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Wells and Wellhead Protection

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1. Analytical modelling of pesticide transport from the soil surface to a drinking water well.

Beltman, W. H. J., Boesten, J. J. T. I., and Zee, S. E. A. T. M. van der.

J hydrol 169: 1/4 pp.209-228. (July 1995).

NAL Call #: 292.8-J82

Descriptors: pesticides- leaching- water-flow drinking-water wells- water-quality groundwater-pollution mathematical-models

Abstract: Pesticide transport through the unsaturated zone was modelled with an analytical solution of the convection-dispersion equation assuming steady water flow, a linear sorption isotherm and first-order transformation kinetics. Pesticide behaviour in the saturated zone was described with an analytical solution of the mass balance equation for

a cylindrical flow system assuming steady flow, no dispersion, linear sorption and first-order transformation. This simplified model for the unsaturated-saturated soil system was developed to identify the processes and parameters with the greatest impact on the fraction of applied pesticide reaching a drinking water well. Leaching from the unsaturated zone was highly sensitive to the parameters describing travel time and transformation rate. Leaching increased when heterogeneity of the soil was taken into account. Pesticide arrival in the well was only moderately sensitive to the characteristic travel time and transformation rate in the aquifer. However, this sensitivity increases if zones without pesticide application were introduced around the wells (protection zones). For representative sandy soils under average Dutch rainfall conditions, processes in the unsaturated zone had a much larger impact on pesticide arrival in the wells than processes in the saturated zone. Protection zones reduced pesticide transport to wells substantially if their half-life was much smaller than the characteristic travel time of the pesticide in the aquifer.

2. **An annotated bibliography on wellhead protection programs.**

United States. Environmental Protection Agency. Office of Ground Water Protection. Washington, D.C. : U.S. Environmental Protection Agency, Office of Water, Office of Ground-Water Protection, [1987] ii, 75 p.

NAL Call #: DNAL Z7935.A56--1987

Descriptors: Wells-Bibliography

3. **Application of petroleum geophysical well logging and sampling techniques for evaluating aquifer characteristics.**

Temples, T. J. and Waddell, M. G.

Ground-water. Columbus, Ohio : Ground Water Pub. Co. May/June 1996. v 34 (3) p. 523-531.

NAL Call #: TD403.G7

Descriptors: aquifers- wells- sampling- groundwater- data-collection geology- analytical-methods porosity- permeability- saturated-hydraulic-conductivity water-quality south-carolina transmissivity-

Abstract: The Hilton Head Island Test Well #1 was drilled to a depth of 3833 feet to evaluate the upper Cretaceous section as a potential ground-water source for Hilton Head Island, South Carolina. The initial plan was to analyze continuous conventional cores. The interval to be analyzed extended from the top of the Eocene to the base of the Cretaceous (approximately 3500 feet). However, due to the high cost (\$400,000), the decision was made to evaluate aquifer potential using advanced geophysical logs with sidewall cores for calibration. The logging suite consisted of a dual induction resistivity, spontaneous potential, compensated neutron, density log, gamma ray, spectral gamma, multipole array acoustic log, caliper, high resolution dipmeter, and a circumferential borehole imaging log. In addition to the wireline logs, 239 sidewall cores and 12 Formation Multi-Test samples were obtained. The log, sidewall core, and FMT information were integrated into an interpretive package using computer generated logs and simple spreadsheets to calculate aquifer properties. Porosity, hydraulic conductivity, transmissivity, and lithologic data derived from this integrated analysis were then used to select screen zones. Water quality in relation to drinking water standards exceeded expectations. The information obtained from the integrated program allowed estimates to

be made about the well's productivity without the expense of conventional coring, flow testing, and completion of the well.

4. **Assessing the condition of your water well and its location.**

Weston, D.

NDSU-Ext-Serv. Fargo, N.D. : The University. Apr 1994. (AE-1074) 6 p.

NAL Call #: S544.3.N9C46

Descriptors: wells- farms- groundwater- planning- water-pollution contaminants- drinking-water site-factors safety-

5. **Assessing your petroleum product storage practices.**

Weston, D.

NDSU-Ext-Serv. Fargo, N.D. : The University. Apr 1994. (AE-1078) 4 p.

NAL Call #: S544.3.N9C46

Descriptors: fuel-tanks groundwater-pollution farm-storage pollutants- leakage- wells- drinking-water assessment- safety- north-dakota

6. **Bacteriological suitability of water from Basrah wells for drinking.**

Al Sulami, A. A. and Yaseen, H. A.

Water Sci Technol J Int Assoc Water Pollut Res Control 24: 2 pp. 89-93. (1991).

NAL Call #: DNAL TD420.A1P7

Descriptors: drinking-water wells- microbial-contamination bacterial-counting health-hazards iraq-

7. **Better homes & groundwater : a homeowner's guide.**

Stevens Point Whiting Plover Wellhead Protection Project.

Stevens Point, WI : Stevens Point-Whiting-Plover Wellhead Protection Project, 1992.

NAL Call #: DNAL TD224.W6B48--1992

Descriptors: Groundwater-Pollution-Wisconsin-Citizen-participation-Handbooks,- manuals,-etc.

8. **Class I injection wells and your drinking water.**

United States. Environmental Protection Agency. Office of Water. Underground Injection Control.

[Washington, D.C.?] : U.S. EPA, Office of Water, [1994] 1 folded sheet (7 p.)

NAL Call #: TD426.8.C53--1994

Descriptors: Injection-wells-Environmental-aspects Drinking-water-United-States-Contamination

9. **Class II injection wells and your drinking water.**

United States. Environmental Protection Agency. Office of Water. Underground Injection Control.

[Washington, D.C.?] : U.S. EPA, Office of Water, [1994] 1 folded sheet (8 p.)

NAL Call #: TD426.8.C532--1994

Descriptors: Injection-wells-Environmental-aspects Drinking-water-Contamination-United-States

10. **Class III injection wells and your drinking water.**

United States. Environmental Protection Agency. Office of Water. Underground Injection Control.

[Washington, D.C.?] : U.S. EPA, Office of Water, [1994] 1 folded sheet (7 p.)

NAL Call #: TD426.8.C533--1994

Descriptors: Injection-wells-Environmental-aspects Drinking-water-United-States-Contamination

11. Class V injection wells and your drinking water.

United States. Environmental Protection Agency. Office of Water. Underground Injection Control.

[Washington, D.C.?] : U.S. EPA, Office of Water, [1994] 1 folded sheet (7 p.)

NAL Call #: TD426.8.C535--1994

Descriptors: Injection-wells-Environmental-aspects Drinking-water-Contamination-United-States Drinking-water-Toxicology-United-States

12. Clean well water? Not always.

Henderson, Z. P.

Hum ecol forum 23: 3 pp. 5-7. (Summer 1995).

NAL Call #: HV1.H8

Descriptors: drinking-water wells- septic-tanks microbial-contamination toxic-substances water-management site-factors leaching- soil-types-structural soil-types-textural waste-water waste-water-treatment monitoring- education- water-quality new-york surveys-

13. Community wellhead protection programs.

Dee, N. and Austin, S.

OSU-Ext-Facts-Coop-Ext-Serv-Okla-State-Univ. Stillwater, Okla. : The Service. Dec 1992. (890) 6 p.

NAL Call #: S544.3.O5O5

Descriptors: groundwater-pollution water-supply water-resources water-purification wells- community-action prevention-

14. Comparability of large-scale studies of agricultural chemical contamination of rural private wells.

Ray, C. and Schock, S. C.

Ground water monit remediat. 16: 2 pp. 92-102. (Spring 1996).

