ABSTRACTS

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Water Quality Management in Wisconsin - Toward a Stronger Local Voice

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Joeres, E. - University of Wisconsin-Madison
David, M. - University of Wisconsin-Madison
Christianson, R. - Wisconsin Department of Natural Resources-Madison

A trend toward stronger local involvement in water quality management issues is becoming apparent in Wisconsin. Interest in a local role has been keen since the settlement period of the last century. Only in the past fifty years has a dominant central authority developed. Initially charged with protecting public health, the centralized statewide agency's purview evolved in the form of the Department of Natural Resources (DNR) to include water quality in general. With the inception of the Section 208 program in the mid-1970's, there has been movement away from centralized water quality management. Examples selected from studies in the Fox and Wisconsin River Valleys and in the Milwaukee area supporting this opinion will be presented. More specifically, selected activities of the Fox Valley Water Quality Planning Agency, the Wisconsin River DNR Task Force, the paper industry's Industry Rivers Study Committee, the Southeastern Wisconsin Regional Planning Commission and several metropolitan sewerage agencies in the state will be discussed. In addition, the ongoing decentralization of certain water quality management functions of the DNR will be discussed in this light.

New discharge permits for municipal and industrial point sources, aimed at a 1983 compliance date will probably reflect the trend toward more local input. Alternatives which are dependent upon increased local involvement such as instream aeration, low flow augmentation and transferable discharge permits will be examined.

The paper will conclude with a discussion of the opportunities and shortcomings associated with continued development of a strong local voice in water quality management.

REGIONAL SUITABILITY ANALYSIS FOR HAZARDOUS WASTE MANAGEMENT IN WISCONSIN.
Bradbury, Kenneth R., Department of Geology and Geophysics, University of Wisconsin-Madison*.

The Wisconsin Department of Natural Resources has estimated that Wisconsin industries generate from 380,000 to 528,000 tons of potentially hazardous chemical, industrial, or agricultural materials each year. Only about 80,000 tons per year, or about 18 percent, of these wastes are currently disposed of in approved hazardous waste facilities. Clearly, there is a need for additional hazardous waste facilities in Wisconsin. Consequently, the Wisconsin DNR initiated a study to identify general areas of the state which might be most suitable, or most unsuitable, for location of hazardous waste treatment, storage, or disposal facilities. The purpose of this report is to provide a general idea of the suitability of areas in Wisconsin for hazardous waste disposal.

Physical factors which influence waste containment and attenuation potential and for which statewide data are available include bedrock type, depth to bedrock, aquifer value, soil permeability, soil texture, topography, and flood hazards. Although additional factors, such as groundwater flow system configurations and water-table elevations are also important in site evaluation, these factors have never been evaluated statewide, and could not be included in the analyses.

For each of the factors chosen, areas most suitable or unsuitable for hazardous waste disposal are outlined on a base map, producing a series of six factor maps. "Suitable" areas are delineated where characteristics of a particular factor are best suited for waste containment and attenuation, and "unsuitable" areas are delineated where containment and attenuation characteristics are poor. For example, areas of dolomite and sandstone, major aquifers over much of Wisconsin, are considered poorly suited for hazardous waste disposal. The igneous and metamorphic rocks of northern Wisconsin might be better suited, providing fractures and faults are locally absent. Shale, which has generally low permeability and little importance as a regional aquifer, may be the most suitable bedrock unit. In any case, hazardous waste facilities will not be constructed directly on bedrock. A minimum depth to bedrock of 50 feet will provide adequate burial depth and attenuation potential. Areas where unconsolidated materials might sustain well yields of 100 gallons per minute or more are rated as unsuitable for waste disposal. This criterion eliminates most permeable outwash and glacio-fluvial deposits. Soil permeability and texture are estimated from the lowermost horizon of surface soils. Soils having permeabilities less than 10^{-5} cm/sec and textural classifications of C (clay) or M (silt) may be suitable for hazardous waste disposal. Areas of major flood hazards and steep slopes are designated unsuitable for disposal areas.

Superimposing the six factor maps allows delineation of areas of the state most suitable in all or many factors. Only limited areas are suitable in all factors studied. These areas occur in Brown, Calumet, and Fond du Lac Counties in eastern Wisconsin where the Maquoketa Shale subcrops along the Niagara Escarpment and where glacio-lacustrine and red till deposits produce thick clay soils of low permeability and fine texture. Areas suitable in 5 of the 6 factors are more extensive and include locations near the Lake Michigan shore in Sheboygan and Ozaukee Counties as well as parts of Brown, Waupaca, and Outagamie Counties. In addition, parts of Price, Sawyer, Rusk, and Lincoln Counties in north central Wisconsin may be suitable if local bedrock is not fractured.

In general, suitable sites for hazardous waste disposal are of very limited extent in Wisconsin, with most of the "Driftless Area" of southwestern Wisconsin, the central sand plains, and much of northeastern and northwestern Wisconsin poorly suited to hazardous waste facilities. This study should serve as a first step in a more detailed, localized search for hazardous waste sites. The final approval of any site for hazardous waste treatment, storage, or disposal must be based on detailed, site-specific investigations of many physical, economic, cultural, and political factors beyond the scope of this report.

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*Report prepared while author employed by the Hazardous Waste Management Section, Bureau of Solid Wastes, Wisconsin Department of Natural Resources, Madison, Wisconsin.

QUALITY CONTROL AND GROUND WATER MONITORING

by
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Hydrogeologist

Residuals Management Technology, Inc.

ABSTRACT

Concern over the environmental impact resulting from land disposal of wastes and recent federal and state legislation have led to increased ground-water quality monitoring and the establishment of complex monitoring systems. Important aspects of these systems include well placement within the flow system, well construction, well development, sampling, and preservation. There is a great deal of time, effort, and money spent on ground-water quality monitoring, yet if the total system is not properly addressed, the results generated by these monitoring programs at least can be difficult to interpret, and are often meaningless.

The location of monitoring wells is critical in obtaining information that is representative of subsurface conditions. Each monitoring system layout is site specific and hydrogeologic, geologic and water quality considerations are all important in the proper design of a ground-water monitoring network. The inhomogeneity and complexity of natural hydrogeologic systems often makes a phased approach to network design desirable. The preliminary boring and monitoring well layout can be directed at defining site geology, ground-water flow directions and pre-existing water quality conditions. This preliminary information decreases uncertainty about the system and aids in optimal placement of second phase wells which will then be far more likely to monitor the desired points in the aquifer.

After deciding the location of the wells, well construction is the next area which must be addressed in designing a monitoring system. Proper sealing of the well above the screen to seal the well at the ground surface and at ground level is important both to prevent introduction of contaminants from the land surface and to ensure that the effective screen of the well is only in contact with the portion of the aquifer which is desired.

Another important factor in ground-water quality is proper development of monitoring wells. In order to eliminate aquifer clogging or potential bacterial contamination, it is important to flush drilling mud from a boring hole. Proper well development will also help reduce the quantity of fine-grained sediments which frequently enter the well during sampling, thus increasing the recovery time of ground-water levels following pumping and ensuring accurate in-field permeability test.

