ABSTRACTS OF THE FIRST ANNUAL TENNESSEE STUDENTS SYMPOSIUM ON WATER RESOURCES

April 23-24, 1993
Tennessee Technological University
Cookeville, Tennessee

Sponsored by:

Tennessee Section, American Water Resources Association
Tennessee Technological University
Center for Management, Utilization, and Protection of Water Resources

In cooperation with:

U.S. Geological Survey, Water Resources Division
Austin Peay State University
Christian Brothers College
Memphis State University
Middle Tennessee State University
The University of Tennessee at Chattanooga
The University of Tennessee at Knoxville
Vanderbilt University
Tennessee Academy of Sciences

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ABSTRACTS

Compiled by

Ferdinand Quinones and John A. Gordon

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INTRODUCTION

The Tennessee Section of the American Water Resources Association (TNAWRA) was established in 1989 to promote communications among the water resources community in the State. Since its birth, TNAWRA has organized an annual two-day statewide water resources symposium. Each year since 1989, efforts were made to involve college students in the annual symposium; however, participation by students has been minimal. The Board of Directors of the TNAWRA concluded that participation could be enhanced through a symposium limited to students. Last fall, plans for the First Annual Tennessee Students Symposium on Water Resources were drafted. The campus of Tennessee Technological University (TTU at Cookeville) was selected to host the activity.

The purpose of this Symposium is to provide students in colleges and universities across Tennessee a forum to report on their research and investigations on water resources issues. The format will provide the students a learning experience on reporting results of their research from an "entry level perspective." Hopefully, the experience also will motivate students to participate in future activities organized by TNAWRA and other professional organizations in the water resources field.

In addition to the participation in the Symposium, students whose research was selected for presentation, will benefit from the publication of the proceedings of the activity in two volumes. This volume includes the abstracts, while later, a second volume will include selected short papers from the Symposium. As part of the Symposium, TNAWRA and TTU also are organizing an informal career fair. We hope to provide an opportunity for students attending and participating in the Symposium to meet potential employers of water resources professionals.

Symposia for higher-education students conducting research on water resources issues will be organized annually, hosted by the different Universities in Tennessee. TNAWRA and TTU hope that everyone attending the First Tennessee Students Water Resources Symposium will have a rewarding experience and wishes the participants the very best future.

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Constructed Wetlands for Wastewater Treatment

by

Melissa M. Schweitzer 1/

ABSTRACT

High costs are now a primary concern in the treatment of wastewater and creative alternatives to traditional treatment must be sought. Standards for water quality and costs to meet those standards are increasing at rates that make traditional wastewater treatment prohibitively expensive. One increasingly popular alternative is the constructed wetland for wastewater treatment. The constructed wetland provides passive biological treatment at lower costs than more traditional treatment methods, and is useful in both municipal and industrial applications. Civil Engineers should explore this kind of treatment as an alternative to traditional treatment.

Constructed Wetlands for Municipal Wastewater Treatment

by

Kaliyasundaram Mathavan 1/

ABSTRACT

Constructed wetlands are man-made wetlands used for treating municipal and agricultural wastewaters, acid mine drainage waters and small scale industrial wastes like pulp-mill wastes. Constructed wetlands aid in the reduction of BOD, pathogens, hydrocarbons and nitrogen removal of the municipal wastewaters. They also act as sinks for trace metals, phosphorous and suspended solids. Based on the mode of flow of the wastewater, the constructed wetlands are classified as free water surface systems (FWS), sub-surface systems (SF), and vertical flow systems (hybrid). Constructed wetlands are used for the planned treatment of both raw and primary wastewaters and also for the advanced treatment of the secondary wastewaters. Constructed wetlands offer several advantages compared to natural systems and conventional treatment systems by way of greater flexibility in sizing, site selection and greater operational control for scientific testing. Constructed wetlands offer an environmentally sound alternative to conventional methods by preserving the ecology in the form of giving refuge for birds, plants and in the enhancement of wildlife. Constructed wetlands have proved to be effective low cost alternatives to conventional treatment processes. This paper deals with the treatment mechanisms involved, optimal design, construction, operational features and a discussion on the relative suitability of the different types of constructed wetland systems.

