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THE EFFECT OF GROUNDWATER POLLUTION
ON RESIDENTIAL PROPERTY VALUES:
Portage County, Wisconsin

By

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Groundwater is one of Wisconsin's most valuable natural resources, providing 70 percent of the state's population with drinking water and providing a key input into the pulp and paper industry, food processing, and many other industrial and agricultural uses. Yet such widespread use of the groundwater resource creates problems in maintaining a high level of groundwater quality.

The major groundwater problems in Portage County are nitrate and aldicarb pollution. Sources of nitrate include fertilizers, manure breakdown, septic tank effluent and others. Portage County is particularly susceptible to nitrate pollution because of a high groundwater table, sandy soils and widespread agricultural use of nitrogen fertilizer and livestock operations. While the carcinogenic effects of nitrate on adults are uncertain, nitrate can be very harmful to young children. Infants under six months are subject to methemoglobinemia or "blue baby syndrome." If a well is contaminated with nitrate, the owner can drill a new well (which usually, but not always, corrects the problem), install a special filter (which may be effective, depending on the type) or import water for consumption uses.

The main health effect of aldicarb is cholinesterase inhibition. Large amounts of aldicarb inhibit the action of the enzyme cholinesterase and disrupt the functions of the nervous system. The amount of aldicarb in Portage County wells is much lower than the level required to induce cholinesterase inhibition. Although the long-term effects of low-level doses of aldicarb are not known, some recent studies suggest an association between

consumption of aldicarb-contaminated groundwater and abnormalities in the human immune system. If a well has aldicarb pollution, the owner can dig a new and deeper well (but the new well may also be contaminated), purchase an expensive filter (with uncertain effects) or import water for consumption purposes (which some owners do).

While nitrate contamination has been a problem for many years, aldicarb pollution is a more recent discovery. Aldicarb residues were first found in the spring of 1980. Wisconsin's Department of Agriculture, Trade and Consumer Protection (DATCP) passed an emergency rule in 1982, establishing aldicarb moratorium areas, limiting the amount of aldicarb application, controlling the timing of the application and forbidding aldicarb use two consecutive years. A permanent rule in 1983 established moratorium areas within a one-mile radius of a well testing more than 10ppb (parts per billion) of aldicarb. In 1986 the moratorium area was extended to a two-mile radius whenever two or more one-mile moratorium areas were contiguous or overlapped.

Groundwater pollution effects the residential property market. Property owners have petitioned their local assessors and the Wisconsin Department of Revenue (DOR) for a reduction in the assessment of their property for tax purposes, arguing that aldicarb pollution has reduced their property values. Many realtors now require a written well test as a part of the contract with the seller for broker services. Local bankers are becoming more cautious in financing purchase of homes that have high nitrate levels in well tests.

Although the presence of aldicarb and nitrate in the groundwater effects the property markets, the potential effect on housing prices is a different question. The hypothesis is that the presence of high levels of aldicarb of

nitrate in a well will lower the price of residential property. However, it is possible that the price is not affected by the pollution if buyers do not have good information on the pollution levels, if buyers discount such information, or if the seller simply must wait longer to locate a suitable buyer who is not aware of, or disturbed by, high aa or nitrate levels in the well. The purpose of the study is to investigate the effect of aldicarb and nitrate pollution on residential property values in Portage County.

THE STUDY DESIGN

If many properties are transferred in a specific area during a particular period of time, and if the characteristics of the properties vary considerably, it is possible to statistically separate the effect of various characteristics on the price of the property.^{1/} These statistical methods will be used to attempt to isolate the effect of nitrate and aldicarb pollution on property values.