Proper sampling technique at the well is also important to obtain representative ground-water quality samples. Stagnant water must be removed from the well prior to sampling. In order to ensure that the analysis only includes dissolved constituents, the sample must be filtered immediately following sampling. Proper presentation of the filtered sample is also important for accurate laboratory analysis.

Decentralized Approaches to Rural Lake Wastewater Planning - 7 Case Studies

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Gerald O. Peters, Jr., WAPORA, Inc., Chevy Chase, MD

Region V of the US Environmental Protection Agency, with the assistance of WAPORA, Inc., has prepared Draft Environmental Impact Statements evaluating proposed conventional wastewater facilities in seven rural lake communities in the midwest. Issues emphasized in the seven EIS's were water quality impacts, secondary impacts, impacts on environmentally sensitive areas, and economic impacts on the systems' users. Consideration of decentralized alternatives to the centralized systems and documentation of existing water quality and public health needs were undertaken in more detail than has previously been provided in an EIS format.

To document needs and to aid in the development of decentralized alternatives, both standard and innovative field data collection methods were used. These included aerial photograph interpretation for surface malfunctions, patterned interviews with residents (sanitary surveys), well water sampling, detection of effluent plumes along shorelines ("Septic Snooper" surveys), sampling of shallow groundwaters around on-site disposal units, and measuring directions and rates of groundwater flow. The benefits, limitations, and approximate costs of these methods are discussed.

The extensive field data collection efforts showed that problems with existing, often old and underdesigned, on-site septic tank systems were not as pervasive as had been supposed by prior planners. Failure of systems to comply with current design standards was not a valid predictor of their ability to protect water quality and public health.

Because of the low level of problems with existing on-site systems, cost-effectiveness and low user charges, EPA has recommended upgrading and publicly supervised maintenance of existing wastewater facilities in five of the seven study areas. Documented problems with existing on-site systems caused by clay soils on small lots resulted in EPA's recommendations to sewer most segments of one community. Recommendations have not yet been made for the seventh community.

GROUND WATER QUALITY AS RELATED TO LAND USE IN CENTRAL WISCONSIN

Byron H. Shaw[1]

Elevated nitrate levels in ground water have been well documented in many parts of Wisconsin as well as other parts of the world. Other water quality parameters that may be associated with high nitrates are, however, not well understood, nor are the sources of nitrates in many contaminated ground water aquifers.

This paper presents the results of a study conducted in 300 private wells in Portage County over a thirteen month period. Samples were collected monthly and analyzed for NO_3-N, NH_4-N, reactive phosphorus, Hardness, Alkalinity and Coliform bacteria. Results indicate the areas of highest NO_3-N concentration correspond closely to areas of irrigated agriculture. In addition to elevated NO_3-N, the irrigated areas showed elevated hardness levels. As NO_3-N levels increased, there was a corresponding decrease in alkalinity as demonstrated by shifts in the Hardness to Alkalinity ratio.

Widely varying seasonal concentrations indicate the importance of frequent sampling and of identifying the recharge area of an individual well if nitrate sources are to be identified and controlled.

The results of this study and other data from central and southern Wisconsin indicate a significant ground water contamination problem exists which cannot be attributed to only local animal or human waste problems. Leaching of fertilizers applied in high production agriculture are the most likely source of increasing NO_3-N levels in Wisconsin ground water.

[1]Professor of Soil & Water Science, College of Natural Resources, University of Wisconsin-Stevens Point

ABSTRACT

Septic Leachate: Critical Contributing Factors and Remedial Design

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The combined use of septic leachate detectors and groundwater flow meters to precisely locate, evaluate, and sample plumes from shoreline septic systems has allowed a fresh new approach to investigations of the factors contributing to shoreline nutrient loading. The septic leachate surveys were conducted for a series of seven environmental impact statements on rural lake wastewater treatment projects. The seven individual projects include Crystal and Crooked/Pickeral in Michigan; Green and Otter Tail in Minnesota; the Salem Township #2 Lakes in Wisconsin; the Steuben Lakes in Indiana; and Nettle Lake in Ohio.

Using a septic leachate detector, the center of erupting plumes were located. Vertical profiling was performed to determine the position of the core of the plume for accurate sampling. The frequency of plumes within different lakeshore segments was plotted versus groundwater flow rates, direction, and redox conditions. A vector plotting of groundwater flow for individual lots can be of important use in tailoring treatment to the actual water quality problem. The absorption efficiency for phosphorus for on-lot leaching fields is substantially influenced by sub-surface flow. The cross-sectional soil volume intercepted by plumes is computed for similar on-lot systems under differing groundwater flow patterns. The frequency of erupting plumes from shoreline dwellings was observed to be highly related to soil conditions, groundwater flow rate, and reducing conditions.

ABSTRACT

Direct Groundwater Flow Measurement for Water Resource Management

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Groundwater flow detectors have been developed by K-V Associates, Inc. to directly measure small-scale capillary sub-surface flow. The detectors have allowed direct determination of groundwater source impact on lake eutrophication. The flow sensors allow documentation of three-dimensional movement of groundwater through varying strata. Employed as remote monitors, the detectors offer direct monitoring of leakage to groundwater underneath sealed storage lagoons.

Observation of Otter Tail Lake, Wisconsin revealed that septic leachate plumes were directly related to measured seasonal groundwater patterns. Direct determinations of groundwater inflow are statistically compared to frequency of plumes from individual shoreline cottages and year-round residences. The observed frequency distributions are compared with patterns anticipated from groundwater gradient analysis.

TERTIARY WASTEWATER TREATMENT USING A NATURAL PEAT BOG

David Mechenich [1] and Byron Shaw[2]

Abstract

The water quality of a peat bog at Drummond, Wisconsin has been monitored since October, 1977, in order to characterize the natural water chemistry and to evaluate the potential of the bog for tertiary wastewater treatment. Water analyses included pH, conductivity, chloride, COD, BOD_5, ortho and total phosphorus, ammonia, nitrate-nitrate and Kjeldahl nitrogen, fecal coliforms, total suspended solids, and some heavy metals. Background values are generally typical of a perched sphagnum bog. Significant background variability occurred across the bog, with depth and over time. These differences were statistically analyzed in order to identify present and future wastewater induced changes.

From June to October, 1979, approximately 1.8 million gallons of wastewater have been filtered through the bog. The wastewater is secondary lagoon effluent diluted with lake water used for initial lagoon filling and sealing. Preliminary analysis of water quality changes indicate an efficient assimilation of the effluent. Chloride concentrations reveal that the effluent water is moving through the bog in the upper foot. The only significant changes in water quality of the bog system appear to be a reduction in background levels of COD, phosphorus, and nitrogen at several well sites within the bog and a reduction in background COD in the bog discharge. In comparison to the lagoon effluent, the bog discharge continues to have significantly lower pH, conductivity, phosphorus, and total suspended solids, and significantly higher COD.