NAL Call #: GB1001.G76

Descriptors: wells- groundwater- groundwater-pollution contaminants- agricultural-chemicals detection- rural-areas surveys- comparisons- usa- ontario- prince-edward-island

Abstract: Detection of agricultural chemicals in ground water has prompted numerous studies. Federal, state, and regional studies were conducted in the last 10 years in order to assess the occurrence of agricultural chemicals in ground water. The results of the studies present the number or percentage of samples with agricultural chemicals above the drinking water standard or health advisory levels as well as samples with detections of one or more compounds. Data comparison from one state or region to another are frequently referred to by regulatory and agency personnel involved in water quality and agriculture issues. Unless the history of pesticide use, method of chemical analyses, detection limits, statistical design of the sampling plan, well type, well depth, geology of the formation material, and typical land use around the wellhead are known, such comparisons can be misleading. Reporting the limitations or presenting a disclaimer should be a key element for a study so that "apples and oranges" are not compared.

15. Comparison of an analytical model and a numerical model for delineating wellhead protection areas.

Ramanarayanan, T. S., Storm, D. E., Smolen, M. D., and Kizer, M. A.

Pap-Am-Soc-Agric-Eng. St. Joseph, Mich. : American Society of Agricultural Engineers,.
Summer 1992. (922036) 15 p.

NAL Call #: 290.9-Am32P

Descriptors: wells- models- gradients-

16. Comparison of models for delineating wellhead protection areas in confined to semiconfined aquifers in alluvial basins.

Forster, C. B., Lachmar, T. E., and Oliver, D. S.

Ground-water. Westerville, Ohio : Ground Water Pub. Co. July/Aug 1997. v. 35 (4) p.
689-697.

NAL Call #: TD403.G7

Descriptors: aquifers- groundwater- hydrology- saturated-hydraulic-conductivity
computer-simulation simulation-models mathematical-models wells- groundwater-flow
groundwater-extraction utah- horizontal-hydraulic-conductivity pumping-wells salt-lake
valley vertical-hydraulic-conductivity

Abstract: The 1986 Safe Drinking Water Act Amendments include provisions for state wellhead protection (WHP) programs that address wellhead protection areas (WHPAs). In many states, WHPAs are delineated based on time-of-travel (TOT) criteria. This study compares 250-day and 15-year TOT capture zones computed in a confined to semiconfined aquifer system in an alluvial basin using semianalytical and two- and three-dimensional numerical ground-water flow models, and evaluates the relative importance of several sources of uncertainty, such as aquifer hydraulic conductivity, aquitard leakage, vertical transit time, hydraulic gradients, transient pumping effects, well interference, and three-dimensional aquifer geometries. A numerical model should be used to delineate 15-year TOT capture zones for wells in confined to semiconfined aquifers in alluvial basins. A semianalytical program may be acceptable for computing the 250-day TOT capture zones; however, such codes can be applied only under a very narrow range of conditions. Hydraulic conductivity plays a critical role in controlling the sizes and shapes of capture zones computed in confined to semiconfined aquifers. Small, circular capture zones are computed in low hydraulic conductivity areas. More complex geometries should be expected where hydraulic conductivities are higher and pumping wells are in close proximity to each other. Aquifers with horizontal hydraulic conductivities that are greater than 1,000 times the vertical hydraulic conductivity of the overlying aquitard are effectively fully confined, and larger capture zones would be computed for these aquifers than for semiconfined aquifers when significant leakage is induced by pumping. In addition, relatively large drawdowns are computed in low hydraulic conductivity areas, resulting in short vertical transit times. Vertical transit times are longer where aquifer hydraulic conductivities are higher.

17. Connecticut's Wellhead Protection Program.

Banach, F. S.

Ground water protection alternatives and strategies in the USA. New York, N.Y. :
American Society of Civil Engineers, 1997. p. 112-124.

NAL Call #: TD223.G736-1997

Descriptors: groundwater-pollution connecticut-

18. Coping with contaminated wells.

Glanville, T.

PM-Iowa-State-Univ-Coop-Ext-Serv. Ames, Iowa : Iowa State University, Cooperative

Extension Service. Dec 1993. (1329,rev.) 6 p.

NAL Call #: 275.29-IO9PA

Descriptors: wells- drinking-water contamination- etiology- coliform-bacteria nitrates-testing- decontamination- iowa.

19. Delineation of wellhead protection areas in fractured rocks.

United States. Environmental Protection Agency. Office of Water. United States.

Environmental Protection Agency. Office of Ground Water Protection.

Washington, D.C. : U.S. Environmental Protection Agency, 1991. xv, 144 p.

Bibliography: p. 79-84.

NAL Call #: TD407.D46-1991

Descriptors: Wells-Protection-United-States Wellheads-

20. Delineation of wellhead protection areas: theory and practice.

Cleary, T. C. B. F. and Cleary, R. W.

Pollution, protection and control of groundwater proceedings of the IAWPRC

International Seminar, held in Porto Alegre, Brazil, 20-21 September 1990. 1st ed.

Oxford [England] ; New York : Pergamon Press, c1992. p. 239-250.

NAL Call #: TD420.A 1P7-v.24-no.11

Descriptors: groundwater-pollution pollution-control wells- pollution- simulation-models aquifers- groundwater-flow groundwater-extraction mathematical-models pollution-sources

21. Delineation of wellhead protection areas using particle tracking analysis and hydrogeologic mapping, northern Anne Arundel County, Maryland.

Wilson, John M., Achmad, Grufron., and Anne Arundel County (Md.) Department of Public Works. Maryland. Department of the Environment.

[Baltimore, MD] : Geological Survey, 1995. vi, 121 p. : ill., maps (some col.): Prepared in cooperation with the Anne Arundel County Department of Public Works and the Maryland Department of the Environment.

NAL Call #: TD426.W74--1995

Descriptors: Wellheads. Maryland. Anne Arundel County. Water-Pollution.

Groundwater. Groundwater-Pollution. Water-supply. Water-supply-Environmental-aspects

22. Dependence of aldicarb residue degradation rates on groundwater chemistry in the Wisconsin central sands.

Kraft, G. J. and Helmke, P. A.

J Environ Qual 21: 3 pp. 368-372. (July/Sept 1992).

NAL Call #: QH540.J6

Descriptors: aldicarb- insecticide-residues degradation- oxidation- hydrolysis-groundwater- groundwater-pollution aquifers- depth- dissolved-oxygen wisconsin-aquifer-depth aldicarb-sulfoxide aldicarb-sulfone

Abstract: Aldicarb sulfoxide (ASO) (2-methyl-2-(methylsulfinyl)propanal O-[(methylamino)carbonyl]oxime) and aldicarb sulfone (ASO2) (2-methyl-2-(methylsulfonyl)propanal O-[(methylamino)carbonyl]oxime) degradation rates were measured in incubations simulating three depths (0.5, 5, and 10 m) of a Wisconsin central sand plain (WCSP) aquifer. The incubations differed mainly in pH (5.8, 6.5, and 7.2, respectively, for the three depths) and PO₂ (20 kPa [0.2 atm] for the 0.5- and 5-m depths, 1.5 kPa [0.015 atm] for the 10-m depth). Degradation rates corresponded to half-

lives ranging from years to less than a month. Aldicarb sulfone (ASO2) degraded faster than ASO at the same depth. No ASO degradation was measured under aerobic, pH 5.8 conditions; no ASO oxidation was observed in any incubation. The shortest half-lives, 19 and 32 d for ASO and ASO2, respectively, were obtained under the low pO2 conditions. The results of this and a previous experiment provide degradation rates for a cross-section of WCSP groundwater chemistries. Thus, with knowledge of the groundwater chemistry at a given WCSP location, degradation rates can be estimated. Degradation rates of common groundwater contaminants as functions of chemical and physical controlling factors could prove valuable to groundwater managers for endeavors such as wellhead protection.

