had non-trihalomethane VOC detects, and two were threatened by nitrates. Massachusett's criteria for drinking water use are as follows: full support is monitoring samples that do not exceed the MCL, threatened is monitoring samples equal to or greater than one-half the MCL, non-support is samples that exceed the MCL. Annual average levels were not considered. These criteria are very similar to EPA's criteria for drinking water use; the major difference is that Massachusetts used one-half the MCL as the criteria to designate "threatened", while EPA did not specify one-half the MCL or any other level. EPA considered water to be threatened when contaminants are detected but do not exceed water quality criteria.

  Massachusetts also presented information on its Comprehensive Source Water Protection Program. In 1995, Massachusetts became the first State in the country to receive EPA's endorsement of this program; a comprehensive, integrated approach to water supply protection for both ground and surface water sources using a coordinating role of the Water Resources Commission and Geographic Information System (GIS) mapping of priority resource areas. Also in 1995, Massachusetts became the fifth State in the country to receive EPA's endorsement of its Comprehensive State Ground Water Protection Program which includes locating the recharge area of all sources and establishing water supply protection areas.

3.2 Groundwater

EPA also developed new guidelines for use in assessing ground water quality as part of the 1996 305(b) reporting cycle. The new guidelines changed the focus from the qualitative generalization of ground water quality on a statewide basis to the quantitative assessment of ground water quality on an aquifer-specific basis. It is this change in focus that makes ground water information reported under the 305(b) program suitable for use in supporting the SWAPs.

The *1996 Ground Water Guidelines* introduced the concept of reporting ground water information on an aquifer-specific basis using two table formats developed to assess aquifer vulnerability and condition. In one of the two table formats (Table 1), States are asked to report on the type and number of contamination sites per aquifer or hydrogeologic setting having the potential to adversely impact ground water quality. Specifically, States are asked to identify the type and number of contaminant source(s) present in the reporting area (e.g., NPL, LUST, RCRA, Superfund), the number of sites that are listed or have confirmed releases, and the number of sites with confirmed ground water contamination.

The data reported in Table 1 support the first two steps of a complete source water assessment: (1) delineation of the source water protection area; and (2) inventorying of the significant potential sources of contamination within the source water protection area. The third step, understanding the susceptibility of the source waters to contamination, represents an analysis of steps one and two. An analysis of the data was not requested in Table 1 of the *1996 Ground Water Guidelines.*

Reporting contaminant source information for specific aquifers was new to States in 1996. However, 29 out of the 33 States that submitted ground water assessments in accordance with the new *Ground Water Guidelines* provided this information in 1996. Twelve out of 14 States provided this information as part of the 1998 305(b) reporting cycle. Although States were not required to focus on ground water resources used for drinking water purposes, the importance of ground water as a drinking water source was evident in the aquifers States selected for assessment.

Hence, as part of the 305(b) program, States have begun the process of delineating ground water aquifers and inventorying potential sources of contamination within the aquifer area. This same information supports SWAPs.

Table 1. Ground Water Contamination Summary

Hydrogeologic Setting ______________________
Spatial Description (optional) ______________________
Map Available (optional) ______________________
Data Reporting Period ______________________

Source Type	Number of sites	Number of sites that are listed and/or have confirmed releases	Number of sites with confirmed ground water contamination	Contaminants	Number of site investigations (optional)	Number of sites that have been stabilized or have had the source removed (optional)	Number of sites with corrective action plans (optional)	Number of sites with active remediation (optional)	Number of sites with cleanup completed (optional)
NPL									
CERCLIS (non-NPL)									
DOD/DOE									
LUST									
RCRA Corrective Action									
Under-ground Injection									
State Sites									
Non-Point Sources									
Other (specify)									

NPL - National Priority List
CERCLIS (non-NPL) - Comprehensive Environmental Response, Compensation, and Liability Information System
DOE - Department of Energy
DOD - Department of Defense
LUST - Leaking Underground Storage Tanks
RCRA - Resource Conservation and Recovery Act

4.0 Use of 305(b) Data for SWAPs

4.1 Drinking Water

The drinking water data provided by the above States may be useful for preparing SWAPs. The monitoring data provided by the States could help fulfill the requirements that the SWAPs include a contamination source inventory for the source water protection area. These States have provided levels of chemicals detected in public drinking water supplies which are linked to specific streams or lakes. This information could be used as the basis for determining the primary sources of contamination in a source area and a determination of the public water supply's susceptibility to contamination. In addition, the information provided by the State of Massachusetts on its Source Water Protection Programs could be useful for fulfilling the requirements for delineation of source water protection areas.

4.2 Groundwater

Data related to ground water vulnerability, as reported under the 305(b) program, will support the first two steps of a complete source water assessment. Specifically, delineation of the source water protection area and inventorying of the significant potential sources of contamination within the source water protection area provide the necessary information for preparing SWAPs. As evidenced by the positive response of States in the 1996 and 1998 305(b) reporting cycles, States have already begun the process of compiling and reporting the required information for selected aquifers and/or hydrogeologic settings within the State. Because the information requested under these two programs is so complementary in nature, it is likely both programs will benefit.

5.0 Other EPA Programs That May Be of Use for SWAPs

Other EPA programs may be useful for preparing SWAPs. The following is a summary of the some of the programs that may provide useful information:

- Wellhead Protection Program: A pollution prevention program designed to protect ground water-based sources of drinking water, under the Safe Drinking Water Act Amendments of 1986.
  - Formal assessments of source water protection areas for ground water have already been completed under this program.

- Water Quality Standards: EPA has developed water quality criteria levels on individual pollutants or parameters, or describe conditions of a waterbody that, if met, will generally protect the designated use of the water. EPA has developed, to date, 103 recommended aquatic life or wildlife criteria and 191 recommended human health criteria.
  - These standards could be used as benchmarks to determine if the water is meeting its drinking water use, and for establishing the basis for controls on pollutant discharges or for management actions to ensure that the drinking water use will be attained.

- Nonpoint Source Program. Clean Water Act, Section 319, specifies that States are to conduct statewide assessments of their waters to identify those that are either impaired or threatened because of nonpoint sources and develop management programs.
  - The assessments developed for this program may serve as valuable sources of information about land-based pollution sources which may contribute to the contamination of drinking water sources.

- Index of Watershed Indicators (IWI): IWI provides a description of the condition and vulnerability of each of the 2,111 watersheds in the U.S. It is built on 15 different water resource indicators.
  - IWI uses a drinking water indicator: rivers and lakes supporting State drinking water designated uses that is based on data provided by the States in the 305(b) reports.

- National Pollutant Discharge Elimination System (NPDES) Program
  - The NPDES program regulates point source discharges to surface waters such as wetlands, lakes, rivers, and oceans. Point source discharges include wastewater from industrial processes, effluent from municipal wastewater treatment plants,

industrial and municipal stormwater, combined sewer overflows, and sanitary sewer overflows. Permits may contain requirements that would be critical in identifying the presence and origin of contaminants in a delineated source water area.

- Total Maximum Daily Load Program (TMDL): Clean Water Act, Section 303(d), specifies that States are to identify waters that do not meet water quality standards, even after implementation of nationally required levels of pollution control technology, and to develop TMDLs for those waters. TMDLs allocate pollutant loadings among pollution sources in a watershed, and provide a basis for identifying and establishing controls to reduce both point and nonpoint source pollutant loadings.
  - State lists that identify waters needing TMDLs, and TMDLs developed for specific water bodies, are a useful source of information, providing data about the sources of pollution and can be used to develop allocation scenarios for pollutant loadings among pollution sources in a watershed.

6.0 Summary

The following matrix presents a summary of the SWAP requirements and drinking water and groundwater data available from 305(b) that could be useful for fulfilling these requirements:

SWAP Requirements:	Delineation of source water protection area	Contamination source inventory	Public water system susceptibility	Protection and benefit of public water systems
305(b) drinking water data	Not included	x	x	Not included
305(b) groundwater data	x	x	x	Not included

In summary, it is evident that the drinking water and groundwater data that is currently being submitted for 305(b) is valuable information, and should be used in conducting source water assessments. Furthermore, the 305(b) groundwater data fully complement the first two steps of a complete source water assessment. The 305(b) drinking water guidelines are constantly evolving. It may be beneficial to consider revising these guidelines to be more consistent with the requirements for SWAPs. In time, the two programs could complement each other in a way that could prove beneficial to both the States and to EPA.

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September 15, 1998

State Drinking Water Data from the 1996 and 1998 305(b) Reports

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1.0 Introduction

The National Water Quality Inventory Report to Congress under the Clean Water Act, Section 305(b), mandates that States develop and report information concerning the quality of the nation's water resources to EPA and the U.S. Congress. Each State must develop a program to monitor the quality of its ground and surface waters and prepare a report every 2 years describing the status of water quality. The States assess their water quality and its ability to meet various uses, including supporting aquatic life, fish consumption, shellfishing, swimming, and drinking water.

EPA prepared Guidelines for the States for the 1996 and 1998 305(b) reporting cycles on assessing drinking water use support. In this report, RTI examines these Guidelines and the 1996 305(b) reports submitted by 11 States: North Carolina, Vermont, West Virginia, Michigan, New York, Wyoming, Arkansas, Alabama, Georgia, Delaware, and Arizona (these States were selected because they tended to report more data on drinking water use than did the other States), and the data reported to date in the 1998 305(b) reports by 10 States or territories: Arkansas, Delaware, Guam, Hawaii, Louisiana, Massachusetts, New Hampshire, Northern Marina Islands, Pennsylvania, and Washington. In addition, RTI discusses the usefulness of the 305(b) data to support other EPA program office initiatives, such as the Index of Watershed Initiatives (IWI).

2.0 1996 Drinking Water Guidelines

Only a small percentage of river/stream miles and lake/reservoir acres were assessed for drinking water use in the early 1990s. To counteract this trend, EPA developed guidelines for States to use in assessing drinking water use support as part of the 1996 305(b) reporting cycle. The Guidelines provided a framework for performing drinking water assessments that incorporated the Safe Drinking Water Act (SDWA) reporting requirements and emphasized the full range of SDWA contaminants. The primary purpose of the Guidelines was to increase the percentage of miles and acres assessed in each State and to promote a more meaningful assessment of drinking water use support within the 305(b) program. In the Guidelines, EPA emphasized the following considerations:

- Use of ambient monitoring data or raw intake water quality data
- Use of treated water quality data
- Drinking water use restrictions imposed on source waters
- Data representativeness given spatial and temporal boundaries
- Use of the 84 contaminants regulated under the SDWA.

Specifically, States were asked to use ambient water quality data, finished water quality data, and drinking water use restrictions to assess use support for each waterbody. The Guidelines provided an assessment framework for drinking water use support, characterizing drinking water use as

- Fully supporting
- Fully supporting but threatened
- Partially supporting
- Nonsupporting
- Unassessed.

States were asked to complete a series of tables summarizing drinking water designated use data. Using Table 7-21 (Summary of Waterbodies Fully Supporting Drinking Water Use), States were asked to summarize the rivers/streams and lakes/reservoirs that fully supported drinking water designated use. States used this same table to list the contaminants considered in the assessment. States summarized the waterbodies that did not fully support drinking water designated use in Table 7-22 (Summary of Waterbodies Not Fully Supporting Drinking Water Use). For each waterbody that was fully supporting but threatened, partially supporting, or not supporting drinking water designated use, States were asked to list the most significant contaminants contributing to the designation.

Using the information summarized in Tables 7-21 and 7-22, States were asked to provide the total number of miles (or acres) designated for drinking water use as well as the total miles (or acres) assessed and calculate the percentage of total miles (or acres) that fully supports, fully supports but is threatened, partially supports, or does not support drinking water use. States were asked to summarize the most significant contaminants contributing to each designation (Tables 7-23 and 7-24).

In a separate table (Table 7-3, Individual Uses Support Summary), States were asked to summarize the same information for all designated uses (e.g., aquatic life, fish consumption, drinking water, swimming). Table 7-3 did not include information on contaminants contributing to the designation. In addition, the States were asked to summarize the reasons waterbodies did not support their designated uses (Table 7-5, Total Sizes of Waters Impaired by Various Cause Categories).

2.1 Summary of Drinking Water Data Reported by States in 1996

The 1996 Report to Congress included several appendices which summarized drinking water use support for rivers and streams, lakes, coastal waters, and estuaries for the States, Tribes, Territories, and/or Commissions. Appendix A, Table A-3e, presents a numerical summary of the drinking water use support in surveyed rivers and streams. Results are as follows:

- Fourteen States reported that all of their surveyed rivers and streams fully supported drinking water use.
- Twenty-four States reported values for two or more of the five categories (fully supporting, threatened, partially supporting, nonsupporting, and not attainable).
- Thirteen States either did not report the information or reported it in a format that could not be quantified.

Of the 11 State 305(b) reports examined by RTI, two (Alabama and Michigan) reported that all of their surveyed rivers and streams were fully supporting of drinking water use; the other nine States classified their rivers and streams in two or more categories. Michigan did not provide a reason for classifying all their rivers and streams as being fully supporting. Alabama reported that

- 98% of community water systems met the turbidity maximum contaminant level (MCL)
- 96% met the trihalomethane MCL
- 100% met inorganic and radiological MCLs.

The information provided by the other nine States varied greatly. However, certain information was provided by all States. For example, a version of Table 7-3 (Individual Uses Support Summary) was used by each State to summarize the total number of miles that supports all designated uses, including drinking water. An example of Table 7-3 follows:

Type of Waterbody	Designated Use	Fully supporting	Partially supporting	Not supporting
River, streams (Miles)	Fish, aquatic life and recreation	2396.9	35.0	250.0
	Primary contact recreation	1046.9	1101.7	502.0
	Secondary contact recreation	2505.2	334.7	0.0
	Industrial supply	2839.9	0.0	0.0
	Public water supply	295.6	0.0	0.0

Most of the States also provided a version of Table 7-5 (Total Sizes of Waters Impaired by Various Cause Categories) from the guidelines which summarizes the reasons waterbodies did not support their designated uses. This table was not broken down by specific use, such as drinking water and there was no breakdown of specific contaminants. An example of this type of table follows:

Stressor Category (for Streams)	Miles Impacted
Metals	1,963
Turbidity	1,948
Salinity	1,104
Pathogens (fecal coliforms)	428
pH	385
Low dissolved oxygen	333
Radiation (gross alpha)	161
Nutrients	114
Pesticides	110
Debris, bottom deposits	106
Other inorganics	50
Suspended solids	25

No States provided Tables 7-21 through 7-24 from the Guidelines. Only Alabama explained why they did not provide these tables; they do not usually assess waterbodies for support of the drinking water use classification.

Only two States provided information on specific contaminants or general categories of contaminants that were used in the assessment: Wyoming and New York. Wyoming provided a separate table summarizing causes of drinking water use impairment of impacted rivers and streams as follows:

- Unknown toxicity
- Pesticides
- Priority organics
- Metals
- Ammonia
- Other inorganics
- Nutrients
- pH
- Siltation
- Salinity
- Flow alterations
- Habitat alterations
- Pathogens
- Radiation
- Oil and grease
- suspended solids
- Filling and draining
- Total toxics
- Turbidity.

New York did not provide a separate summary table but did provide large tables for every river basin in the State that summarized the segment type and size, the primary use impaired, including drinking water, the severity, the primary pollutant, and the primary source. Arizona provided the same sort of tables for every river basin, but they included information on the number and type of samples, the standards or criteria exceeded, the range of values, and the frequency exceeded. Delaware provided maps for every river basin with detailed information on water quality assessment, biological monitoring, point sources, nonpoint sources, and percent of use support per designated use. However, Delaware rarely provided information on drinking water as a designated use.

Little information was provided by the States explaining how they classified waterbodies for drinking water use. Vermont was an exception; they explained their classification system for every use. For drinking water they used the following system:

- Fully supported: No drinking water supply closures or advisories in effect during reporting period; no treatment necessary beyond "reasonable" levels.
- Partially supported: One drinking water supply advisory lasting 30 days or less per year, or problems not requiring closures or advisories but adversely affecting treatment costs and the quality of treated water, such as taste and odor problems, color, excessive turbidity, high dissolved solids, and pollutants requiring activated charcoal filters.
- Not supported: One or more drinking water supply advisories lasting more than 30 days per year, or one or more drinking water supply closures per year.

North Carolina outlined the system they use to determine whether a body of water meets its intended use, including drinking water. If more than one source of data exists for a stream, the rating is assigned according to the following hierachy:

- Fish consumption advisories
- Benthic bioclassification/fish community structure
- Chemical/physical data
- Monitored data >5 years old
- Compliance/toxicity data.

Several States provided information on the number of MCL violations for public water systems. West Virginia provided a table with the total number of community public water systems with MCL violations (for finished/treated ground water) and the population served. MCL contaminants included

- Metals
- VOCs, including trichloroethene, tetrachloroethene, and total halomethanes
- Pesticides
- Nitrates
- Bacteria.

Arkansas presented MCL violations for ground water systems with the following MCLs:

- Bacteriological
- Turbidity
- Organic
- Inorganic
- Radiochemical
- Trihalomethane.

As discussed above, Alabama used their lack of MCL violations to justify their classification of all rivers and streams meeting the drinking water use classification.

3.0 1998 Drinking Water Guidelines

The guidelines for States to use in assessing drinking water use support for the 1998 305(b) cycle were revised in order to provide more flexibility to the States. These guidelines emphasize that States may consider prioritizing their water resources and performing drinking water use support assessments for a limited percentage of their water resources. States are then encouraged to expand their drinking water assessment efforts to include additional waters each subsequent reporting cycle. The guidelines recommend prioritization based on waters of greatest drinking water demand, with further prioritization with respect to vulnerability or other State-priority factors. In addition, the guidelines encourage States to consider using a tiered approach in the assessment. This tiered approach would accommodate the different types of data currently available to States and allows for differing levels of assessment. The guidelines encourage States to use the best available data that reflects the quality of the resource, and does not ask States to conduct additional monitoring that does not fit in with other State priorities.

The guidelines provide three tables for the States to fill out on drinking water use. Table 4-20 consists of a summary of contaminants used in the assessment, Table 4-21 summarizes the miles (for lakes and streams): fully supporting drinking water use, fully supporting but threatened for drinking water use, partially supporting drinking water use, and not supporting drinking water use, and Table 4-22 is identical to Table 4-21 except it deals with lakes and reservoirs and is presented in acres, instead of miles.

In addition, the guidelines provide the following assessment framework for determining the degree of drinking water use support:

Classification	**Monitoring Data**		**Use Support Restrictions**
Full support	Contaminants do not exceed water quality criteria	and/or	Drinking water use restrictions are not in effect
Full support but threatened	Contaminants are detected but do not exceed water quality criteria	and/or	Some drinking water use restrictions have occurred and/or the potential for adverse impacts to source water quality exists
Partial support	Contaminants exceed water quality criteria intermittently	and/or	Drinking water use restrictions resulted in the need for more than conventional treatment

Classification	Monitoring Data		Use Support Restrictions
Nonsupport	Contaminants exceed water quality criteria consistently	and/or	Drinking water use restrictions resulted in closures
Unassessed	Source water quality has not been assessed.		

3.1 Summary of Drinking Water Data Reported by States in 1998

Some States provided much more detail on drinking water use support in the 1998 305(b) cycle. A review of the 1998 305(b) reports that have currently been received (ten States or territories) showed

- Three States had separate drinking water sections providing detailed information on monitoring results and their criteria for classification of drinking water use
- Three States did not have a separate drinking water section but discussed drinking water as a designated use
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- **ARKANSAS:** Arkansas presented data on analysis from 133 ambient water quality sampling stations. Elevated levels of some pesticides were found, but none exceeded the maximum contaminant levels (MCLs). The three pesticides with the highest occurrences above the detection level were atrazine, metolachlor, and molinate. Monthly data for nitrate and minerals (chlorides, sulfates, total dissolved solids) were compared to the MCLs. Of more than 8500 miles assessed for drinking water use support, 77.7 miles were not meeting the use and there was concern for an additional 38.1 miles. Many of the exceedances were from nitrate values greater than 10 mg/L. Arkansas did not prepare Tables 4-21-23 from the guidance; they did, however, prepare a list of the pesticides for which they analyzed.

- **HAWAII:** Hawaii summarized the length of streams used for drinking water and presented the list of contaminants being monitored: all current MCLs including bacteriological, organics, inorganics, and pesticides (the same information asked for in Table 4-20). All streams were found to be fully supporting drinking water use, but Hawaii did not present the monitoring results. A summary table was provided reporting the lengths of streams (in miles) used for drinking water and it was noted that all streams are considered fully supporting drinking water use. They did not prepare Tables 4-21 or 4-22.

- **MASSACHUSETTS:** Massachusetts provided a very detailed drinking water section. They did not prepare Table 4-20; however, they did state that they are currently monitoring for up to 133 contaminants, including the volatile organic compounds

(VOCs), inorganic compounds (IOCs), synthetic organic compounds (SOCs), microbiological contaminants, turbidity, and radionuclides. Of 231 public ground water sources closed, 136 were contaminated by VOCs, 63 by IOCs, SOCs, or natural causes, and 18 by two or more chemicals. Fifteen sources reported nitrate detections above the MCL, several had problems with lead and copper action levels, and several had sodium above Massachusett's recommended guideline level. For surfacewater, 96% were in full compliance, 28% had non-trihalomethane VOC detects, and 2 were threatened by nitrates. The criteria for drinking water use are as follows: full support is monitoring samples that do not exceed the MCL, threatened is monitoring samples equal to or greater than one-half the MCL, non-support is samples that exceed the MCL. Annual average levels were not considered. Massachusetts did not prepare Tables 4-21 or 4-22.

4.0 305(b) Data and the IWI Project

The IWI project is a compilation of data that characterizes the overall condition of the water resources of this country. Characterization is based on the use of 15 indicator parameters selected to describe whether rivers, streams, lakes, wetlands, and coastal areas are "well" or "ailing" and whether activities are placing the waters at risk. Seven of the indicators characterize the condition of the nation's water resources, and eight characterize vulnerability.

There is one indicator which deals with drinking water. It is titled, "Importance of the Indicators of Source Water Condition for Drinking Water Systems" and uses three surrogate measures from different data sets to provide a partial picture of the source water condition. The three indicators used to characterize source water condition are: a) rivers and lakes supporting State drinking water designated uses, b) two Safe Drinking Water Information System (SDWIS) surrogate indicators of source water condition, and c) the occurrence of chemicals regulated under the Safe Drinking Water Act in ambient waters. These indicators are then used to identify if there is evidence in the watershed of 1) no significant source water impairment, 2) partial source water impairment, or 3) significant source water impairment.