Leaching studies using Drummond Peat cores were also done to estimate the long term potential of the bog to remove phosphorus by physical and chemical processes. Preliminary results indicate 25 to 45 pounds of phosphorus per acre-foot can be removed, although flushing may mobilize up to 17% of the absorbed phosphorus.

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Peatland Systems As Sites For Effluent Disposal:
A Cautionary Tale

Abstract

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The use of peatlands for the disposal and treatment of sewage effluent is receiving increased attention. The information gathered during the monitoring of nutrient levels in such projects has been used to develop nutrient budgets and quantify nutrient assimilation capabilities of wetland systems.

Parameters other than nutrient immobilization require attention before the widespread use of such systems becomes common. We know little about the capacity of various systems to assimilate nutrients nor the functional response of different peatland communities to this treatment.

The long term behavior of peatlands to sewage effluent disposal must be assessed. Our research suggests the need to examine: productivity values over several years to establish baseline figures; the life history and phenology of dominant peatland species; nutrient levels in dominant species, because different parts of plant species can have different patterns and concentrations of mineral elements; and changes in species composition which could affect the functioning of the ecosystem.

Data from a peatland in northern Wisconsin, on which effluent is currently being applied, and a review of other case studies are presented to illustrate those parameters which should be considered in monitoring to minimize the impact of effluent disposal on peatland systems.

The Movement of Water from Peatland
into Surrounding Groundwater

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Abstract

To further illuminate the relationship between bogs and their surrounding drainage basins, the flow of groundwater between and out of two bogs in Southwest Michigan was investigated. Both wetlands are located in "kettle-like" depressions in a complex upland covered by glacial outwash and till. The North Bog extends over three basins, one of which still contains open water, and the South Bog fills one basin. Neither bog has any surficial inlet or outlet. Typical bog plant species dominate, including Sphagnum, leatherleaf and high-bush blueberry. The South Bog is forested with tamarack, mountain holly, buckthorn and blueberry; roughly concentric zones of shrubby and herbaceous vegetation surround the forest. The North Bog does not have a forest canopy. Shallow wells, placed around and between the bogs, served to measure the elevation of groundwater and determine its chemical constituents. Through the entire area, the water table slopes through the North Bog and to the South Bog. Both wetlands are "perched" above the surrounding groundwater. Alkalinity, pH and (Ca^{++}) decrease from north of the North Bog to the south end of the South Bog. The groundwater table seems to be only slightly affected by heavy precipitation; comparing stations north and south of both wetlands, fluctuations in groundwater level are diminished in magnitude on the "downslope" sides of both bogs. The data suggest that groundwater is moving from the North Bog to the South Bog and then southward, and that, at least locally, the chemical constituents of groundwater are affected by the wetlands, and specifically by past and present vegetation.

The Effects of Dredging on Groundwater-Lake Interactions, Richard Beauheim, Department of Geology and Geophysics, University of Wisconsin-Madison, and Office of Inland Lake Renewal, Wisconsin Department of Natural Resources.

A groundwater study conducted in conjunction with a dredging project at Lilly Lake, Wisconsin, from 1977-1980, has revealed the occurrence of several significant changes in groundwater-lake interactions. Lilly Lake is an 88-acre kettle lake which receives water only through seepage inflow and precipitation, and loses water only through seepage outflow and evaporation. Prior to dredging, Lilly Lake was a flow-through lake with a natural flushing rate of 1-2 years. Precipitation provided roughly two-thirds of the water input to the lake. During dredging, the lake was drawn down about 4-5 ft, and it became a groundwater-discharge lake. After dredging ended, the lake remained a groundwater-discharge lake as lake level recovered to its pre-dredging level. Once that level is attained, it is thought that the lake will return to a flow-through condition. The deepening of the lake by dredging has more than doubled both the volume of the lake, and the rate of seepage inflow to the lake. One result of this is that the major contribution of water to the lake now comes from seepage rather than from precipitation. The flushing rate has remained about the same. The change in the proportions of water coming from different sources can be highly significant from a nutrient-loading point of view.

CHARACTERISTICS OF WISCONSIN LAKE SEDIMENTS AND EVALUATION OF SOME DISPOSAL ALTERNATIVES

By
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Office of Inland Lake Renewal
Wisconsin Department of Natural Resources

Sediment characteristics were determined for several Wisconsin lakes. Analyses were made for selective physical properties, nutrients, and in some cases metals and organic pesticides. The primary purpose of these analyses was to determine an appropriate method of disposal.

Lake sediments can be generated from either allochthonous or autochthonous sources. Deposits accumulated through internal processes are primarily organic in nature, often averaging over 60 percent. These sediments are "unpolluted" in almost all instances. The only exceptions were those lakes which had been previously treated with sodium arsenite for weed control.

The sediments from two lakes, Lilly Lake in Kenosha County and Lilly Lake in Marathon County were evaluated for their disposal potential on agricultural land, either by spray irrigation or by low level flooding. Dredging and disposal has been completed for the lake rehabilitation project in Kenosha County, and preliminary work has been performed for the project in Marathon County.

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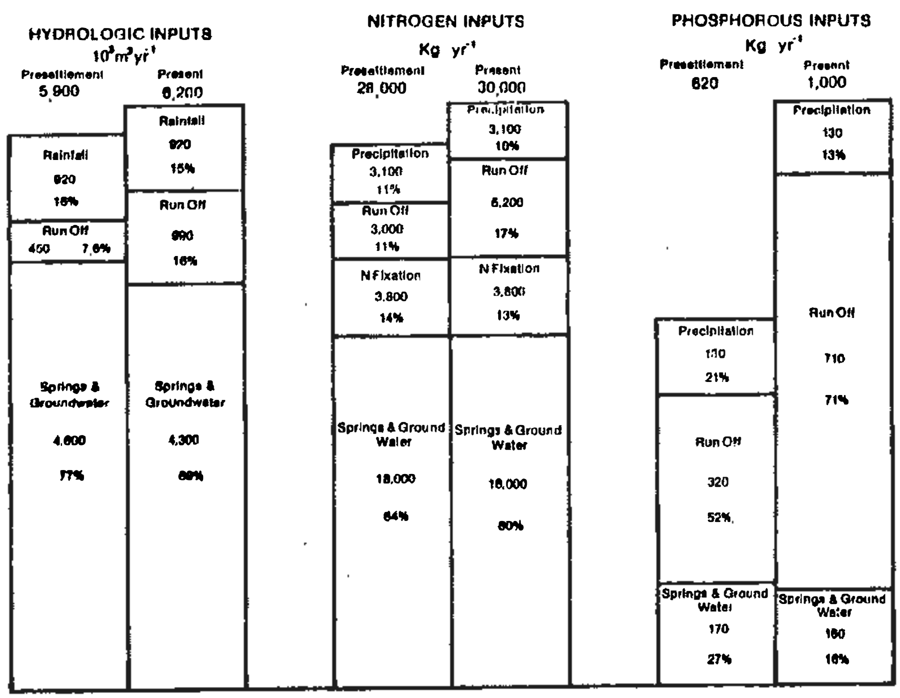
URBANIZATION IMPACTS ON THE LAKE WINGRA WATERSHED

HYDROLOGIC AND NUTRIENT BUDGETS

To assess the impact of urbanization on the hydrologic and nutrient budgets of a watershed, a hydrologic transport model based on the Stanford Watershed Model was used to simulate present and presettlement hydrologic loading to Lake Wingra, a small eutrophic lake in Madison, Wisconsin. The output of this model,coupled with flow-weighted nutrient concentrations measured in the drainage basin, permitted the estimation of present and presettlement nitrogen and phosphorus loadings to the lake.