The Study Area

Seven towns (rural unincorporated municipalities) in the vicinity of the City of Stevens Point in Portage County were chosen for the study: Amherst, Buena Vista, Hull, Linwood, Plover, Sharon and Stockton. Some towns have considerable problems with aldicarb and nitrate pollution; others have little or none. The area was chosen because there are many sales of nonfarm property with private wells; groundwater pollution is a problem in the area; aldicarb moratorium areas have been in effect in the region since 1983 so

^{1/} The statistical procedure is regression analysis, which has been used to examine the effect of soil conservation investments on land prices, air pollution on property values, water quality on residential housing prices, and many others.

there is enough time for the market to have reacted to the information; the pollution problem has had much publicity, so buyers and sellers should be aware of the potential problem; technical units at the Portage County Health Department and the Groundwater Center at the University of Wisconsin-Stevens Point have an extensive public information and outreach program, so information is available to the public. Table 1 shows the approximate percentage of each town under moratorium areas in 1985. Map 1 shows the towns and the moratorium areas.

Table 1
Percent of Town Area in Aldicarb Moratorium Area, 1985

<u>Town</u>	<u>Percent of Area Covered by Aldicarb Moratorium</u>
Amherst	0 %
Buena Vista	6
Hull	25
Linwood	42
Plover	47
Stockton	47
Sharon	21

The Residential Property Market

If groundwater pollution affects property values, the mechanism for the effect is the residential property market. Therefore, understanding how the market works is absolutely necessary in interpreting the results of the statistical procedures. Informal conversations were held with local bankers, realtors, property appraisers, local assessors, county officials, University staff and other informed sources. Each informant provided basically the same information and insights on the market, so it is possible to be reasonably confident of the responses. The market actors have different amounts of information about nitrate and aldicarb. The reaction to nitrate levels is

more complex and more information is available. The market reaction to nitrate will be discussed first.

Realtors. In dealing with nitrate pollution, brokers, bankers, buyers and sellers follow a very specific procedure. If an individual decides to sell his home through a realtor, the broker asks if a nitrate test has been done on the well. The broker will usually recommend a test if one has not been done recently. If the nitrate level is above 10ppm (state standard) the broker will often suggest that the problem be fixed by drilling a new well or installation of a filter. The seller can also choose to simply wait and re-test the well at a later time because nitrate levels do fluctuate and a later test may show a lower level.

The well test result is not included in the description of the house when listed by the broker. Thus, when a prospective buyer makes an offer to purchase, he/she does not necessarily have information on the well test results. However, the offer is usually contingent on the results of a well test showing an acceptable level of nitrate. This contingency is included on the real estate offer form that is used by realtors in the Stevens Point area. In fact, the condition of the water and the well must be listed on the "Seller's Real Estate Condition Report" that the buyer must review before the sale is closed. Some brokers indicate that they require information on nitrate pollution in order to protect themselves from lawsuits.

If the well test shows very low nitrate levels, there is no further decision necessary. If the nitrate level is high, the buyer has several options: (1) ignore the nitrate pollution information and purchase the property anyway; (2) rescind the offer; (3) lower the offer price to reflect the costs of digging a new well, buying a filter, and for the risk that these

measures may not work; (4) require the seller to fix the problem before closing the sale. Thus, it appears that buyers will be aware of nitrate pollution problems for homes listed for sale through a realtor.

Lenders. For residential property that is sold by the owner, the owner may not provide the buyer with information on the nitrate levels, and the buyer may not be aware of the nitrate pollution problem. However, even homes sold without a realtor need to be financed, and most of these buyers receive financing through a formal lending institution. The lenders require information on nitrate levels because mortgages are usually sold through a secondary market where ease of resale is an important consideration. When a potential buyer approaches the lending institution for financing, the lender will frequently ask for the results of the nitrate well test. Lenders appear to use some rules-of-thumb: if the nitrate is less than 10ppm the purchase is financed (assuming other conditions are met as well); if the nitrate level is between 10ppm and 20ppm the case will be further examined; if the nitrate level is over 20ppm the financing will be refused.

Buyers. The key link in the chain of events from a polluted well to a price for residential property is the reaction of the buyer to the information on nitrate levels. It seems clear that at least in the majority of cases, the buyer will be aware of the potential for nitrate pollution in the water supply of the property he intends to purchase. The key question is whether buyers consider nitrate pollution a problem that might affect them or their family, whether they understand the meaning of the well test and act accordingly, whether they ignore the information on nitrate pollution, or whether they simply are not aware of the potential problem in spite of the information available.