The first indicator, (rivers and lakes supporting drinking water designated uses) is based solely on the data provided by the States in the 305(b) reports. Currently, as discussed above, this assessment is far from comprehensive across the United States. However, as more States report this information, the IWI will be able to provide a more comprehensive analysis.

The second indicator (SDWIS surrogate indicators) consists of two indicators developed from SDWIS data: 1) populations served by community water systems that reported one or more violations of national health-based drinking water standards during 1991-1996 for chemical contaminants that are source related, and 2) populations served by community water systems that have treatment in place in 1996 to remove chemical contaminants that are source related.

The third indicator (occurrence of regulated chemicals) uses sampling results in the STOrage and RETrieval (STORET) national database from both surface water and ground water for all chemical contaminants regulated under the Safe Drinking Water Act. Observations above 50% of the MCL (1990-1995) were summed for each watershed.

The 305(b) reports have the potential to provide additional information to be useful to IWI in the future. For example, as more States add information on the causes of water not meeting drinking water use, this information could be added to IWI as an additional layer expressing risk for drinking water quality impairment. This information would be helpful in further characterizing the State of this country's water resources.

5.0 Conclusions

A comparison of the 1996 and 1998 305(b) reports shows an improvement in the amount and level of detail provided by a number of States concerning drinking water use. The revised guidelines appear to have been successful in the attempt to encourage more flexibility and prioritization by the States. It does not appear that major changes are needed to the guidance for the next 305(b) reporting cycle; the trend appears to be toward States reporting more and better information in each cycle. Any changes in the guidance should be oriented toward helping those States who have not yet reported drinking water use data in their 305(b) reports to begin doing so, perhaps by providing examples of the type of assessments done by a few States who have reported these data.

DIVIDER PAGE

September 15, 1998

The Use of Nitrate as an Indicator Parameter of Water Quality

Table of Contents

1.0 Introduction

Obtaining water quality data that are totally appropriate and reliable is problematic. In response to widespread problems concerning the reliability of water quality databases, an Intergovernmental Task Force on Monitoring Water Qaulity (ITFM) was formed in 1992. The purpose of the ITFM was to develop a framework for water quality monitoring and to recommend environmental indicators of aquatic condition that agencies could use for different purposes.

In their August 1997 report, the Ground Water Focus Group of the ITFM establishes a strong framework for developing a monitoring plan for ground-water quality (ITFM, 1997). Ground-water quality indicators that may be appropriate for monitoring in areas having different types of land use and sources of contaminants are presented. Nitrate is listed as a potential indicator of contamination originating from municipal, domestic, commercial, and agricultural land uses. Specific land uses and sources for nitrate contamination include municipal sewer/pipeline; municipal and commercial sanitation; irrigation; animal feedlots; and cultivation.

Other potential indicators of ground-water quality are also included in the ITFM report. Physical parameters, volatile organic compounds, semi-volatile organic compounds, petroleum hydrocarbon compounds, pesticides, trace metals, biological and inorganic constituents are listed. Although a broad array of potential indicator parameters exists, their usefulness depends upon their relevance to the monitoring objectives, analytical methodologies, and land use impacts. In assessing ground-water quality on a National basis, nitrate meets the objectives of an overall indicator and has received prominence on both the National and the State levels.

2.0 Use of Nitrate Within the 305(b) Program

Nitrate is well suited for use as a national indicator parameter. Sources of nitrate are widespread and abundant at the land surface. Nitrate is soluble, relatively persistent, and mobile in the environment. Its presence in ground-water systems is indicative of anthropogenic activities and it can be detected at relatively low concentrations through the use of standard, reliable, and relatively inexpensive analytical methodologies. Thus, the objective of maximizing the collection of meaningful ground-water quality information while minimizing the cost is met.

Recognizing this, the use of nitrate as a national indicator of ground-water quality was promoted through the Clean Water Act Section 305(b) program in which States are asked to monitor and assess the quality of their water resources. As part of this program, EPA developed a set of guidelines to assist States in reporting ground-water information. In these guidelines, EPA requested that States assess ground-water quality for selected aquifers within the State. Parameters suggested for use in the assessments include volatile organic compounds, semi-volatile organic compounds, and nitrate. Nitrate was specified due to the existence of widespread sources, ease of monitoring, relatively inexpensive cost, and environmental mobility.

Ground-water data reported by States for the 1996 and 1998 305(b) cycles clearly shows that nitrate is already being used by States as an important indicator of ground-water quality and vulnerability. For example, more data were reported for nitrate for ambient ground-water monitoring networks than for any other indicator parameter during both 305(b) cycles and States asked to supply individual ground-water assessments opted to use nitrate in their analyses.

Thirty-three States reported ground-water monitoring data during the 1996 305(b) cycle. Of these States, 32 provided data for nitrate. More data were reported for nitrate than any other indicator parameter. States reported nitrate data for ambient ground-water monitoring networks, untreated and treated samples collected from public water supply systems, untreated water samples collected from private water supply systems, and special studies. Although the Clean Water Act Section 305(b) ground-water program does not assign use-support designations, nitrate was used by States to delimitate ground-water quality in the following categories:

- background ground-water conditions (i.e., nitrate concentrations less than 3 mg/L);
- potentially impacted conditions (i.e., nitrate concentrations ranging from 3 to 5 mg/L);
- marginally impacted conditions (i.e., nitrate concentrations ranging from 5 to 10 mg/L); and,
- impacted conditions (i.e., nitrate concentrations exceeding the maximum contaminant level as defined under the Safe Drinking Water Act).

Using nitrate as an indicator of ground-water quality, States reported that they developed ground-water management strategies and plans.

States continued to use nitrate to report ground-water monitoring data as part of the 1998 305(b) cycle. As of August 1998, a total of 15 States submitted *State Water Quality Reports* and 12 of the 15 reported monitoring results for nitrate. States reported data for ambient ground-water monitoring networks, untreated and treated samples collected from public water supply systems, and untreated water samples collected from private water supply systems. Some States reported recent monitoring results for the same aquifer systems assessed during the 1996 305(b) cycle (e.g., Idaho, Arkansas). Other States reported monitoring results for new aquifer systems, thus increasing the number and area of assessed aquifers (e.g., Alabama, Texas).

The predominance of nitrate as an indicator of ground-water quality was further emphasized during production of the *National Water Quality Inventory 1998 Report to Congress*, which relies on 305(b) data reported by States in their *State Water Quality Reports*. Select States were contacted and asked to provide ground-water assessments in a geographic information system (GIS) format. The purpose of this exercise was to highlight examples of State capabilities and assessment methodologies. As a consequence, assessment parameters were not specified by EPA, but rather left to the discretion of the individual States. Although assessment parameters were not specified, it was assumed by EPA that States would likely provide ground-water assessments using a variety of different analytes (e.g., metals, volatile organic compounds, pesticides). However, five out of five States opted to provide ground-water assessments for nitrate, thus emphasizing the importance of nitrate as an indicator parameter on the State level.

Finally, nitrate was selected for use as an indicator parameter because the Clean Water Act Section 305(b) program is geared toward developing an accurate representation of our Nation's ground-water condition. This purpose was congruent with another EPA initiative, the National Environmental Goals for Water, which selected nitrate as a national indicator of ground-water quality (EPA, 1996). Data completeness for the national indicator was lacking and a data source was needed. The 305(b) program had by necessity begun the task of developing a data base to compile and maintain the large volume of ambient ground-water quality data reported by States. Thus, a framework for collecting and managing ambient ground-water data for nitrate on a biennial basis was established and could be used to support EPA's National Environmental Goals Initiative.

3.0 Nitrate as an Indicator Parameter

Nitrate meets the main requirements for an indicator parameter. Specifically, nitrate is mobile and persistent in the environment; characterized by widespread and abundant sources at the land surface; representative of anthropogenic sources of contamination; easily measured by standard, reliable, and relatively inexpensive analytical methodologies; currently being measured on national, state, and local scales; and measured data are readily available (e.g., public water supply system databases). Thus, it is not a coincidence that interest in nitrate as an overall indicator of ground-water quality evolved over the course of the past decade as interest in assessing ground-water quality gained momentum.

3.1 Special Studies Involving Nitrate

Nitrate was an important indicator parameter in two national studies of ground-water quality conducted in the early 1990s. As part of the National Survey of Pesticides in Drinking Water Wells, EPA sampled approximately 1,300 community water system wells and rural domestic wells between 1988 and 1990. Samples were analyzed for the presence of 101 pesticides, 25 pesticide degradates, and nitrate. The survey results statistically represent approximately 94,600 drinking water wells at community water systems and over 10.5 million rural domestic wells throughout the United States.

The second national study incorporating indicator parameters is the U.S. Geological Survey's (USGS) National Water Quality Assessment (NAWQA) Study that was implemented in 1991. NAWQA was designed to describe the status and trends in the quality of our Nation's ground water and surface water resources and to provide a sound understanding of the natural and human factors that affect the quality of these resources. To best accomplish this task, the USGS sought advice on which contaminants were most important to focus on. There was almost unanimous agreement that nutrients (i.e., nitrogen and phosphorus) and pesticides were widespread and longstanding issues of concern. Thus, occurrences of nutrients and pesticides were selected as the first two issues requiring study by the USGS.

The NAWQA program addresses a broad spectrum of water-quality issues. The National Synthesis Program aims to synthesize NAWQA results obtained from individual study units within the United States with information from other programs, agencies, and researchers to produce regional and national assessments for priority water quality issues. The first topics addressed by the National Synthesis are pesticides, nutrients, volatile organic compounds, aquatic biology, and trace elements. The National Synthesis focusing on nutrients aims to understand how human and natural influences affect the movement of nitrogen and phosphorus through ground and surface waters. Discussions on these and other water quality topics are published in periodic summaries of the quality of the Nation's ground and surface water, as the information becomes available. A listing of currently available reports is provided in Appendix A.

Two data sets are also available from the USGS nutrient study. The data sets are available online and can be found at http://wwwrvares.er.usgs.gov/nawqa/nutrients/datasets.html. These datasets include data describing the patterns of risk for nitrate contamination in ground water and nutrients in ground water and surface water.

In addition to the National studies undertaken by EPA and the USGS, States are conducting studies to verify the usefulness of nitrate as an indicator parameter of ground-water condition and vulnerability. One such study was conducted by the State of South Carolina, which compared nitrate data obtained from public water supply systems to existing databases of carbon-14 and tritium ground-water quality data. The purpose of the comparison was to determine if nitrate could be used as a less expensive alternative to the carbon-14 and tritium indicator parameters. Although the comparison is still in progress, initial results indicate that nitrate compares favorably and is an excellent indicator of anthropogenic impacts to water quality. However, because nitrate may be subject to denitrification, the converse cannot be said (i.e., the absence of nitrate does not implicitly indicate that the ground water aquifer has not been impacted by anthropogenic activities).

The State of Washington used nitrate to create a ground-water vulnerability map of Puget Sound Basin. Using logistic regression, the occurrence of elevated nitrate concentrations in samples from 1,967 public water supply wells was related to natural factors to assess aquifer susceptibility, and to natural and anthropogenic factors to assess ground-water vulnerability. Significant factors included well depth, surficial geology, and the percentage of agricultural and urban land use within a two-mile radius of a well. The vulnerability assessment is used for planning land use, targeting ground-water monitoring, monitoring changes in risk of nitrate contamination of ground-water, and evaluating risk from other contaminants. Studies conducted by the States of South Carolina and Washington are just two such studies among the many that are currently being undertaken on the State level.

To further evaluate the use of nitrate as an indicator parameter, the *Water Resources Abstract* database was searched for references to nitrate in ground-water monitoring studies. Searches were limited to references published between January 1993 and April 1998. Two keyword searches were conducted. The first search was conducted using the keywords "nitrate" and "ground water." A total of 552 references were returned. A second search focused on "nitrate" and "ground-water quality" and a total of 382 references were returned. Key-phase searches using "environmental indicator" and "environmental parameter" did not return any references.

Abstracts for 79 references are contained in Appendix B. Information synthesized from the abstracts of the 79 references is summarized as follows:

- Many of the studies focusing on assessing the impact of different land use parameters (e.g., agricultural, animal farming, rural residential, suburban residential) on regional ground-water quality used nitrate as a measurement of water quality (i.e., nitrate levels in relation to the maximum contaminant level [MCL]);

- The general theme of most of the papers was the use of nitrate concentrations (often in comparison to the MCL) and distributions in ground water as a means of studying the mechanisms and sources of nitrate contamination in ground water;
- Nitrate was only used as a measure of water quality with respect to contaminant sources containing nitrate or from which nitrate may be derived (mostly fertilizers, animal wastes, and septic tanks);
- Some of the studies used nitrate in conjunction with other parameters such as pesticides, bacteria, and trace metals (e.g., lead). However, these parameters were used independently of each other.

Nitrate was found to be used as an overall indicator of ground-water quality and concentrations can be related to differences in land-use practices and soil-drainage properties. Generally, nutrient concentrations are highest in agricultural areas and in areas of well-drained soils and intensive cultivation. Although other parameters are available for use as possible indicator parameters (e.g., phosphorus, various trace metals, organic compounds, suspended sediment, fecal coliform bacteria), nitrate meets the requirements for a general ground-water quality indicator parameter. The extensive use of nitrate further validates its importance as an indicator of ground-water quality.

3.2 Potential Limitations

Several limitations to the use of nitrate as a general ground-water indicator parameter exist. Natural background nitrate concentrations in ground water are generally less than 3 mg/L. However, elevated concentrations of naturally occurring nitrate may exist locally. Although high concentrations of naturally occurring nitrate may initially be misleading, competent ground-water professionals should easily discern the difference between naturally occurring conditions and actual ground-water contamination problems.

Sources of nitrate occur on the land surface. The risk of ground-water contamination by nitrate is dependent upon releases to the land surface and the degree to which an aquifer is vulnerable to nitrate leaching and accumulation. Studies have shown that nitrate contamination is generally associated with shallow aquifer systems, thereby possibly limiting the use of nitrate in deep aquifer systems. It is reasonable to assume that the majority of all other potential indicator parameters would be subject to this same limitation.

Nitrate is subject to reactions reflecting the metabolic activity of bacteria: nitrification and denitrification. Under aerobic conditions, nitrifying bacteria oxidize ammonium ion to nitrite, which in turn, is then oxidized to nitrate. Denitrification involves the reduction of nitrate to nitrogen gas. This process is a form of anaerobic respiration from which denitrifying bacteria derive oxygen.

Depending upon the conditions of the ground-water system (i.e., aerobic or anaerobic), nitrate concentrations may be increased or decreased as a result of microbial activity. The degree to which nitrate concentrations are affected is difficult to quantify. However, these reactions do not limit the use of nitrate as an indicator parameter. As observed in the South Carolina study, elevated concentrations of nitrate in ground-water systems can be linked to surface contamination. The absence of nitrate, however, does not implicitly imply the absence of surface contamination.

As shown in the literature review, many of the studies using nitrate as an indicator parameter are doing so in connection with specific land use concerns (e.g., inorganic fertilizer applications, animal farming, septic tanks). In a study conducted by the USGS, nitrate was shown to pose a high risk to ground-water quality in areas having high nitrogen input factors and high aquifer vulnerability factors (USGS, 1998). The Midwest and parts of western and northeastern United States were shown to have a high risk of ground-water contamination by nitrate. Nitrate would especially be a suitable indicator parameter in these areas. However, the susceptibility of the aquifer decreases in areas having low nitrogen input and low aquifer vulnerability (e.g., western United States). This does not pose a serious problem because ground-water professionals indicate that nitrate sources are abundant and ubiquitous throughout the United States.

Although some limitations to the use of nitrate as an overall indicator of ground-water quality do exist, none of the limitations pose a serious problem. Furthermore, there are no other known indicator parameters that would not be similarly affected by these same or other limitations.

4.0 Conclusions

Nitrate is well suited for use as a national indicator of ground-water quality and vulnerability. It is evident that nitrate is currently being used for this very purpose on national, state, and local scales. As an indicator, nitrate meets the necessary requirements that maximize information while minimizing costs. It is

- mobile and relatively persistent in the environment;
- representative of anthropogenic sources of contamination;
- characterized by widespread and abundant sources at the land surface;
- easily measured by standard, reliable, and relatively inexpensive analytical methodologies, and
- large accumulations of data on National and State scales are currently being compiled into databases (NAWQA, CWA 305(b)).

Hence, evidence supports the use of nitrate to assess general ground-water quality and derive a better understanding of the vulnerability of our Nation's ground water systems.

5.0 References

EPA. 1996. *Environmental Indicators of Water Quality in the United States.* United States Environmental Protection Agency. Office of Water. EPA 841-R-96-002. June 1996.

ITFM. 1997. *Conceptual Frameworks for Ground-Water-Quality Monitoring*. Ground Water Focus Group, Intergovernmental Task Force on Monitoring Water Quality. August 1997.

USGS. 1998. *A National Look at Nitrate Contamination of Ground-Water.* Nolan, B.T., B.C. Ruddy, K.J. Hitt, and D.R. Helsel. United States Geological Survey. Water Condition and Purification Magazine.

Appendix A: Select NAWQA References

The following reports were prepared by the NAWQA NATIONAL SYNTHESIS PROJECT:

A National Look at Nitrate Contamination of Ground Water. Bernard T. Nolan, Barbara C. Ruddy, Kerie J. Hitt, and Dennis R. Helsel. Water Conditioning and Purification, v. 39, no. 12, pages 76-79. January 1998. This article refines the national risk map presented in Fact Sheet FS-092-96.

Nitrate in ground waters of the United States--Assessing the risk. Bernard T. Nolan and Barbara C. Ruddy. United States Geological Survey. Fact Sheet FS-092-96. April 1998. The map presented in this fact sheet has been refined and is now available in *a National Look at Nitrate Contamination of Groundwater.*

Nutrients in the Nation's Waters--Too Much of a Good Thing? David K. Mueller and Dennis R. Helsel. United States Geological Survey. Circular 1136. http://wwwrvares.er.usgs.gov/nawqa/CIRC-1136.html.

Nutrients in Ground Water and Surface Water of the United States -- a Summary of NAWQA's Analysis of Data Through 1992. Featured article in National Water Quality Evaluation Project (NWQEP) Notes. North Carolina State University Water Quality Group Newsletter. March 1996. Based on United States Geological Survey WRI95-4031.

Nutrients in Ground Water and Surface Water of the United States -- a Summary of NAWQA's Analysis of Data Through 1992. United States Geological Survey. Water-Resources Investigations Report 95-4031. Press release August 24, 1995.

Refining 1970's Land-Use Data With 1990 Population Data to Indicate New Residential Development. Kerie J. Hitt. United States Geological Survey. Water-Resources Investigations Report 94-4250.

Nonpoint and Point Sources of Nitrogen In Major Watersheds of the United States. Larry J Puckett. United States Geological Survey. Water-Resources Investigations Report 94-4001.

The following reports were prepared by the NAWQA STUDY UNITS:

Apalachicola-Chattahoochee-Flint Basin

Hippe, Daniel J., Wangsness, David J., Frick, Elizabeth A., and Garrett, Jerry W. 1994. *Are Farmers Contaminating the Shallow Ground Water*? Modified from United States Geological Survey Investigations Report 94-4183.

Hippe, Daniel J., Wangsness, David J., Frick, Elizabeth A., and Garrett, Jerry W. 1994. *Suspended Sediment and Agricultural Chemicals in Floodwaters Caused by Tropical Storm Alberto.* Modified from United States Geological Survey Water-Resources Investigations Report 94-4183.

Wangsness, D.J., Frick, E.A., Buell, G.R., and Devivo, J.C. *Effect of the Restricted Use of Phosphate Detergent and Upgraded Wastewater Treatment Facilities on Water Quality in the Chattahoochee River near Atlanta, Georgia.* Based on United States Geological Survey Open-File Report 94-99.

Central Columbia Plateau

Greene, K.E., Ebbert, J.C., and Munn, M.D. 1994. *Nutrients, Suspended Sediment, and Pesticides in Streams and Irrigation Systems in the Central Columbia Plateau, in Washington and Idaho, 1959-1991.* United States Geological Survey Water-Resources Investigations Report 94-4215.

Jones, J.L., and Wagner, R.J. 1995. *Ground-water Quality of the Central Columbia Plateau in Washington and Idaho: Analysis of Available Nutrient and Pesticide Data, 1942-1992.* United States Geological Survey Water-Resources Investigations Report 94-4258.

Ryker, S.J., and Jones, J.L. 1995. *Nitrate Concentrations in Ground Water of the Central Columbia Plateau.* United States Geological Survey Open-File Report 95-445. Fact Sheet.

Georgia-Florida Coastal Plain

Berndt, M.P. 1994. *National Water Quality Assessment Program-- Preliminary Assessment of Nitrate Distribution in Ground Water in the Georgia-florida Coastal Plain Study Unit, 1972-1990.* United States Geological Survey Open-File Report 93-478.

Oaksford, E.T. 1994. *National Water Quality Assessment Program--Preliminary Results: Agricultural Chemicals in the Suwannee River Basin, Georgia-florida Coastal Plain Study Unit.* United States Geological Survey Open-File Report 94-103. Water Fact Sheet.

Berndt, M.P. 1996. *Ground-water Quality Assessment of the Georgia-florida Coastal Plain Study Unit--analysis of Available Information on Nutrients, 1972-1992.* United States Geological Survey Water-Resources Investigations Report 95-4039.

Ozark Plateaus

Davis, J.V., Petersen, J.C., Adamski, J.C., and Freiwald, D.A. 1996. *Water-Quality Assessment of the Ozark Plateaus Study Unit, Arkansas, Kansas, Missouri, and Oklahoma--Analysis of Information on Nutrients, Suspended Sediment, and Suspended Solids, 1970-1992.* United States Geological Survey Water-Resources Investigations Report 95-4042.