Results (see figure) suggest that the increase in impervious area around the lake has resulted in a substantial increase in runoff. This increase is largely balanced by decreases in subsurface flows and evapotranspiration. Because the ratio of N:P in surface runoff is much lower than is the ratio in subsurface flows, this modest shift in hydrology appears likely to have had a substantial impact on the N and P loading to the lake. If one considers the reduction in lake area and volume caused by lake level manipulation since settlement, presettlement simulations suggest that N and P loadings may have increased by as much as 70 and 140% respectively. In addition, the N:P ratio in total lake loading may have decreased by as much as 40%, giving a competitive advantage to nitrogen-fixing blue-green algae.

Recommendations for avoiding such impacts stress the use of natural drainage systems, detention ponds and green belts near streams and lakes to encourage infiltration of storm waters.



Vicki Watson, Center for Biotic Systems
Institute of Environmental Studies, University of Wisconsin--Madison

Kratz, T.K., M.J. Winkler, and C.B. DeWitt. Investigation of hydrologic conditions causing accumulation of peat in an elevated sedge meadow in Waubesa Wetlands, southern Wisconsin.

Although water is one of the crucial factors governing the dynamics of wetlands, wetland hydrology is poorly understood. This study is an attempt to describe the relationships among groundwater, water level, subsurface topography, surface topography, and peat accumulation in a small, functionally isolated part of Waubesa Wetlands, southern Wisconsin.

The study site is a three hectare, rectangularly shaped sedge meadow. One side of the sedge meadow is adjacent to the upland, the other three sides are bordered by areas with relatively steep slopes of peat (drops of 1.5 - 2.0 meters in 50 meters). Small springs occur at the base of the slopes.

Preliminary evidence from detailed records of precipitation, solar radiation, and water level suggest the sedge meadow is a ground water discharge area. We hypothesize the approximately three meters of peat covering the sedge meadow may act as a 'cap' over a diffuse spring system. The steady source of water such a diffuse spring provides, may account for the unusual accumulation of peat on the steep-sided sedge meadow.

To further investigate this hypothesis, we prepared a series of maps depicting 1) the surface contours of the peat, 2) the contours of the interface between the peat and the mineral substrate below, 3), the elevation of the water table, and 4) a pieziometric surface which was made using one-half inch titanium piping sunk to a depth below the mineral soil-peat interface.

Interesting correlations occur among these maps, providing evidence in support of the 'capped spring' hypothesis. In addition, there are interesting relationships among the factors described above and the distribution of vegetation and ant mounds on the sedge meadow.

The Association Between an Aquatic Fungus and Eurasian Watermilfoil

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A fungus, tentatively identified as *Trichothecium* sp., was isolated consistently in the summers of 1978 and 1979 from Eurasian watermilfoil (*Myriophyllum spicatum* L.) growing submerged in University Bay of Lake Mendota. Evidence from anatomical studies, scanning electron microscopy, and the use of surface-disinfestants indicated that the fungus can grow endophytically. *Trichothecium* was associated with stems and leaves, but not with root systems. Seasonal incidence increased in unhealthy plants, but remained relatively constant or decreased in healthy milfoil. Milfoil from Lake Wingra was more vigorous than that from University Bay, and a lower percentage of Lake Wingra milfoil contained the endophyte. Experiments in vitro showed that when plants were stressed, proliferation of the endophyte accompanied decline of the host. Preliminary surveys demonstrated that the fungus is not restricted to Eurasian milfoil, but can occur sporadically in other aquatic plants including the American milfoil (*Myriophyllum exalbescens* Fern.) and white water lily (*Nymphaea tuberosa* Paine). The potential of *Trichothecium,* which appears to be an opportunistic pathogen for the biological control of Eurasian milfoil is under investigation.

Fluctuations of ground-water levels in response to drought.

Alexander ZAPOROZEC, Wisconsin Geological Survey, Madison, Wisconsin.

In 1976, much of the United States experienced a serious water shortage caused by prolonged periods of deficient precipitation. One of the areas most severely affected was Wisconsin. Soil moisture was depleted, streamflows reduced, and levels in lakes, reservoirs and wells declined. Approximately 500 wells were reported as dry or reduced in productive capacity. That resulted in providing emergency supply of water in many communities and in large expenditures for drilling new wells or deepening and redevelopment of the old ones. The problems can be avoided if the wells were designed with the possible "drought-proof" depth in mind, which would extend below the extremely low levels and would ensure water supplies even in the periods of drought. However, people in humid or subhumid areas are not used to drought conditions because they are not stricken by drought regularly; and consequently, they are not equipped to cope with the problems created by drought and are seldom prepared for the declining water levels. Even though the drought periods are not predictable, their effects are and can be anticipated. Statistical analysis of precipitation records and long-term ground-water level measurements on shallow wells in a glaciated area of northern Wisconsin was made to determine the historical drought periods in Wisconsin and their relation to ground-water levels; and to develop a method for estimating extremely low levels, which could be used for efficient design of wells so that they would not be affected by drought. The analysis has shown that drought periods are quite common in Wisconsin, and occur on the average once in 6-7 years statewide. The periods of low ground-water levels closely correlate with drought periods. The most serious decline of water levels was recorded in late 1940's, late 1950's, and middle 1960's. Similar effects of drought can be expected in the future, and therefore, it is necessary to develop a method which would enable planners or well owners to be prepared for declining water levels. Based on the premise that the water levels in a given area with similar hydrogeologic conditions exhibit a normal probability distribution, relationship was established between record minimum and mean water levels. By plotting results from a number of wells, type curve was developed from which the expected minimum levels can be predicted within selected confidence limits.

ABSTRACT

INFLUENCES OF GROUND WATER ON A COASTAL BLUFF

by Robert J. Sterrett[1] and Tuncer B. Edil[2]

Shoreline recession on the Great Lakes has caused millions of dollars worth of property damage in the lake bordering states and Canadian provinces in recent years. A variety of projects have been funded to study the erosion problem. The general conclusion of these studies is that wave action at the base of the bluff is the most important basic cause of bluff top retreat. Along a certain stretch of the shoreline, 9 to 10 m. per year of bluff top recession has been recorded which is not correlated to toe erosion. Through the installation of 18 piezometers a complex ground water flow system was defined. A glacial sand unit which is under artesian pressure was found 5 m. above the toe of the bluff. Another "perched" system was described in a fractured till unit at the top of the bluff. Water table fluctuations have been recorded over a year and fluctuations of up to 11 meters in the lower sand unit were found. These wide fluctuations were found to have an influence on bluff stability only by causing the sloughing of the sand layer which caused failure of the overlying till. A two-dimensional finite difference computer model was used to assess head distributions in the bluff cross-section. Pore pressures calculated from these head distributions were then used in a Bishop's Simplified Slope Stability Analysis. Long-term safety factors were then determined for various pore pressure distributions.