23. **Description and evaluation of selected methods used to delineate wellhead-protection areas around public-supply wells near Mt. Hope, Kansas.**

Hansen, Cristi V. and United States. Environmental Protection Agency. Geological Survey (U.S.).

Lawrence, Kan. : U.S. Dept. of the Interior, U.S. Geological Survey ; Denver, Colo. : Books and Open-File Reports [distributor], 1991. x, 39 p.

NAL Call #: GB701.W375-no.90-4102

Descriptors: Water,-Underground-Kansas Wellheads-Protection-Kansas

24. **Determinants of ground-water quality in a multi-layer glacial drift aquifer system : implications for wellhead protection of small community water supply systems in agricultural settings. Laboratory permeability measurements of glacial drift samples collected in Cass County Michigan. Pneumatic slug test results for selected monitoring wells in the Donnell Lake area, Cass County Michigan. Modflow simulation of the Donnell Lake area, Cass County, Michigan. Geophysics.**

Chidester, Steven D., Chidester, Steven D., Lovett, Cole., Passero, R. N., and Michigan State University. Institute of Water Research.

East Lansing, MI : Institute for Water Research, Michigan State University, [1993] viii, 40, [62] leaves : ill., maps: Cover title. "May 3, 1993." "Project Number 92-G2026-02." Includes bibliographical references.

CONTENTS NOTE: Laboratory permeability measurements of glacial drift samples collected in Cass County Michigan / Steven D. Chidester -- Pneumatic slug test results for selected monitoring wells in the Donnell Lake area, Cass County Michigan / Cole Lovett -- Modflow simulation of the Donnell Lake area, Cass County, Michigan / Steven Chidester -- Geophysics.

NAL Call #: TD224.M5D48--1993

Descriptors: Groundwater-Michigan-Cass-County-Quality Agricultural-chemicals-Environmental-aspects-Michigan-Cass-County Wellheads-Protection-Michigan-Cass-County Hydrogeology-Michigan-Cass-County

25. **Developing a State Wellhead Protection Program : a user's guide to assist State Agencies under the Safe Drinking Water Act.**

United States. Environmental Protection Agency. Office of Ground Water Protection. Washington, D.C. : U.S. Environmental Protection Agency, [1988] 42 p.

NAL Call #: DNAL TD370.D48--1988

Descriptors: Drinking-water-United-States Water-quality-United-States

26. **Development and applications of a wellhead protection area delineation computer program.**

Guiguer, N. and Franz, T.

Pollution, protection and control of groundwater proceedings of the IAWPRC International Seminar, held in Porto Alegre, Brazil, 20-21 September 1990. 1st ed. Oxford [England] ; New York : Pergamon Press, c1992. p. 51-62.

NAL Call #: TD420.A1P7 -v.24-no.11

Descriptors: groundwater-pollution wells- pollution-control computer-software mathematical-models aquifers- groundwater-extraction groundwater-flow water-purification pollutants- removal- simulation-models computer-simulation puerto-rico massachus etts- flowpath-software

27. **The development of a wellhead protection area program for the Beatrice, Nebraska Municipal Wellfield.**

Smith, David M.

1993. 98 leaves : ill.: Thesis (M.S.)--University of Nebraska--Lincoln, 1993. Includes bibliographical references.

NAL Call #: NBU LD3656-1993-S658

Descriptors: Wellheads-Nebraska-Beatrice Groundwater-Nebraska-Beatrice-Quality.

28. **Domestic well water quality in rural Nebraska: focus on nitrate-nitrogen, pesticides, and coliform bacteria.**

Gosselin, D. C., Headrick, J., Tremblay, R., Chen, X. H., and Summerside, S.

Ground water monit remediat 17: 2 pp. 77-87. (Spring 1997).

NAL Call #: GB1001.G76

Descriptors: drinking-water wells- groundwater- groundwater-pollution water-quality contaminants- nitrate-nitrogen pesticides- coliform-bacteria rural-areas nebraska-drinking-water-quality

Abstract: For this statewide assessment, 1808 wells were sampled and a data base compiled that included water-quality data (NO₃(-1)-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 NO₃(-1)-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.

29. **Drinking water contamination: understanding the risks.**

Webendorfer, B. and Jackson, G.

Publ-Univ-Wis-Coop-Ext-Serv. Madison, Wis. : The Service. 1989. (G3339) 6 p.

NAL Call #: S544.3.W6W53

Descriptors: drinking-water water-pollution water-quality pesticide-residues risk- wells-wisconsin.

30. **Drinking water testing.**

Norris, P. E., Storm, D. E., Allen, E. R., and Smolen, M. D.

OSU-Ext-Facts-Coop-Ext-Serv-Okla-State-Univ. Stillwater, Okla. : The Service. Nov

1991. (878) 4 p.

NAL Call #: S544.3.O5O5

Descriptors: drinking-water testing- water-quality water-supply wells- oklahoma-

31. **Drinking water testing for private well owners.**

Lewis, S.

Fact-Sheet-Coll-Agric-Univ-Nev-Reno-Nev-Coop-Ext. [Reno, Nev.] : The College. Sept

1992. (92-30) 4 p.

NAL Call #: S544.3.N3C66

Descriptors: drinking-water wells- testing- water-quality contamination- coliform-bacteria

32. **Drinking water wells.**

McCann, A. and Husband, T. P.

Nat-resour-facts. Kingston, R.I. : The University of Rhode Island, College Resource Development, Department of Natural Science. June 1990. (90-3) 3 p.

NAL Call #: TD224.R4N37

Descriptors: drinking-water wells- construction

33. **Evaluation of ground-water contamination from nonpoint sources: a case study.**

Brink, C. van den and Zaadnoordijk, W. J.

Ground-water. Columbus, Ohio : Ground Water Pub. Co. May/June 1995. v. 33 (3) p. 356-365.

NAL Call #: TD403.G7

Descriptors: groundwater-pollution pollutants- contaminants- nitrate- leaching-computer-analysis computer-software computer-simulation simulation-models groundwater-flow geographical-information-systems water-quality groundwater-extraction wells- groundwater- hungary- shallow-groundwater flunit-program nitron-program fluzo-program arclinfo-program welcon-program triwaco-program nonpoint-source-pollution

Abstract: In many countries a substantial part of the drinking-water supply comes from subsurface-water resources. During the last several decades an increasing extent of diffuse pollution has endangered these water resources. Knowledge of the changes in ground-water quality is necessary in order to know if, and to what extent, ground-water quality is endangered. Changes in ground-water quality can be predicted by means of models describing both the ground-water flow and the transport of contaminants. A Geographic Information System is an efficient tool to handle the storage and manipulation of the large amount of data needed for the description of diffuse pollution.

A methodology to predict changes in ground-water quality, which is called FLU NIT, has been built around the programs FLUZO, NITRON, ARC/INFO, dBASE, and WELCON, and the ground-water flow package TRIWACO. The method runs on a PC (with 386 processor). The system has been applied to a well field on Csepel Sziget (near Budapest, Hungary). The purpose was not so much the prediction of the ground-water quality, but much more the evaluation of ground-water protection strategies based on risk analysis and effectivity of possible measures. The system has been designed in such a way that the important information can be used with the available resolution, and that new and more detailed data can be added efficiently. Change of the nitrogen concentrations in the extracted water can be predicted. The resolution is sufficient for the evaluation of alternative ground-water protection strategies. Moreover, detailed insight into changes in ground-water quality can be obtained quickly.