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A Laboratory Scale Constructed Wetlands System for Treating Dairy Lagoon Effluent

by

Brian Benham 1/ and Dr. C. Roland Mote 2/

ABSTRACT

Wetlands were once considered wasted land. It is now clear, however, that they provide irreplaceable benefits to the environment. Wetlands can effectively remove or convert large quantities of pollutants from point and non-point sources, thus improving water quality. Various process are involved in removing pollutants from wastewaters entering wetlands. Natural filtration and sedimentation mechanically remove pollutants, while chemical and biochemical reactions degrade and transform complex compounds into simpler substances. Surface flow constructed wetlands attempt to mimic marsh like natural wetlands and endeavor to implement the wastewater treatment mechanisms that are inherent in natural wetlands. Discharge of livestock waste from concentrated production facilities (dairies, swine and poultry operations) into natural water courses is a significant source of water pollution. The success of constructed wetlands in treating a variety of waste streams has stirred interest in the agricultural community as to the applicability of constructed wetland treatment technology to various agricultural waste streams. This study address the applicability of surface-flow constructed wetlands technology to the treatment of a dairy lagoon effluent. The study involves ten laboratory scale (1.5 m by 0.5 m) constructed wetland cells. The system, housed in the University of Tennessee Agricultural Engineering Structures and Environment Lab, is designed so that a number of experimental factors may be examined. The first stage of the study involves investigation of treatment efficacy given three organic loading rates (waste strength levels) and three types of microbial attachment sites. Much of the treatment achieved in these systems is a result of microbial degradation performed by adherent bacteria. This study compares treatments utilizing living (plant) and non-living (inert) attachment sites, with cells having no attachment site serving as a control. The inert attachment sites are wooden dowels, while the plant attachment sites are bulrush (Scirpus). Monitoring and analysis of standard water quality parameters will yield information as to treatment efficacy. Also, the inclusion of time as an experimental factor will allow investigation of cell maturity and its impact on wastewater renovation. The second stage of the study will utilize the combination previously deemed most effective and attempt to further treat the wastewater by inducing a denitrification zone. Nitrogen inputs into the system are predominately in the form of ammonia. Literature suggests that nitrification, thanks to the adherent growth environment, occurs in these systems. Literature further suggests that denitrification will occur given a sufficient carbon source. In order to provide such a source, and create a sequential treatment system, untreated lagoon effluent will be diverted from the wetland cell's headworks and introduced into the system at intermediate locations along the length of the cell. Levels of blend ratio (the percentage of diverted cell influent) and mixing points (the intermediate influent introduction locations) will be evaluated as to the effectiveness of nitrogen removal and overall waste treatment effectiveness.

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Establishment of Scirpus Validus in a Constructed Wetland for Wastewater Treatment

by

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ABSTRACT

An EPA sponsored subsurface flow wetland was built in Baxter, Tennessee by the Tennessee Technological University Water Center. Construction began in fall of 1991; and system startup using wastewater began on July 13, 1992. Gravel beds were available for planting on April 1, 1992 before wastewater was available. Water from a nearby creek was used to irrigate the Scirpus validus rhizomes until wastewater became available. Fertilization rates simulated nutrient levels of wastewater. Attempts were made to avoid previous problems encountered during wetland plant establishment in other gravel bed systems. Information was available for transplanting in natural soil habitats, but very little information was available for the gravel systems. This paper describes how soft-stem bulrush was successfully planted and maintained prior to system startup in a gravel bed wastewater system. Information sources, plant sources, rhizome preparation and storage, planting, fertilization and maintenance procedures are discussed.

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Efficacy of Using Constructed Wetlands to Lower the Toxicity of Wastewaters at the Oak Ridge Department of Energy (DOE) Facilities

by

James Egner 1/

High concentrations of sulfate are present in wastewaters from several waste treatment operations at DOE facilities in Oak Ridge, TN and many industrial wastewaters nationwide. The sulfate originates in part from the use of sulfuric acid to neutralize Ph after contaminants have been removed by conventional waste-treatment procedures. The high concentrations of sulfate can result in the failure of toxicity tests, which are used to evaluate the biological quality of the wastewaters prior to their release. A bench-scale experimental system was devised to explore the use of constructed wetland biotechnology for reducing the toxicity of sulfate-rich wastewaters. Microbes in anoxic sediments reduce sulfate to sulfide; causing vigorous reactions with any metals present in the sediment. Insoluble pyrite (FeS2) forms when sulfide reacts with iron. The results of chemical analysis of water entering and exiting the model, and the results of tests with Cerodaphnia dubia (a freshwater microcrustacean, used to quantify toxicity) are discussed in relation to the possibility of using constructed wetlands to polish sulfate-rich wastewaters.