Appendix B: Select Water Resources Abstracts

Record 1 of 79 - Water Resources Abs. 1/93-4/98

TI: Ground water age and nitrate distribution within a glacial aquifer beneath a thick unsaturated zone.
AU: Johnston,-C.T.; Cook,-P.G.; Frape,-S.K.; Plummer,-L.N.; Busenberg,-E.; Blackport,-R.J.
SO: GROUND-WATER 19980200 vol. 36, no. 1, pp. 171-180
AB: The impact on ground water quality from increasing fertilizer application rates over the past 40 years is evaluated within a glacial aquifer system beneath a thick unsaturated zone. Ground water ages within the aquifer could not be accurately determined from the measured distribution of super(3)H and as a result, chlorofluorocarbon (CFC) and super(3)H/ super(3)He dating techniques were applied. Beneath a 25 m thick unsaturated zone, ground water ages based on CFC-11 concentrations were greater than super(3)H/ super(3)He ground water ages by 6 to 10 years, due to the time lag associated with the diffusion of CFCs through the unsaturated zone. Using the corrected CFC-11 and super(3)H/ super(3)He ground water ages and the estimated travel time of super(3)H within the unsaturated zone, the approximate position of ground water recharged since the mid-1960s was determined. Nitrate concentrations within post mid-1960s recharge were generally elevated and near or above the drinking water limit of 10 mg-N/L. In comparison, pre mid-1960s recharge had nitrate concentrations <2.5 mg-N/L. The elevated NO sub(3) super(-) concentrations in post mid-1960s recharge are attributed mainly to increasing fertilizer application rates between 1970 and the mid- to late 1980s. Anaerobic conditions suitable for denitrification are present within pre mid-1960s recharge indicating that removal of DO is a slow process taking tens of years. Over the next 10 to 20 years, nitrate concentrations at municipal well fields that are currently capturing aerobic ground water recharged near the mid-1960s are expected to increase because of the higher fertilizer application rates beginning in the 1970's and 1980s.
AN: 4257230

Record 2 of 79 - Water Resources Abs. 1/93-4/98

TI: Effects of fire severity on nitrate mobilization in watersheds subject to chronic atmospheric deposition.
AU: Riggan,-Ph.J.; Lockwood,-R.N.; Jacks,-P.M.; Colver,-Ch.G.; Weirich,-F.; DeBano,-L.F.; Brass,-J.A.
SO: ENVIRON.-SCI.-TECHNOL. vol. 28, no. 3, pp. 369-375
AB: Severe fires in chaparral watersheds subject to air pollution from metropolitan Los Angeles mobilized accumulated nitrogen and caused streamwater to be polluted with nitrate at concentrations exceeding the Federal Water Quality Standard. Streamwater NO sub(3) super(-) concentrations were elevated during peak flows, the largest of which was a debris flow that transported NO sub(3) super(-) at concentrations as high as 1.12 mequiv/L. Annual NO sub(3) super(-) loss from severely burned watersheds, averaging 1.2 kequiv/ha, was 40 times greater than that from areas that remained unburned. Fires of moderate intensity produced a more subdued response in stream discharge and soil nitrification and less than one-seventh the NO sub(3) super(-) loss observed after severe burning. We infer that the combination of atmospheric deposition with severe wildfires provides a strong and recurrent source of nitrate that could

contribute to existing groundwater pollution in parts of eastern Los Angeles County. Moderating the fire regime by prescribed burning could provide substantial mitigation.
AN: 4222380

Record 3 of 79 - Water Resources Abs. 1/93-4/98

TI: Transboundary water resources and public health in the U.S.-Mexico border region.
AU: Varady,-R.G.; Mack,-M.D.
SO: J.-ENVIRON.-HEALTH vol. 57, no. 8, pp. 8-13
AB: The 'Ambos Nogales Water Project' represents an interdisciplinary study of water management policy in a community straddling the U.S.-Mexico border. The project was a joint effort undertaken from 1989 through 1993 by the Udall Center for Studies in Public Policy at the University of Arizona and El Colegio de la Frontera Norte (COLEF) in Nogales, Sonora. Funding was provided by the Ford Foundation. Three key water management issues were the research focus: quantity (water supply), sewerage (water and waste removal), and quality. All three have inseparable linkages with public health. Regarding quantity, the study revealed that entire neighborhoods, especially in Nogales, Sonora, are unsupplied or undersupplied with running water, suggesting negative implications for the health of residents on both sides of the border. Sewerage systems do not reach many neighborhoods in Nogales, Sonora. Even sewered areas are problematic due to breaks in poorly maintained systems, resulting in leaks to the aquifer and threats to groundwater quality. A pilot, water sample survey to assess water quality of area wells revealed significant bacteriologic contamination due to wastewater, elevated nitrate levels, and detectable concentrations of volatile organic compounds, all of which have potentially deleterious health effects. The project database offers an opportunity to analyze environment-related health problems in Ambos Nogales. The authors were not involved in the primary water resources research or sampling surveys that are the background of this essay. They have employed the data generated to discuss previously unaddressed public health aspects of the work and reviewed some of the project's implications within the larger context of research on U.S.-Mexico border environmental health. The project itself contributes a model for cooperative, transboundary research on an important set of factors affecting public health. Project outputs are particularly valuable given that the newly created North American Development Bank (NADBank) and its sister institution, the Border Environmental Cooperation Commission (BECC), have identified water-related problems as their initial priority to improve quality of life in the border region.
AN: 4222259

Record 4 of 79 - Water Resources Abs. 1/93-4/98

TI: Nitrate movement through soil profile and groundwater pollution by nitrogen fertilizer in sand dune upland soil.
AU: Nonaka,-M.; Abe,-R.; Kamura,-T.
SO: JAP.-J.-SOIL-SCI.-PLANT-NUTR. 19961200 vol. 67, no. 6, pp. 633-639
AB: The study on relationship between nitrogen fertilizer and accumulated water (precipitation

and irrigation) and nitrate movement through soil profile on groundwater pollution was carried out on the experimental field in sandy soil for 1 year. The nitrogen fertilizers were applied to 268 N kg ha super(-1) as chemical fertilizers in autumn radish cropping and 171 N kg ha super(-1) as organic matters in summer tobacco cropping. The results were summarized as follows: 1) The chemical form of leached nitrogen was mostly as nitrate. The nitrate concentration in groundwater was increased by more than 100 mm accumulated water per month, but was decreased by below 100 mm accumulated water per month. 2) In the cast of more than 100 mm accumulated water per month, the maximum peak of nitrate leaching appeared at 3 weeks after basal application during autumn radish cropping. But, in the drought summer season of 1994, the nitrate leaching was depressed during summer tabacco cropping.
AN: 4228633

Record 5 of 79 - Water Resources Abs. 1/93-4/98

TI: Predicting the probability of elevated nitrate concentrations in the Puget Sound Basin: Implications for aquifer susceptibility and vulnerability.
AU: Tesoriero,-A.J.; Voss,-F.D.
SO: GROUND-WATER 19971200 vol. 35, no. 6, pp. 1029-1039
AB: The occurrence and distribution of elevated nitrate concentrations (greater than or equal to 3 mg/l) in ground water in the Puget Sound Basin, Washington, were determined by examining existing data from more than 3000 wells. Models that estimate the probability that a well has an elevated nitrate concentration were constructed by relating the occurrence of elevated nitrate concentrations to both natural and anthropogenic variables using logistic regression. The variables that best explain the occurrence of elevated nitrate concentrations were well depth, surficial geology, and the percentage of urban and agricultural land within a radius of 3.2 kilometers of the well. From these relations, logistic regression models were developed to assess aquifer susceptibility (relative ease with which contaminants will reach aquifer) and ground-water vulnerability (relative ease with which contaminants will reach aquifer for a given set of land-use practices). Both models performed well at predicting the probability of elevated nitrate concentrations in an independent data set. This approach to assessing aquifer susceptibility and ground-water vulnerability has the advantages of having both model variables and coefficient values determined on the basis of existing water quality information and does not depend on the assignment of variables and weighting factors based on qualitative criteria.
AN: 4228144

Record 6 of 79 - Water Resources Abs. 1/93-4/98

TI: Risk of nitrate in groundwater of the United States - a national perspective.
AU: Nolan,-B.T.; Ruddy,-B.C.; Hitt,-K.J.; Helsel,-D.R.
SO: ENVIRON.-SCI.-TECHNOL. 19970800 vol. 31, no. 8, pp. 2229-2236
AB: Nitrate contamination of groundwater occurs in predictable patterns, based on findings of the U.S. Geological Survey's (USGS) National Water Quality Assessment (NAWQA) Program. The NAWQA Program was begun in 1991 to describe the quality of the Nation's water resources,

using nationally consistent methods. Variables affecting nitrate concentration in groundwater were grouped as "input" factors (population density and the amount of nitrogen contributed by fertilizer, manure, and atmospheric sources) and "aquifer vulnerability" factors (soil drainage characteristic and the ratio of woodland acres to cropland acres in agricultural areas) and compiled in a national map that shows patterns of risk for nitrate contamination of groundwater. Areas with high nitrogen input, well-drained soils, and low woodland to cropland ratio have the highest potential for contamination of shallow groundwater by nitrate. Groundwater nitrate data collected through 1992 from wells less than 100 ft deep generally verified the risk patterns shown on the national map. Median nitrate concentration was 0.2 mg/L in wells representing the low-risk group, and the maximum contaminant level (MCL) was exceeded in 3% of the wells. In contrast, median nitrate concentration was 4.8 mg/L in wells representing the high-risk group, and the MCL was exceeded in 25% of the wells.
AN: 4220944

Record 7 of 79 - Water Resources Abs. 1/93-4/98

TI: Atrazine and nitrate transport to the Brazos River floodplain aquifer.
AU: Chakka,-K.B.; Munster,-C.L.
SO: TRANS.-ASAE 19970600 vol. 40, no. 3, pp. 615-621
AB: The potential for contamination of groundwater and surface water from agricultural chemicals used on river floodplains is a serious concern in many parts of the United States, An agricultural research site located near College Station, Texas, was instrumented to determine the fate of agricultural chemicals typically applied to the Brazos River floodplain. Nine well nests were installed in a 3x3 grid pattern, parallel and perpendicular to the river. Each well nest has four monitoring wells screened at various depths throughout the aquifer. Ammonium-nitrate fertilizer and the herbicide atrazine were applied to this research site at the time a corn crop was planted in 1994 and 1995. Groundwater and river samples were periodically collected and tested for nitrate-N, ammonium-N, and atrazine. Increases in nitrate-N in the groundwater were not observed due to high background concentrations of nitrate-N. Ammonium-N was not detected in the groundwater above background concentrations (<1 mg/L) due to nitrification of ammonium-N to nitrate-N in the clay soil. Atrazine was detected in the groundwater 24 days after the second application indicating preferential flow through the Ships clay surface layer that was 6 m thick. A pump test that was conducted at the research site just after the second atrazine application facilitated the movement of atrazine to a depth of 18 m.
AN: 4219617

Record 8 of 79 - Water Resources Abs. 1/93-4/98

TI: A study of the temporal variability of atrazine in private well water. Part II: Analysis of data.
AU: Pinsky,-P.; Lorber,-M.; Johnson,-K.; Kross,-B.; Burmeister,-L.; Wilkins,-A.; Hallberg,-G.
SO: ENVIRON.-MONIT.-ASSESS. 1997 vol. 47, no. 2, pp. 197-221
AB: In 1988, the Iowa Department of Natural Resources, along with the University of Iowa, conducted the Statewide Rural Well Water Survey, commonly known as SWRL. A total of 686

private rural drinking water wells was selected by use of a probability sample and tested for pesticides and nitrate. A subset of these wells, the 10% repeat wells, were additionally sampled in October, 1990 and June, 1991. Starting in November, 1991, the University of Iowa, with sponsorship from the United States Environmental Protection Agency, revisited the 10% repeat wells to begin a study of the temporal variability of atrazine and nitrate in wells. Other wells, which had originally tested positive for atrazine in SWRL but were not in the 10% population, were added to the study population. Temporal sampling for a year-long period began in February of 1992 and concluded in January of 1993. All wells were sampled monthly, a subset was sampled weekly, and a second subset was sampled for 14 day consecutive periods. Of the 67 wells in the 10% population tested monthly, 7 (10.4%) tested positive for atrazine at least once during the year, and 3 (4%) were positive each of the 12 months. The average concentration in the 7 wells was 0.10 mu g/L. For nitrate, 15 (22%) wells in the 10% repeat population monthly sampling were above the Maximum Contaminant Level of 10 mg/L at least once. This paper, the second of two papers on this study, describes the analysis of data from the survey. The first paper (Lorber et al., 1997) reviews the study design, the analytical methodologies, and development of the data base.
AN: 4215684

Record 9 of 79 - Water Resources Abs. 1/93-4/98

TI: Agricultural land use effects on nitrate concentrations in a mature karst aquifer.
AU: Boyer,-D.G.; Pasquarell,-G.C.
SO: WATER-RESOUR.-BULL. 1996 vol. 32, no. 3, pp. 565-573
AB: The impact on water quality by agricultural activity in karst terrain is an important consideration for resource management within the Appalachian Region. Karst areas comprise about 18 percent of the Region's land area. An estimated one-third of the Region's farms, cattle, and agricultural market value are on karst terrain. Nitrate concentrations were measured in cave streams draining two primary land management areas. The first area was pasture serving a beef cow-calf operation. The second area was a dairy. Nitrate-N concentrations were highest in cave streams draining the dairy and a cave stream draining an area of pasture where cattle congregate for shade and water. The dairy contributed about 60 to 70 percent of the nitrogen load increase in the study section of the cave system. It was concluded that agriculture was significantly affecting nitrate concentrations in the karst aquifer. Best management practices may be one way to protect the ground water resource. (DBO)
AN: 4214529

Record 10 of 79 - Water Resources Abs. 1/93-4/98

TI: Springflow effects on chemical loads in the Snake River, south-central Idaho.
AU: Clark,-G.M.; Ott,-D.S.
SO: WATER-RESOUR.-BULL. 1996 vol. 32, no. 3, pp. 553-563
AB: The 150-kilometer middle reach of the Snake River (middle Snake) in south-central Idaho receives large quantities of water from springs discharging along the north side of the river from

the regional Snake River Plain aquifer. Water-quality samples collected from nine north-side springs in April 1994 indicated that springs in the upstream part of the reach had larger concentrations of dissolved solids, dissolved nitrate, total nitrogen, tritium, and heavy isotopes of hydrogen and oxygen than to springs in the downstream part of the reach. Because the spring chemistry varies in the reach, discharge from the springs resulted in a degradation in water quality in some parts of the middle Snake and improvements in water quality in other parts. Depending on the annual discharge in the Snake River, the contribution from the north-side springs represented 33 to 66 percent of the discharge, 32 to 57 percent of the dissolved solids, 26 to 50 percent of the total nitrogen, and 7 to 14 percent of the total phosphorus transported annually from the middle Snake. Synoptic sampling showed that the north-side springs contributed 84 percent of the discharge and 35, 40, and 10 percent of the dissolved solids, total nitrogen, and total phosphorus load, respectively, to the Snake River during the peak of the irrigation season in 1994. (DBO)
AN: 4214528

Record 11 of 79 - Water Resources Abs. 1/93-4/98

TI: The potential risks of groundwater and surface water contamination by agricultural chemicals used in vegetable production.
AU: Beach,-E.D.; Fernandez-Cornejo,-J.; Huang,-W.-Y.; Uri,-N.D.
SO:
J.-ENVIRON.-SCI.-HEALTH-PART-A-ENVIRON.-SCI.-ENG.-TOXIC-HAZARD.-SUBST.-CONTROL 1995 vol. A30, no. 6, pp. 1295-1325
AB: This study identifies those agricultural chemicals used in vegetable production in Arizona, Florida, Michigan, and Texas that are potential contaminants of groundwater and surface water which, in turn, pose risks to human health. Arizona and Florida are more likely to have nitrate leaching problems than Michigan or Texas. The potential for pesticide leaching is relatively high in Arizona head lettuce production and Michigan asparagus production but only moderate in Florida tomato production and Texas watermelon production. The potential for soil-adsorbed runoff and solution runoff in Arizona head lettuce, Florida tomatoes, and Michigan asparagus production is low to moderate. The potential for these sorts of losses in Texas watermelon production is relatively high. Vegetable production around Phoenix, Arizona, in southeast Texas, and in the entire state of Florida is located such that groundwater aquifers which supply drinking water are vulnerable to contamination.
AN: 4209990

Record 12 of 79 - Water Resources Abs. 1/93-4/98

TI: Assessment of forest management effects on nitrate removal by riparian buffer systems.
AU: Hubbard,-R.K.; Lowrance,-R.
SO: TRANS.-ASAE 1997 vol. 40, no. 2, pp. 383-394
AB: A study was conducted to determine the impact of different forest management techniques on shallow groundwater quality in coastal plain riparian zones. Considerable past research had

shown that riparian zones are effective in removing or assimilating nitrates entering from upslope agricultural fields via shallow lateral flow, but the impact of different forest management techniques on this process was unknown. The study was conducted at a site near Tifton, Georgia, on a second-order coastal plain stream. The riparian buffer system consisted of a grass buffer, a managed forest zone, and a forest zone adjacent to the stream. Three forest treatments were studied: mature forest (MF), clearcut (CC), and selective thinning (ST). Following a nine-month pretreatment period, trees were completely or selectively removed from the CC and ST treatments, respectively. Shallow groundwater quality was evaluated in networks of wells on transects extending downslope from the edge of the agricultural field to the stream. Results from the study showed that all three forest management treatments were effective in assimilating nitrate-nitrogen (NO sub(3)-N). Significant differences in NO sub(3)-N concentrations in the shallow groundwater between the three different treatments did not occur. The only statistically significant effect that was observed on groundwater quality was under the CC treatment, where solute concentrations (both NO sub(3)-N and chloride [Cl]) decreased after the tree cutting. This was attributed to a combination of effects including possible increased NO sub(3)-N uptake by rapidly growing vegetation, dilution associated with less evapotranspiration by young vegetation as compared to mature forest, and more throughfall of rainfall under the CC than under the other two treatments. No treatment effects were observed on ammonium-nitrogen (NH sub(4)-N) concentrations. Overall the study showed that regardless of forest management techniques, coastal plain riparian forests are effective in assimilating NO sub(3)-N.
AN: 4208139

Record 13 of 79 - Water Resources Abs. 1/93-4/98

TI: Statistical analysis of rural well contamination and effects of well construction.
AU: Glanville,-T.D.; Baker,-J.L.; Newman,-J.K.
SO: TRANS.-ASAE 1997 vol. 40, no. 2, pp. 363-370
AB: A previous statewide survey showed that 14% of rural wells in Iowa contained detectable concentrations of pesticides. To determine if improved private well construction regulations should be included in Iowa's State Pesticide Management Plan, a two-year study was undertaken to determine: the effects of well construction on pesticide, nitrate-nitrogen, and bacterial contamination of wells; and the possible role of point sources of contamination. Eighty-eight rural water supply wells in nine Iowa counties were sampled daily for five weeks during late spring and summer of 1993, and 20% of these were resampled in 1994. Short-term variation in nitrate-nitrogen concentrations was examined as a possible indicator of rapid inflow of shallow groundwater associated with well construction defects. Mean total coliform bacteria, nitrate-nitrogen, chloride, atrazine, alachlor, and metolachlor concentrations were statistically analyzed to determine if they were correlated, and t-tests also were used to determine if these water quality parameters were affected significantly by physical well parameters such as depth, type of casing, grouting, location within frost pits, and proximity to various potential sources of contamination. Study results indicate that: short-term water quality fluctuations, by themselves, were not a reliable indicator of deteriorated or improperly constructed wells; although the magnitude and frequency of positive total coliform test results was noticeably higher in shallower wells, a substantial fraction (21%) of wells greater than 30.5 m (100 ft) deep also had positive

coliform results; t-tests and correlation analysis failed to show significant differences in mean atrazine or alachlor concentrations when comparing "shallow" and "deep" wells; increased well depth, by itself did not ensure water supply protection from chemical or biological contaminants; mean nitrate-nitrogen and mean chloride concentrations had the strongest correlation ($R = 0.57$, $p = 0.0001$) among any of the contaminants tested; and mean atrazine and alachlor concentrations correlated moderately well with those for the more highly-mobile nitrate-nitrogen and chloride.
AN: 4208136

Record 14 of 79 - Water Resources Abs. 1/93-4/98

TI: Agricultural chemicals in alluvial aquifers in Missouri after the 1993 flood.
AU: Heimann,-D.C.; Richards,-J.M.; Wilkison,-D.H.
SO: J.-ENVIRON.-QUAL. 1997 vol. 26, no. 2, pp. 361-371
AB: Intense rains produced flooding during the spring and summer of 1993 over much of the midwestern USA including many agricultural areas of Missouri. Because of potential contamination from floodwater, an investigation was conducted to determine the changes in concentrations of agricultural chemicals in water samples from alluvial wells in Missouri after the flood. Water samples from 80 alluvial wells with historical data were collected in March, July, and November 1994, and analyzed for dissolved herbicides, herbicide metabolites, and nitrate (NO sub(3)). There were no statistically significant differences in the distribution of alachlor (2,chloro-2'-6'-diethyl-N-[methoxymethyl]-acetanilide), atrazine (2-chloro-4-ethylamino-6-isopropylamino-1,3,5 triazine), and nitrate concentrations between pre- and postflood samples (alpha = 0.05). The detection frequency of alachlor and atrazine in postflood samples was generally lower than the frequency in preflood samples. Analyses of agricultural chemicals in water samples from an intensely sampled well field indicate significant differences between the distribution of dissolved P concentrations in pre- and postflood samples (alpha = 0.05). However, no significant differences were detected between the pre- and postflood distributions of NO sub(3) or ammonia concentrations. Because of the numerous sources of temporal variability and the relatively short record of water-quality data for the study wells, a cause-and-effect relation between changes in agricultural chemical concentration and a single factor of the 1993 flood is difficult to determine. Based on the results of this study, the 1993 flood did not cause widespread or long-term significant changes in concentrations of agricultural chemicals in water from alluvial aquifers in Missouri.
AN: 4113781

Record 15 of 79 - Water Resources Abs. 1/93-4/98

TI: Impact of historical and current farming systems on groundwater nitrate in Northern Missouri.
AU: Kitchen,-N.R.; Blanchard,-P.E.; Hughes,-D.F.; Lerch,-R.N.
SO: J.-SOIL-WATER-CONSERV. 1997 vol. 52, no. 4, pp. 272-277
AB: A major objective of the Management Systems Evaluation Areas (MSEA) Project has been to assess farming system impact on NO sub(3)-N concentrations in shallow aquifers. In Missouri

our interest was to assess farming systems on the claypan soil/glacial aquifer. Three fields were selected and instrumented with groundwater wells in the spring of 1991. Wells were sampled quarterly and analyzed for NO sub(3)-N. Average NO sub(3)-N concentration since 1991 was 7 mg l super(-1), but 25% of the wells had NO sub(3)-N in excess of 10 mg l super(-1). In one field, NO sub(3) concentrations were much higher and are still decreasing after apparently receiving excess nitrogen (N) from manure and N fertilizer before 1980. Long-term N management has long-term impacts on groundwater quality in this aquifer. Current farming systems are probably affecting groundwater quality, but, because of the glacial till's apparent buffer for NO sub(3) storage, groundwater NO sub(3) concentration changes are slow.
AN: 4113201