It was found that flow systems are highly complex at the land-lake interface due to the inhomogeneities of the glacial materials which compose the bluffs. Because of these complexities, extrapolation of results to other stretches of the shoreline are difficult. However, methodologies and the awareness of how water table fluctuations and multi-layered ground water flow systems affect slope stability can be of help in other field situations.

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WISCONSIN'S GROUND WATER - A POTENT SOURCE OF ENERGY

By Jack Connelly
Wisconsin Geological and Natural History Survey

ABSTRACT

A study by the Wisconsin Geological and Natural History Survey has shown that ground-water heat pumps can be used efficiently to heat and cool Wisconsin homes. With funds from the Upper Great Lakes Regional Commission (UGLRC), survey researchers have investigated: 1) the physical and chemical impact of heat pumps on local ground water and 2) the cost savings of using a ground-water heat pump system instead of a conventional system.

Two operating heat pump systems in Medford, Wisconsin have been studied extensively for one year. The cone of depression caused by each of the wells supplying the heat pumps does not interfere with other wells in the area because both homes are on ten acre lots. Both homeowners discharge water from their heat pumps onto the land surface. The discharge water is 5-10°F cooler in winter and warmer in summer. There is a slight increase in the copper level between water entering and leaving the heat pumps. However, the quality of the discharge water falls well within the standards set for drinking water.

Increased use of ground-water heat pumps in Wisconsin could lower both the state's dependence on fossil fuels and the heating costs incurred by individual homeowners. The owners of the two heat pump systems in Medford spent 30-50% less per year to heat their home than they would have spent if they had used a conventional system such as oil, propane gas or electric resistance heating.

Water leaving a ground-water heat pump may be discharged legally to the land surface (provided neighboring property is not affected) or to surface water. But many individuals who own small lots or have no access to surface water are unable to install such systems. One solution is to discharge the water down a second well, but at present a Wisconsin law prohibits the use of wells for this purpose. Results of this study have convinced Survey researchers that injection of discharge water into wells should be permitted because:

1) discharge water from heat pumps is not a threat to the quality of local ground water;

2) reinjection would prevent the depletion of water in an aquifer; and

3) reinjection would prevent interference between wells supplying heat pumps in adjacent homes.

AN EXTENSION INFORMATION PROGRAM FOR RESIDENTIAL WELL WATER QUALITY

Abstract

Older inland lake communities in Wisconsin comprise a relatively high risk area for degraded drinking water supplies. Many residences are on shallow sandy, soils; have shallow driven wells; a high water table; and are in close proximity to their own or their neighbor's septic system.

There is a risk of water quality problems in these communities. Many such residences, as long as no major rehabilitation is undertaken, are relatively immune from local regulations and codes, and they almost always are excluded from the present criteria of the federal Clean Drinking Water Act. Recognition of this potential problem area and the attendant (perhaps temporary) gap in institutional response led to the creation of this Extension education program. The objective is to provide these communities with enough motivation and information to voluntarily upgrade their residential waste disposal and water supply systems.

Upon invitation of a lake district or rural community, a limited number of residential drinking water "screening tests" are conducted consisting of at least a total coliform analysis, chloride test, and nitrate-nitrite analysis. The test results are returned at a community information meeting to describe the parameters tested; potential sources of pollution related to the local hydrologic environment; and appropriate preventive and remedial approaches to protect the water resource.

In two summers of application, eight programs have been held as well as three community demonstrations involving only testing of chemical parameters. In all, about 500 samples have been analyzed, 200 of which included bacterial screening for total coliform. A review of the data from these programs shows that there is considerable interest and support from the residential public for the program. Further, a surprising number of tested wells appear to be contaminated to some degree when compared to present EPA water quality criteria.

Submitted by:

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University of Wisconsin-Extension
Environmental Resources Unit

THE PREVENTION OF GROUND-WATER POLLUTION DUE TO ANTICIPATED MINING ACTIVITIES--AN APPLICATION IN FOREST COUNTY, WISCONSIN

ABSTRACT

Forest County is in northeastern Wisconsin in the "Canadian shield" geologic region. In the southwest part of this county near Crandon, Exxon USA plans to mine a massive sulfide ore rich in zinc and copper. The Precambrian bedrock of which this ore is a part is of volcanogenic origin. The associated pyrite presents a potential problem of acid mine drainage. Major areas of possible contamination are the mine-mill site and the tailings pond. Ground-water flow directions will affect the ultimate disposition of any acid mine drainage unless it is superconcentrated. These flow directions are mapped in this study. To control hypothesized pollution, the technological alternatives presented offer answers to a wide variety of water problems. This technology includes various refuse treatments, mine seals, water diversion, barrier wells, electrodialysis, neutralization, adsorption, ion exchange and land disposal. There has been much legislation concerning mining and its pollution potential. That which concerns the prevention of ground-water pollution has been summarized here. Wise decisions on proper utilization of available technology are dependent on adequate environmental data. The chemical quality and flow pattern fluctuations of the ground-water must be monitored over time for a large geographical area before mining begins. Only in this way can changes be realistically measured and source areas traced. This study shows that, with proper preparation and quick action, the county's ground-water can be kept pure during and beyond the life of the mine.

by: Lee Trotta, Hydrologic Technician, U.S.G.S. - Madison

Thermal and Mineral Characteristics of
Water in Two Flooded Iron Mines
Gogebic Range, Iron County, Wisconsin

ABSTRACT

The Montreal and Cary Mines in Northern Wisconsin produced over 64 million tons of iron ore during their 76 years of operation. When these mines closed they left behind a catacomb of shafts and tunnels that represent over 668 million cubic feet of underground space that is now filled with water. It was the purpose of this study to evaluate the thermal and mineral characteristics of these waters from three perspectives; as a low temperature geothermal heat source, as a possible source of water for public water supply, and as a possible source of valuable waters containing extractable quantities of dissolved minerals.

Temperature profiles in one shaft from each mine showed different results. The Montreal No. 5 Shaft is heated 9 to 10 degrees above the normal ground water temperature of 47° F and is well mixed throughout. Water temperatures in the Cary Mine New Shaft are stratified. Near the top of the shaft water temperatures were 54° to 55° F and remained relatively constant down to a depth of 2794 feet below ground surface. At this depth the water temperature increased sharply 10° and at a depth of 3680 feet reached a temperature of 74.1° F.

If an average water temperature of 55° F is assumed throughout the mine and a 15° temperature drop through a heat exchange system is feasible then 625 billion BTU's or 158 trillion calories are in storage and available for use. Using the same reasoning and assuming the mines can sustain a pumping rate of 700 gpm then a yield of 126 million BTU or 32 billion calories per day is available. This is equivalent to 900 gallons of home heating oil per day.