34. Evaluation of nitrate analysis using test strips: comparison with two analytical laboratory methods.

Bischoff, M., Hiar, A. M., and Turco, R. F.

Commun soil sci plant anal. 27: 15/17 pp.2765-2774. (1996).

NAL Call #: S590.C63

Descriptors: drinking-water wells- chemical-analysis nitrate- nitrogen-content analytical-methods evaluation- accuracy- test-procedure water-pollution contamination-determination- water-quality

Abstract: Nitrate remains a contaminant of concern for users of well water. Well-water evaluation, either to assess nitrate contamination or to evaluate sites prior to including them in a larger water quality study, often involves costly laboratory analysis. A cost effective alternative to laboratory analysis are dip-style test strips. However, the accuracy of these types of products must be reliable, as failure to identify the contaminant may, for example, persuade a homeowner to neglect to have a potential problem further investigated. The testing of nitrate using such strips typically involves dipping the strip into the water sample and reading the color development after a specific period of time. The color development is then compared to a color scale which corresponds to concentration provided with the test. The results of these types of analysis are especially open to interpretation by the evaluator of the results. An experiment was conducted to evaluate test strips in which individuals or "readers" tested water samples collected in the field and nitrate standards prepared in the laboratory with nitrate test strips. The results obtained by the "readers" were compared to analysis of nitrate by high performance liquid chromatography and colorimetric analysis using a colorimetric ion analyzer.

35. Evaluation of wellhead protection area delineation methods on a rural farmstead in Pennsylvania.

Doscher, C. Jr. and Robillard, P. D.

Pap-Am-Soc-Agric-Eng. St. Joseph, Mich. : American Society of Agricultural Engineers., Summer 1992. (922037) 36 p.

NAL Call #: 290.9-Am32P

Descriptors: wells- farms- rural-areas computer-simulation pennsylvania-

36. Factors related to nitrate-nitrogen contamination of Ohio farm water wells.

Rausch, J. N., Hitzhusen, F. J., Forster, D. L., and Elliot, W. J.

Econ-sociol-occas-pap. Columbus : Ohio State University, Dept. of Agricultural Economics and Rural Sociology. June 1992. 12 p.

NAL Call #: HD1411.O3

Descriptors: drinking-water water-quality wells- water-pollution nitrate- nitrogen- factor-analysis ohio-

37. **Farm-A-Syst: Rx for safe ground water in Wisconsin.**

Moberg, D. P.

Soil Water Conserv U S Dep Agric Soil Conserv Serv. 13: 1 pp.19. (May/June 1992).

NAL Call #: DNAL aS622.S6

Descriptors: watershed-management water-quality farm-management farm-surveys wisconsin-

38. **Farmstead assessment for whole farm water quality protection.**

Jackson, G. W. and Anderson, J. L.

Agricultural research to protect water quality proceedings of the conference February 21-24, 1993 Minneapolis, Minnesota, USA. Ankeny, IA : The Society, [1993]. p. 517-519. pp.

NAL Call #: TD427.A35A49-1993

Descriptors: groundwater- wells- drinking-water water-quality farms- risk- assessment-educational-programs educational-planning plan-implementation-and-evaluation wisconsin- minnesota- farmstead-assessment-program-farm*a*syst well-water

39. **A farmstead checklist.**

Weston, D.

NDSU-Ext-Serv. Fargo, N.D. : The University. Apr 1994. (FS-548) 4 p.

NAL Call #: S544.3.N9C46

Descriptors: wells- farms- groundwater- drinking-water safety- water-pollution site-factors waste-water-treatment waste-disposal chemicals- storage- handling- livestock-dairying- north-dakota.

40. **Good wells for safe water.**

Glanville, T.

PM-Iowa-State-Univ-Coop-Ext-Serv. Ames, Iowa : Iowa State University, Cooperative Extension Service. Mar 1993. (840, rev.) 4 p.

NAL Call #: 275.29-IO9PA

Descriptors: wells- safety- construction- water-quality drinking-water water-systems well-drainage regulations- iowa-

41. **Ground water protection alternatives and strategies in the U.S.A.**

Ahmed, Nazeer and American Society of Civil Engineers. Task Committee on Ground Water Protection.

New York, N.Y. : American Society of Civil Engineers, 1997. iv, 283 p.

NAL Call #: TD223.G736--1997

Descriptors: Groundwater-Pollution-United-States Wellhead-protection-United-States

42. **Groundwater and wellhead protection in Battle Mountain, Nevada.**

Neufeld, J.

Fact-sheet-Max-C-Fleischmann-Coll-Agric,-Coop-Ext-Serv. [Reno, Nev.] : The College, 1993. (93-19) 4 p.

NAL Call #: S544.3.N3C66

Descriptors: groundwater- wells- water-conservation water-table aquifers- hydrology-geology- nevada- battle-mountain-well-protection-area

43. Groundwater & public policy series.

Soil and Water Conservation Society (U.S.). Freshwater Foundation.

[Wayzata, Minn.] : Freshwater Foundation, [1991-1993] 17 v. .

CONTENTS NOTE: 1. What is groundwater? / George H. Davis -- 2. Understanding how contaminants reach groundwater / Arthur G. Hornsby -- 3. Sources and extent of groundwater contamination / David W. Moody -- 4. The costs of groundwater contamination / William B. O'Neil and Robert S. Raucher -- 5. Agricultural best management practices / Terry J. Logan -- 6. Protecting groundwater quality by managing local land use / Douglas A. Yanggen and Stephen M. Born -- 7. Groundwater quality: a public policy perspective / Lawrence W. Libby -- 8. Key policy choices in groundwater quality management / Sandra S. Batie and Penelope L. Diebel -- 9. Federal policies and programs to protect groundwater quality / Leon E. Danielson and David E. M. Patte -- 10. A voluntary approach to reducing agricultural contamination of groundwater / Steve Padgett -- 11. Liability issues in groundwater quality protection / Theodore A. Feitshans -- 12. Blameless contamination / Terence J. Centner -- 13. Community wellhead protection programs / Norbert Dee and Stan Austin -- 14. Financing approaches for local groundwater protection / Norbert Dee -- 15. Local groundwater management and policy decisions / Norbert Dee and Marian Mlay -- 16. A comprehensive approach to groundwater management for rural local governments / E. Gaynell McGary Meij and Charles W. Abdalla -- 17. Communicating water quality risk issues to the public / Clifford W. Scherer.

NAL Call #: GB1003.2.G76--1991

Descriptors: Groundwater- Groundwater-Protection Groundwater-Quality Groundwater-Pollution

44. Groundwater quality: responsible agriculture and public perceptions.

Goss, M. J. and Barry, D. A. J.

J agric environ ethics 8: 1 pp. 52-64. (1995).

NAL Call #: BJ52.5.J68

Descriptors: groundwater-pollution water-quality drinking-water wells- farming-agricultural-policy canada-

45. Guidance for applicants for state Wellhead Protection Program assistance funds under the Safe Drinking Water Act.

United States. Environmental Protection Agency. Office of Ground Water Protection.

Washington, D.C. : U.S. Environmental Protection Agency, Office of Water, Office of Ground-Water Protection, [1987] 1 v.

NAL Call #: TD426.G84-1987

Descriptors: Well-Head-Protection-Program Wellheads-Protection-United-States Water,- Underground-Quality Drinking-water

46. Handbook : ground water and wellhead protection.

Eastern Research Group, Inc. United States. Environmental Protection Agency. Office of Drinking Water. United States. Environmental Protection Agency. Office of Science Planning and Regulatory Evaluation. Center for Environmental Research Information U. S. .