Record 16 of 79 - Water Resources Abs. 1/93-4/98

TI: Heterogeneities in ground-water geochemistry in a sand aquifer beneath an irrigated field.
AU: Kelly,-W.R.
SO: J.-HYDROL.-AMST. 1997 vol. 198, no. 1-4, pp. 157-176
AB: The contamination of shallow aquifers by elevated nitrate concentrations is a common problem in many rural regions of the world. Aquifers under irrigated land are especially susceptible to this type of contamination. An intensive three-dimensional investigation of water chemistry was undertaken in a shallow unconfined sand aquifer in an area of intensive irrigation in Mason County, Illinois, in order to investigate processes affecting water quality. Results reveal considerable heterogeneity in the aqueous chemistry in three spatial dimensions and temporally. Recharge is rapid in this system and the water chemistry of the recharge water is variable both spatially and temporally, being especially influenced by agricultural practices. Nitrate concentrations are elevated in a zone between about 6 and 10 m beneath the surface, although in certain areas and at certain times this zone was not found. The maximum nitrate concentrations in this zone were slightly greater than 20 mg l super(-1) as N, well above the US Environmental Protection Agency's maximum contaminant level (MCL) of 10 mg l super(-1). Nitrate was generally absent both above and below this depth in the aquifer. Water relatively depleted in nitrate recharges the aquifer from the surface at the site, producing a zone of dilute water near the water table. Beneath the plume, denitrification reactions are responsible for removing nitrate from solution, probably mainly coupled to oxidation of sulfide minerals; tritium data suggest that vertical movement of solutes is rapid and thus there has been enough time to transport surface-applied fertilizer to depths in excess of 30 m in the aquifer. This rapid vertical movement is almost certainly enhanced by intensive irrigation in the county. A number of aqueous species and chemical parameters (Ca, Mg, Sr, Fe, Si, dissolved inorganic carbon (DIC), dissolved oxygen, total dissolved solids, and pH) are correlated with nitrate concentrations, primarily because, like nitrate, they are either a significant fraction of fertilizers or are redox-sensitive. Drinking water quality is generally not degraded by fertilizer applications in this area, because almost all drinking-water wells are screened well below the zone of elevated nitrate concentrations.
AN: 4108555

Record 17 of 79 - Water Resources Abs. 1/93-4/98

TI: Nitrogen and chloride concentration in deep soil cores related to fertilization.
AU: Salameh-Al-Jamal,-M.; Sammis,-T.W.; Jones,-T.
SO: AGRIC.-WATER-MANAGE. 1997 vol. 34, no. 1, pp. 1-16
AB: Shallow-rooted, high-value vegetable crops are normally heavily fertilized with nitrogen. Improving farmers' management practices requires a simple method to monitor nitrogen loading below the root zone, and irrigation efficiency. In fields with low nitrogen and water use efficiencies, alternative Best Management Practices (BMPs) should be initiated and evaluated to reduce nitrogen loading to the ground water while maintaining yields. The objective of the study was to estimate the extent of nitrate-nitrogen leaching below the root zone of shallow-rooted onions, and deep-rooted chile and alfalfa, using chloride in the irrigation water as a tracer. Soil samples were taken from seven fields in 15 cm increments to 180 cm at the end of the 1994 growing season. The samples were analyzed for nitrate-nitrogen and chloride. Irrigation efficiency ranged from 70 to 76% for the chile fields, 77-80% for onions and was 97% for alfalfa. Nitrogen loading below the root zone of chile fields varied from 290 kg ha-1 per year for sandy loam soils to 64 kg ha-1 for clay soils. Nitrogen loading below the root zone of onions varied from 199 kg ha-1 per year for a loamy sand field to 161 kg ha-1 per year for a clay field. The nitrogen loading below the root zone of a sandy loam alfalfa soil was only 42 kg ha-1 per year because of the low leaching fraction. Results indicated that irrigation efficiencies are reasonable but nitrogen applications amounts need to be decreased by using alternative BMPs.
AN: 4107169

Record 18 of 79 - Water Resources Abs. 1/93-4/98

TI: Nitrogen leaching from forest soil cores after amending organic recycling products and fertilizers.
AU: Insam,-H.; Merschak,-P.
SO: WASTE-MANAGE.-RES. 1997 vol. 15, no. 3, pp. 277-292
AB: Many alpine forests are severely depleted of nutrients by extensive logging and by grazing of cattle and wildlife. Fertilization may be a remedy, but nitrate leaching may pose problems for the groundwater. However, use of slow-release fertilizers may avoid this problem, whilst improving the Ca, Mg, K, and P status of these soils. Intact soil cores (11 cm diameter, 40 cm depth) from a mixed forest and a Norway spruce stand in the Northern Calcareous Alps of Austria were used in a laboratory experiment to study the effects of adding organic fertilizers and recycling products on patterns of nitrate and ammonium release. The amended (corresponding to 300 kg N ha super(-1)) and control cores were incubated for 29 weeks at 15 degree C. Soil water (retrieved 5 cm below the soil surface) and leachate were analysed for nitrate and ammonium in regular intervals. After the incubation, soil microbial biomass, basal respiration and nitrogen mineralization were determined. Some of the organic fertilizers, especially those that had undergone composting processes (compost of organic waste, compost of bark+sewage sludge, compost of sawdust+sewage sludge, Biovin registered) and Biosol registered , caused only minor increases of nitrate and ammonium in the soil water and leachate. Others, like uncomposted sewage sludge products (Primafert registered and sewage sludge+shale), resulted

in elevated (up to 150 mg nitrate-N l super(-1)) nitrate concentrations in the soil water and in the leachate. Fertilization with N-rich fertilizers (Biosol registered , Primafert registered , sewage sludge+shale) resulted in significant decreases in microbial biomass and basal respiration at the end of the 6-month incubation. Microbial biomass and basal respiration were not affected by the other organic fertilizers.
AN: 4097633

Record 19 of 79 - Water Resources Abs. 1/93-4/98

TI: The geochemical effects of benzene, toluene, and xylene (BTX) biodegradation.
AU: Kelly,-W.R.; Herman,-J.S.; Mills,-A.L.
SO: APPL.-GEOCHEM. 1997 vol. 12, no. 3, pp. 291-303

Record 20 of 79 - Water Resources Abs. 1/93-4/98

TI: Impact of suburbanization on ground water quality and denitrification in coastal aquifer sediments.
AU: Aelion,-C.M.; Shaw,-J.N.; Wahl,-M.
SO: J.-EXP.-MAR.-BIOL.-ECOL. 1997 vol. 213, no. 1, pp. 31-51
AB: The South Carolina coastal plain is currently facing rapid population growth and suburbanization. Suburbanization brings the potential for surface- and ground water contamination from the use of nitrogen-based fertilizers, which can render water toxic to humans and fish, and lead to eutrophication. Additionally, nitrate is highly mobile in sediments and poses the potential for contamination of receiving waters, downstream areas, and ground water. The objectives of this study were to evaluate the differences in ground water quality and sediment denitrification rates at two sites, an undeveloped forested area (Oyster Creek, North Inlet, SC) and an area which has been developed for residential and commercial use (Dog Creek, Murrells Inlet, SC). Ground water monitoring wells were installed at the two sites at several sampling depths ranging from 0.6 m to 5 m. Ground water samples were collected every 4-8 weeks for 16 months, and analyzed in the field for pH, conductivity, temperature, and dissolved oxygen (DO), and in the laboratory for nitrate, nitrite, ammonia, phosphate and total organic carbon (TOC). Additionally, sediment samples were collected from two locations in both creek bottoms from approximately 1.0 m depth, and microbial denitrification was estimated using the acetylene block technique by measuring the accumulation of nitrous oxide (N sub(2)O). Ground water at both sites was microaerophilic, ranging from 0.4 to 1 mg O sub(2)/l. Ammonia and TOC concentrations were significantly higher at the forested site due to higher inputs of organic matter in the form of leafy vegetation, whereas nitrate concentrations were significantly higher at the suburban site. Sediments from both sites were able to rapidly convert NO sub(3) to N sub(2)O with progressive depletion of NO sub(3) in extracted sediments. Both the rate of N sub(2)O production and the conversion efficiencies were found to increase with increasing nitrate concentrations from 0.1 to 0.5 mg/g. The smallest nitrate concentration had the lowest N sub(2)O production and NO sub(3) conversion efficiency. However, for the intermediate treatment (0.25 mg/g) conversion efficiencies were variable. In addition to potential increased NO sub(3) inputs,

increased drainage for development present at suburban sites may cause aeration of near channel soils and favor the oxidized, more mobile form of nitrogen. Because the suburban site has steeper hydraulic gradients, and nitrate is highly mobile, there is potential for both nitrate transport to the estuary and accumulation in the shallow water-table aquifer at the suburban site. However, it appears that the microbial communities from both sites were well adapted to denitrifying inputs of nitrate in the concentration ranges tested.
AN: 4092451

Record 21 of 79 - Water Resources Abs. 1/93-4/98

TI: Domestic well water quality in rural Nebraska: Focus on nitrate-nitrogen, pesticides, and coliform bacteria.
AU: Gosselin,-D.C.; Headrick,-J.; Tremblay,-R.; Chen,-Xun-Hong; Summerside,-S.
SO: GROUND-WATER-MONIT.-REMEDIAT. 1997 vol. 17, no. 2, pp. 77-87
AB: For this statewide assessment, 1808 wells were sampled and a data base compiled that included water-quality data (NO sub(3)-N, pesticides, coliform bacteria) and site-specific data collected at each location. Domestic, rural water quality in Nebraska varies substantially from one ground water region to another and is a function of well characteristics, distances to potential contamination sources, and hydrogeologic and site characteristics. The percentage of wells exceeding the 10 ppm MCL for NO sub(3)-N ranged from 3 to 39 percent, depending on the ground water region. This large range of values indicates the inadequacy of stating that an average of 19 percent of domestic wells in Nebraska are contaminated by nitrates. This statistic does not describe the nature, extent, and variability of the contamination problem. Depending on the ground water region, the degree of nitrate contamination in rural domestic drinking water wells has remained generally unchanged or has only slightly increased since the last statewide assessment conducted from 1985 to 1989. Bacterial contamination has either remained the same or has decreased. The percentage of wells affected by bacteria ranged from 8 to 26 percent, depending on the ground water region. Statewide, about 70 wells, or 4 percent of the wells sampled, had detectable pesticide levels, of which atrazine was the most common. Eighty-two percent of the detections were in the Platte River Valley or in the South Central Plains, both of which are characterized by heavily irrigated corn and a statistical association between nitrate and atrazine contamination. To improve the quality of domestic drinking water will require a combination of activities, including the application of best management practices specific to a ground water region and individual action at rural households, such as conducting sanitary surveys of existing wells before installing new wells.
AN: 4091724

Record 22 of 79 - Water Resources Abs. 1/93-4/98

TI: Nitrogenous nutrient sources and sinks in the Juan de Fuca Strait/Strait of Georgia/Puget Sound Estuarine System: Assessing the potential for eutrophication.
AU: Mackay,-D.L.; Harrison,-P.J.
SO: ESTUAR.-COAST.-SHELF-SCI. 1997 vol. 44, no. 1, pp. 1-21

AB: This paper estimates the overall nitrogenous nutrient budget for the Puget Sound/Strait of Georgia/Juan de Fuca Strait estuarine ecosystem, and the potential for eutrophication of this system by anthropogenic nutrient inputs. Large-scale eutrophication is unlikely for two reasons. First, ambient nitrate + ammonia concentrations are high (2-20 mu M N) over much of the total area, so that total primary productivity is relatively insensitive to moderate increases or decreases. Second, exchange of water by estuarine and tidal currents is rapid (c. 1 year turnover time), and entering water carries naturally high nutrient concentrations. Natural nitrogen inputs by the estuarine circulation are very much larger than all other sources combined: 2600-2900 tonnes N day super(-1) for the entire system and 1400-1500 tonnes N day super(-1) for the inner basins (Strait of Georgia and Puget Sound) vs. <100 tonnes N day super(-1) for sewage inputs, <160 tonnes N day super(-1) for river inputs plus sewage, <15 tonnes N day super(-1) for coastal groundwater discharge exclusive of sewage, and <10 tonnes N day super(-1) for atmospheric inputs. The largest loss terms for nutrients are also due to estuarine exchange. Surface-layer advective export of dissolved inorganic nitrogen is 2100-2400 tonnes N day super(-1) through Juan de Fuca Strait and about 1000 tonnes N day super(-1) from the inner basins. Advective export of organic nitrogen can be estimated only roughly, but is probably between 100 and 300 tonnes N day super(-1) as dissolved organics, and 100-200 tonnes N day super(-1) as living and detrital particulates. Due to the dominant role of estuarine exchange, the overall nutrient budget is likely to be strongly affected by variations in river discharge (affecting total flow) and offshore oceanographic conditions (affecting nutrient content of incoming deep water). Sensitivity to nutrient addition varies with location. The least sensitive sub-regions are the Strait of Juan de Fuca and the tidally-mixed passages linking it to Puget Sound and the Strait of Georgia. The most sensitive sub-regions are some tributary inlets and fjords that have low flushing rates and that adjoin urbanized shorelines.
AN: 4082902

Record 23 of 79 - Water Resources Abs. 1/93-4/98

TI: Effects of artificial recharge on ground water quality and aquifer storage recovery.
AU: Ma,-Li; Spalding,-R.F.
SO: J.-AM.-WATER-RESOUR.-ASSOC. 1997 vol. 33, no. 3, pp. 561-572
AB: Ground water nitrate contamination and water level decline are common concern in Nebraska. Effects of artificial recharge on ground water quality and aquifer storage recovery (ASR) were studied with spreading basins constructed in the highly agricultural region of the Central Platte, Nebraska. A total of 1.10 million m super(3) of Platte River water recharged the aquifer through 5000 m super(2) of the recharge basins during 1992, 1993, and 1994. This is equivalent to the quantity needed to completely displace the ground water beneath 34 ha of the local primary aquifer with 13 m thickness and 0.25 porosity. Successful NO sub(3)-N remediation was documented beneath and downgradient of the recharge basins, where NO sub(3)-N declined from 20 to 2 mg L super(-1). Ground water atrazine concentrations at the site decreased from 2 to 0.2 mg L super(-1) due to recharge. Both NO sub(3)-N and atrazine contamination dramatically improved from concentrations exceeding the maximum contaminant levels to those of drinking water quality. The water table at the site rose rapidly in response to recharge during the early stage then leveled off as infiltration rates declined. At the end of the

1992 recharge season, the water table 12 m downgradient from the basins was elevated 1.36 m above the preproject level; however, at the end of the 1993 recharge season, any increase in the water table from artificial recharge was masked by extremely slow infiltration rates and heavy recharge from precipitation from the wettest growing season in over 100 years. The water table rose 1.37 m during the 1994 recharge season. Resultant ground water quality and ASR improvement from the artificial recharge were measured at 1000 m downgradient and 600 m upgradient from the recharge basins. Constant infiltration rates were not sustained in any of the three years, and rates always decreased with time presumably because of clogging. Scraping the basin floor increased infiltration rates. Using a pulsed recharge to create dry and wet cycles and maintaining low standing water heads in the basins appeared to reduce microbial growth, and therefore enhanced infiltration.
AN: 4082883

Record 24 of 79 - Water Resources Abs. 1/93-4/98

TI: Nitrate leaching under a cereal rye cover crop.
AU: Brandi-Dohrn,-F.M.; Dick,-R.P.; Hess,-M.; Kauffman,-S.M.; Hemphill,-D.D., Jr.; Selker,-J.S.
SO: J.-ENVIRON.-QUAL. 1997 vol. 26, no. 1, pp. 181-188
AB: Winter cover crops hold potential to capture excess NO sub(3) super(-) and reduce leaching by recycling nutrients. The objective of this study was to compare winter NO sub(3)-N leaching losses under winter-fallow and a winter cereal rye (Secale cereale L.) cover crop following the harvest of sweet corn (Zea mays L.) or broccoli (Brassica oleracea var. italica Plenck). Leachate was sampled with passive capillary wick samplers that apply a suction of 0 to 5 kPa to the soil-pore water and intercept leachate in a pan of known area. Without disturbing the over-laying soil profile, 32 samplers (0.26 m super(2)) were installed at a depth of 1.2 m in a Willamette loam (fine-silty mixed mesic Pachic Ultic Argixeroll). The randomized complete-block split plot design of this cover crop-crop rotation study (initiated in 1989) has cropping system (winter fallow vs. winter cereal rye) as main plots and three N application rates, ranging from 0 to 280 kg N ha super(-1) yr super(-1), as subplots. At the recommended N rate for the summer crops, NO sub(3) leaching losses were 48 kg N ha super(-1) under sweet corn-winter-fallow for winter 1992-1993, 55 kg N ha super(-1) under broccoli-winter-fallow for winter 1993-1994, and 103 kg N ha super(-1) under sweet corn-winter-fallow for winter 1994-1995, which were reduced to 32, 21, and 69 kg N ha super(-1), respectively, under winter cereal rye. For the first two winters, most of the variation (61%) in NO sub(3) super(-) leaching was explained by N rate (29%), cereal rye N uptake (17%), and volume of leachate (15%). Seasonal, flow-weighted concentrations at the recommended N rate were 13.4 mg N L super(-1) under sweet corn-winter-fallow (1992-1993), 21.9 mg N L super(-1) under broccoli-winter-fallow, and 17.8 mg N L super(-1) under sweet corn-winter-fallow (1994-1995), which were reduced by 39, 58, and 22%, respectively, under winter cereal rye.
AN: 4054912

Record 25 of 79 - Water Resources Abs. 1/93-4/98

TI: Agriculture and nitrate concentrations in Maryland community water system wells.
AU: Lichtenberg,-E.; Shapiro,-L.K.
SO: J.-ENVIRON.-QUAL. 1997 vol. 26, no. 1, pp. 145-153
AB: The presence of NO sub(3)-N in well water is a cause of growing concern throughout the USA. Previous studies indicate that agriculture is a major contributor to this problem. This study uses data on NO sub(3)-N concentrations in drinking water wells, on hydrological characteristics of those wells, and on measures of agricultural activity and of the extent of residential land use to construct statistical relationships between land use and well water quality in Maryland community water system wells. Tobit regression was used to correct for truncation bias arising from the fact that NO sub(3)-N was not reported at concentrations below 0.1 mg/L. Exponential and linear specifications were estimated; non-nested hypothesis tests indicated that the exponential specification fit the data better than the linear one. Deeper wells appear less vulnerable to NO sub(3)-N contamination, wells in unconfined aquifers and especially limestone formations, more so. Broiler and corn (Zea mays L.) production were associated with higher NO sub(3)-N concentrations in drinking water in both specifications, indicating that agriculture-oriented efforts aimed at preserving groundwater quality should be concentrated on corn and broiler production. Septic systems for waste disposal also appear to have a substantial impact on NO sub(3)-N concentrations in drinking water, suggesting that land use planning measures such as minimum lot size zoning may be needed to prevent conversion of crop and livestock production to residential units relying on septic systems from exacerbating groundwater quality problems.
AN: 4054906

Record 26 of 79 - Water Resources Abs. 1/93-4/98

TI: Release of contaminants from a sewage stabilization pond and its influence on ground water quality - a case study.
AU: Hameed,-A.S.; Madhavan,-K.; Velayudhan,-K.T.; Vasu,-K.
SO: POLLUT.-RES. 1994 vol. 13, no. 2, pp. 125-132
AB: A study was conducted to find out the migration of pollutants from the sewage treatment plant of Calicut Medical College to the surrounding areas and their influence on the quality of ground water in the area. Water samples were drawn from domestic wells distributed around the stabilization ponds at monthly intervals. Nitrogen and phosphorus were considered as indicative elements for the pollutants. Soil samples were analysed for the above elements and organic carbon. The data indicated fairly high level of nitrogen, phosphorus and organic carbon in the soil profiles around study area upto a depth of 120 cm than the normal average nutrient present in the local soil. Significant variations in electrical conductivity, nitrate nitrogen, Chloride of water samples drawn from domestic wells were observed. Among metals, while sodium exhibited much variation, the concentration of potassium did not vary much. The level of iron and phosphorus found in the well water is fairly below the tolerance limit which can be due to the immobile nature of phosphorus in soil and its precipitation as iron and aluminium phosphates.
AN: 4053425

Record 27 of 79 - Water Resources Abs. 1/93-4/98

TI: The effect of watershed, reservoir volume, and rainfall on nitrate levels in surface drinking water supplies.
AU: Shamblen,-R.G.; Binder,-D.M.
SO: J.-SOIL-WATER-CONSERV. 1996 vol. 51, no. 6, pp. 457-461
AB: Three separate water sources provide drinking water to about one million people in Columbus, Ohio. About 80 percent of the city's drinking water is supplied by two surface water sources, and the remainder by groundwater. Three instream reservoirs, managed by the city, retain runoff from two separate watersheds. Agricultural production predominates in both watersheds, yet only one of the two watersheds, the Scioto River watershed, has a history of exceeding the Safe Drinking Water Act Nitrate-N Maximum Contaminant Level (MCL) standard of 10 mg/L. We review the trends in nitrate-N concentration and loading in this watershed from 1982 to 1995.
AN: 4040904

Record 28 of 79 - Water Resources Abs. 1/93-4/98

TI: Who is drinking nitrate in their well water? A study conducted in rural northeastern Oregon.
AU: Mitchell,-T.J.; Harding,-A.K.
SO: J.-ENVIRON.-HEALTH 1996 vol. 59, no. 3, pp. 14-19
AB: This study evaluated the health risks for a rural northeastern Oregon population which is exposed to high nitrate levels in well water. The study also identified possible sources of nitrate contamination, and investigated measures the residents had taken to reduce their nitrate exposure from well water. Three data sets were used in the study, including a telephone survey of the residents, existing information collected by the Oregon Department of Environmental Quality about well water nitrate concentrations, and demographic information from census records. Results revealed that 23% of the surveyed population was drinking well water that contained nitrate in excess of the 10 ppm nitrate-nitrogen maximum contaminant level adopted by the U.S. Environmental Protection Agency for drinking water. Seventy-two percent of the households with nitrate levels exceeding the 10 ppm level did not use devices that effectively remove nitrates. The population included few women of childbearing age, and was generally older than other nearby urban or rural populations. Resident infants were not exposed to well water nitrate in excess of the 10 ppm level, and were therefore not at apparent risk for methemoglobinemia ("blue-baby syndrome"). Although the risk of infant methemoglobinemia was low in this area, it is recommended that alternative water sources be explored, and that follow-up monitoring be performed by state and/or local agencies.
AN: 4020257

Record 29 of 79 - Water Resources Abs. 1/93-4/98

TI: Monitoring groundwater for pesticides at selected mixing/loading sites in Arkansas.