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The Isolation and Use of Motor Oil Degrading Microorganisms

by

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Aliphatic hydrocarbons are threatening the potable water supply and the aquatic ecosystem. Given the right microbial inhabitant(s) and the right treatment system , a large portion of these aliphatic hydrocarbons could be biodegraded before reaching the water supply. Our purpose is to isolate possible oil degrading organisms. Soil samples were taken from hydrocarbon laden soils at petroleum terminals , a petroleum refinery waste treatment facility, a sewage treatment plant grease collector, a site of previous bioremediation, and from various other places. Some isolates known to be good degraders were obtained from culture collection services. These samples were plated on a 10W-30 multigrade motor oil solid media to screen for aliphatic hydrocarbon degraders. The degrading microorganisms were isolated, identified, and tested for their ability to degrade motor oil using CO2 evolution BOD and COD. Thirty seven organisms were tested and the most efficient degraders were Serratia marcescens, Escherichia coli, and Enterobacter agglomerans. These oil degraders were then tested in model waste treatment systems. The models were of a trickling filter, an activated sludge and an anaerobic digester.

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Sources of Oxygen-Demanding Materials to Tennessee Valley Authority Reservoirs

by

Julia Burr Avera 1/ and John A. Gordon 2/

ABSTRACT

Diffuse sources of oxygen-demanding materials, such as particulate, organic carbon and ammonia are transported into reservoirs by hydrologic processes. These diffuse materials have contributed to the depletion of dissolved oxygen in reservoirs throughout the Tennessee Valley and elsewhere. These materials are transported during late winter, spring and summer months prior to stratification and are stored in the reservoir during stratification. Subsequent microbial and chemical activity apparently decrease the dissolved oxygen to unacceptable levels. This project involves sampling 13 streams which flow into 8 storage reservoirs within the Tennessee Valley during the inflow period from mid-February to August. It is believed that sampling the streams during this time of year will allow an investigation into the type and levels of oxygen-demanding or diffuse materials entering a reservoir. Two reservoirs are controls while the other 6 have adverse hypolimnetic dissolved oxygen levels.

This is a three-year study which began in March 1992. The project will focus on a specific group of reservoir hydrologic events during one year while baseline water quality data are collected during the other two years. Douglas, Cherokee and Norris reservoirs were the focal reservoirs for 1992. During 1993, Nottely, Chatuge and Blue Ridge reservoirs are the focal reservoirs. South Holston and Watauga reservoirs will be studied in 1994.

All samples collected are being tested for biochemical oxygen demand, nitrogen series, total and ortho phosphate and total and dissolved organic carbon. Temperature, dissolved oxygen, Ph, ORP, and conductivity are being taken as the sites are sampled. The data are entered into a spreadsheet, with further analysis being performed at the end of the sampling year. The desired results are regressions between flow and water quality based upon the unit hydrograph components of base flow, rising limb and falling limb.

This paper will present the rationale for the study, the sampling protocol and an analysis of the first year of data.

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Struvite Control in Flush Water Recycle Components of Livestock Waste Management Systems

by

John R. Buchanan 1/ and Dr. C. Roland Mote 2/

ABSTRACT

The consumers of America's livestock industry demand safe and inexpensive meat products. One management practice the livestock industry has adopted is the use of confinement housing systems. This allows the producer to maintain full control over the animals and raise the most animals on the least amount of land. By concentrating the livestock, manure is also concentrated to the point of overloading nature's recycling processes. Engineered systems must be developed that treat and dispose of animal waste in a manner that is environmentally and economically sound. One such system uses water to hydraulically collect and transport deposited waste to anaerobic lagoons. The research conducted by this study was to address the problem of recycling the lagoon effluent back through the waste management system. The goal of the recycle concept is to reduce the amount of water required for waste disposal, thus reducing the amount of water that must be treated. All water that comes in contact with manure becomes livestock waste and must be treated as waste. The primary method of wastewater treatment is to spread the lagoon contents on agricultural soils. A reduction in the amount of water treated reduces the potential for contamination of ground and surface waters. Since the recycle approach continuously reuses the effluent, a supersaturation of nutrients from the metabolic waste produces crystalline precipitates which deposit within the recycle components. The primary crystalline species has been identified as magnesium ammonium phosphate hexahydrate, commonly known as struvite. The approach taken by this research was to determine if struvite can be inhibited by some type of chemical treatment. An analytical solution containing the typical concentration of struvite ions found in lagoons was developed for bench-top evaluation of potential inhibitors. The testing protocol included agitation to simulate pump and pipe turbulence and an extended settling period to allow for equilibrium. Potential inhibitors were chosen from other industries that experience scale control problems. Inhibitors were judged by any delay in formation and by the concentration of struvite ions still in solution after the settling period. Twenty products were tested, out of which seven products showed potential to prevent struvite formation. From this group, inhibitors will be selected on the bases of cost to the producer, danger in handling the product, and any environmental impacts that may arise when the treated lagoon contents are land applied.