Aldicarb. Site-specific information on aldicarb levels in well water is not generally available to buyers. The test for aldicarb is expensive and is not available locally. Real estate brokers do not require an owner to test for aldicarb before listing the property for sale. However, brokers indicated that they would not knowingly list a house with high levels of aldicarb because of a desire to sell property quickly and because of fear of liability suits. Likewise, lenders do not require aldicarb tests before financing the purchase. In some cases, local market actors indicated that they take the level of nitrate is a good proxy for the presence of aldicarb. A well with high nitrate levels may also have aldicarb problems; low levels of nitrate are taken to mean little chance of aldicarb pollution. The accuracy this rule-of thumb, and the reaction of buyers to this information is not known. The level of buyer awareness of the aldicarb problem is also unknown. The aldicarb moratorium area are well-defined and receive considerable local publicity, but the extent of buyer awareness is not known. Of course those moving into the Portage County area from outside will not have been exposed to the publicity and may have less information.

The Data

One hundred ninety-two residential property sales were used in the study. These are all sales in the selected towns during 1985-86 that were considered "arms-length" transactions representative of the market by the DOR. These criteria eliminated sales between family members, sales to charitable organizations, foreclosure sales and other transactions that might not involve a willing buyer and seller, both with good information about the market, both with other alternatives, and each trying to obtain the best possible price.

The price of a house is a function of the characteristics of the house itself, the characteristics of the neighborhood and the level of groundwater quality. Data on the characteristics of the house were obtained from the DOR property transfer forms and the assessors' cards that describe in detail each property. The data include price of the residential property, lot size, water frontage, sale date, type of transfer (land contract or warranty deed), location of the property in or outside an aldicarb moratorium area, location relative to a well polluted with aldicarb, the nitrate level in the well at the property, distance of the property from the center of Stevens Point, the effective property tax rate, the age of the house, number of bedrooms and bathrooms, a quality rating for the kitchen and bathroom(s), square footage of living space, presence of absence of a wood-burning fireplace, and the "grade factor" which is the assessor's judgement of the overall quality of materials and workmanship in the dwelling. The mortgage interest rate in the area at the time of sale was included to capture the effect on housing prices of changes in the mortgage interest rate.

THE RESULTS

The statistical results will be summarized.^{2/} Separate analysis was conducted for aldicarb and nitrate because the number of observations with complete information for the combined sample was too low to produce statistically valid results.

^{2/} The regression results are included in the appendix to this paper. More detailed discussion of the statistical methods, problems and experimentation can be found in Patricia Malone, "The Effects of Groundwater Contamination on Rural Nonfarm Residential Property Values," Master of Science Thesis, Department of Agricultural Economics, University of Wisconsin-Madison, 1987.

Nitrate Pollution

There were 113 sales with available information on all variables including a well test for nitrate. The minimum nitrate level was zero ppm and the maximum level was 31ppm, with the mean level 5.31ppm.

In general the statistical results were consistent with conventional wisdom about the effect of various characteristics on the price of residential property. Those variables that increased the price of the residential property included: square feet of finished living space, wood-burning fireplace and lot size. Variables with a negative effect on price were: age of the house, distance to Stevens Point, and sale date.^{3/}

No Effect of Nitrate Levels. The variable of interest, nitrate level, had no statistically significant effect on residential property prices. Many different statistical models were developed and computed, but in no case did the nitrate variable show a statistically significant effect on housing prices. The results do not support the hypothesis that the higher the level of nitrate contamination the lower the price of the residential property. However, we do not accept the hypothesis that nitrate levels have no economic effect in the housing market, because the market may react to nitrate in several ways, only some of which would be reflected in a sale price of property.

Why No Effect? The level of nitrate pollution may affect the residential property market through the time required for a seller with a polluted well to locate a buyer who either ignores the nitrate information, is not aware of its meaning, or simply does not care about nitrate pollution.

^{3/} See the appendix for the regression results and interpretation.