AU: Senseman,-S.A.; Lavy,-T.L.; Daniel,-T.C.
SO: ENVIRON.-SCI.-TECHNOL. 1997 vol. 31, no. 1, pp. 283-288
AB: Groundwater monitoring studies have been conducted in recent years to survey contamination due to pesticides, yet few have addressed wells where pesticides are mixed, loaded, or rinsed. Beginning in 1990, a monitoring study conducted over a 2-year period included five collections at each of 16 mixer/loader locations to assess any pesticide and nitrate contamination. At sites in 11 counties, samples for pesticide analysis were extracted with solid-phase extraction (SPE) disks. Samples were screened using gas chromatography-electron capture detection (ECD) and high-performance liquid chromatography-UV detection (LCUV) for 17 pesticides commonly used in Arkansas. Detections were confirmed by gas chromatography-mass spectroscopy (MS) or co-chromatography. Fourteen samples revealed atrazine (1 detection), cyanazine (4), parathion-methyl (2), metolachlor (2), norflurazon (1), pendimethalin (1), propanil (2), or trifluralin (1) at eight locations during the 2-year study. Two detections of parathion-methyl and one detection of trifluralin were above the Lifetime Health Advisory Level (LHAL) of 2 mu g L super(-1). Data suggested a high correlation between pesticide used and pesticide detected at sites sampled. Three wells contained NO sub(3)-N concentrations of 10 mg L super(-1) or higher, but these did not correlate with pesticide concentrations. The pesticide's proximity to the wells during mixing, rinsing, or loading was considered to be a greater influence on temporary contamination of groundwater than chemical or site-specific characteristics.
AN: 4018084

Record 30 of 79 - Water Resources Abs. 1/93-4/98

TI: Analysis of nitrate in near-surface aquifers in the midcontinental United States: An application of the inverse hyperbolic sine Tobit model.
AU: Yen,-S.T.; Liu,-Shiping; Kolpin,-D.W.
SO: WATER-RESOUR.-RES. 1996 vol. 32, no. 10, pp. 3003-3011
AN: 4015565

Record 31 of 79 - Water Resources Abs. 1/93-4/98

TI: Shallow ground-water quality beneath a major urban center: Denver, Colorado, USA.
AU: Bruce,-B.W.; McMahon,-P.B.
SO: J.-HYDROL.-AMST. 1996 vol. 186, no. 1-4, pp. 129-151
AB: A survey of the chemical quality of ground water in the unconsolidated alluvial aquifer beneath a major urban center (Denver, Colorado, USA) was performed in 1993 with the objective of characterizing the quality of shallow ground-water in the urban area and relating water quality to land use. Thirty randomly selected alluvial wells were each sampled once for a broad range of dissolved constituents. The urban land use at each well site was sub-classified into one of three land-use settings: residential, commercial, and industrial. Shallow ground-water quality was highly variable in the urban area and the variability could be related to these land-use setting classifications. Sulfate (SO sub(4)) was the predominant anion in most samples from the

residential and commercial land-use settings, whereas bicarbonate (HCO sub(3)) was the predominant anion in samples from the industrial land-use setting, indicating a possible shift in redox conditions associated with land use. Only three of 30 samples had nitrate concentrations that exceeded the US national drinking-water standard of 10 mg l super(-1) as nitrogen, indicating that nitrate contamination of shallow ground water may not be a serious problem in this urban area. However, the highest median nitrate concentration (4.2 mg l super(-1)) was in samples from the residential setting, where fertilizer application is assumed to be most intense. Twenty-seven of 30 samples had detectable pesticides and nine of 82 analyzed pesticide compounds were detected at low concentrations, indicating that pesticides are widely distributed in shallow ground water in this urban area. Although the highest median total pesticide concentration (0.17 mu g l super(-1)) was in the commercial setting, the herbicides prometon and atrazine were found in each land-use setting. Similarly, 25 of 29 samples analyzed had detectable volatile organic compounds (VOCs) indicating these compounds are also widely distributed in this urban area. The total VOC concentrations in sampled wells ranged from nondetectable to 23 442 mu g l super(-1). Widespread detections and occasionally high concentrations point to VOCs as the major anthropogenic ground-water impact in this urban environment. Generally, the highest VOC concentrations occurred in samples from the industrial setting. The most frequently detected VOC was the gasoline additive methyl tert-butyl ether (MTBE, in 23 of 29 wells). Results from this study indicate that the quality of shallow ground water in major urban areas can be related to land-use settings. Moreover, some VOCs and pesticides may be widely distributed at low concentrations in shallow ground water throughout major urban areas. As a result, the differentiation between point and non-point sources for these compounds in urban areas may be difficult.
AN: 4010047

Record 32 of 79 - Water Resources Abs. 1/93-4/98

TI: Denitrification and mixing in a stream-aquifer system: Effects on nitrate loading to surface water.
AU: McMahon,-P.B.; Boehlke,-J.K.
SO: J.-HYDROL.-AMST. 1996 vol. 186, no. 1-4, pp. 105-128
AB: Ground water in terrace deposits of the South Platte River alluvial aquifer near Greeley, Colorado, USA, had a median nitrate concentration of 1857 mu mol/l. Median nitrate concentrations in ground water from adjacent floodplain deposits (468 mu mol/l) and riverbed sediments (461 mu mol/l), both of which are downgradient from the terrace deposits, were lower than the median concentration in the terrace deposits. The concentrations and delta super(15)N values of nitrate and N sub(2) in ground water indicated that denitrifying activity in the floodplain deposits and riverbed sediments accounted for 15-30% of the difference in nitrate concentrations. Concentrations of Cl super(-) and SiO sub(2) indicated that mixing between river water and ground water in the floodplain deposits and riverbed sediments accounted for the remainder of the difference in nitrate concentrations. River flux measurements indicated that ground-water discharge in a 7.5 km segment of river had a nitrate load of 1718 kg N/day and accounted for about 18% of the total nitrate load in the river at the downstream end of that segment. This nitrate load was 70% less than the load predicted on the basis of the median nitrate

concentration in the terrace deposits and assuming no denitrification or mixing in the aquifer. Water exchange between the river and aquifer caused ground water that originally discharged to the river to reenter denitrifying sediments in the riverbed and floodplain, thereby further decreasing the nitrate load in this stream-aquifer system. Results from this study indicated that denitrification and mixing within alluvial aquifer sediments may substantially decrease the nitrate load added to rivers by discharging ground water.
AN: 4005527

Record 33 of 79 - Water Resources Abs. 1/93-4/98

TI: Hydrologic and microbiological factors affecting persistence and migration of petroleum hydrocarbons spilled in a continuous-permafrost region.
AU: Braddock,-J.F.; McCarthy,-K.A.
SO: ENVIRON.-SCI.-TECHNOL. 1996 vol. 30, no. 8, pp. 2626-2633
AB: Fuel spills, totaling about 1300 m super(3), occurred between 1976 and 1978 adjacent to Imikpuk Lake, a drinking water source near Barrow, AK. Substantial contamination of soils and groundwater near the lake persists. We examined the magnitude and direction of groundwater flux and the microbial activity at this site to understand the persistence of contamination and its effect on the lake. We found that groundwater flux is small due to shallow permafrost, which restricts the cross-sectional area available for flow, and to the short annual thaw season (ca. 90 days). The small flux and limited depth also constrain contaminant transport and dispersion, resulting in persistent, shallow contamination. The numbers of hydrocarbon-oxidizing microorganisms and their laboratory mineralization potentials for benzene (at 10 degree C) were higher in samples from contaminated areas than in reference samples. Benzene mineralization potentials in groundwater samples were comparable to more temperate systems (0.1-0.5 mg of benzene mineralized L super(-1) day super(-1)) and were stimulated by nutrient additions. Field measurements of dissolved oxygen, nitrate, ferrous iron, and sulfide in groundwater provided evidence that biodegradation of petroleum hydrocarbons is occurring in situ. Despite evidence of an active microbial population, microbial processes, like contaminant transport, are likely limited at this site by the short annual thaw season.
AN: 3996184

Record 34 of 79 - Water Resources Abs. 1/93-4/98

TI: Variables indicating nitrate contamination bedrock aquifers, Newark Basin, New Jersey.
AU: Clawges,-R.M.; Vowinkel,-E.F.
SO: WATER-RESOUR.-BULL. 1996 vol. 32, no. 5, pp. 1055-1066
AB: Variables that describe well construction, hydrogeology, and land use were evaluated for use as possible indicators of the susceptibility of ground water in bedrock aquifers in the Newark Basin, New Jersey, to contamination by nitrate from the land surface. Statistical analyses were performed on data for 132 wells located throughout the Newark Basin. Concentrations of nitrate (as nitrogen) did not exceed the U.S. Environmental Protection Agency maximum contaminant level of 10 milligrams per liter (mg/L) in any of the water samples (U.S. Environmental

Protection Agency, 1991). Variables that describe hydrogeology and well construction were found not to be statistically significant in relation to concentrations of nitrate. This finding can be attributed to the complex nature of flow in bedrock aquifers and mixing of water from shallow and deep water-bearing zones that occurs within these wells, which are constructed with long open intervals. Distributions of nitrate concentrations were significantly different among land-use groups on the basis of land use within both a 400- and an 800-m radius zone of the well. The median concentrations of nitrate (as N) in water from wells in predominantly urban-residential (2.5 mg/L) and agricultural areas (1.8 mg/L) were greater than the median concentration of nitrate in water from wells in predominantly undeveloped areas (0.5 mg/L).
AN: 3991123

Record 35 of 79 - Water Resources Abs. 1/93-4/98

TI: Nitrogen transport from tallgrass prairie watersheds.
AU: Dodds,-W.K.; Blair,-J.M.; Henebry,-G.M.; Koelliker,-J.K.; Ramundo,-R.; Tate,-C.M.
SO: J.-ENVIRON.-QUAL. 1996 vol. 25, no. 5, pp. 973-981
AB: Discharge and N content of surface water flowing from four Karst watersheds on Konza Prairie Research Natural Area, Kansas, managed with different burn frequencies, were monitored from 1986 to 1992. The goal was to establish the influence of natural processes (climate, fire, and bison grazing) on N transport and concentration in streams. Streams were characterized by variable flow, under conditions that included an extreme flood and a drought during which all channels were dry for over a year. The estimated groundwater/stream water discharge ratio varied between 0.15 to 6.41. Annual N transport by streams, averaged across all watersheds and years, was 0.16 kg N/ha/yr. Annual N transport per unit area also increased as the watershed area increased and as precipitation increased. Total annual transport of N from the prairie via streams ranged from 0.01 to 6.0% of the N input from precipitation. Nitrate and total N concentrations in surface water decreased (P < 0.001, r values ranged from 0.14-0.26) as length of time since last fire increased. Increased watershed area was correlated negatively (P < 0.0001) to stream water concentrations of NO sub(3) super(-)-N and total N (r values = -0.43 and -0.20, respectively). Low N concentration is typical of these streams, with NH sub(4) super(+)-N concentrations below 1.0 mu g/L, NO sub(3) super(-)-N ranging from below 1.4 to 392 mu g/L, and total N from 3.0 to 714 mu g/L. These data provide an important baseline for evaluating N transport and stream water quality from unfertilized grasslands.
AN: 3985632

Record 36 of 79 - Water Resources Abs. 1/93-4/98

TI: Movement of nitrate fertilizer to glacial till and runoff from a claypan soil.
AU: Blevins,-D.W.; Wilkison,-D.H.; Kelly,-B.P.; Silva,-S.R.
SO: J.-ENVIRON.-QUAL. 1996 vol. 25, no. 3, pp. 584-593
AB: Although water from 20 to 25% of shallow farmstead wells in northern Missouri has concentrations of nitrate (NO sub(3) super(-)) exceeding 10 mg L super(-1) as nitrogen (N), many potential sources for this NO sub(3) super(-) are usually present. A field experiment was

designed to trace and isolate the amount of a single application of N fertilizer lost to a glacial-till aquifer and runoff from a 400 m super(2) corn (Zea mays L.) plot with bromide (Br super(-)) and isotopically labeled (super(15)N) fertilizer. Soil at the plot is a Albaquic Hapludalf of the Adco Series containing a 61 cm claypan beneath 41 to 43 cm of topsoil. Groundwater levels ranged from 0.38 to 2.40 m below the land surface. Transport of water and NO sub(3) super(-) to the saturated zone was not substantially retarded by the claypan. Labeled-N fertilizer accounted for as much as 8.6 mg L super(-1) of the NO sub(3) super(-) (as N) in groundwater, but only in the top 1 to 2 m of the saturated zone. After two growing seasons (16 mo), <2% of the labeled-N fertilizer was lost to runoff, about 30% was in the saturated zone, 27.3% was removed with the grain, and about 5% remained in the unsaturated zone. A large part of the remaining labeled N may have been lost in gaseous N forms. The presence of labeled NO sub(3) super(-) only in the top 2 m of the aquifer, slow horizontal transport, and winter recharge indicate grass crops such as wheat (Triticum aestivum L.) or rye (Secale cereale L.) might be used to extract near-surface N during the winter recharge period. Also, fall fertilizations can be expected to readily leach. Because groundwater concentrations of labeled NO sub(3) super(-) were still increasing after two growing seasons, rotation of crops requiring small N inputs could be expected to limit the cumulative effect of large annual fertilizer applications on groundwater.
AN: 3948855

Record 37 of 79 - Water Resources Abs. 1/93-4/98

TI: The potential impact of soil carbon content on ground water nitrate contamination.
AU: Adelman,-D.D.; Tabidian,-M.A.
CF: 2. IAWQ Int. Specialized Conference and Symposia on Diffuse Pollution, (Czech Rep.) 13-18 Aug 1995
SO: DIFFUSE POLLUTION '95. Straskraba,-M. (ed.) 1996 pp. 227-232.
AB: A potential buildup of nitrate in the ground water resources of the eastern Sandhills of Nebraska has been projected to occur due to the intensive use of nitrogen fertilizer on irrigated cropland. A root-zone nitrate leaching study in this area revealed that soils with a high carbon concentration had minimal leaching compared to soils with lower concentrations. Soils high in carbon have an active population of denitrifying bacteria possibly causing denitrification and in turn reduction of nitrate leaching. Denitrifying bacteria are principally heterotrophic using soil organic carbon for both an energy and carbon source. The objective of this research was to interpret how root-zone denitrification affected nitrate leaching and ground water contamination by nitrate. A modified version of a solute transport model developed for the Eastern Sandhills was used to assess the risk of nitrate contamination for combinations of fertilizer and irrigation rates and for various soil carbon levels. The first attempt was to make risk assessment with eight farm management practices for cells with increasingly greater carbon levels until only those cells with the greatest carbon level were kept in production. Results of this assessment showed that even with excessive fertilizer and irrigation rates, risk of nitrate leaching was reduced as the minimum carbon level was increased. However, since less cropland was leaching nitrate with each successive risk calculation, the impact that root-zone denitrification had in nitrate leaching reduction could not be definitively determined. This prompted a model modification of the risk calculation procedure which kept all cropland in production and computed nitrate leachate risk

for increasingly higher artificial carbon levels during successive risk calculations. Changing carbon levels was still more detrimental on nitrate leaching rates than changing farm management practices.
AN: 3947466

Record 38 of 79 - Water Resources Abs. 1/93-4/98

TI: Effects of agricultural practices and vadose zone stratigraphy on nitrate concentration in ground water in Kansas, USA.
AU: Townsend,-M.A.; Sleezer,-R.O.; Macko,-S.A.
CF: 2. IAWQ Int. Specialized Conference and Symposia on Diffuse Pollution, (Czech Rep.) 13-18 Aug 1995
SO: DIFFUSE POLLUTION '95. Straskraba,-M. (ed.) 1996 pp. 219-236.
AB: Differences in nitrate-N concentrations in ground water in Kansas can be explained by variations in agricultural practices and vadose-zone stratigraphy. In northwestern Kansas, past use of a local stream for tailwater runoff from irrigation and high fertilizer applications for sugar-beet farming resulted in high nitrate-N enncentrations (12-60 mg L super(-1) in both soil and ground water. Nitrogen isotope values from the soil and ground water range from +4 to +8ppt, which is typical for a fertilizer source. In parts of south-central Kansas, the use of crop rotation and the presence of both continuous fine-textured layers and a reducing ground-water chemistry resulted in ground-water nitrate-N values of < 3 mg L super(-1). The effects of denitrification in the vadose zone and ground water are indicated by enriched sigma super(15)N values of +10 to +15ppt. At a site study, irrigated continuous corn was grown on sandy soils with discontinuous fine-textured layers. Here, nitrate-N concentrations were often > 10 mg L super(-1); in both soil and groundwater. Nitrogen isotope values of +3 to +7ppt indicate a fertilizer source. Crop rotation decreased nitrate-N values in the shallow ground water (9 m). However, deeper ground water showed increasing nitrate-N concentrations as a result of past farming practices.
AN: 3947465

Record 39 of 79 - Water Resources Abs. 1/93-4/98

TI: Temporal and spatial variability in water quality of wetlands in the Minneapolis/St. Paul, MN metropolitan area: Implications for monitoring strategies and designs.
AU: Detenbeck,-N.E.; Taylor,-D.L.; Lima,-A.; Hagley,-C.
SO: ENVIRON.-MONIT.-ASSESS. 1996 vol. 40, no. 1, pp. 11-40
AB: Temporal and spatial variability in wetland water-quality variables were examined for twenty-one wetlands in the Minneapolis/St. Paul metropolitan area and eighteen wetlands in adjacent Wright County. Wetland water quality was significantly affected by contact with the sediment (surface water vs. groundwater), season, degree of hydrologic isolation, wetland class, and predominant land-use in the surrounding watershed ($p < 0.05$). Between years, only nitrate and particulate nitrogen concentrations varied significantly in Wright County wetland surface waters. For eight water-quality variables, the power of a paired before-and-after comparison

design was greater than the power of a completely randomized design. The reverse was true for four other water-quality variables. The power of statistical tests for different classes of water-quality variables could be ranked according to the predominant factors influencing these: climate factors > edaphic factors > detritivory > land-use factors > biotic-redox or other multiple factors. For two wetlands sampled intensively, soluble reactive phosphate and total dissolved phosphorus were the most spatially variable (c.v. = 76-249%), while temperature, color, dissolved organic carbon, and DO were least variable (c.v. = 6-43%). Geostatistical analyses demonstrated that the average distance across which water-quality variables were spatially correlated (variogram range) was 61-112% of the mean radius of each wetland. Within the shallower of the two wetlands, nitrogen speciation was explained as a function of dissolved oxygen, while deeper marsh water-quality variables were explained as a function of water depth or distance from the wetland edge. Compositing water-quality samples produced unbiased estimates of individual sample means for all water quality variables examined except for ammonium.
AN: 3928142

Record 40 of 79 - Water Resources Abs. 1/93-4/98

TI: Ground-water quality and flow in a shallow-glaciofluvial aquifer impacted by agricultural contamination.
AU: Kehew,-A.E.; Straw,-W.T.; Steinmann,-W.K.; Barrese,-P.G.; Passarella,-G.; Peng,-Wei-Shyuan
SO: GROUND-WATER 1996 vol. 34, no. 3, pp. 491-500
AB: The Prairie Ronde fan, a discrete glaciofluvial deposit in southwestern Michigan, contains a productive but highly vulnerable unconfined aquifer used for irrigation, municipal, and domestic supply. A comprehensive hydrogeological study of the aquifer delineated shallow, local flow systems that interact with ponds and wetlands on the fan surface, overlying a deeper intermediate/regional flow system extending to the base of the glacial drift. Ground water within the shallow flow systems contains tritium concentrations indicative of a post-bomb age and is heavily impacted by nonpoint source contamination. Nitrate commonly exceeds drinking water standards in the shallow flow system. Although no continuous physical barrier separates the two flow systems, the deeper flow system is generally lacking in tritium as well as nonpoint source contaminants derived from surface land uses. High capacity pumping from the deeper flow system, however, will likely draw contaminants downward from the shallow flow system. Background-water quality in the aquifer is controlled by equilibrium with calcite and slight undersaturation with respect to dolomite. No spatial trends in major ions were observed, suggesting that carbonate mineral equilibrium is achieved rapidly in the vadose zone and further chemical evolution along ground-water flow paths is minimal. Iron concentrations are highly variable in the aquifer and not correlated with depth. Recharge from lakes and wetlands is a significant cause of elevated iron concentrations in the shallow flow systems.
AN: 3920744