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A Simple Flow Measuring Device for Grit Chambers

by

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ABSTRACT

A practically simple flow measuring device having linear head discharge characteristics has been designed for grit chambers. An extended bell mount weir with the addition of a rectangular base in the form of a pedestal has studied with a numerical optimization procedure, called "Range of Points Method." It has been shown that the provision of a base has a salutary effect on the discharge characteristics of the extended bell mouth weir in improving its linearity range and lowering the reference plane below the crest of the weir, making it more sensitive and very useful as an outlet weir for grit chambers. The most significant effect is that in the entire range of head, $0.85R \leq h \leq 5.00R$ (4.15R), the linear head discharge relationship is expressed by one law in the form $Q=mH\pm C$. The weir parameters are optimized to obtain a maximum range of linearity, keeping the maximum allowable error, in discharge computations, within $\pm 1.0\%$. Experiments with two weirs confirm the theory by giving a constant average coefficient of discharge as 0.63.

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Evaluation of Prediction Equations for Determining Reareation Coefficients for Low-Slope Stream Reaches

by

G. Kevin Thompson 1/ and others

ABSTRACT NOT SUBMITTED

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Effect of Combined Sewer Overflows on the Water Quality of the Cumberland River using CE-QUAL-W2"

by

W. Reid Adams 1/ and Dr. E. L. Thackston 2/

ABSTRACT

This project is a joint effort between Metro Nashville (Metro), Consoer, Townsend & Associates, and Vanderbilt University. Metro Nashville is in the process of trying to improve the water quality of the Cumberland River (Cheatham Lake) through the abatement of their combined sewer overflows (CSO). As an integral part of the CSO abatement program, a mathematical model, CE-QUAL-W2, developed by the Corps of Engineers, was used to accurately simulate the hydrodynamics and water quality of the river. The preliminary calibration of CE-QUAL-W2 was accomplished using daily averaged input data from the drought year 1988, and compared against Metro's weekly river run data. The verification of the model included a much more extensive set of input data collected from the USGS, USCOE, Metro, and the National Weather Service from September 1991 through August 1992. Model predictions were compared against continuous water quality data from automatic monitoring devices, Metro's river run data, and two, four-day intensive river surveys in April and August, 1992. Water quality parameters such as temperature, dissolved oxygen, biochemical oxygen demand, ammonia, and algae were predicted at various depths within Cheatham Lake the model and calibrated against observed data. The final analyses showed that CE-QUAL-W2 provided excellent predictions of water quality. The calibrated model was then used to simulate river conditions during heavy rainfall events which result in combined sewer overflows and waste water treatment plant bypasses. Low flows and summer conditions were simulated during these events to represent "stressed conditions" in the reservoir. The results of these simulations will be used by Metro and regulatory agencies to determine the impact of CSO events on the overall water quality of the river and to identify the necessary improvements to the waste water collection and treatment systems.

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Forecasting of Rainfall Using Neural Networks

by

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ABSTRACT

The objective of this research is to use artificial neural networks in forecasting annual rainfall. The network used for this study was a backpropagation network; which consists of an input layer, hidden layer, and output layer. The computer algorithm, including (1)Data Analysis, (2)Training Mode, and (3)Predict Mode, was written in BASIC language. Predicting rainfall is an extremely difficult task, but by teaching neural networks to recognize the precipitation pattern from the previous data, the network is able to interpolate the training data and estimate the desired output.

Annual rainfall from the last 58 years was collected from the City of Memphis; the first 50 rainfall values were grouped to train the networks and the last 8 values were used to verify the output networks. When training the networks various training parameters are initialized to speed the process. The first is the training coefficient, which is used to control the rate at which connection weights are adjusted. While everything else in the network remains constant, connection weights change as the network samples new information. Herein lies the ability to learn, adapt, and decipher complex relationships. The momentum coefficient is used to launch the training process out from the local minimum, which can eliminate the difference between the input and output data. Following the sigmoid function, the discrepancy allows the training process to fall into a local minimum of errors by being propagated back into the input layer. When the discrepancy is converged to the desired accuracy, the network indicates that the training has been completed. The training and momentum coefficients for this network were initialized to equal 0.9 (Malasri and Lin, 1990). The major problem in using neural networks is to determine the training pairs. A trial and error method suggested by Malasri et al. was used ascertain the training pairs. As a result, a 21-input-layer with one-output-layer took the least amount of training time, and was hence the optimum solution. 21 input layers, 21 hidden layers, and 1 output layers were selected to train the network. The resulting training time took less than an hour to achieve the designated accuracy. Although it showed a 10-15% difference between the predicted data and actual data, the results indicate that the forecasted pattern pretty much follows the actual rainfall pattern. As attested by the accuracy of the predicted data, the selection of the training parameters for networks is a critical step. The results suggest a shorter training time could provide higher capability of the networks to recognize the precipitation pattern.