The water quality within the mines is chemically marginal for drinking water purposes but does improve with depth. With standard treatment facilities it seems probable that the mine waters could be used as a source for public water supply.

Based on mine pumpage records and the rate of filling of the mines after abandonment the mines can yield 700 to 1000 gpm perennially.

No water samples were retrieved which contained sufficient total dissolved solids to be considered a brine. Based on this it is concluded that brines reported in earlier investigations are only in the deepest portions of the mines out of reach of our sampling techniques, diluted and mixed throughout the mines or were of a transient nature and are no longer present in the mines.

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The Pollutional effects of an infiltration pond's seepage upon adjacent surface waters

T.W. Peters

The effects of the overflow and seepage from a sewage treatment plant's infiltration pond upon an adjacent creek was documented. The infiltration pond was located within the headwater region of a groundwater discharge stream which flowed approximately three-quarters of a mile to Geneva Lake. Loss of the pond's effectiveness through age and poor site suitability resulted in the pond's seepage passing through the soil with minimal nutrient removal and entering the groundwater regiem. High concentrations of phosphorous, conductance, ammonia and chloride found throughout the creek's channel indicated that the source of contamination was in the headwater region. Studies in 1976 and 1977 identified the hydrologic and nutrient impact of this seepage and overflow on Geneva Lake. Although the creek contributed only 4% of the total hydrologic loading, it was responsible for 48% of the total phosphorous loading to Geneva Lake. The new infiltration pond began operation in December 1978. Monitoring of the creek's water quality during six months since the new pond went into operation has shown considerable improvement in the creek's water quality with an 18% reduction in total phosphorous loading to Geneva Lake.

Keywords: infiltration pond, headwater region, groundwater discharge, hydrologic loading

Abstract

Semi-Automated Determination of Total Phosphorus and Total Kjeldahl Nitrogen for Use in Water Quality Studies.

by

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A semi-automated digestion technique has been developed to measure total phosphorus and total Kjeldahl nitrogen in water and it has been evaluated through three years of routine laboratory operation. Data comparing the digestion technique using a Technicon BD-40 Block Digestor with Standard Methods procedures are provided. Using the block digestion technique, the total phosphorus data were comparable to those developed by following Standard Methods; however, the total Kjeldahl nitrogen data were higher in the block digestion runs. Quality control data show that the Block Digestor technique provides improved precision and accuracy over the Standard Methods techniques. Block digestion also significantly increases the laboratory productivity for total Kjeldahl nitrogen (usually a tedious technique) while simultaneously reducing sample volume requirements. The usefullness of these Block Digestor techniques to water quality studies is explained.

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- ABSTRACT -

DETENTION/RETENTION FOR ENHANCEMENT OF THE QUALITY OF STORM WATER RUNOFF: STATE-OF-THE-ART

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During the past decade, detention/retention (D/R) facilities have gained increasing popularity as major elements in urban storm water control systems. The principal motivation for this evolving use of storage-oriented facilities seems to have been cost savings that are sometimes achieved relative to the traditional conveyance-oriented systems. An apparent second motivation for the growing use of D/R facilities is their aesthetic, recreational, and other multi-purpose values.

Because of growing concern with management of non-point source pollution in unsewered or separately sewered areas, a potential third reason for considering utilization of D/R facilities has arisen: enhancement of urban storm water runoff. However, relatively little planning, design, and operation and maintenance experience is available and that which is available, along with the research and development studies that are under way or have been completed, is scattered about varying institutions and literature.

This paper reviews the state-of-the-art of the use of D/R facilities for enhancing storm water runoff in urban and urbanizing areas. This review is intended to be of use to practitioners who are evaluating technical, economic, environmental, and other aspects of D/R facilities and also is intended to be of use to the research community by identifying research needs.

Topics discussed in survey form include: siting considerations; techniques for determining pollutant loads to D/R facilities; determination of volume, area, depth, and overall geometry; pollutant removal mechanisms, efficiency and identification of significant parameters based on monitoring and modeling studies; complimentary multiple uses; operation and maintenance requirements; adverse effects; costs and benefits; and safety considerations.

Research needs identified and discussed include use of localized artificial marshes at inflow points to serve as physical and biological filters; leaching of accumulated pollutants into shallow groundwater; improved methods of estimating pollutant removal efficiency; and the need to focus on potential pollutants other than sediment.

SOURCES OF COLOR AND SUSPENDED SOLIDS AND THEIR EFFECTS ON PHYTOPLANKTON PRODUCTION IN THE WISCONSIN RIVER

Chris Mechenich[1] and Byron H. Shaw[2]

Since May, 1978, a study has been conducted to determine the contribution of industries to the color and suspended solids levels in the Wisconsin River, and its effect on the growth of algae. Samples were collected from 12 Wisconsin River sites, 18 tributaries, and 13 pulp and paper mills. Results indicate that at Mosinee Flowage, a minimum of 21.9% of the true color and 30.9% of the apparent color is caused by industry. Below Mosinee, the increased flow of the river and lower color of the mill effluents and tributaries minimizes further increases in river color.

The spectral composition of light penetrating the surface of Lake DuBay, the first reservoir below Mosinee, is typical of turbid eutrophic waters. Results of primary production experiments in Lake DuBay indicate that light is presently a limiting factor. In situ experiments were run using large plastic bags to simulate conditions of decreased river color. Carbon-14 uptake was measured using river water samples suspended in the plastic bags. This data showed that a decrease in color of 20-40% produced a 10-39% increase in carbon assimilation. Decisions on future efforts to further improve water quality in the river should take such relationships into account.

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Factors Effecting Phytoplankton Biomass and Photosynthetic Rates in the Upper Wisconsin River

J. F. Sullivan

Measurements of phytoplankton biomass and photosynthetic rates were determined during the summer periods of 1978 and 1979 in the Upper Wisconsin River. This information was collected to serve as a data base for the calibration and verification of the Qual - 3 water quality computer model. This model is being used by the Wisconsin Department of Natural Resources for the development of wasteload allocations for the main stem point source dischargers.

Chlorophyll a profiles increased from low levels at Rhinelander Dam to high concentrations in the Wisconsin Rapids area. This response was attributed to increased nitrogen and phosphorus loading as well as an increase in the residence time of the impoundments along this gradient. The phytoplankton composition was normally dominated by centric diatoms in June and September and by blue-green algae in July and August. The blue-green alga, Aphanizomenon flos-aquae, was particularly abundant in large impoundments below Mosinee in August. Areal photosynthetic rates were greatest in reaches with high phytoplankton biomass. The trophogenic zone was normal limited to the upper 1.0 to 1.5 meters and approximated the compensation point. The depth of maximum photosynthesis occurred at about 73 percent of surface irradiance.

Factors influencing the depth and magnitude of the maximum photosynthetic rates are discussed. In addition, information will be presented on the use of the Qual - 3 computer model to simulate phytoplankton concentrations in response to changes in light, nutrients, residence time and other factors effecting phytoplankton growth.