Record 41 of 79 - Water Resources Abs. 1/93-4/98

TI: Ground water discharge of agricultural pesticides and nutrients to estuarine surface water.
AU: Gallagher,-D.L.; Dietrich,-A.M.; Reay,-W.G.; Hayes,-M.C.; Simmons,-G.M., Jr.
SO: GROUND-WATER-MONIT.-REMEDIAT. 1996 vol. 16, no. 1, pp. 118-129
AB: This research investigated the transport of land-applied nutrients and pesticides from unconfined aquifers to tidal surface waters of Virginia's coastal plain. Ground water, estuarine surface water, ground water discharge, upland soil, and offshore sediment samples were collected from May 1992 until February 1993 from four agricultural sites. Samples were analyzed for inorganic nitrogen and phosphorus and five pesticides: atrazine, cyanazine, alachlor, metolachlor, and carbofuran. Pesticides from aqueous samples were determined by liquid-solid phase extraction followed by gas chromatography-electron capture detection (GC-ECD) and/or by pesticide-specific immunoassay. Soil and sediment samples were analyzed by extraction and gas chromatography/mass spectrometry (GC/MS). Nutrient measurements indicated that fertilizer nitrogen was moving from the ground water to the surface water, and nitrogen fluxes across the sediment-water interface were correlated with fresh water discharge rates. Mean nitrate-N flux was 2.48 mg/m super(2)/hr, with a maximum value of 30.98 mg/m super(2)/hr. Pesticides were detected in more than half of the upland soil samples, in approximately 40 percent of the ground water samples, and in just under 20 percent of the seepage meter samples. Pesticides were not detected in any of the offshore sediment samples or surface water samples. Alachlor and metolachlor were detected in upland soil samples at concentrations ranging from 10 to almost 500 mu g/kg. All five pesticides were found in ground water samples at concentrations generally below 1 mu g/L, with alachlor, atrazine, and metolachlor most frequently found. Alachlor, atrazine, cyanazine, and metolachlor were detected in water discharging across the sediment-water interface and entering estuarine waters at concentrations ranging from 0.05 to 0.5 mu g/L. These levels were generally consistent with the amount of dilution due to the mixing of fresh ground water and saline pore waters prior to discharge across the sediment-water interface. Based on all positive detections of pesticides in ground water discharge, which represented approximately 18 percent of all samples, average flux rates of cyanazine, metolachlor, alachlor, and atrazine were 0.32, 0.37, 0.80, and 1.12 mu g/m super(2)/hr, respectively. These findings indicate that submarine ground water transport of both nutrients and pesticides does occur, and this transport route should be considered when implementing agricultural management practices. The levels of nitrogen transport to surface water appears significant. The overall levels of pesticide movement through ground water, although generally quite low, represent a transport route that is commonly neglected in watershed management.
AN: 3873465

Record 42 of 79 - Water Resources Abs. 1/93-4/98

TI: Combined use of groundwater dating, chemical, and isotopic analyses to resolve the history and fate of nitrate contamination in two agricultural watersheds, Atlantic Coastal Plain, Maryland.
AU: Boehlke,-J.K.; Denver,-J.M.
SO: WATER-RESOUR.-RES. 1995 vol. 31, no. 9, pp. 2319-2339
AN: 3997047

Record 43 of 79 - Water Resources Abs. 1/93-4/98

TI: The Platte River watershed program.
AU: Lathrop,-B.
SO: J.-SOIL-WATER-CONSERV. 1995 vol. 50, no. 6, pp. 601-604
AB: The Platte River originates in the mountains of Colorado and Wyoming, and its watershed drains two-thirds of the state of Nebraska. Groundwater is a critical component of this watershed, as there are extensive wetlands where surface water/groundwater meet. The Platte River alluvial aquifer provides drinking water for 70 percent of Nebraska's citizens. The U.S. Environmental Protection Agency and Nebraska Department of Environmental Quality (NDEQ) have initiated a Platte River Watershed Program to examine and plan for environmental concerns in the area. These include nonpoint sources of pollution, nitrate and pesticide contamination, wetlands and habitat destruction and alteration, floodplain development, and hydrologic modification.
AN: 3874574

Record 44 of 79 - Water Resources Abs. 1/93-4/98

TI: Agricultural impacts on bacterial water quality in karst groundwater.
AU: Pasquarell,-G.C.; Boyer,-D.G.
SO: J.-ENVIRON.-QUAL. 1995 vol. 24, no. 5, pp. 959-969
AB: A 2-yr study (1991-1992) was conducted in a karst region in southeast West Virginia to determine the impact of agriculture on groundwater quality. The primary agriculture is characterized by seasonal cattle grazing. Fecal coliform densities were measured weekly in the resurgences of three karst basins possessing different degrees of agricultural intensity (79, 51, and 16% land use in agriculture). Fecal coliforms were also measured in a creek at sites upstream and downstream of the known resurgences from the most agriculturally intensive (79%) basin. The fecal coliform densities in the resurgences peaked in the summer and declined in the fall, with a recovery in late winter before the introduction of new cattle. The timing of the recovery indicated that significant storage of fecal material had taken place, which was transported to the groundwater when soil water conditions permitted. For most of each year, soil water effects appeared to have a greater bearing on the fecal coliform densities than did the presence or absence of cattle. The data did not generally support a strong relationship with percent land use in agriculture. This was attributed to the high variability in the data and to low soil moisture during periods of recession that inhibited the transport of fecal material to the groundwater. The karst resurgence springs of the most intensively agricultural basin were contaminated with fecal bacteria. Fecal bacteria concentrations were observed to significantly increase, in the receiving surface stream, from a point upstream of the resurgence springs to a point downstream of the resurgence springs.
AN: 3843713

Record 45 of 79 - Water Resources Abs. 1/93-4/98

TI: Wetlands/groundwater quality in agricultural landscapes.
AU: Rickerl,-D.H.; Kringen,-D.E.; Machacek,-T.A.
SO: J.-MINN.-ACAD.-SCI. 1995 vol. 59, no. 4, pp. 18-24
AB: In the Prairie Pothole Region (PPR - SD, ND, MN, IA), wetlands classified as "semi-permanent" or "seasonal" can act as groundwater recharge sites. The nutrient filtering capacity of wetlands has been investigated for both natural and constructed wetlands linked to surface water, but there is little information available on their subsequent impact on groundwater quality. This study investigates four seasonal and two semi-permanent wetlands in the PPR of eastern South Dakota. Transitional no-till (TNT) and organic farm (ORG) management systems border the wetlands. The objective is to determine the effects of farm management system on wetland surface water and groundwater quality. This project is part of a more comprehensive study including wildlife-habitat investigation and economic analyses. Water quality data include nitrate (NO sub(3) super(-)-N) and orthophosphate (PO sub(4) super(3-)-P) concentrations from wetland surface water, groundwater at wetland and upland sites, and run-off water from surrounding weirs. The results will be used to determine to what extent PPR wetlands act as sinks for nutrient run-off and establish baseline NO sub(3) super(-)-N and PO sub(4) super(3-)P data for the development of PPR wetland water quality standards. The results indicate greater surface water NO sub(3) super(-)-N concentrations in semi-permanent than in seasonal wetlands. Surface water concentrations of PO sub(4) super(3-)-P, however, were greater in seasonal than semi-permanent wetlands. Groundwater sampled near the wetland perimeter had greater PO sub(4) super(3-)-P concentrations than groundwater sampled from nearby upland sites. The farming system effects were observed in weir data that indicated large concentrations of NO sub(3) super(-)-N in runoff following nitrogen (N) application in the transitional no-till system. Large NO sub(3) super(-)-N concentrations were also found in groundwater sampled from the organic semi-permanent wetland site which is cropped to alfalfa (Medicago sativa L.) and receive manure application. Orthophosphate concentrations were significantly greater in groundwater near the seasonal wetland in the ORG (0.68 mg L super(-1)) than the TNT (0.20 mg L super(-1)). Water quality monitoring will continue in 1995, but preliminary results suggest that both wetland classification and adjacent farming practices impact wetland and groundwater quality.
AN: 3838180

Record 46 of 79 - Water Resources Abs. 1/93-4/98

TI: Relation of ground-water quality to land use on Long Island, New York.
AU: Eckhardt,-D.A.V.; Stackelberg,-P.E.
SO: GROUND-WATER 1995 vol. 33, no. 6, pp. 1019-1033
AB: Water-quality data from 90 monitoring wells screened within 50 feet of the water table in the unconfined upper glacial aquifer beneath five areas of differing land use in Nassau and Suffolk Counties, Long Island, were compared to assess the effects of land use on ground-water quality. The areas, which range from 22 to 44 square miles, represent suburban land sewered more than 22 years at the time of the study (long-term sewered), suburban land sewered less than 8 years (recently sewered), suburban land without a regional sewer system, agricultural land, and undeveloped (forested) land. Comparison of water-quality data from the 90 wells indicated that

samples from the undeveloped area had the lowest and smallest range in concentrations of several human-derived constituents, such as nitrate, alkalinity, boron, synthetic solvents, and pesticides. Concentrations of these constituents in samples from the three suburban areas and the agricultural area generally were intermediate to high and had the widest variation. Maximum-likelihood logistic regression analysis of explanatory variables that characterize the type of land use and population density within a one half -mile radius of each of the 90 wells was used to develop predictive equations for contaminant occurrence in ground water within 50 feet of the water table. Two logistic regression equations for the 90 monitoring wells were compared with equations developed independently from ground-water quality data at more than 240 other wells throughout Nassau and Suffolk Counties to evaluate the predictive value of the land-use variables at the larger two-county scale. The results demonstrate that the population density and amount of agricultural, commercial, and high- and medium-density residential land within specified areas around wells can be reliable predictors of contaminant presence. The strength of the correlations supports the premise that land use affects the quality of water in water-table aquifers overlain by highly permeable material because land use commonly determines the types and amounts of chemicals introduced at land surface. When coupled with GIS technology and accurate, detailed land-use and water-quality information, the methods and results of this study can be useful to local planning boards in evaluation of potential effects of development on ground-water quality. The methods can also be useful to hydrologists in the analysis and design of ground-water-monitoring networks.
AN: 3836943

Record 47 of 79 - Water Resources Abs. 1/93-4/98

TI: Nitrate concentrations in karst springs in an extensively grazed area.
AU: Boyer,-D.G.; Pasquarell,-G.C.
SO: WATER-RESOUR.-BULL. 1995 vol. 31, no. 4, pp. 729-736
AB: The impact on water quality by agricultural activity in karst terrain is an important consideration for resource management within the Appalachian Region. Karst areas comprise about 18 percent of the Region's land area. An estimated one-third of the Region's farms, cattle, and agricultural market value are located on karst terrain. Nitrate concentrations were measured in several karst springs in Southeastern West Virginia in order to determine the impact of animal agriculture on nitrate pollution of the karst ground water system. Karst basins with 79, 51, 16, and 0 percent agriculture had mean nitrate concentrations of 15.8, 12.2, 2.7, and 0.4 mg/l, respectively. A strong linear relationship between nitrate concentration and percent agricultural land was shown. Median nitrate concentration increased about 0.19 mg l super(-1) per percent increase in agricultural land. Weather patterns were also found to significantly affect the median nitrate concentrations and the temporal variability of those concentrations. Lower nitrate concentrations and lower temporal variability were observed during a severe drought period. It was concluded that agriculture was significantly affecting nitrate concentrations in the karst aquifer. Best management practices may be one way to protect the ground water resource.
AN: 3834937

Record 48 of 79 - Water Resources Abs. 1/93-4/98

TI: Groundwater quality near two cattle feedlots in Texas High Plains: A case study.
AU: Sweeten,-J.M.; Marek,-T.H.; McReynolds,-D.
SO: APPL.-ENG.-AGRIC. 1995 vol. 11, no. 6, pp. 845-850
AB: A groundwater sampling study was conducted at two cattle feedlots with capacities of 45,000 (Feedlot A) and 42,500 head (Feedlot B), respectively, in Castro and Parmer Counties in the Southern High Plains of Texas. At both feedlots, groundwater was sampled from the Ogallala Aquifer at four water wells supplying cattle drinking water and from 10 or 11 irrigation wells within a distance of 1.07 to 1.41 km (0.67 to 0.88 mile) from the feed pens or playa basins (natural depressions) used for collection of feedlot runoff. Water table depth was 82.3 to 97.5 m (270 to 320 ft). Nitrate-nitrogen (NO sub(3)N) concentrations averaged less than 1.2 mg/L at Feedlot A (maximum value of 2.23 mg/L) and 5.21 mg/L at Feedlot B (maximum value of 9.54 mg/L). These are below the USEPA primary drinking water standard of 10.0 mg/L NO sub(3)-N. Other nutrient and salinity values were low. The well water in all feedlot wells and in farm irrigation wells appears to be suitable for irrigation, livestock watering, and human consumption. Minimal differences were found between parameter concentrations in feedlot wells and adjacent farm irrigation wells. Groundwater quality near these two feedlots met primary and secondary EPA drinking water standards for those parameters tested.
AN: 3828621

Record 49 of 79 - Water Resources Abs. 1/93-4/98

TI: Pesticides in eastern North Carolina rural supply wells: Land use factors and persistence.
AU: Maas,-R.P.; Kucken,-D.J.; Patch,-S.C.; Peek,-B.T.; Van-Engelen,-D.L.
SO: J.-ENVIRON.-QUAL. 1995 vol. 24, no. 3, pp. 426-431
AB: Water samples were collected from 171 rural domestic well supplies in eastern North Carolina and analyzed for eight pesticides. Information on borehole depth, well-casing depth, distance to nearest pesticide mixing area, types of pesticides used, and distance to nearest field application was obtained for each site. Four herbicides [alachlor, 2-chloro- 2'-6'diethyl-N-(methoxymethyl)- acetanilide; atrazine, 2-chloro-4- ethylamino-6- isopropylamino-s- triazine; metolachlor, 2-chloro-N- (2-ethyl-6-methylphenyl) -N-(2-methoxy-1- methylethyl) acetamide; trifluralin, alpha , alpha , alpha - trifluoro-2,6- dinitro-N,N- dipropyl-p- toluidine] were detected in the samples, with detection frequencies of 8.8, 8.2, 3.6, and 1.8%, respectively. About 15% of the samples contained at least one of these herbicides, with resampling indicating persistence throughout the year. Only alachlor concentrations were in excess of maximum contaminant levels (MCLs; 2.0 mu g L super(-1)) or Health Advisory Levels (HALs; 0.4 mu g L super(-1)) established by the U.S. Environmental Protection Agency (USEPA). Neither atrazine nor alachlor detection exhibited statistical correlation with well depth, although both were rarely detected in wells >100 feet deep. Atrazine concentrations and detection frequencies did not correlate with distance to nearest application site, while alachlor had a significantly greater detection frequency for wells further from the nearest application site. For nearly one-half of the wells with detectable atrazine and alachlor, there was no reported usage of either herbicide on the same farm during the previous three years, possibly indicating herbicide transport in groundwater

or long times before degrading. No statistically significant relationships were observed between the presence of alachlor or atrazine, and distance from the well to the nearest pesticide handling and storage area. Although inconclusive by itself, this indicates that at least some contamination originated from other than point-source spills. Nitrate-N concentrations in well water were poor predictors for atrazine and alachlor presence in this study.
AN: 3815993

Record 50 of 79 - Water Resources Abs. 1/93-4/98

TI: The occurrence of agricultural chemicals in Illinois' rural private wells: Results from the pilot study.
AU: Mehnert,-E.; Schock,-S.C.; Barnhardt,-M.L.; Caughey,-M.E.; Chou,-S.F.J.; Dey,-W.S.; Dreher,-G.B.; Ray,-C.
SO: GROUND-WATER-MONIT.-REMEDIAT. 1995 vol. 15, no. 1, pp. 142-149
AB: Water samples from 240 private wells in rural Illinois were collected over one year and analyzed for 39 agricultural chemicals. Sampling was conducted to provide preliminary information to refine a plan for a statewide survey of the agricultural chemical contamination of rural private wells. Wells were sampled according to a stratified random sampling plan that included four classes of depth to the uppermost aquifer material and two classes of well type. Depth to uppermost aquifer material was defined as the depth from ground surface to a geologic material that, if saturated, could be used as an aquifer. Occurrence, defined as the presence of one or more target analytes in a well water sample above some specified concentration, was shown to be higher in large-diameter bored or dug wells than in small-diameter drilled wells. For small-diameter wells, occurrence generally decreased as the depth to the uppermost aquifer material increased. In addition, depth to the uppermost aquifer material could be used to predict the occurrence of some individual agricultural chemicals, such as nitrate and atrazine, but could not be used to predict the occurrence of picloram or pesticides in small-diameter wells. Of the 39 target analytes, 10 were detected at concentrations exceeding their respective minimum reporting levels. Nitrate and atrazine were the only compounds found at concentrations exceeding their respective maximum contaminant levels (MCLs) or U.S. EPA lifetime health advisory limits (HALs). A nonparametric statistical technique, contingency table analysis, identified factors associated with the occurrence of agricultural chemicals in three of the five study areas. Elevated specific conductance (greater than or equal to 500 mu mhos/cm) of the sampled water was strongly associated with the occurrence of agricultural chemicals. This association was common to all three study areas analyzed. Identification of the source of the specific conductance could help identify the dominant pathway for transport of agricultural chemicals to ground water.
AN: 3815988

Record 51 of 79 - Water Resources Abs. 1/93-4/98

TI: Effects of agriculture on ground-water quality in five regions of the United States.
AU: Hamilton,-P.A.; Helsel,-D.R.
SO: GROUND-WATER 1995 vol. 33, no. 2, pp. 217-226

AB: Water-quality conditions in surficial unconsolidated aquifers were assessed in five agricultural regions in the United States. The assessment covers the Delmarva Peninsula, and parts of Long Island, Connecticut, Kansas, and Nebraska, and is based on water-quality and ancillary data collected during the 1980s. Concentrations of nitrate in ground water in these areas have increased because of applications of commercial fertilizers and manure. Nitrate concentrations exceed the maximum contaminant level (MCL) for drinking water of 10 milligrams per liter as nitrogen established by the U.S. Environmental Protection Agency in 12 to 46 percent of the wells sampled in the agricultural regions. Concentrations of nitrate are elevated within the upper 100 to 200 feet of the surficial aquifers. Permeable and sandy deposits that generally underlie the agricultural areas provide favorable conditions for vertical leaching of nitrate to relatively deep parts of the aquifers. The persistence of nitrate at such depths is attributed to aerobic conditions along ground-water-flow paths. Concentrations of nitrate are greatest in areas that are heavily irrigated or areas that are underlain by well-drained sediments; more fertilizer is typically applied on land with well-drained sediments than on poorly drained sediments because well-drained sediments have a low organic-matter content and low moisture capacity. Concentrations of other inorganic constituents related to agriculture, such as potassium and chloride from potash fertilizers, and calcium and magnesium from liming, also are significantly elevated in ground water beneath the agricultural areas. These constituents together impart a distinctive agricultural-chemical trademark to the ground water, different from natural water.
AN: 3788874

Record 52 of 79 - Water Resources Abs. 1/93-4/98

TI: Survey of nitrate contamination in shallow domestic drinking water wells of the Inner Coastal Plain of Georgia.
AU: Stuart,-M.A.; Rich,-F.J.; Bishop,-G.A.
SO: GROUND-WATER 1995 vol. 33, no. 2, pp. 284-290
AB: Beginning in 1990, 2,588 wells were sampled within the Inner Coastal Plain of Georgia in an effort to assess the quality of ground water in this major farm belt. The project was one aspect of an EPA-sponsored program to assess ground-water quality statewide. Several variables were measured, including pH, specific conductivity, dissolved oxygen, temperature, nitrate, nitrite, total hardness, calcium, magnesium, and bicarbonate. In some wells sulfate, chloride, potassium, iron, and manganese contents were also determined. Particular emphasis was placed, however, on pH, specific conductivity, temperature, and nitrite/nitrate content. Generally, pH was between 6 and 8, and temperatures were within a range of 18 degree and 24 degree Celsius. Measurements of specific conductivity varied, but averaged 250-275 microsiemens/cm. Nitrite contamination was negligible, and nitrate contamination of the ground water within the shallow aquifers did not appear to be significant. In fact, 56% of the wells sampled showed no detectable signs of nitrate or nitrite contamination. There were, however, a few isolated wells where nitrate as nitrogen measurements exceeded the EPA's Safe Drinking Water Standard of 10 ppm. The general lack of contamination may be the result of the nature of the agricultural practices used in this region and/or the effect of natural denitrification.
AN: 3779002

Record 53 of 79 - Water Resources Abs. 1/93-4/98

TI: Comparison of shallow ground-water quality between urban and agricultural land-use settings, South Platte River Basin, Colorado and Nebraska.
AU: Bruce,-B.W.; McMahon,-P.B.
CF: 1994 South Platte Forum, Greeley, CO (USA) 26-27 Oct 1994
SO: INTEGRATED WATERSHED MANAGEMENT IN THE SOUTH PLATTE BASIN: STATUS AND PRACTICAL IMPLEMENTATION. PROCEEDINGS OF THE 1994 SOUTH PLATTE FORUM, OCTOBER 26-27, 1994, GREELEY, COLORADO. Klein,-K.C.; Williams,-D.J. (eds.) COLORADO STATE UNIVERSITY, FORT COLLINS, CO 80523 (USA) COLORADO WATER RESOURCES RESEARCH INSTITUTE. 1994 pp. 23-24.
AB: As part of the National Water-Quality Assessment Program's South Platte River Basin study, the U.S. Geological Survey has sampled shallow alluvial ground water beneath urban (Denver, Colo.) and agricultural (South Platte River alluvium from Brighton, Colo. to North Platte, Nebr.) land-use settings to determine the effect of land use on water quality. Thirty randomly distributed wells in each land-use setting were sampled for nutrients, trace elements and radon, pesticides and volatile organic compounds (VOC's). Nutrient species concentrations generally were lower in the urban setting than in the agricultural setting. The median concentration of dissolved nitrite plus nitrate as nitrogen in the urban setting was 2.1 milligrams per liter. Preliminary results indicate a median concentration of 7.0 milligrams per liter for nitrite plus nitrate in the agricultural setting. Trace-element and radon concentrations indicated no correlation with land-use setting. However, uranium and radon occurred at elevated concentrations in both land-use settings (median concentrations of uranium and radon were 25 micrograms per liter and 1100 picoCuries per liter). The distribution of uranium and radon in ground water probably was affected mostly by local geology rather than by land use. Pesticide compounds detected in ground-water samples from both land-use settings generally occurred at low concentrations. Prometon, a nonselective herbicide, was the most frequently detected pesticide in the urban setting and atrazine was the most frequently detected pesticide in the agricultural setting. However, both of these compounds were detected in each of the land-use settings. VOC's were detected in 86 percent of the urban wells sampled, and concentrations of specific compounds frequently exceeded National Drinking Water Standards. Preliminary results indicate that VOC's are almost nonexistent in alluvial ground water of the agricultural setting. The presence of VOC's affected redox conditions in the alluvial aquifer in the urban setting and, consequently, the chemistry of the urban ground water. Data indicated that land use does have a measurable effect on the quality of ground water in the South Platte River alluvial aquifer and that ground-water quality differs between urban and agricultural land-use settings.
AN: 3834955

Record 54 of 79 - Water Resources Abs. 1/93-4/98

TI: Nitrate contamination from dairy lagoons constructed in coarse alluvial deposits.
AU: Korom,-S.F.; Jeppson,-R.W.