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Techniques for Estimating Flood Hydrographs for Ungaged Watersheds in Tennessee

by

Kevin Klueh 1/ and James Smoot 2/

ABSTRACT

Synthetic or measured flood hydrographs associated with peak discharges of specified recurrence interval are needed for design or evaluation of large drainage structures and flood protection embankments. In ungaged watersheds, this information is especially difficult to obtain. To meet this need, the engineer may use existing hydrologic models such as HEC-1, TR-20, and others, or apply inferential statistical techniques. This research provides a procedure to estimate flood hydrographs for rural and urban ungaged watersheds in Tennessee using statistical techniques.

The U.S. Geological Survey recently developed a simple procedure for synthesizing flood hydrographs in Tennessee that incorporates two dimensionless unit hydrographs: one for east and central Tennessee, and the other for west Tennessee. To apply this technique, the user must estimate both the peak discharge for a specific recurrence interval flood and the lagtime of a watershed. Both peak discharge and watershed lagtime may be estimated from regional equations. The storm hydrograph may then be synthesized by multiplying the appropriate dimensionless unit hydrograph by the respective peak discharge and lagtime for that watershed.

The authors are currently developing an alternative statistical approach for synthesizing flood hydrographs for ungaged basins. The technique uses regional regression equations to approximate a number of points on the unit hydrograph of a watershed. Physical and hydrologic characteristics are the independent variables in these equations. These regional equations and the applicable watershed characteristics may then be used to synthesize a unit hydrograph for the watershed. This unit hydrograph may be used to determine a design storm hydrograph. The results of this research will be compared to the U.S. Geological Survey dimensionless unit hydrograph technique to determine the relative merits of the two approaches and the possibility for development of an improved, non-resource intensive tool applicable to ungaged watersheds. The goal of this work is to include the influence of physical, hydrologic, and geomorphologic watershed characteristics across diverse physiographic region.

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Integrated Simulation and Optimization for a Large Water-Distribution System

by

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ABSTRACT

Optimization of a water-distribution system is concerned principally with minimizing the energy costs of operating pumps. Due to the complex interaction between pumps and distribution systems, and to the discrete, noncontinuous nature of the variables, nonlinear optimization procedures are always performed on greatly simplified models which may not accurately represent the distribution system. An optimization program called SEARCH is presented to find the minimum operating cost. The well-known simulation program KYPIPE is linked to the SEARCH program to provide information about flows, pump heads, and pressures. Data from on-line pump tests provides information concerning pump efficiency and head- flow curves. The distribution system layout provides additional information: a checkpoint's physical proximity to each pumping station that determines its 'influence' on that pumping station. An example problem using the Memphis water-distribution network is presented. The example contains 16 constant-speed pumps and 16 variable-speed pumps, located at 9 stations. The KYPIPE model contains 1634 pipes, 15 tanks, and 10 booster pumps. The strengths and the limitations of the optimization procedure are illustrated through the example problem.

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Use of Geographic Information Systems for Site Selection of Areas for Land Application of Municipal Wastewater, Rutherford County, Tennessee

by

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ABSTRACT NOT SUBMITTED

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AUTOMATED JOINT MAPPING FOR ASSESSMENT OF GROUNDWATER CONTAMINATION HAZARDS

by

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ABSTRACT

The presence and orientation of jointing or vertical fractures in the bedrock of a particular area will have a great effect on the introduction of surface pollutants into the local groundwater. Therefore, the methods used to detect and analyze these fractures is of concern to anyone interested in water quality. What is proposed is to obtain the same, or hopefully more accurate, data as from usual methods, through application of digital image processing. This method was devised with Karst areas in mind, although, it could be successfully applied in other non-carbonate, terrains with shallow soil cover. The key factor is the detection of soil slumping features due to preferential erosion along joints. This produces a depression in the surface which will have a higher moisture content than the surrounding area, and therefore a decrease in emitted radiation detected by the sensing device. Once the imagery is obtained, target features are further discriminated by shape. Linear trends are then defined to show the underlying joints producing the target features. There are essentially five main steps in producing a joint map in this way; they are imagery acquisition, primary target discrimination, secondary target discrimination, and distribution analysis. Preliminary findings show that since target features are relatively small scale, aerial MSS (Multi-Spectral Scanner) data is the best imagery choice. Once the software routines are in place, the rest of the analysis is performed by the computer, eliminating the need for visual inspection of the images. By automating the process of joint mapping, much effort is saved while providing a useful watershed management tool. Once the data has been collected and processed, it is ready for whatever application the end user wishes to put it to. In locating potential groundwater pollution hazards it could be very useful. First a density map representing the number of features per unit area is correlated with possible source areas for pollution. Next surface drainage must be overlain and taken into account as a possible conduit into a susceptible area. Finally, fracture orientation can be used to predict the probable path of pollutants in the subsurface. The result is a region zoned into areas of relative pollution hazard. In the case of point source pollution, various groundwater samplings could be "backtracked" to the most likely source. That is to say, instead of asking where the contaminants could go, ask instead where could they have come from. In this respect, we now have a useful tool in remediation, as well as prevention, of groundwater contamination.