Cincinnati, Ohio : U.S. Environmental Protection Agency, Center for Environmental Research Information, 1994. xvii, 269 p.

NAL Call #: TD403.H36--1994

Descriptors: Groundwater-Handbooks,-manuals,-etc Wellheads-Handbooks,-manuals,-etc Water-supply-Handbooks,-manuals,-etc

47. **How to conduct an inventory in your wellhead protection area : a training manual for use with volunteers.**

University of Idaho. Idaho Water Resources Research Institute.

[Moscow, ID] : University of Idaho, [1995?] 113 p. : ill.: "This project was developed through a cooperative effort of the: Idaho Water Resources Research Institute, University of Idaho ... [et al.].

NAL Call #: TD224.I2H69--1995

Descriptors: Water-quality-management-Idaho-Citizen-participation Drinking-water-Contamination-Idaho-Prevention-Citizen-participation

48. **How well is your well?.**

Rasmussen, Jeanne., Liukkonen, Barbara., Kroll, Mary., and Minnesota Extension Service.

[St. Paul, Minn.] : Minnesota Extension Service, University of Minnesota, 1992. 4 p. : ill.: Cover title. "Clean water, you can make a difference." "4H-FO-5979-B."

NAL Call #: TD407.R37--1992

Descriptors: Wells- Groundwater-Testing Drinking-water-Testing

49. **Hydrogeology and results of tracer tests at the old Tampa well field in Hillsborough County, with implications for wellhead-protection strategies in west-central Florida.**

Robinson, James L. and Southwest Florida Water Management District. Geological Survey (U.S.).

Tallahassee, Fla. : U.S. Dept. of the Interior, U.S. Geological Survey ; Denver, CO : Earth Science Information Center, Open-File Reports Section [distributor], 1995. vi, 63 p. NAL Call #: DNAL GB701.W375--no.93-4171

Descriptors: Aquifers-Florida Groundwater-flow-Florida Hillsborough-County-Fla

50. **Improving home water quality.**

Langston, J.

MP-Univ-Arkansas-Coop-Ext-Serv. Little Rock, Ark. : The Service. Jan 1989. (292) 22 p.

NAL Call #: DNAL 275.29-AR4MI

Descriptors: water-quality drinking-water wells- springs- water-supply testing-treatment- chlorine- sodium-carbonate water-filters arkansas-

51. **Is someone contaminating-- your drinking water? : an overview of potentially harmful shallow injection wells.**

United States. Environmental Protection Agency. Ground Water Protection Council (U.S.).

[Washington, DC?] : U.S. Environmental Protection Agency ; Oklahoma City, OK : Ground Water Protection Council, [1990?] 10 p.

NAL Call #: TD761.I8--1990

Descriptors: Injection-wells-Environmental-aspects-Juvenile-literature Drinking-water-Contamination-Juvenile-literature Water-Pollution-Juvenile-literature Groundwater-Pollution-Juvenile-literature

52. **Is your drinking water safe.**

Glanville, T.

PM-Iowa-State-Univ-Coop-Ext-Serv. Ames, Iowa : The Service. Aug 1991. (1334i, rev.) 2 p.

NAL Call #: 275.29-IO9PA

Descriptors: drinking-water safety- wells- testing- inspection- contaminants- sampling-iowa.

53. Mangement tools for preventing water pollution on farms.

Nevers, E., Jackson, G., Castelnuovo, R., and Knox, D.

Environmentally sound agriculture proceedings of the second conference 20 22 April 1994 /30-37. (1994).

NAL Call #: S589.7.E57-1994

Descriptors: farms- groundwater-pollution risk- assessment- wells- drinking-water contamination- point-sources water-quality environmental-protection pollution-control programs- farmstead-assessment-system

54. Make sure drinking water is safe.

Glanville, T. and Miller, L.

PM-Iowa-State-Univ-Coop-Ext-Serv. Ames, Iowa : Iowa State University, Cooperative Extension Service. Nov 1994. (1563g) 2 p.

NAL Call #: 275.29-IO9PA

Descriptors: drinking-water safety- wells- contaminants- coliform-bacteria polluted-water tests- nitrate- health-hazards iowa.

55. Monitoring pesticide and nitrate in Virginia's groundwater--a pilot study.

Bruggeman, A. C., Mostaghimi, S., Holtzman, G. I., Shanholz, V. O., Shukla, S., and Ross, B. B.

Trans ASAE. 38: 3 pp. 797-807. (May/June 1995).

NAL Call #: 290.9-Am32T

Descriptors: groundwater- water-quality wells- pesticides- groundwater-pollution monitoring- aquifers- nitrate- sampling- virginia-

Abstract: Between October 1992 and February 1993, a total of 359 private wells in Northampton County were sampled and data on water-quality variables (temperature, pH, and conductivity), well construction, and site characteristics were collect ed. The groundwater samples were analyzed for aldicarb, alachlor, atrazine, carbofuran, linuron, methomyl, metolachlor, metribuzin, napropamide, pendimethalin, pronamide, simazine, and nitrate. The wells were stratified into shallow wells, withdrawing wat er from the unconfined aquifer, and deep wells, withdrawing water from the deeper confined aquifers. The study was undertaken as a pilot study to demonstrate the applicability of a recently developed framework for evaluating the extent of pesticide contam ination in Virginia's groundwater. Pesticides were detected in 14% of the shallow wells and in 7% of the deep wells sampled. Pesticide detection was associated with the well depth, with a higher probability of detecting a pesticide in the shallow unconfin ed aquifer than in the deeper aquifers. Nitrate above the U.S. EPA drinking water standard of 10 mg/L was found in 17% of the shallow and 1% of the deep wells. Pesticide and nitrate detections were not significantly related to well and site characteristic s, such as crop type, location of well head, and distance to the nearest water body.

56. National survey of pesticides in drinking water wells : phase I report.

United States. Environmental Protection Agency. Office of Pesticides and Toxic Substances.

[Washington, D.C.] : United States Environmental Protection Agency, Office of Water, Office of Pesticides and Toxic Substances, [1990] 1 v.

NAL Call #: TD427.P35N374-1990

Descriptors: Pesticides-Environmental-aspects-United-States Drinking-water-United-States-Contamination Wells-United-States Water-quality-United-States

57. **The nitrate contamination of private well water in Iowa.**

Kross, B. C., Hallberg, G. R., Bruner, D. R., Cherryholmes, K., and Johnson, J. K.
Am J Public Health. 83: 2 pp. 270-272. (Feb 1993).

NAL Call #: 449.9-AM3J

Descriptors: water- wells- nitrates- rural-areas contamination- iowa-

Abstract: The State-Wide Rural Well-Water Survey was conducted between April 1988 and June 1989. About 18% of Iowa's private, rural drinking-water wells contain nitrate above the recommended health advisory level (levels of NO₃-N greater than 10 mg/L); 37% of the wells have levels greater than 3 mg/L, typically considered indicative of anthropogenic pollution. Thirty-five percent of wells less than 15 m deep exceed the health advisory level, and the mean concentration of nitrate-nitrogen for these wells exceeds 10 mg/L. Depth of well is the best predictor of well-water contamination. Individually, NO₃-N levels of more than 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, these three contaminants were detected in nearly 55% of rural private water supplies.

58. **Nitrate in rural wells of Missouri.**

Sievers, D. M. and Fulhage, C. D.

Trans A S A E 35: 5 pp. 1633-1637. (Sept/Oct 1992).