Jones, R. Christian and Kurt Walti. Institute for Environmental Studies and Department of Botany. University of Wisconsin-Madison. LIGHT EXTINCTION BY PHYTOPLANKTON AS A FACTOR IN THE DECREASED ABUNDANCE AND VITALITY OF A SUBMERSED MACROPHYTE IN LAKE WINGRA, WISCONSIN.

The dominant submersed macrophyte in Lake Wingra, Eurasian water milfoil *Myriophyllum spicatum*, has undergone a marked decrease in biomass, productivity, and vitality since the mid-1970's. This decline can be documented using biomass and coverage data from quadrat samples and aerial photographs. We have noted a substantial decrease in light penetration in the past several years (as reflected in light extinction coefficients and Secchi disc readings) coinciding with the macrophyte decline. We hypothesize that increased phytoplankton biomass in the water column has resulted in decreased light penetration and inhibition of macrophyte growth. We will report on tests of this hypothesis using field data collected during 1978 and 1979 and computer simulations of macrophyte growth under the changed conditions.

Abstract

An Ultimate Biochemical Oxygen Demand Procedure and Its Application to Water Quality Modeling in the Wisconsin and Fox Rivers, Wisconsin.

by

John W. Rogers,[1] Dennis D. Hintz,[2] Dale J. Patterson,[1] George T. Bowman,[2] and Joseph J. Delfino[2]

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A procedure to determine the ultimate biochemical oxygen demand (BOD_u) of water and wastewater has been developed. The method is simpler to use than previous procedures. The resultant BOD_u data are used in water quality models for the Wisconsin and Fox Rivers.

The BOD_u procedure involves monitoring the dissolved oxygen (DO) concentration of water and wastewater samples in special two-liter BOD bottles for up to 150 days. The cumulative DO depletion data are analyzed either graphically or statistically to determine (a) the BOD_u; (b) the ratio of BOD_u to five-day biochemical oxygen demand (BOD_5); and (c) the laboratory decay rates. The precision among replicates is within 15%.

Evaluation of several hundred BOD_u analyses shows that (a) as many as 150 days of testing are often necessary to adequately calculate the BOD_u; (b) significant nitrification often occurs in BOD_5 tests on highly treated wastes; and (c) the BOD_u to BOD_5 ratios ranged from 1.5 for some municipal wastes to 10 for various sulfite pulp mills. Ratios of 3 to 10 are common for pulp and paper mills while ratios of less than 3 are common for municipal sewage treatment systems. These ratios are higher than those previously reported in the literature.

The ratio of BOD_u to BOD_5 is used to convert measured effluent BOD_5 data to BOD which are then used in river dissolved oxygen modeling. Use of the BOD_u procedure and a subsequent increased understanding of wastewater properties has significantly improved the water quality modeling efforts of the Wisconsin Department of Natural Resources.

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Instream Aeration as a Management Alternative
for the Lower Fox River, Wisconsin

James D. Ruff - Wisconsin Department of Natural Resources

In order to develop an implementable areawide water quality management plan for the Lower Fox River, it is of extreme importance to examine various feasible water quality control alternatives to determine the most cost-effective way of achieving water quality standards. Due to the discharge of organic wastes from four major urban areas and twelve pulp and paper mills, there are several dissolved oxygen problem areas in the upper segments of the Lower Fox River, especially during low flow conditions. If reliance were placed entirely on traditional end-of-pipe waste treatment, these problem reaches would require additional sophisticated treatment facilities beyond the levels already specified in the Clean Water Act regulations. Politically speaking, the knowledge that other potentially less costly alternatives exist would greatly reduce the changes of implementing such a plan, since the cost of such advanced treatment might impose significant negative impacts on the regional economy. In this situation a more flexible and cost-effective approach could be to utilize one or more alternatives such as instream aeration, low flow augmentation, dredging of oxygen-demanding sediments, dam removal, or outfall relocation. This paper discusses one of these alternatives, instream aeration, with particular emphasis on the major technical questions and decisions addressed in examining this option.

The Department's mathematical water quality simulation model (Qual-III) was used in a steady state mode with various waste load scenarios to determine the capacity of the Lower Fox River to assimilate oxygen-demanding wastes. Initial dissolved oxygen sag curves were developed. The model was then used with an iterative procedure to determine the amount of oxygen transfer required in order to maintain a minimum of 5.0 ppm of dissolved oxygen. A number of technical judgements that had to be made will be addressed. A statistical methodology for selecting the design river flow and temperature conditions for input to the model will also be discussed. Finally, the annualized costs of various instream aeration systems will be presented. Due to the relatively low capital investment and operating costs this method appears to have great potential as a feasible, cost-effective solution for maintaining water quality standards on the Lower Fox River.

Milwaukee Metropolitan Sewerage District

RELATIONSHIP OF SEDIMENT OXYGEN DEMAND AND RECEIVING STREAM IMPACTS ON THE MILWAUKEE RIVER

The Milwaukee River exhibits tremendous dissolved oxygen sags in its lower reaches following stormwater runoff events. The modeling tasks of the CSO project, part of the 201 effort, could not duplicate these sags using the instream concentrations found in the monitoring program. Extensive field monitoring was then conducted to quantify the source and mechanism of these sags. After numerous investigations, the bottom sediments in the lower reaches were found to be the source of the rapid dissolved oxygen declines.

The first effort in determining the cause of the D.O. sag observed in the River was to determine the magnitude of the sediment oxygen demand using In Situ techniques. The values determined using these techniques were then used to calibrate our model and additional sediment oxygen demand data was used to verify the model. The results of the verification effort still left a great deal of the oxygen sag unaccounted for and it was determined that further research was needed.

The next attempt at accounting for the extreme magnitude of oxygen sag observed was to determine the ultimate oxygen demand that the implace sediments could exert on the river system. These determinations pointed to the possiblity that the oxygen sag observed could be linked to the sediments when the ultimate sediment oxygen demand values were fed into the modeling effort. The mechanism by which the ultimate sediment oxygen demand was expressed in the river was then determined.

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DAG:le

AWRA Abstract

An Assessment of Chemical Usage in the Lower Fox River Basin: Initial Findings.

by

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Increased awareness of the sources, distribution and fate of organic chemicals in natural waters has led to an assessment of the use or production of these materials in the Lower Fox River Basin in northeastern Wisconsin. This Basin is a densely developed industrial area and is known for heavy discharges of organic pollutants to the aquatic environment. The Wisconsin DNR, for example, recently identified over 100 organic compounds in the water, wastewaters, sediments and biota of the Basin, 20 of which appear on the USEPA priority pollutant list.

As part of this assessment study, an inventory of chemicals used in the Basin was developed. It provides a means of ascertaining the potential number and quantities of organic chemicals which might ultimately reach the Lower Fox River and Green Bay. Initial steps in the inventory process included identifying industrial and municipal point source discharges and potential non-point pollution areas. Sections 144.54 and 147.02 of the Wisconsin Statutes require submission of information on chemicals used in industrial processes. Although the files are incomplete, they provide one useful information source for the inventory. Other chemicals of potential interest were identified from the industrial process literature, from trade journals and from on-site visits to certain industrial plants.