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GIS-Based Ground-Water Flow Modeling

by

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ABSTRACT NOT SUBMITTED

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Hydrologic Responses to Rainfall at Two Wetlands at Spring City, Tennessee

by

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ABSTRACT

Hydrologic responses to rainfall of two small wetlands at Spring City, Tennessee were studied from December 1991 to November 1992. One of the wetlands was a pre-existing wetland and one was artificially excavated to replace a wetlands disturbed by the construction of a road embankment. These two areas were studied to determine if they meet the definition that wetlands are those areas where the water table is at, near, or above the land surface for a significant part of most years.

Water levels were monitored in five 6-inch diameter wells, approximately 5-feet deep, that were installed in the wetlands and equipped with water-level recorders. The casing was slotted from above land surface to a depth of about 4 feet. The water-level recorders provided continuous records of stage during periods wetlands inundation and records of groundwater levels during periods when the wetlands were not inundated. Water levels also were measured periodically in 20 smaller diameter wells installed in the wetlands.

Rainfall in the area and stream gage in nearby Town Creek, which forms the southeastern border of the wetlands area, were also monitored. A recording rain gage was installed in the larger of the two wetlands areas, and a continuous stage recorder was installed in the creek.

An analysis of the rainfall, stage, and water-level data indicated that the two wetlands were inundated an average of 33 percent of the time and that the water table beneath the wetlands generally was within 18 inches of land surface even during periods when the wetlands were not inundated. The wetlands water levels rose rapidly in response to rainfall and declined slowly during periods of no rainfall.

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An Alternative for Improving Water Quality

by

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ABSTRACT

Dissolved oxygen (D.O.) in an aquatic system is an important indicator of the quality of the system. A stringent dissolved oxygen criterion for aquatic systems has been announced by U.S. EPA in order to prevent aquatic life impairment caused by oxygen depletion. An alternative to meet the D.O. criteria in a heavy municipal or industrial discharge area is the supplemental reaeration of secondarily treated effluent instead of advanced wastewater treatment upgrading if natural reaeration is insufficient, e.g. in pooled streams. The reaeration of secondarily treated effluent has been recognized as a cost effective choice while in-stream aeration may be limited by navigation or recreation. Weirs, mechanical surface aerators, bubble diffusers, downflow bubble contact aerators, U-Tube bubble contact units and pressurized gas transfer units are the types used in the reaeration process. Pure oxygen can be economically more desirable than air as an oxygen source and in addition opens some options not available when using air due to dissolved nitrogen supersaturation problems. However, the system for dissolving the oxygen must be selected and designed with care to ensure efficient absorption. The special application of a certain type will depend on the situation of a treatment plant, such as the flow rate, and the head and area availability, the features of the types of units, the amount of oxygen dissolved, and the hydraulic characteristics of the receiving stream. The discussion of applicability of each type of aeration unit will be presented in this paper.

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Initial Observations of Water Quality Monitoring in West Sandy Creek, Henry County, Tennessee

by

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ABSTRACT

Water quality in West Sandy Bay and Big Sandy Bay of Kentucky Lake Reservoir has become a concern in recent years. Fishermen and mussel divers have reported a decline in fin and mussel fisheries in these bays. Previous monitoring in West Sandy Bay has indicated that during the summer months water quality severely degrades, particularly in terms of low dissolved oxygen levels. West Sandy Creek at Elkhorn Road is the canal receiving runoff from the West Sandy watershed that drains northern Henry County including the city of Paris. The stream is separated from the bay by a dike which has a pumping station on it that regulates flow from the stream into the bay. Water is held back in the winter to flood the West Sandy Wildlife Area for migratory waterfowl and in the spring is pumped down to prevent drowning of timbers. In order to try and understand how the flow from West Sandy Creek might be adding to the problems in West Sandy Bay, macroinvertebrate sampling using Hester-Dendy artificial substrate samplers was begun in West Sandy Creek in 1989 and has continued. In the fall of 1991 physico-chemical and bacteriological sampling were added to the monitoring strategy for the creek. In addition to the Hester-Dendys, Ponar dredge and sweep bank samples were also added for sampling the macroinvertebrates. The data reviewed will be from the first three six week sampling periods of the sampling year September 1991 to September 1992. Initial observations suggest a degraded habitat and community in West Sandy Creek.