NAL Call #: 290.9-AM32T

Descriptors: wells- depth- nitrates- rural-areas water-quality missouri-

Abstract: Two hundred twenty six rural wells in Missouri were tested for NO₃-N. Nineteen percent exceeded Environmental Protection Agency (EPA) drinking water standards. Nitrate concentrations were most strongly related to well depth. Well construction, depth to aquifer and well age had lesser influence. Distance from well to livestock was a poor predictor of nitrate pollution.

59. **Nitrogen loading model for wellhead protection areas.**

Horsley, S. W.

Ground-water-monit-remediat. Dublin, OH : Ground Water Pub. Co., c1993-. Winter 1995. v. 15 (1) p. 66-67.

NAL Call #: GB1001.G76

Descriptors: nitrogen- nitrate-nitrogen wells- water-quality models- massachusetts-

60. **NLEAP application for developing municipal wellhead protection strategies in the Central Wisconsin Sand Plain.**

Kaap, J. D., Ebert, W., Kraft, G., and Brodahl, M. K.

Animal waste and the land-water interface . Boca Raton : Lewis Publishers, c1995. p. 325-332. pp.

NAL Call #: TD930.A55-1995

Descriptors: nitrate-nitrogen pesticides- crop-management land-use groundwater-pollution pollution-control wisconsin- integrated-crop-management best-management-practices

61. **Occurrence of selected herbicides and herbicide degradation products in Iowa's ground water, 1995.**

Kolpin, D. W., Kalkhoff, S. J., Goolsby, D. A., Sneek Fahrer, D. A., and Thurman, E. M. *Ground-water*. Westerville, Ohio : Ground Water Pub. Co. July/Aug 1997. v. 35 (4) p. 679-688.

NAL Call #: TD403.G7

Descriptors: triazine-herbicides herbicide-residues triazines- groundwater-pollution groundwater- polluted-water contamination- wells- surveys- aquifers- geographical-variation slope- runoff- depth- iowa- well-depth

Abstract: Herbicide compounds were prevalent in ground water across Iowa, being detected in 70% of the 106 municipal wells sampled during the summer of 1995. Herbicide degradation products were three of the four most frequently detected compounds for this study. The degradation product alachlor ethanesulfonic acid was the most frequently detected compound (65.1%), followed by atrazine (40.6%), and the degradation products deethylatrazine (34.9%), and cyanazine amide (19.8%). The corn herbicide acetochlor, first registered for widespread use in the United States in March 1994, was detected in a single water sample. No reported herbicide compound concentrations for this study exceeded current U.S. Environmental Protection Agency's maximum contaminant levels or health advisory levels for drinking water, although the herbicide degradation products examined have yet to have such levels established. A significant, inverse relation was determined between total herbicide compound concentrations in ground water and the average soil slope within a 2-km radius of sampled wells. Steeper soil slopes may increase the likelihood of surface runoff occurring rather than ground-water infiltration--decreasing the transport of herbicide compounds to ground water.

62. **Pesticides in eastern North Carolina rural supply wells: land use factors and persistence.**

Maas, R. P., Kucken, D. J., Patch, S. C., Peek, B. T., and Van Engelen, D. L.

J environ qual 24: 3 pp. 426-431. (May/June 1995).

NAL Call #: QH540.J6

Descriptors: pesticides- detection- wells- persistence- spatial-distribution temporal-variation nitrate-nitrogen indicators- land-use agricultural-land drinking-water water-quality water-pollution north-carolina

Abstract: Water samples were collected from 171 rural domestic well supplies in eastern North Carolina and analyzed for eight pesticides. Information on borehole depth, wet-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, a,a,a-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 microgram L⁻¹) or Health Advisory Levels (HALs; 0.4 microgram L⁻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.

63. Pesticides in shallow groundwater in the Delmarva Peninsula.

Koterba, M. T., Banks, W. S. L., and Shedlock, R. J.

J Environ qual. 22: 3 pp. 500-518. (July/Sept 1993).

NAL Call #: QH540.J6

Descriptors: pesticide-residues groundwater- water-quality depth- spatial-distribution wells- drinking-water groundwater-pollution delaware- maryland- virginia-

Abstract: A regional study of the areal and depth distribution of pesticides in shallow groundwater in the Delmarva Peninsula of Delaware, Maryland, and Virginia was done to (i) relate the pesticides detected to landscape and shallow subsurface features, and (ii) evaluate aquifer vulnerability and the potential contamination of drinking-water supplies. Water samples collected at 100 wells from 1988 to 1990 were analyzed for concentrations of 36 pesticides, four metabolites, and other constituents. The most commonly detected residues were atrazine, cyanazine, simazine, alachlor, metolachlor, and dicamba. Concentrations were low, few exceeded 3 microgram L⁻¹. Most detections correlate with the intensive use of these herbicides in three widely distributed and commonly rotated crops-corn (*Zea mays* L.), soybean [*Glycine mar (L.) Merr.*], and small grain-particularly if grown in well-drained soils. Most detections occurred in samples collected from shallow wells screened within 10 m of the overlying water table. The shallow depth distribution of most residues is consistent with their suspected history of use (ca. 20 yr), and patterns in shallow groundwater flow in the surficial aquifer in the study area. The areal and depth distributions of detectable residues in groundwater did not correlate with a vulnerability index, nor any of the component scores developed to estimate that index using the DRASTIC method. The shallow depth of most detections also indicates why few samples from water-supply wells in this study had measurable concentrations of pesticides; most supply wells are deeper than 10 m below the water table. The low number of contaminated samples from supply wells implies that deep groundwater currently (1992) used for drinking generally does not contain detectable pesticide residues.

64. Physiographic and land use characteristics associated with nitrate-nitrogen in Montana groundwater.

Bauder, J. W., Sinclair, K. N., and Lund, R. E.

J Environ qual. 22: 2 pp. 255-262. (Apr/June 1993).

NAL Call #: QH540.J6

Descriptors: drinking-water wells- water-quality nitrate-nitrogen geographical-distribution dry-farming rotations- site-factors climatic-factors groundwater-pollution montana-

Abstract: Occurrence of NO₃(-)-N in drinking water at concentrations > 10 mg L⁻¹ 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⁻¹ 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⁻¹ 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 and percentage of tested wells in each county with NO₃(-)-N concentration > 10 mg L⁻¹ were correlated (P < 0.10) with 16 independent variables, most of which were associated with precipitation, soil properties, and land-use practices. The closest correlations were with 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 could 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.

65. **Planning your well: guidelines for safe, dependable drinking water.**

Korab, H.

Land-water. Urbana-Champaign : The Service, 1982-. Apr 1990. (14) 11 p.

NAL Call #: S624.I3L36

Descriptors: wells- homes- site-factors groundwater- planning- water-requirements construction- disinfection- regulations- permits- water-quality illinois-

66. **Proceedings, 1996 Ground Water Protection Council Annual Forum : a stakeholders conference on ground water, watershed, source water, wellhead protection and underground injection control : September 22-25, 1996, Radisson St. Paul, St. Paul, Minnesota. 1996 Ground Water Protection Council Annual Forum.**

St. Paul, Minn. : The Council, [1996?] 224 p. : ill., maps.

NAL Call #: GB1015.G76--1996

Descriptors: Groundwater-United-States-Congresses

67. **A program to support management of farmstead activities and structures: a systems approach to farm wellhead protection.**

Carpenter, J. and Miller, W.

Agricultural research to protect water quality proceedings of the conference February 21-24, 1993 Minneapolis, Minnesota, USA /. Ankeny, IA : The Society, [1993]. p. 515-516.