Chemical additives are heavily used in many processes in the Basin and their compositions are known only to the manufacturers. The USEPA Toxic Substances Control Act inventory had to be consulted in an attempt to attach chemical identities to many of the additives. Also of some use were chemical buyers guides. In cases where chemicals were known to be discharged but which did not appear in the chemical usage lists, hypotheses were suggested to account for their formation during various manufacturing processes. The reaction products of chlorination are of particular interest since chlorinated compounds, as a class, are known to bioaccumulate in aquatic organisms.

The chemical inventory is the initial phase in our Sea Grant-funded project. It will be used to identify selected organic compounds for additional study and it will aid in the development of a preliminary mass balance for those compounds in the context of the Lower Fox River Basin environment.

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ABSTRACT

TOXIC SUBSTANCES SURVEY OF LAKES MICHIGAN, SUPERIOR, AND TRIBUTARY STREAMS

by

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The presence of microcontaminants in the Lake Michigan ecosystem has been recognized for more than a decade. The use of persistent organochlorine insecticides, metallic pesticides, and polychlorinated biphenyls has led to the contamination of water, sediment and fish in all five of the Great Lakes. However, Lake Michigan has historically shown higher levels of microcontaminants than the other four Great Lakes.

The Department of Natural Resources has tested more than 2,500 fish samples for PCBs and a few other limited parameters since 1970. However, Department testing has been mainly a trouble-shooting, problem-oriented program, dealing with individual crises as they arose. There are major gaps in our Agency's PCB data record because many locations have not been monitored and others have been tested on a sporadic basis. There is also a lack of data concerning other toxic chlororganic compounds and heavy metals in Lakes Michigan and Superior and tributary streams. Although aware of isolated problems, the state has never made a single comprehensive study of the scope of toxic contamination in Lakes Michigan, Superior, and their tributary streams.

In July, 1977, the Department of Natural Resources received a $135,000 grant from the Wisconsin Coastal Management Program to conduct a systematic and comprehensive survey of 16 toxic substances in Wisconsin's coastal zone. The two-year project will involve the analysis of 1,500 fish samples from 60 locations in the coastal zone, including 21 near shore, 7 offshore, and 32 tributary stream sampling stations along Lakes Michigan and Superior.

The sampling plan, major objectives, preliminary data, and measurable end products of this project are discussed.

WATER-TABLE MOUNDING BENEATH SEPTIC TANK SYSTEMS IN WISCONSIN

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A transient, two-dimensional groundwater flow model was used to simulate the build-up of groundwater mounds beneath septic tank-soil absorption systems in Wisconsin. Field studies by Bouma et al. (1972) and Dudley and Stephenson (1973) indicate that under certain conditions, artificial recharge of effluent from septic tank systems causes the formation of a small groundwater mound and a local reversal in the direction of groundwater flow. This effect may be a consideration in the placement of shallow water supply wells. The model was used to establish correlations between hydraulic conductivity, loading rates, the pre-existing hydraulic gradient and the occurrence of mounding. The shape of the mound and the time necessary for formation were also considered.

THE RESPONSE OF MACROINVERTEBRATES TO WATER QUALITY IMPROVEMENTS AND CURRENT VELOCITY CHANGES IN THE LOWER FOX RIVER, WISCONSIN

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The lower Fox River is 40 miles long with eleven (11) cities, approximately eighteen (18) pulp and paper mills, and eight (8) municipal treatment plants between Lake Winnebago and Green Bay.

A macroinvertebrate artificial substrate program was initiated in 1971 to monitor the water quality changes in the water column of the river. Modified barbeque baskets were utilized and sampling was conducted over the low flow and high temperature period from May to October.

In the past, a high biochemical oxygen demand (BOD) and suspended solids load to the river from point source discharge caused a decrease in the river's dissolved oxygen (DO) which suppressed the type and numbers of macroinvertebrates found. New primary and secondary waste treatment facilities for industry and municipalities have resulted in significant changes within the macroinvertebrate community structure. The diversities and densities of the filter-feeding macroinvertebrate forms have displayed an increase since 1971.

The following significant changes have occured in the lower Fox River since 1971.

1. an increase of the caddis flies in the middle and lower stretches of the river,
2. a decrease of the segmented worm population in the middle and lower portion, and
3. an increase of the DO concentrations.

Furthermore, recent data have shown the importance that river velocity, enrichment, and substrate type have in the distribution of collecting-filtering and collecting-gathering types of macroinvertebrates.

Through the analysis of the macroinvertebrate data, predictions can be made of areas in the Fox River where water quality improvements are expected within the next few years.

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ABSTRACT

WISCONSIN'S MUNICIPAL SLUDGE MANAGEMENT PROGRAM

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Approximately 70% of Wisconsin's municipalities dispose of sludge on agricultural lands. The remainder use either sanitary landfills, incineration (with ash to landfill) or a public distribution system.

Currently, Wisconsin is in the process of implementing a statewide sludge management program. Its purpose is to obtain more information on sludge disposal operations and to require municipalities to develop ongoing continuous management plans. Under this program, municipalities (the generators of sludge) must receive approval of their plans from the Wisconsin Department of Natural Resources. The plans are submitted on forms which the Department has prepared to assist the municipalities.

Through this program, the Department provides guidance on how to properly store, transport, utilize and dispose of sludge. It also provides guidance on the amount of sludge applied, the crops grown, monitoring and other operational activities. It is using the information contained in its own guideline document (Guidelines for the Application of Wastewater Slud e to A ricultural Land in Wisconsin by Dennis Keeney, Kwang Lee and Leo Walsh and other more current publications such as those from EPA (technical bulletin on Municipal Sludge Management: Environmental Factors) and the scientific community to control sludge disposal practices. The Department believes its program is workable and provides the level of protection needed to assure prevention of health and environmental hazards.

ABSTRACT (Poster Presentation)

DETAILS OF A COMPUTER-ENHANCED HYDROLOGY COURSE

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A computer-enhanced hydrology course will teach basic concepts by example and will allow for the development of sophisticated concepts in basic water resources courses. Interactive instructional modules and text review packages help the student to understand basic hydrologic principles and analytical techniques. Each instructional module is composed of exercises designed to illustrate a single concept. Text review packages are quizzes composed of multiple choice questions keyed to standard hydrology texts. Exercises in the modules use single-purpose computer programs to perform basic calculations and present results so that the student can analyze a problem as a problem in hydrology rather than an exercise in mathematical manipulation. User's manuals for the support programs provide detailed descriptions of the formulas or models used in each program as well as a brief discussion of the principles involved. The manuals are keyed to hydrology texts to guide further study. Some modules and most of the computer support programs have been developed. Continuing additions and modifications will increase flexibility as classroom use reveals problems in the system. While the project is being developed for traditional classroom use, it will be easy to modify for independent study and continuing education programs.