SO: J.-ENVIRON.-QUAL. 1994 vol. 23, no. 5, pp. 973-976
AB: In an effort to reduce surface inflows of nutrients to Deer Creek Reservoir in north central Utah, several dairies in Heber Valley constructed unlined lagoons to store wastes for later application onto fields as fertilizer. Previous research indicated that dairy lagoons sealed with use and were not significant sources of contamination; however, the soils in Heber Valley are coarser than in the literature. Therefore, two of Heber Valley's dairy lagoons were studied as sources of NO super(-) sub(3)-N to the groundwater system. One lagoon was constructed on Holmes subsoils (loamy-skeletal, mixed, frigid Typin Argixerolls); its seepage rate was estimated at 13 to 91 mm/d, which is as high or higher than any of the rates reported in the literature. The other lagoon was constructed on Deer Creek subsoils (fine, montmorillonitic, frigid Typic Palexerolls). Leachate quality from both lagoons typically exceeded the drinking water standard of 10 mg NO super(-) sub(3)-N/L and sometimes exceeded 100 mg NO super(-) sub(3)-N/L. The likely reason for the high NO super(-) sub(3)-N concentrations was that the coarse soils in Heber Valley sometimes permitted the aerobic conditions necessary for nitrification of immobile NH super(+) sub(4) to mobile NO super(-) sub(3). We concluded that the unlined dairy lagoons were significant sources of N (as NO super(-) sub(3)) contamination to the Heber Valley aquifer.
AN: 3697288

Record 55 of 79 - Water Resources Abs. 1/93-4/98

TI: Contribution of spray irrigation of wastewater to groundwater contamination in the karst of southeastern Minnesota, USA.
AU: Mooers,-H.D.; Alexander,-E.C., Jr.
SO: APPL.-HYDROGEOL. 1994 vol. 2, no. 1, pp. 34-43
AB: A vegetable- and meat-canning facility located in the karst of southeastern Minnesota disposes approximately 2.85 x 10 super(5) m super(3) yr super(-1) of wastewater by spray irrigation of an 83.7-ha field located atop the local groundwater divide. Cannery effluent contains high levels of chloride and nitrogen (organic and ammonia), in excess of 7000 mg/l and 400 mg/l, respectively. Nitrate-nitrogen concentrations are generally <5 mg/l. Agricultural, domestic, and municipal sources of chloride and nitrate are common in the region, and water supplies frequently exceed the drinking-water limit for nitrate-nitrogen of 10 mg/l. Fifty-two area wells and thirteen surface-water locations were sampled and analyzed for five ionic species, including: chloride (Cl), nitrate-nitrogen (NO sub(3)-N), sulfate (SO sub(4)), nitrite-nitrogen (NO sub(2)-N), and phosphate (PO sub(4)). Two distinct chloride plumes flowing outward from the groundwater divide were identified, and 65% of the wells sampled had nitrate-nitrogen concentrations in excess of 10 mg/l. The data were divided into two groups: one group of samples from wells located near the canning facility and another group from outside that area. A correlation coefficient of R super(2) = 0.004 for Cl vs. NO sub(3)-N in the vicinity of the irrigation fields indicates essentially no relationship between the source of Cl and NO sub(3). In areas of agricultural and domestic activities located away from the cannery, an R super(2) of 0.54 suggests that Cl and NO sub(3) have common sources in these areas.
AN: 3692112

Record 56 of 79 - Water Resources Abs. 1/93-4/98

TI: Ground-water nitrate contribution to Tampa Bay an investigation of the Lithia/Buckhorn Springs nitrate problem.
AU: Jones,-G.W.; Upchurch,-S.B.
CF: 14. Annu. International Symposium of the North American Lake Management Society, Orlando, FL (USA) 31 Oct-5 Nov 1994
SO: LAKE-RESERV.-MANAGE. 1994 vol. 9, no. 2, p. 85
AB: It has been determined that the Alafia River delivers approximately 705 tons of nitrate to Tampa Bay each year. Lithia and Buckhorn Springs are two of the major sources of nitrate in the Alafia River, contributing approximately 22 percent (157 tons/yr) of the total. Lithia and Buckhorn Springs are among the most nitrate-rich springs in Florida with average nitrate as N concentrations of 3.1 and 2.3 mg/l respectively. Lithia Springs has experienced a 17-fold increase in nitrate concentrations since 1923 while concentrations in Buckhorn Springs have increased 9-fold since 1966. Analysis of data collected during a two-year study indicates that water discharging from the springs first enters the Floridian aquifer in the southern portion of an area known as the Brandon Karst Terrain (BKT), an internally-drained karst escarpment in central Hillsborough County. Nitrogen isotopic data from wells in this area and interpretation of historical aerial photographs indicated that the principal source of nitrate was the concentrated production of citrus that occurred for over 50 years. Numerous dairy farms in the area also contributed nitrate albeit to a lesser degree. The citrus and diary farms in the BKT have gradually been replaced over the last 25 years by suburban development. This suburban development has resulted in the installation of over 11,000 septic tanks in the BKT. It is anticipated that within the next 20 years, nitrate from agricultural sources will move out of the flow system and will be replaced by nitrate from suburban sources that include septic tanks and landscape fertilizers.
AN: 3690133

Record 57 of 79 - Water Resources Abs. 1/93-4/98

TI: N-15 identification of nonpoint sources of nitrate contamination beneath cropland in the Nebraska Panhandle: Two case studies.
AU: Exner,-M.E.; Spalding,-R.F.
SO: APPL.-GEOCHEM. 1994 vol. 9, no. 1, pp. 73-81
AB: Monitoring of municipal wells near the town of Sidney and domestic wells near Oshkosh in Nebraska's Panhandle indicated the nitrate-nitrogen (NO sub(3)-N) levels were increasing and exceeded the maximum contaminant level of 10 mg/l NO sub(3)-N in several wells. Both areas are located in narrow stream valleys that are characterized by well-drained soils, highly permeable intermediate vadose zones, shallow depths to groundwater, and intensive irrigated corn production. Both areas also have a large confined cattle feeding operation near the suspected contamination and potentially could be contaminated by more than one nitrate source. At Sidney NO sub(3)-N concentrations were measured in 13 monitoring wells installed along an east-west transect in the direction of groundwater flow, 26 private wells, and eight municipal wells. Nitrate-nitrogen concentrations were homogeneous beneath a 5 km by 1.2 km area and averaged 11.3 plus or minus 1.8 mg/l NO sub(3)-N. The delta super(15)N-NO sub(3) values in the

monitoring and municipal wells had a narrow range from +5.8 to +8.8ppt. The isotopic ratios are indicative of a mixed source of nitrate contamination, which originates from agronomic (commercial fertilizer N and mineralized N) N and animal waste. Both commercial fertilizer N and animal wastes are applied to the irrigated fields.
AN: 3666372

Record 58 of 79 - Water Resources Abs. 1/93-4/98

TI: Nitrogen and phosphorus in water as related to environmental setting in Nebraska.
AU: Helgesen,-J.O.; Zelt,-R.B.; Stamer,-J.K.
SO: WATER-RESOUR.-BULL. 1994 vol. 30, no. 5, pp. 809-822
AB: Spatial distributions of nitrogen and phosphorus in water were related to environmental setting as part of a regional water-quality assessment of the Central Nebraska Basins. The environmental settings (Sandhills, Loess Hills, Glaciated Area, and Platte Valley) were characterized by different concentrations of nitrogen and phosphorus in ground water and stream water. Statistically significant differences in nitrate concentrations in both ground-water and stream-water samples were related to regional distributions of cropland and rangeland. Nitrate concentrations were larger, especially in shallow ground water, in environmental settings dominated by cropland and associated fertilizer use than in settings dominated by rangeland. Similarly, total-nitrogen and nitrate concentrations were relatively large in selected streams draining primarily cropland. Comparative concentrations of phosphorus in stream water on the basis of environmental setting were similar to those of nitrogen, although the largest phosphorus concentrations probably relate to wastewater discharge into small streams. Nitrogen and phosphorus concentrations in much of the Platte River apparently reflected the quality of water entering the study unit from upstream and limited base-flow contributions from within the Platte Valley itself.
AN: 3632977

Record 59 of 79 - Water Resources Abs. 1/93-4/98

TI: Ground water as a source of nutrients and atrazine to streams in the South Platte River basin.
AU: McMahon,-P.B.; Litke,-D.W.; Paschal,-J.E.; Dennehy,-K.F.
SO: WATER-RESOUR.-BULL. 1994 vol. 30, no. 3, pp. 521-530
AB: Concentrations of nitrite plus nitrate, ammonia, orthophosphate, and atrazine were measured in streams and ground water beneath the streams at 23 sites in the South Platte River basin of Colorado, Nebraska, and Wyoming to assess: (1) the role of ground water as a source of nutrients and atrazine to streams in the basin, and (2) the effect of land-use setting on this process. Concentrations of nitrite plus nitrate, ammonia, orthophosphate, and atrazine were higher in ground water than in the overlying streams at 2, 12, 12, and 3 of 19 sites, respectively, where there was not a measurable hydraulic gradient directed from the stream to the ground water. Orthophosphate was the only constituent that had a significantly higher ($p < 0.05$) concentration in ground water than in surface water for a given land-use setting (range land). Redox conditions in ground water were more important than land-use setting in influencing

whether ground water was a source of elevated nitrite plus nitrate concentrations to streams in the basin. The ratios of nitrite plus nitrate in ground water/surface were significantly lower ($p < 0.05$) at site having concentrations of dissolved oxygen in ground water < 0.5 mg/L. Elevated concentrations of ammonia or atrazine in ground water occurred at sites in close proximity to likely sources of ammonia or atrazine, regardless of land-use setting. These results indicate that land-use setting is not the only factor that influences whether ground water is a source of elevated nutrient and atrazine concentrations to streams in the South Platte River Basin.
AN: 3615385

Record 60 of 79 - Water Resources Abs. 1/93-4/98

TI: Chemical use practices and opinions about groundwater contamination in two unsewered subdivisions.
AU: Mechenich,-C.; Shaw,-B.H.
SO: J.-ENVIRON.-HEALTH 1994 vol. 56, no. 6, pp. 17-22
AB: Residents of two subdivisions with private wells and septic systems in central Wisconsin were surveyed about use of various household and lawn chemicals and their opinions about causes and severity of groundwater pollution problems. The overall response rate in the survey was 78 percent. Of 139 homeowners surveyed, 109 reported fertilizing their lawns an average of 1.8 times per year. Commonly used lawn and garden insecticides included diazinon, malathion and Sevin. Most commonly used household products were laundry detergent, toilet bowl cleaner, and tub and tile cleaners. Residents of both subdivisions were fairly accurate in describing the largest sources of groundwater contamination both in the county and in their own subdivisions. Their greatest concerns about groundwater quality were nitrate and pesticide contamination. Overall, 90 percent of participants were aware that individual homeowners may adversely affect groundwater quality, and 87 percent believed that education is the most effective solution to groundwater problems. Education needs for groundwater protection in these subdivisions include regular water testing, record keeping on well depth, the potential interrelationships of wells and septic systems in shallow groundwater systems, alternatives to hazardous household cleaning products, and modifications of lawn care practices.
AN: 3588526

Record 61 of 79 - Water Resources Abs. 1/93-4/98

TI: Estimation of nitrate concentrations in groundwater using a whole farm nitrogen budget.
AU: Barry,-D.A.J.; Goorahoo,-D.; Goss,-M.J.
SO: J.-ENVIRON.-QUAL. 1993 vol. 22, no. 4, pp. 767-775
AB: Contamination of groundwater under agricultural land by NO sub(3) is influenced by the kind of farming system. One possible method of selecting farming systems that result in less NO sub(3) leaching is to calculate whole farm N budgets, that are simplified by assuming soil-N remains constant from one cycle of a rotation to the next. This method was applied to two model crop rotations using average crop yield data for two regions of Ontario, and to a cash-crop farm and a dairy farm using information on purchases, sales, and crop yields, for these farms. The

model rotations were corn (Zea mays L.)-soybean [Glycine max (L.) Merr.]-wheat (Triticum aestivum L.) and corn-soybean-wheat-hay (mixture of timothy, Phleum pratense L. and alfalfa, Medicago sativa L.)-hay-hay. Atmospheric deposition (18.4 kg N ha super(-1) yr) was obtained by literature review. Symbiotic N sub(2) fixation by legume crops with different yields was estimated from regression equations. A net surplus in the N balance was converted to maximum mean NO sub(3)-N concentration in groundwater by assuming a groundwater recharge rate of 160 mm/yr, and no denitrification. Predicted NO sub(3)-N concentrations in leachate for the model corn-soybean-wheat rotation were greater for southwestern Ontario (22.4 mg/L) than western Ontario (8.5 mg/L), probably because more N fertilizer was recommended in the southwest. Including hay in the model rotation increased the amount of N leached by a factor of two in western Ontario, but only by 9% in the southwest. Predicted NO sub(3)/N concentration in groundwater for the cash crop farm was 6.7 mg/L, compared with an average measured value of 9.5 mg/L in the tile drainage water. For the dairy farm the predicted value was 58 mg L super(-1) and a measured value was not available. The simplified N balance method provided useful estimates of potential NO sub(3) leaching losses even though it relied on some major assumptions. A major uncertainty was atmospheric deposition of ammonia volatilized from on-farm sources. Denitrification could be as much as 62 kg N ha super(-1) yr super(-1) under continuous production of grain corn, based on differences between N present after harvest and amount of N leached.
AN: 3859591

Record 62 of 79 - Water Resources Abs. 1/93-4/98

TI: Hydrologic and land-use factors associated with herbicides and nitrate in near-surface aquifers.
AU: Burkart,-M.R.; Kolpin,-D.W.
SO: J.-ENVIRON.-QUAL. 1993 vol. 22, no. 4, pp. 646-656
AB: Selected herbicides, atrazine (2-chloro-4-ethylamino- 6-isopropylamino-s-triazine) metabolites, and NO sub(3) super(-) were examined in near-surface unconsolidated and bedrock aquifers in the midcontinental USA to study the hydrogeologic, spatial, and seasonal distribution of these contaminants. Groundwater samples were collected from 303 wells during the spring and late summer of 1991. At least one herbicide or atrazine metabolite was detected in 24% of the samples collected for herbicide analysis (reporting limit 0.05 mu g/L). No herbicide concentration exceeded the USEPA's maximum contaminant level (MCL) or health advisory level. The most frequently detected compound was the at razine metabolite deethylatrazine [2-amino-4-chloro- 6-(isopropylamino)-s-triazine] followed by atrazine, deisopropylatrazine [2-amino-4-chloro- 6-(ethylamino)-s-triazine], prometon (2,4-bis(isopropylamino)- 6-methyoxy-s-triazine), metolachlor [2-chloro-N- (2.ethyl-6-methylphenyl)-N-(2-methoxy-1 methylethyl)acetamide], alachlor [2-chloro-N-(2,6-diethylphenyl)- N-(methoxymethyl)acetamide], metribuzin [4-amino-6-(tert-butyl)- 3-methylthio-as-triazine-5(4H)-one], simazine [2-chloro-4,6-bis(ethylamino)- s-triazine], and cyanazine [2[[4-chloro-6-(ethylamino)-1,3,5-triazin- 2-yl]amino]-2-methylpropionitrile]. Nitrite plus nitrate, as nitrogen (N), exceeding 3.0 mg/L (excess NO sub(3) super(-)), was found in 29% of the samples, and 6% had sub(3) super(-) exceeding the MCL of 10 mg/L. Ammonium as N

was detected in excess of 0.01 mg/L in 78% of the samples. A nonlinear increase in the frequency of atrazine detection occurred with decreases in reporting limit. The frequency of atrazine residue detection (atrazine + deethylatrazine + deisopropylatrazine) was 25% greater than for atrazine alone. Herbicide detections and excess NO sub(3) super(-) were notably lacking in the eastern part of the study region where it was estimated that herbicide and fertilizer use were among the largest in the region. Prometon, the second most frequently detected herbicide, was associated with nonagricultural land use. Herbicide and excess NO sub(3) super(-) were more frequent in unconsolidated aquifers than in bedrock aquifers. Aquifer depth, as direct measurement of proximity to recharge sources, was inversely related to frequency of herbicide detection and excess NO sub(3) super(-).
AN: 3849070

Record 63 of 79 - Water Resources Abs. 1/93-4/98

TI: Chemical constituents in water from wells in the vicinity of the Naval Reactors Facility, Idaho National Engineering Laboratory, Idaho, 1990-91.
AU: Bartholomay,-R.C.; Knobel,-L.L.; Tucker,-B.J.
CA: Geological Surv., Idaho Falls, ID (USA)
SO: 1993. 70 pp.
RN: Rept. No: DOEID22106, USGSOFR9334
AB: The US Geological Survey, in response to a request from the US Department of Energy's Pittsburgh Naval Reactors Office, Idaho Branch Office, sampled 12 wells as part of a long-term project to monitor water quality of the Snake River Plain aquifer in the vicinity of the Naval Reactors Facility, Idaho National Engineering Laboratory, Idaho. Water samples were analyzed for manmade contaminants and naturally occurring constituents. Sixty samples were collected from eight groundwater monitoring wells and four production wells. Ten quality-assurance samples also were collected and analyzed. Most of the samples contained concentrations of total sodium and dissolved anions that exceeded reporting levels. The predominant category of nitrogen-bearing compounds was nitrite plus nitrate as nitrogen. Concentrations of total organic carbon ranged from less than 0.1 to 2.2 milligrams per liter. Total phenols in 52 of 69 samples ranged from 1 to 8 micrograms per liter. Extractable acid and base/neutral organic compounds were detected in water from 16 of 69 samples. Concentrations of dissolved gross alpha- and gross beta-particle radioactivity in all samples exceeded the reporting level. Radium-226 concentrations were greater than the reporting level in 63 of 68 samples.
AN: 3743773

Record 64 of 79 - Water Resources Abs. 1/93-4/98

TI: Impact of irrigation water use on water quality in the central Colorado water conservancy district.
AU: Emond,-H.; Loftis,-J.C.; Podmore,-T.
SO: TECH.-REP.-COLO.-WATER-RESOUR.-RES.-INST. COLORADO STATE UNIVERSITY, FORT COLLINS, CO 80523 (USA) COLORADO WATER RESOURCES

RESEARCH INSTITUTE. 1993 22 pp.
RN: COMPLETION REPORT: 179
AB: This paper presents the results of a two year study sponsored by the Colorado Water Resources Research Institute, the United States Geological Survey, and the United States Environmental Protection Agency on the impact of irrigation water use on water quality in the agricultural area near Greeley, Colorado. Data on water management techniques, consumptive use, irrigation application efficiency, deep percolation, surface runoff and nitrate levels were collected. Results indicated a wide range of application efficiencies and deep percolation percentages. Nitrate levels in the pumped ground water often exceeded EPA drinking water standards, while nitrate levels of water from the South Platte River were generally below the drinking water standards. There are opportunities for improving irrigation application efficiency in this area, but there may be repercussions for downstream water users. Decreasing the quantity of nitrate going into the ground water can occur through increased water conservation and through reducing the actual amount of nitrates applied in the irrigation water or fertilizers. There is currently little incentive for farmers to implement these measures.
AN:. 3692807

Record 65 of 79 - Water Resources Abs. 1/93-4/98

TI: Spatial distribution of nitrate leaching "hot spots" and nitrate contributions to the South Platte River Basin aquifers.
AU: Wylie,-B.K.; Wagner,-D.G.; Hoffer,-R.M.; Maxwell,-S.; Shaffer,-M.J.
SO: TECH.-REP.-COLORADO-WATER-RESOUR.-RES.-INST. COLORADO STATE UNIVERSITY, FORT COLLINS, CO 80523 (USA) COLORADO WATER RESOURCES RESEARCH INSTITUTE. 1993 26 pp.
RN: Completion Report: 181
AB: This project specifically addresses the issue of ground water quality in the South Platte River Basin Aquifer due to nitrate contamination. Areas north and south of Greeley, Colorado, currently have many wells supplying groundwater containing more than 10 ppm of nitrates. A numerical model, the Nitrate Leaching and Economic Analysis Package (NLEAP) is used to estimate nitrates leached (NL) from agricultural crop root zones by simulating weather, fertilizer inputs, irrigation practices, evapotranspiration, soil types and a variety of other cropping practices. Combining such a model with the spatial distribution of soils and cropping practices within a geographic information system (GIS) framework allows the identification of the geographical extent and spatial distribution of nitrate leaching "hot spots." Model runs were correlated to groundwater NO sub(3)-N for 37 pumping irrigation wells within the study area for the 1989-1991 growing seasons. The strongest single nitrate leaching factor correlated to groundwater NO sub(3)-N concentrations was proximity-to-feedlots. Manuring practices or inadequate crediting of manure-source nitrogen in determining fertilizer requirements are possible causes of the importance of proximity-to-feedlots. The reason is unclear at this level of analysis. Variation in NLEAP NL estimates associated with soil variability was the second strongest leaching factor related to groundwater NO sub(3)-N concentration. Fertilizer application rates varied as a function of organic matter in the soil and potential crop yields for that soil. The combination of two nitrate leaching factors that gave the strongest correlations to

groundwater NO sub(3)-N concentrations was proximity-to-feedlots and soils. Conclusions reached from the research suggested that spatial variations in NLEAP simulated NL, associated with proximity-to-feedlots, was related to groundwater NO sub(3)-N contamination in the study area.
AN: 3673272