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Downdip Water Quality Analysis of the Fiery Gizzard Creek

by

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ABSTRACT

Plans to build an earthen dam and reservoir at the 14.6 mile point of Big Fiery Gizzard Creek made it imperative to obtain water quality data for the creek and the surrounding area prior to construction. Water quality of the Big Fiery Gizzard Creek was determined at every fifty foot drop in elevation. The concentrations of Fe, Mn, Zn, Al, and Cu as well as sulfates, Ph, hardness and total dissolved solids were measured. This data provides a baseline which may be used to determine possible effects of the proposed earthen dam and reservoir. While the focus of this work is on Big Fiery Gizzard Creek, waters flowing into the creek were also analyzed to localize the possible sources of contamination.

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The Use of Lemna Minor L. As an Assessor of Water Quality in the Big South Fork River, Cumberland Plateau, Tennessee-Kentucky

by

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ABSTRACT

The Big South Fork (BSF) of the Cumberland River is the premier feature of a National River and Recreation Area (BSFNRRA) now under the jurisdiction of the National Park Service (NPS). The region was extensively impacted by logging, surface and deep mining, oil extraction, localized agriculture, and industry. This project investigates the applicability of Lemna minor L. (duckweed) for a bioassay of water conditions (ATSM, 1992). This bioassay at the primary producer level can be used to identify sites where further analyses are desirable. Duckweed multiplies and spreads by fragmentation every two to four days, and changes in water quality are quickly manifested. Division and growth have been documented to be proportional to the concentration of toxins (Hillman and Cully, 1978). Nine collection sites were chosen: the New River Bridge, Burnt Mill Bridge, Leatherwood Ford, Station Camp (TN); Blue Heron Mine, Yamacraw Bridge, Alum Ford, (KY); Bandy Creek, (TN); Upper Bear Creek, (KY). These sites include the major tributaries, and also represent the conditions of the river from confluence to Lake Cumberland. Bandy Creek and Upper Bear Creek are low-order tributaries, selected because one drains an open strip mine site and the other drains a modern waste-treatment system. With the NPS (S. Bakaletz, NPS Abstract, 1992), six water collection trips were made: 5 June, 16 July, 11 October, and 18 December 1991; 25 March and 20 August 1992. Selected samples from the nearby, but discrete, Obed River were also tested in adjunct runs. Duckweed was repetitively grown in control stock solution adapted form Wang (1990), and in water samples collected at the BSF or Obed sites. End-point counts of frond numbers and weights were determined. Water quality in the river seems to be generally satisfactory for the production of duckweed. Preliminary results do indicate differences with regard to the mine drainage waters. Growth experiments have been concluded, and duckweed response quantifications are now being tested.

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Silent Invaders Stalk the Tennessee Valley

by

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ABSTRACT

The Tennessee Valley has some uninvited guests. This invader, Dreissena Polymorpha, better known as "Zebra Mussels", has been identified at several locations on the Tennessee and Cumberland Rivers within the past year. This invasion has the potential to disrupt the ecosystem by means of the food webs, biologically foul industrial and Municipal water intake facilities, and interfere with commercial and sport fishing, navigation and recreational boating throughout the Valley. The sad thing is, there may not be a method to prevent their spread in the Valley--they may be here to stay!

The zebra mussels have found their way here by way of the Great Lakes where it is thought a freighter from Europe discharged ballast water containing young zebra mussels called veligers. It is estimated that last year the damage caused by zebra mussels in the Great Lakes basin was at least 500 million dollars. Since the zebra mussels have been found in densities as great as 700,000 per square meter in Lake Erie, one can only imagine what their population growth will be in the Tennessee Valley. With longer spawning seasons due to longer, warmer seasons in the South, they may find Tennessee to be a very hospitable environment.

What can be done? U. S. Government Agencies must be responsible for:

- Coordination of scientific research on the zebra mussel,
- Monitoring the distribution, spread and abundance of zebra mussels,
- General education of the public on how to slow the spread and abundance of zebra mussels.

This will help control their spread and help us learn to live with this uninvited guest.