Sellers may have some "reservation price," a price below which they are not willing to sell their house. If high nitrate levels make the house less attractive to buyers, the seller may simply wait longer to sell, rather than dropping the asking price to induce potential buyers to make a purchase offer. There is some evidence for this conclusion in the Portage County housing market. Realtors, bankers and others indicated that although the years 1985-86 were a "buyers' market," housing prices were not declining. This suggests that sellers were simply waiting a longer time for a potential buyer to make an offer, rather than dropping the asking price in order to attract buyers.^{4/}

If nitrate levels are not reflected in residential property prices because sellers simply wait longer to sell their property, the costs of nitrate pollution are absorbed by the sellers. The seller must postpone his move, or wait to recover the equity in the property. In either case, the cost of waiting is a cost of the nitrate pollution. It may be reflected in the market through waiting time rather than through price.

Another possible reason for observing no statistically significant effect of nitrate levels on housing prices is that buyers may not be reacting to information on nitrate levels in expected ways. First, it is possible that some buyers care greatly about nitrate levels, but these buyers are avoiding the study area altogether and locating in a city or village with a

^{4/} It is recognized that the asking price is seldom the final price and most sales involve some bargaining between buyer and seller. But in a buyer's market, or for a property with nitrate pollution, theoretically one would expect to find prices drop in order to clear the market during any given, short, time period. An alternative is for sellers to simply postpone the transaction and hold out for a higher price, which seems to have occurred in the area and may explain the statistical results.

public water supply. Thus, only buyers who are not particularly concerned with nitrate pollution may seek homesites in the rural, town areas. Second, buyers without children may have good information on nitrate pollution but not take it into account because of a belief that the pollution will not affect adults.

Third, it is possible that the nitrate information is used by market participants, but in manner that does not show a price effect. For example, the buyer is unlikely to have good information on the level of nitrate pollution prior to making the offer to purchase. The offer is usually contingent on a well test. If nitrate levels are unsafe, the buyer can back out of the sale or require the seller to fix the problem prior to sale. As a result, the costs of nitrate pollution may not be reflected in the sale price--price is set by an offer that is based on no knowledge of nitrate levels. The costs of high nitrate levels may be absorbed by the seller in the process of drilling a new well or purchasing a filter, rather than absorbed in the price of the property at transfer to the buyer.

Aldicarb Pollution

The analysis of the effect of aldicarb pollution was considerably more difficult. The first problem was in defining the variable to use as a measure of aldicarb pollution, since well test data are not generally available. The only realistic option was to use the location of a residential property inside a moratorium area to indicate the potential for aldicarb pollution. But only houses downstream (down-gradient) from a source of aldicarb pollution would be affected, so an alternative measure of aldicarb pollution was taken to be location of the house down-gradient from a contaminated well that forms the center of the moratorium area.

The statistical analysis encountered many problems because of the location of the residential properties that were transferred in 1985-86 and which were located down-gradient from an aldicarb polluted well. Of the ten down-gradient sales, seven were in the Love Creek neighborhood near the Wisconsin River. Because of the concentration of such sales in one neighborhood, it was not possible to separate the effect on price from location in an aldicarb moratorium area from the effect on price of location in a neighborhood with great scenic or other amenities. It was impossible to separate the effect of the Love Creek neighborhood on housing prices from the effect of aldicarb on prices. This unfortunate coincidence makes it impossible to separate the price effect of the neighborhood from the price effect of aldicarb pollution.

CONCLUSION

The pollution of groundwater from nitrate and aldicarb is a serious problem for residents of Portage County and the State of Wisconsin. The pollution of groundwater has many effects on the Wisconsin economy and on the quality of life for residents of polluted areas. One possible effect of groundwater pollution is to lower residential property values. In theory, buyers would not be willing to pay as much for a house with a polluted well as for an identical house with an unpolluted well. The effect of aldicarb and nitrate pollution on residential property values was examined in seven town in the vicinity of Stevens Point. Data were collected for residential property that was sold in 1985-86, including data on sale prices, detailed characteristics of the house, lot and neighborhood, nitrate levels in the well water and location relative to moratorium areas.

The statistical analysis found no statistically significant effect of nitrate pollution on residential property values. It is possible that the sale prices of some specific property or properties have been effected by the presence of nitrate pollution but, in general, nitrate levels have no statistically significant effect on prices of residential property. This result is less surprising in light of detail on how the residential property market functions and how individuals may react to information about pollution.