NAL Call #: TD427.A35A49-1993

Descriptors: groundwater-pollution wells- risk- assessment- educational-programs pollution-control program-development rural-areas farms- michigan- farmstead-assessment-program-farm*a*syst

68. **Protecting ground water from the bottom up : local responses to wellhead protection : Conference proceedings. Conference on protecting ground water from the bottom up, local responses to wellhead protection, October 1989.**
 United States. Environmental Protection Agency. Region I. Underground Injection Practices Council (U.S.). Research Foundation. New England Water Works Association. [Oklahoma City, Okla.? : The Foundation?, 1989] v, 327 p.
 NAL Call #: TD388.5.P76-1989
Descriptors: Water,-Underground-Pollution-New-England-Congresses Water,-Underground-Protection-New-England-Congresses Wells-New-England-Congresses
69. **Protecting local ground-water supplies through wellhead protection. Protecting local ground water supplies through wellhead protection.**
 United States. Environmental Protection Agency. Office of Water.
 [Washington, D.C.] : U.S. Environmental Protection Agency, Office of Water, [1991] 18 p.
 NAL Call #: Fiche--S-133-EP-2.2:W-45/5-
Descriptors: Groundwater-United-States-Quality Wellhead-protection-United-States
70. **Protecting local groundwater resources.**
 Smutko, L. S. and Hoag, D. L.
AG-NC-Agric-Ext-Serv. Raleigh : North Carolina Agricultural Extension Service, May 1995. (473-21) 6 p.
 NAL Call #: S544.3.N6N62
Descriptors: groundwater-pollution contaminants- sources- drinking-water hazards-pollution-control water-management wells- community-action land-use-planning north-carolina groundwater-protection
71. **Protecting your private well.**
 Bonner, J.
Publ-Miss-State-Univ,-Coop-Ext-Serv. State College, Miss. : Cooperative Extension Service, Mississippi State University. May 1993. (1868) 4 p.
 NAL Call #: 275.29-M68Ext
Descriptors: wells- drinking-water water-quality pollution-control
72. **Protecting your well by shock chlorination.**
 Thomas, J. G., Carroll, J. W., and Holder, T. S.
Publ-Miss-State-Univ,-Coop-Ext-Serv. State College, Miss. : Cooperative Extension Service, Mississippi State University. May 1993. 4 p.
 NAL Call #: 275.29-M68Ext
Descriptors: wells- drinking-water chlorine- disinfection-
73. **Quality of well water on Tennessee poultry farms.**
 Goan, H. C., Denton, P. H., and Draughon, F. A.
Environmentally sound agriculture proceedings of the second conference 20 22 April 1994 / pp. 368-372. (1994).
 NAL Call #: S589.7.E57-1994
Descriptors: water-quality drinking-water wells- regional-surveys nitrate-nitrogen nitrogen-content bacteria- fecal-flora poultry-farming tennessee
74. **The relationship between monitoring well and aquifer solute concentrations.**
 Chiang, C., Raven, G., and Dawson, C.
Ground-water. Columbus, Ohio : Ground Water Pub. Co. Sept/Oct 1995. v. 33 (5) p.

718-726.

NAL Call #: TD403.G7

Descriptors: aquifers- groundwater-pollution monitoring- wells- pollutants- contaminants- petroleum-hydrocarbons underground-storage underground-structures industry- fuel-tanks equations- mathematics- texas- petroleum-industry

Abstract: Disparities between organic solute concentration in the aquifer and that in monitoring wells have been observed; an order of magnitude disparity had been recorded in some cases. Therefore, it is important to be able to relate concentrations between the two media for design of remediation systems. More significantly, to assess the impact of leachate from a landfill on a downgradient drinking water well, it is important to correlate aquifer concentration with that in a drinking water well such that the true risk is properly estimated. A three-dimensional finite-difference flow and transport model has been applied to demonstrate that the disparity between aquifer and well concentrations results primarily from advective flow phenomena and can be quantified. The modeling shows that the concentration in the well is a function of the initial vertical concentration profile in the aquifer, the volumetric flow rate from below the partially penetrated well, the penetration fraction, and the amount of water purged before sampling. Under steady-state conditions, the dilution of concentrations in monitoring wells may be expressed as a simple analytic function of the above parameters. The result from this analytic function agrees well with numerical solutions and field sampling data.

75. **Rural domestic water supply.**

Vomocil, J. and Hart, J.

Ext-Circ-EC-Oreg-State-Univ-Ext-Serv. Corvallis, Or. : The Service. Feb 1991. (1374) 4 p.

NAL Call #: 275.29-OR32C

Descriptors: wells- water-use water-quality drinking-water oregon-

76. **Rural water quality database: educational program to collect information.**

Lemley, A. and Wagenet, L.

J-ext. Madison, Wis. : Extension Journal. Fall 1993. v. 31 p. 11-13.

NAL Call #: 275.28-J82

Descriptors: water-quality rural-communities databases- drinking-water extension-education contamination- testing- wells- program-evaluation program-effectiveness new-york

77. **Seminar publication : wellhead protection : a guide for small communities.**

Center for Environmental Research Information (U.S.). United States. Environmental Protection Agency. Office of Science, Planning and Regulatory Evaluation. United States. EPA. Office of Ground Water Protection.

Cincinnati, OH : U.S. EPA, Office of Research and Development [1993] ix, 144 p.

NAL Call #: TD223.S46--1993

Descriptors: Wellheads-Protection Groundwater-Quality Water-quality-management

78. **Shallow injection well practices : Class V : well facts.**

United States. Environmental Protection Agency. Office of Drinking Water.

[Washington, D.C.?] : Office of Drinking Water, [1992?] 1 v.

NAL Call #: TD407.S32-1992

Descriptors: Injection-wells-Government-policy-United-States Wells-Government-policy-United-States

79. A simple analytical approach for predicting nitrate concentrations in pumped ground water.

Lerner, D. N. and Papatolios, K. T.

Ground-Water. Dublin, Ohio : Ground Water Pub. Co. May/June 1993. v. 31 (3) p. 371-375.

NAL Call #: TD403.G7

Descriptors: groundwater-pollution pollutants- nitrates- wells- groundwater-recharge concentration- prediction- models- aquifers- england- pumped-wells

Abstract: A simple analytical expression is presented which predicts how solute concentrations evolve with time in a pumped well. The basic expression is for uniform recharge and uniform concentration of a conservative solute (e.g. nitrate) in the recharge. It shows that pumped concentrations are independent of pumping rates. The expression can be developed to allow for more complex patterns of recharge and solute loading, and an example is given with three zones of recharge and concentrations, induced river recharge, and a cross-boundary inflow. Predictions are made for Edgmond Bridge, a new pumping station which lies in a drift-filled valley in the Triassic sandstone aquifer of Shropshire, UK. The model predicts that concentrations of nitrate will stay below the drinking water limit for 78 years, although this would be substantially reduced if the aquifer were significantly layered or if nitrate loads from agriculture increased. Predictions were reevaluated after two years and found to be consistent with observed patterns once actual, rather than expected, conditions were incorporated in the model.

80. Soil nitrate-N variability and distribution in the Tipton Wellhead Protection Area.

Ramanarayanan, T. S., Storm, D. E., Smolen, M. D., Rao, M. N., Kizer, M. A., and Guertal, E. A.

Pap-Am-Soc-Agric-Eng. St. Joseph, Mich. : American Society of Agricultural Engineers., Summer 1993. (932086) 19 p.

NAL Call #: 290.9-Am32P

Descriptors: profiles- spatial-variation nitrate-nitrogen oklahoma-

81. Some factors influencing nitrate contamination of drinking water in private wells of rural Alabama.

Datiri, B., Ankumah, R., and Hodge, W.