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Fate and Transport of Nitrate in the Saturated Soil (Adsorption and Desorption)

by

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ABSTRACT

Nitrate from the underground structures such as septic tank and underground storage tank can transport through the saturated soil and reached to the groundwater. It was important to know that how much nitrate remains in the contaminated source and associates with groundwater flow. An experiment was conducted to determine the affinity between nitrate and soil in the laboratory. The soil sample and water sample were collected from the field. Soil characteristics including bulk density, size distribution, and permeability coefficient showed that the soil can be classified as sandy clay. A batch study of adsorption and desorption were studied with low and high concentration of nitrate; 4.5 mg/l and 30 mg/l, respectively. The theoretical adsorption capacity of the nitrate for a particular contaminant can be determined by calculating its adsorption isotherm. The isotherm was developed based on laboratory results for adsorption and desorption. Two isotherms for low and high concentration were calculated. A general isotherm for nitrate in the saturated soil can be expressed as:

$$x/m = e\text{-}kCe$$

(1) Where x/m is the mass rate of nitrate adsorbed and soil, mg/g; Ce is the equilibrium concentration of nitrate, mg/l; and k is the experimental constant.

Based on the mass balance, very little diffusion and biodegradation in soil were found. The results showed that adsorption and desorption are the two major processes for nitrate transport in the soil. Also it was found that most of nitrate can transport through the soil and directly contaminate the groundwater, only a trivial nitrate can be adsorbed by the soil.

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Nitrate Removal by Injection of Bacillus into the Groundwater Supply

by

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ABSTRACT

An investigation was conducted to determine the feasibility of injecting bacteria, responsible for denitrification, into the groundwater supply to reduce nitrate and nitrite contaminants. In the laboratory Bacillus megaterium were grown and introduced into untreated groundwater with a high level of nitrates. The efficiency of these bacteria to convert the nitrate and nitrite to a gaseous form of nitrogen was determined, and compared to the expression proposed by Van Uden. Groundwater from the Memphis aquifer has little to no organic material, and an equally low concentration of nitrates. The samples taken from the groundwater supply were spiked with Sodium nitrate to simulate contaminated groundwater. Bacillus megaterium in concentrations ranging from 5.1 X 104 to 1.25 X 107 bacteria per milliliter of sample were added to groundwater containing nitrate concentrations from 36 to 5 mg/l. The samples were then tested at regular intervals for concentrations of nitrates. The consumption rates of these bacteria were found. Overall reduction of nitrates ranged from 30 to 42%. The bacteria were grown in nutrient broth and incubated over a period of 24 hours.

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Groundwater Monitoring Network Design Using Minimum Well Density

by

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ABSTRACT

Limited resources for groundwater quality monitoring projects demand definition of groundwater contaminant plumes with a minimum number of sampling wells. The relationship between loss of information (or plume definition error) and degree of reduction in the number of sampling wells has been investigated by the authors. A proprietary sampling design product (E4) was used to select variably sized subsets of sampling wells from two existing natural gradient tracer tests. The tracer plume defined by data from each subset of wells was compared to the plume defined by data from the full set of wells. Differences between each subset plume and its corresponding full set plume were quantified and used to generate an error versus sampling density and time since tracer introduction function. Combined analysis of three sampling events from one tracer test and two from another revealed that the number of wells used for four of the events could have been reduced with minimal loss in contaminant plume definition. This suggests that E4 may be applied in the design of groundwater monitoring well networks.

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Comparison of Slug Test Methods for Estimating Hydraulic Conductivity in Unconfined Aquifers

by

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ABSTRACT

One field technique utilized in estimating hydraulic conductivity in aquifers is the slug test. Slug tests are performed on individual wells by suddenly adding (or withdrawing) a "slug" of water and then measuring the rate of fall (or rise) with respect to time as the water level returns to equilibrium. One distinct advantage of the slugtest is that it imparts minimal perturbation to a subject hydrogeologic unit which can be a consideration in contaminant transport evaluations. In this case, slug tests were conducted by the additive method and data were collected for analysis from 4 wells at a site located at the University of Tennessee Agricultural Experiment Station, Ames Plantation, Grand Junction, Tennessee.

Methods of estimating hydraulic conductivity of Bouwer and Rice; Cooper, Bredehoeft, and Papadopulos; Nguyen and Pinder; and Hvorslev were applied to the slug test data. The methodology and assumptions of each technique are summarized and the resulting hydraulic conductivities compared. A discussion of the results addresses possible reasons for variations and agreement among the methods as they apply to the hydrogeologic unit under study. Strengths and weaknesses with respect to applicability and usability are summarized.

The estimation of hydraulic conductivity based on well slug tests is best determined by using more than one evaluation method and comparing the results. It is likely that anomalies will be more apparent as a consequence of analyzing the data in the different formats required by the subject methodologies.

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