First, it is possible that some individuals ignore data on nitrate pollution because they do not understand its meaning, feel they would personally be unaffected by nitrate in drinking water, or simply are uninformed about the problem.

Second, the offer price for residential property is generally made before levels of nitrate pollution are known, and the offer is usually contingent on a well test showing acceptable levels of nitrate. If nitrate levels are high, the buyer may withdraw the offer or require the seller to fix the problem before purchase by drilling another well or installing a filter. So the costs of nitrate pollution may be absorbed by the seller in fixing the problem, rather than being reflected in market prices.

Third, sellers may simply choose to wait longer to sell their property, hoping for either an improvement in the well test with the passage of time, or for the appearance of a buyer who is unconcerned about the level of nitrate in the water. In this case the costs of nitrate pollution are absorbed by the seller through a longer waiting time until sale, and by the buyer to the extent that health problems result from ignoring nitrate levels

in drinking water. The costs of groundwater pollution may not be absorbed into property values.

The statistical analysis to isolate the effect of aldicarb on residential property values was not successful because of a unfortunate coincidence in the location of properties near aldicarb contaminated wells that sold during the 1985-86 period. Seven of ten such sales were in the Love Creek area and it proved impossible to separate the price effect of location near aldicarb contamination from the price effect of location in the Love Creek neighborhood.

The costs of aldicarb and nitrate pollution are borne in a variety of ways by residents of the Stevens Point area. The effects of nitrate pollution do not seem to have any clearly measurable effects on the prices of residential property overall. No conclusion can be drawn for aldicarb pollution because of the unfortunate coincidence of locations of sales down-gradient from aldicarb contaminated wells. But the absence of a statistically significant effect on property values does not mean that nitrate and aldicarb pollution have no costs. Sellers may absorb the cost in fixing the pollution problem before sale, or waiting longer to sell the property. Buyers who are unaware of the potential problem of groundwater pollution, or who ignore or misunderstand the information that is presented to them may also bear part of the costs of groundwater pollution through the possible health effects of drinking contaminated water. Groundwater pollution has a cost. The only question is how the cost is paid and who pays it.

Appendix

Regression Results: Effect of Nitrate and Aldicarb
Levels on Residential Property Values

Variable	Coefficient	t-Value*	Coefficient	t-Value*
Lot Size (ac.)	479	2.79	382	4.12
Sale Date	-0.07	-2.19	-.005	-0.19
Year Built	390	5.09	144	3.07
Warranty Deed ^{1/}	9663	2.38	2585	0.94
Distance to Stevens Point	-357	-1.84	-344	-1.86
Wood Fireplace ^{2/}	8626	3.81	8366	4.35
Finished Living Area (sq. ft.)	22	8.34	17	7.11
Grade Factor	1743	1.86	--	--
Tax Rate (\$/\$1000)	--	--	939131	
Mortgage Interest Rate	--	--	199	0.27
Bathroom Rating ^{3/}	--	--	-6258	-3.52
Water Frontage ^{4/}	--	--	4705	1.37
Nitrate (ppm)	115	0.71	--	--
Aldicarb ^{5/}	--	--	1197	0.34

R^2 .7350 .7034
n 86 123

Department variable: price recorded for sale.

*A t-value above 1.69 is taken as statistically significant (at the .10 level).

^{1/} Equals 1 if property transferred with warranty deed; equals zero if transfer was by land contract.

^{2/} Equals 1 if property has a wood-burning fireplace; otherwise equals zero.

^{3/} Assessor's judgment of overall quality; 1 = very good, 4 = poor.

^{4/} Equals one if property is within 500 ft of water; zero otherwise.

^{5/} Equals one if property is located within an aldicarb moratorium area; zero otherwise.

NOTE: For a complete discussion and additional empirical results, see Patricia Malone, "The Effects of Groundwater Contamination on Rural Nonfarm Residential Property Values." Master of Science Thesis, Department of Agricultural Economics, University of Wisconsin-Madison, 1987.