Record 66 of 79 - Water Resources Abs. 1/93-4/98

TI: Evaluation of surface irrigation systems near Greeley, Colorado.
AU: Emond,-H.; Loftis,-J.C.; Podmore,-T.H.; Roberts,-J.; Leaf,-F.
CF: 1993 South Platte Forum, Fort Collins, CO (USA) 27-28 Oct 1993
SO: SEEKING AN INTEGRATED APPROACH TO WATERSHED MANAGEMENT IN THE SOUTH PLATTE BASIN. Klein,-K.C.; Williams,-D.J. (eds.) COLORADO STATE UNIVERSITY, FORT COLLINS, CO 80523 (USA) COLORADO WATER RESOURCES RESEARCH INSTITUTE. 1993 pp. 47-48.
AB: Sustainable agriculture and the minimizing of negative impacts by agriculture on the environment, has been generating much interest lately. Particularly in northeastern Colorado, there are concerns that return flows from irrigated agriculture are a source of pollution to ground water and surface water. Excess irrigation water not stored in the root zone for beneficial crop use can result in deep percolation below the crop root zone or surface runoff. This excess water is free to transport fertilizers and pesticides to the ground water and surface water downstream of the irrigation, possibly contributing to the degradation of water quality. In a study on sustainable agriculture by the Central Colorado Water Conservancy District of Greeley, Colorado and funded by the Environmental Protection Agency, a field team from Colorado State University conducted on-farm monitoring of irrigation water use and water quality. The monitoring study is helping to identify the pollution potential of current irrigation practices in the South Platte Basin. The CSU team intensively monitored three surface fields during the summer of 1992 and 1993. A mass balance approach was used to quantify the water inputs to selected fields and the amount of water lost to deep percolation and surface runoff. The amount of water applied to individual fields and the amount of water running off were monitored. The quantity of water used by the plants was estimated using a reference evapotranspiration equation and weather data. The relative loss from deep percolation was calculated. Irrigation application efficiency, tail water ratio and deep percolation ratio were calculated. The nitrate level, of concern for health considerations, was regularly tested in the irrigation pump water and surface water. The range of irrigation application efficiencies measured for the surface irrigated fields was surprisingly wide, ranging from 7% to 67%. The resulting deep percolation for the three fields indicates how leaching of nitrates to the ground water might be affected by this wide range of efficiencies. Although low application efficiencies suggest an opportunity to improve irrigation system performance and reduce nitrate leaching, downstream users of the South Platte River are dependant upon irrigation return flows for late season irrigation. Further analyses of water use, water quality and transport processes of pollutants in the soil are needed to make recommendations regarding measures to improve ground water quality.
AN: 3661161

Record 67 of 79 - Water Resources Abs. 1/93-4/98

TI: Regional evaluation of the alluvial groundwater quality of the South Platte Basin from Denver to Greeley, Colorado.
AU: Leaf,-F.A.; Leaf,-C.F.
CF: 1993 South Platte Forum, Fort Collins, CO (USA) 27-28 Oct 1993
SO: SEEKING AN INTEGRATED APPROACH TO WATERSHED MANAGEMENT IN THE SOUTH PLATTE BASIN. Klein,-K.C.; Williams,-D.J. (eds.) COLORADO STATE UNIVERSITY, FORT COLLINS, CO 80523 (USA) COLORADO WATER RESOURCES RESEARCH INSTITUTE. 1993 p. 39.
AB: A regional water balance was simulated for the period 1950-1988 for the reach of the South Platte River from Denver to Greeley. This area includes a total of 259,100 acres in southeastern Weld County, of which 150,400 acres is overly alluvial material and 135,400 acres is irrigated cropland. The average annual inflow for the period simulated totaled 915,000 acre-feet and the average outflow totaled 922,000 acre-feet. Average precipitation and potential crop evapotranspiration for the study area totaled 178,000 and 288,00 acre-feet respectively. The annual crop water requirement for the study area supplied through the conjunctive use of groundwater and surface water, averaged 190,100 acre-feet. Average alluvial groundwater storage totaled 2.02 million acre-feet and experienced no appreciable change in storage for the 39 years studied. Average groundwater nitrate - nitrogen (NO sub(3)-N) concentrations have increased approximately 7.9 milligrams per liter from the mid 1950's to the late 1980's. For the same period, the area-weighted average increase was 8.2 mg/l NO sub(3)-N. This increase in NO sub(3)-N concentration is attributed to agricultural and other land use practices. The net area-weighted annual impact to the groundwater resource in the study area is 9.14 pounds per acre nitrate - nitrogen. This corresponds to an average annual increase in groundwater nitrate - nitrogen concentration of 0.25 milligrams per liter from 1958 - 1990.
AN: 3661156

Record 68 of 79 - Water Resources Abs. 1/93-4/98

TI: Origin and fate of high nitrate concentrations in water from the South Platte River alluvial aquifer-preliminary results.
AU: McMahon,-P.B.; Bruce,-B.; Dennehy,-K.F.
CF: 1993 South Platte Forum, Fort Collins, CO (USA) 27-28 Oct 1993
SO: SEEKING AN INTEGRATED APPROACH TO WATERSHED MANAGEMENT IN THE SOUTH PLATTE BASIN. Klein,-K.C.; Williams,-D.J. (eds.) COLORADO STATE UNIVERSITY, FORT COLLINS, CO 80523 (USA) COLORADO WATER RESOURCES RESEARCH INSTITUTE. 1993 p. 38.
AB: Data for the areal and vertical distribution of dissolved nitrate and related compounds in water from the South Platte River alluvial aquifer were used to determine the origin and fate of high nitrate concentrations in water from a part of the aquifer underlying an area of intensive irrigated agriculture between Platteville and Greeley, Colorado. Nitrate concentrations at the water table varied areally from < 0.5 to 47 milligrams per liter as nitrogen, and average nitrate

concentrations were higher in aerobic water underlying agricultural fields (22.6 plus or minus 12.3 milligrams per liter) than in anaerobic water underlying the river (6.2 plus or minus 4.2 mg/L). There was no apparent relation between nitrate concentration and depth. Values of delta super(15)N for dissolved nitrate in aerobic water underlying fields (11.0 plus or minus 2.3 per mil) were consistent with an animal-waste source for the nitrate. Heavier delta super(15)N values for dissolved nitrate in anaerobic water underlying the river (17.6 plus or minus 2.1 per mil) and the lower nitrate concentrations in water underlying the river indicate that microbial denitrification in the anaerobic part of the aquifer lowered nitrate concentrations, leaving the residual nitrate enriched in super(15)N prior to ground-water discharge to the river. Further evidence for microbial denitrification in the aquifer included a buildup of N sub(2) and N sub(2)O gases, both products of dentrification, in anaerobic water from the aquifer. These results may have important consequences for agricultural nitrate-management practices and aquatic biological assessments in the study area.
AN: 3661155

Record 69 of 79 - Water Resources Abs. 1/93-4/98

TI: Trinity River Basin, Texas.
AU: Ulery,-R.L.; Van-Metre,-P.C.; Crossfield,-A.S.
SO: WATER-RESOUR.-BULL. 1993 vol. 29, no. 4, pp. 685-712
AB: In 1991 the Trinity River Basin National Water-Quality Assessment (NAWQA) was among the first 20 study units to begin investigations under full-scale program implementation. The study-unit investigations will include assessments of surface-water and ground-water quality. Initial efforts have focused on identifying water-quality issues in the basin and on the environmental factors underlying those issues. The environmental setting consists of both physical and cultural factors. Physical characteristics described include climate, geology, soils, vegetation, physiography, and hydrology. Cultural characteristics discussed include population distribution, land use and land cover, agricultural practices, water use, and reservoir operations. Major water-quality categories are identified and some of the implications of the environmental factors for water quality are presented.
AN: 3509148

Record 70 of 79 - Water Resources Abs. 1/93-4/98

TI: Effect of forested wetlands on nitrate concentrations in ground water and surface water on the Delmarva Peninsula.
AU: Phillips,-P.J.; Denver,-J.M.; Shedlock,-R.J.; Hamilton,-P.A.
SO: WETLANDS 1993 vol. 13, no. 2, spec. iss., pp. 75-83
AB: The Delmarva Peninsula is an extensively farmed region in which nitrate from commercial fertilizers and poultry has entered the ground water and streams. The peninsula contains forested wetlands in a variety of settings, and their size and location are a result of the surrounding hydrologic and soil conditions. Three regions, here referred to as hydrogeomorphic regions, were selected for study. Each region has characteristic geologic and geomorphic features, soils,

drainage patterns, and distribution of farmland, forests, and forested wetlands. In all three regions, forested wetlands generally occupy poorly drained areas whereas farmlands generally occupy well-drained areas. The three hydrogeomorphic regions studied are the well-drained uplands, the poorly drained uplands, and the surficial-confined region. The well-drained uplands have the largest amount of farmland and the smallest amount of forested wetlands of the three regions; here the forested wetlands are generally restricted to narrow riparian zones. The poorly drained uplands contain forested wetlands in headwater depressions and riparian zones that are interspersed among well-drained farmlands. The surficial-confined region has the smallest amount of farmland and largest amount of forested wetlands of the three regions studied. Wetlands in this region occupy the same topographic settings as in the poorly drained uplands. Much of the farmland in the surficial-confined region was previously wetland. Nitrate concentrations in ground water and surface water on the peninsula range widely, and their distribution reflects (1) the interspersion of forests among farmland, (2) hydrogeologic conditions, (3) types of soils, and (4) the ground-water hydrology of forested wetlands. The well-drained uplands had higher median nitrate concentrations in ground water than the poorly drained uplands or the surficial-confined region. The highest nitrate concentrations were in oxic parts of the aquifer, which are beneath well-drained soils that are farmed, and the lowest were in anoxic parts of the aquifer, which are beneath poorly drained soils overlain by forested wetlands. The effect of forested wetlands on water quality depends on the hydrogeologic conditions, extent of farming, and type of soils. The three regions contain differing combinations of these factors and thus are useful for isolating the effects of forested wetlands on water quality.
AN: 2995987

Record 71 of 79 - Water Resources Abs. 1/93-4/98

TI: Occurrence of Nitrate in Groundwater A Review.
AU: Spalding,-R.-F.; Exner,-M.-E.
SO: Journal of Environmental Quality JEVQAA, Vol. 22, No. 3, p 392-402, July/September 1993. 7 fig, 88 ref.
AB: The results of federal, state, and local surveys, which included more than 200,000 NO3-N data points, are summarized in this review of NO3 in groundwater in the USA. The levels of NO3-N are associated with source availability and regional environmental factors. In regions where well-drained soils are dominated by irrigated cropland, there is a strong propensity toward the development of large areas with groundwater that exceeds the maximum contaminant level of 10 mg/L NO3-N. Most of these areas are west of the Missouri River where irrigation is a necessity. Aquifers in highly agricultural areas in the southeastern USA reportedly are not contaminated. Vegetative uptake and denitrification in this warm, wet, C-rich environment are responsible for the natural remediation of NO3 in shallow aquifers. In the Middle Atlantic states and the Delmarva Peninsula, localized contamination occurs beneath cropped, well-drained soils that receive excessive applications of manure and commercial fertilizer. Extensive tile drainage has for the most part prevented a NO3 problem in the groundwater of the Corn Belt states. Throughout the USA there are recurring themes. They include a decrease in NO3-N levels with depth; lower NO3-N levels in shallow wells (<8 m); and a significant increase in NO3-N in older wells and in wells with poor construction. The factors affecting the distribution of NO3 in

aquifers are complex and poorly understood. Interdisciplinary studies using discrete depth sampling, geohydrological indicators, isotopic tracers, and microbiological techniques are necessary to unravel the complex dynamics. (Author's abstract) 35 012605040
AN: 9309694

Record 72 of 79 - Water Resources Abs. 1/93-4/98

TI: Small Treatment Systems and Alternative Sewers.
AU: Jantrania,-A.-R.
SO: Water Environment Research, Vol. 65, No. 6, p 349-353, June 1993. 46 ref.
AB: The U.S. Environmental Protection Agency has published a manual that details wastewater treatment and disposal systems for small communities. Wastewater reuse for non-potable purposes is also offered as an attractive option for small communities. Septic systems can be used as a wastewater treatment option in small communities. Different soils, peat and gravel chambers have been tested for septic systems. Land treatment and spray or drip irrigation systems have been tried for domestic wastewater treatment. A low-pressure distribution system was developed for on-site disposal of wastewater. Septic management is often regulated and monitored in many communities. Groundwater monitoring is done to determine if septage causes nitrate or bacterial contamination of groundwater. Wetland wastewater treatment allows management of wastewater in many small communities. Waste stabilization ponds have also been studied for wastewater treatment in small communities. Sewerage systems for small communities have been studied in regard to gas and odor emission, pipe corrosion, vacuum sewers, and gravity sewers. (Geiger-PTT)
AN: 9309565

Record 73 of 79 - Water Resources Abs. 1/93-4/98

Record 74 of 79 - Water Resources Abs. 1/93-4/98

TI: Nutrient Flux Through Soils and Aquifers to the Coastal Zone of Guam (Mariana Islands).
AU: Matson,-E.-A.
SO: Limnology and Oceanography LIOCAH, Vol. 38, No. 2, p 361-371, March 1993. 10 fig, 5 tab, 33 ref.
AB: Nitrification enriches terrestrial soil waters with nitrate, and other solutes also leach rapidly (within hours to days after saturating rain) through Guam's northern karst plateau into a largely unconfined carbonate aquifer system. Nutrient chemistry and discharge of these enriched aquifer waters into the inter- and subtidal zone was measured to evaluate the importance of this flux to the coastal nutrient regime of the island. Aquifer waters mix with seawater in the coastal transition zone, produce about a 10% seawater mixture, leak year-round through cracks and fissures and from seeps in beaches around the entire perimeter (57 km) at rates of 2.2-110 cu m (m of shoreline)/d (avg, 5.1 cu m/m/d). The theoretical maximum rate can average 14 cu m/m/d, which is equal to net annual aquifer recharge. At the shoreline, the discharged aquifer waters average 3.14 ppt salinity, 96+/-21 microM NO3(-), 28+/-6.8 microM Si, 0.85+/-0.26 microM P,

and 0.18+/-0.19 microM Fe. Deep seawater under the aquifer averages 33.8 ppm salinity, 8.5+/-2.1 microM NO3(-), 7.2+/-1.8 microM Si, and 0.05+/-0.04 microM Fe. The aquifer system can potentially discharge 1,340 microM NO3(-)/sq m/d, 390 microM Si/sq m/d, 12 microM P/sq m/d, and 2.5 microM Fe/sq m/d, out to a distance of 1 km from shore, which enriches surface seawater by about 20 times the ambient concentration per day. In general, natural flux of nutrient in aquifer waters from tropical carbonate islands will increase as a function of island diameter, aquifer recharge, head, the thickness of the soil layers in which remineralization occurs, and as the acquisition of solutes from subterranean volcanics above sea level increases. (Author's abstract)
AN: 9307679

Record 75 of 79 - Water Resources Abs. 1/93-4/98

TI: Physiographic and Land Use Characteristics Associated with Nitrate-Nitrogen in Montana Groundwater.
AU: Bauder,-J.-W.; Sinclair,-K.-N.; Lund,-R.-E.
SO: Journal of Environmental Quality JEVQAA, Vol. 22, No. 2, p 255-262, April/June 1993. 2 fig, 6 tab, 16 ref.
AB: Occurrence of NO3(-)-N in drinking water at concentrations >10 mg/L is being reported in the literature with increasing frequency. Some occurrences of high NO3(-)-N concentrations have been attributed to irrigation and fertilization practices. A private well water testing program in Montana, involving nearly 3400 well owners, found NO3(-)-N concentrations >10 mg/L in nearly 6% of all tested wells. Most of the agricultural land in Montana is nonirrigated and is not subject to high rates of N fertilization. Dryland crop/fallow cereal grain rotations are the main practices. Well water test results were combined with MAPs, a geographic information system (GIS), to identify correlations between county average NO3(-)-N concentration in groundwater, well water sample probability of exceeding 10 mg/L NO3(-)-N, geographic, climatic, and geologic conditions, and land use practices. From a list of 67 independent variables, county average well water NO3(-)-N concentration >10 mg/L were correlated with 16 independent variables, most of which were associated with precipitation, soil properties, and land use practices. The closest correlations were March 1 through June 30 precipitation, distribution of dryland crop production and summer fallow, soil water holding capacity, and mapping units of the general soil map of Montana. Two-, three-, and four-variable, linear, multiple regression models indicated that 53% to 61% of the variability in county average well sample NO3(-)-N concentration would be accounted for by these independent variables. Results of these analyses support the hypothesis that summer fallow practices and associated mineralization of organic matter may be contributing to regionalized NO3(-)-N contamination of shallow groundwater in Montana. (Author's abstract) 35 012306044
AN: 9307574

Record 76 of 79 - Water Resources Abs. 1/93-4/98

TI: A Survey of Lead, Nitrate and Radon Contamination of Private Individual Water Systems in

Pennsylvania.
AU: Swistock,-B.-R.; Sharpe,-W.-E.; Robillard,-P.-D.
SO: Journal of Environmental Health JEVHAH, Vol. 55, No. 5, p 6-12, March 1993. 8 fig, 39 ref.
AB: Private individual water systems throughout Pennsylvania were sampled for dissolved lead, nitrate-N and radon to determine the prevalence of these primary pollutants. Approximately 1,600 sources were tested for lead and nitrate and 989 were tested for radon. Twenty-eight percent of sampled homes had lead concentrations above 10 microg/L and 19% were above 15 microg/L. These percentages increased to 50 and 34% respectively when calculated total (digested) lead data were used, suggesting that total lead analysis may be appropriate even when dealing with relatively clear, low turbidity samples. Nitrate contamination was less prevalent and more regional than lead. Nine percent of sampled homes contained nitrate-N above 10 mg/L with nearly all (96%) of these homes located in the agricultural south-central and southeastern regions of the state. Nearly 80% of the groundwater wells tested contained radon concentrations above the proposed maximum contaminant level of 300 pCi/L. Excessive radon concentrations existed in all regions of the state but were most prevalent in the eastern regions near the Reading Prong geologic formation. (Author's abstract) 35 009222081
AN: 9306542

Record 77 of 79 - Water Resources Abs. 1/93-4/98

TI: Nitrate Contamination of Private Well Water in Iowa.
AU: Kross,-B.-C.; Hallberg,-G.-R.; Bruner,-D.-R.; Cherryholmes,-K.; Johnson,-J.-K.
SO: American Journal of Public Health AJHEAA, Vol. 83, No. 2, p 270-272, February 1993. 1 fig, 2 tab, 21 ref.
AB: The State-Wide Rural Well-Water Survey conducted in Iowa between April 1988 and June 1989 revealed that about 18% of the state's private, rural drinking water wells contain nitrate above the recommended health advisory level of 10 mg/L. Thirty-seven percent of the wells have levels greater than 3 mg/L, typically considered indicative of anthropogenic pollution. Thirty-five percent of wells < 15 m deep exceed the health advisory level, and the mean concentration of nitrate-nitrogen for these wells exceeds 10 mg/L. The depth of the well was the best predictor of well water contamination. Individually, NO3-N levels of > 10 mg/L occurred alone in about 4% of the private wells statewide; pesticides were present alone in about 5%. Total coliform positives occurred alone at 27% of the sites. In a cumulative sense, nitrates, pesticides, and coliform positives were detected in nearly 55% of rural private water supplies. High nitrate levels have been associated with increased risks for birth defects or cancer in humans in several studies. The high nitrate levels in groundwater in Iowa have been attributed to agricultural runoff in areas with high fertilizer and manure use. It is recommended that normal prenatal care for rural patients should include well testing fo r nitrates, and use of safer water for the preparation of infant formulas where high nitrate levels are detected. Routine monitoring of wells used for drinking water is also recommended along with the implementation of groundwater protection strategies, such as sustainable agriculture practices. (Geiger-PTT)
AN: 9306113

Record 78 of 79 - Water Resources Abs. 1/93-4/98

TI: Nitrogen Isotopes as Indicators of Nitrate Sources in Minnesota Sand-Plain Aquifers.
AU: Komor,-S.-C.; Anderson,-H.-W.
SO: Ground Water GRWAAP, Vol. 31, No. 2, p 260-270, March/April 1993.6 fig, 1 tab, 31 ref.
AB: Nitrate concentrations in excess of national drinking- water standards (10 mg/L as N) are present in certain sand- plain aquifers in central Minnesota. To investigate nitrate sources in the aquifers, nitrogen-isotope values of nitrate (delta-15N NO3) were measure d in shallow groundwater from 51 wells in five land-use settings. The land-use settings and corresponding average nitrate concentrations (as N) and delta-15N NO3 values were: livestock feedlots, 12.7 mg/L, 21. 3 ppt; cultivated-irrigated fields, 13 mg/L, 7.4 ppt; residential area with septic systems, 8.3 mg/L, 6.0 ppt; non-irrigated cultivated fields, 15.5 mg/L, 3.4 ppt; and natural, undeveloped areas, 3.8 mg/L, 3.1 ppt. Values of delta-15N NO3 less than 2 ppt suggest that nitrogen from commercial inorganic fertilizers exists in groundwater beneath all settings except the feedlots. Values of delta- 15N NO3 greater than 10 ppt suggest that nitrogen from animal waste is present in groundwater beneath certain feedlots, cultivated-irrigated fields that are fertilized with manure, and residential areas with septic systems. Values of delta-15N NO3 between 22 and 43 ppt in groundwater beneath the feedlots probably result from denitrification. Values of delta-15N NO3 increase with depth in many locations in the sand-plain aquifers. These increases may be caused by progressive denitrification with depth or by changes with depth in the proportions of nitrate from different sources. Similarly, variations of delta-15N NO3 values from 1986 to 1987 in certain locations may be due to temporal variations in the amounts of denitrification or to changes in the proportions of nitrate from different sources. Ambiguities in the interpretation of changes in delta-15N NO3 values could be eliminated by increasing the spatial and temporal frequency of sampling. (Author's abstract)
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TI: Stable Isotopes of Oxygen and Nitrogen in Source Identification of Nitrate from Septic Systems.
AU: Aravena,-R.; Evans,-M.-L.; Cherry,-J.-A.
SO: Ground Water GRWAAP, Vol. 31, No. 2, p 180-186, March/April 1993. 4 fig, 40 ref.
AB: Stable isotopes, 15N and 18O, were used as tracers to differentiate a contaminant nitrate plume emanating from a single domestic septic system, in a groundwater system characterized by high and similar nitrate content outside and inside the contaminant plume. A good delineatio n of the nitrate plume of septic origin was obtained using analysis of 15N in nitrate. The 15N content of the non-plume nitrate is in agreement with the sources of nitrate (solid cattle manure, synthetic fertilizer (NH4-NO3), and soil organic nitrogen) at the study site. 18-Oxygen analysis in nitrate did not provide enough isotopic contrast to permit separation of nitrate derived from the septic system and that in the surrounding groundwater, derived from agricultural fertilizer sources. Thus, the 18O data indicated that nitrification of ammonium is the main process responsible for formation of nitrate at the study site. Nonetheless, the 18O in groundwater clearly delineated the

groundwater plume associated with the septic system; this suggests that this tracer should be considered in studies related with contaminant plumes of different origin. (Author's abstract)
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