Tuskegee horiz. 4: 1 pp. 20. (Fall 1993).

NAL Call #: S31.T84

Descriptors: wells- rural-communities drinking-water water-pollution nitrate- alabama-

82. Sources of water to wells for transient cyclic systems.

Reilly, T. E. and Pollock, D. W.

Ground-water. Westerville, Ohio : Ground Water Pub. Co. Nov/Dec 1996. v. 34 (6) p. 979-988.

NAL Call #: TD403.G7

Descriptors: wells- well-drainage groundwater-extraction groundwater-flow groundwater-recharge seasonal-variation climate- aquifers- temporal-variation simulation- flow-to-wells

Abstract: Many state agencies are currently (1995) developing wellhead protection programs. The thrust of some of these programs is to protect water supplies by determining the areas contributing recharge to water-supply wells and by specifying regulations to minimize the opportunity for contamination of the recharge water by

activities at the land surface. The area contributing recharge to a discharging well is the surface area at the water table through which the water flowing to the well entered the ground-water system. In the analyses of ground-water flow systems, steady-state average conditions are commonly used to simplify the problem and make a solution tractable. However, recharge is usually cyclic in nature, with seasonal cycles and longer term climatic cycles. The effect of these cyclic stresses on the area contributing recharge to wells is quantitatively analyzed for a hypothetical alluvial valley aquifer system that is representative of a large class of ground-water systems that are extensively developed for water supply. The analysis shows that, in many cases, these cyclic changes in the recharge rates do not significantly affect the location and size of the areas contributing recharge to wells. The ratio of the mean travel time to the length of the cyclic stress period appears to be an indicator of whether the transient effects of the cyclic stress must be explicitly represented in the analysis of contributing areas to wells. For the cases examined, if the ratio of the mean travel time to the period of the cyclic stress was much greater than one, then the transient area contributing recharge to wells was similar to the area calculated using an average steady-state condition. However, cyclic stresses on systems with ratios less than one do have an effect on the location and size of the areas contributing recharge to wells.

83. **Statistical analysis of rural well contamination and effects of well construction.**

Glanville, T. D., Baker, J. L., and Newman, J. K.

Trans ASAE. 40: 2 pp.363-370. (Mar/Apr 1997).

NAL Call #: 290.9-Am32T

Descriptors: atrazine- alachlor- metolachlor- nitrate-nitrogen chloride- coliform-bacteria wells- groundwater-pollution building-materials design- drinking-water transport-processes water-quality contamination- iowa- physical-properties-of-wells

Abstract: 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.

84. A study of the temporal variability of atrazine in private well water. I. Study design, implementation, and database development.

Lorber, M., Johnson, K., Kross, B., Pinsky, P., Burmeister, L., Thurman, M., Wilkins, A., and Hallberg, G.

Environ monit assess. 47: 2 pp.175-195. (Sept 1997).

NAL Call #: TD194.E5

Descriptors: atrazine- metabolites- triazines- nitrates- wells- drinking-water water-supply sampling- design- analytical-methods temporal-variation rural-areas regional-surveys databases- costs- iowa- temporal-variability-of-atrazine-contamination -of-private-well-water-supplies

85. A study of the temporal variability of atrazine in private well water. II. Analysis of data.

Pinsky, P., Lorber, M., Johnson, K., Kross, B., Burmeister, L., Wilkins, A., and Hallberg, G.

Environ monit assess. 47: 2 pp. 197-221. (Sept 1997).

NAL Call #: TD194.E5

Descriptors: atrazine- metabolites- triazines- nitrates- drinking-water water-supply wells-rural-areas seasonal-variation regional-surveys data-processing databases- iowa-temporal-variability-of-atrazine-contamination-of-private-well-water-suppl ies

86. Survey of nitrate contamination in shallow domestic drinking water wells of the Inner Coastal Plain of Georgia.

Stuart, M. A., Rich, F. J., and Bishop, G. A.

Ground-water. Columbus, Ohio : Ground Water Pub. Co. Mar/Apr 1995. v. 33 (2) p. 284-290.

NAL Call #: TD403.G7

Descriptors: groundwater-pollution nitrate- water-quality wells- surveys- coastal-plains contamination- aquifers- nitrogen- ph- water-temperature high-water-tables electrical-conductivity drinking-water georgia- nitrite- shallow-aquifers specific- conductivity

Abstract: 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 man ganese 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 degrees and 24 degrees Cel sius.

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.

87. Testing of private wells.

Wyman, J. and Kamrin, M.

Ext-Bull-Water-Qual-Ser. East Lansing, Mich. : The Service. Feb 1988. 2 p.

NAL Call #: DNAL TD224.M5E97

Descriptors: drinking-water wells- groundwater- contaminants- testing- sampling- michigan.

88. Underground injection wells and your drinking water.

United States. Environmental Protection Agency. Office of Water. Underground Injection Control (U.S.).

[Washington, D.C.?] : U.S. EPA, Office of Water, [1994] 1 folded sheet (10 p.)

NAL Call #: TD426.8.U53--1994

Descriptors: Injection-wells-Environmental-aspects Drinking-water-Contamination-United-States

89. Water quality and private water supplies.

McManus, M.

Publ-Univ-Tenn-Agric-Ext-Serv. Knoxville, Tenn. : The Service. Mar 1990. 19 p.

NAL Call #: DNAL S115.P82

Descriptors: wells- water-quality groundwater-pollution drinking-water standards- contaminants- health-hazards testing- tennessee-

90. Watershed project models efficient farming practices.

Miller, G. A. and Jost, M.

IFM-Iowa-State-Univ-Ext. Ames, Iowa : The Extension. July 1989. (2) 2 p.

NAL Call #: S561.6.I8I35

Descriptors: demonstration-farms water-pollution extension-education wells- drinking-water safety- watershed-management iowa- upper-bluegrass-watershed-project

91. Well testing program yields encouraging results.

Summer, K.

Agfocus. 7-8. (July 1994).

NAL Call #: S544.3.N7A4

Descriptors: wells- water-quality drinking-water laboratory-tests new-york water-quality-incentive-program

92. Wellhead protection.

Thomas, J. G. and Carroll, J.

Publ-Coop-Ext-Serv-Miss-State-Univ. State College, Miss. : The Service. Apr 1992.

(1815) 3 p.

NAL Call #: 275.29-M68EXT

Descriptors: wells- groundwater-pollution construction- maintenance- mississippi-

93. Wellhead protection area delineation using the analytic element method of groundwater modeling.

Wuolo, R. W., Dahlstrom, D. J., and Fairbrother, M. D.

Ground-water. Dublin, Ohio : Ground Water Pub. Co. Jan/Feb 1995. v. 33 (1) p. 71-83.

NAL Call #: DNAL TD403.G7

Descriptors: aquifers- groundwater-extraction groundwater-flow simulation-models
wells- water-table minnesota-

94. **Wellhead protection areas for surface factors using simulated annealing.**

Muttiah, R. S. and Engel, B. A.

Pap-Am-Soc-Agric-Eng. St. Joseph, Mich. : American Society of Agricultural Engineers,.
Winter 1991. (917567) 13 p.

NAL Call #: 290.9-Am32P

Descriptors: water-systems computer-simulation

95. **Wellhead protection effects on agricultural and rural areas.**

Ray, B. W.

Pap-Am-Soc-Agric-Eng. St. Joseph, Mich. : American Society of Agricultural Engineers,.
Winter 1992. (92-2502/92-2520) 7 p.

NAL Call #: 290.9-Am32P

Descriptors: wells- environmental-protection groundwater

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