# Midwest Technology Assistance Center for Small Public Water Systems

**USEPA Grant# X829218-01**

## 2004 Annual Progress Report
**(January 1- December 31, 2004)**

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# for
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### (January 1- December 31, 2004)

The Midwest Technology Assistance Center (MTAC) was established October 1, 1998 to provide assistance to small public water systems throughout the Midwest via funding from the United States Environmental Protection Agency (USEPA) under section 1420(f) of the 1996 amendments to the Safe Drinking Water Act. This report summarizes progress made for the third quarter of 2004.

MTAC is a cooperative effort of the ten states of the Midwest (congruent with USEPA regions 5 and 7), led by the Illinois State Water Survey and the University of Illinois. The Director of their Water Resources Institute coordinates the participation of each state in MTAC. Richard Warner, John Braden and Kent Smothers were the Principal Investigators for this project. Kent Smothers serves as the Managing Director of the Center, and is responsible for conducting routine activities with the advice and council of Dr. Richard Warner and Dr. John Braden.

# FY01 Projects

## Competitive Grants

MTAC funded four competitive grants from the FY01 fiscal cycle. All of these proposals underwent an external review, and were approved as suitable topics by the USEPA. These projects were completed and reported upon in a previous annual report. Copies of these reports can be found on the MTAC web site at http://mtac.sws.uiuc.edu/finalrep.asp.

# Outreach Activities

MTAC funded a number of Outreach Activities in FY01. All but one of these were completed and reported upon in the last annual report. One project is still in progress due to a prolonged illness by the Principal Investigator. This project should be completed early this summer. This project is discussed below.

### *Development of a Workshop to Introduce Small Drinking Water Systems Managers to Financial Benchmarking*

Tom Bik, Dr. Ben Dziegelewski
Southern Illinois University, Carbondale

**Tasks 1 & 3**

All of the workshop materials have been completed and reviewed by training staff from the Environmental Resources Training Center and Illinois Department of Commerce and Economic Opportunity, as well as members of the Illinois American Water Works Association Educational Committee. Substantial revisions have been made based upon these reviews. Portions of the workbook have been shared with USEPA and Rural Community Assistance Program staff members in response to inquiries from these organizations related to other training activities.

**Tasks 2**

A Workshop was scheduled for the Illinois Southern and Southwestern Operators Associations Small System Conference at Giant City Park on October 22, 2005. Unfortunately, the workshop had to be cancelled due to illness and schedule conflicts of the presenters.

Two workshops have been scheduled in conjunction with events sponsored by the Illinois American Water Works Association (IAWWA). Benchmarking Workshops will be held on July 21st in Joliet and August 18th in Rockford. Both will be four hour afternoon sessions. The IAWWA has obtained approval for participants to receive contact hours for attending the workshop. Participants will pay a small fee to cover site expenses. IAWWA is also considering hosting a Benchmarking Workshop in conjunction with their "visitation" day events later this Spring (Mattoon and Moline).

Repeated contacts continue to be made with other potential host organizations. The times and locations of future workshops will be sent to MTAC as they are confirmed.

**Tasks 4, 5, & 6**

Outputs from these tasks will be prepared as submitted to MTAC as they are completed.

# FY02 Projects

## Competitive Grants & Applied Research

### *Competitive Grants:*

MTAC issued a Request for Proposals (RFP) in August 2002. MTAC received a total of nine proposals from several different states. These proposals underwent a rigorous peer review process, with each proposal having a minimum of three reviewers. The highest rated proposals were selected. We have listed the title, institution, and principal investigators for the proposals that were selected for funding below. Three of these projects are completed, and we have received the final reports or deliverables. We have received the final report for the fourth project, but are withholding release pending submission of patent paperwork.

***Development of Sulfur-Limestone Autotrophic Denitrification Processes for Treatment of Nitrate-Contaminated Groundwater in Small Communities***
Dr. Tian C. Zhang
University of Nebraska-Lincoln at Omaha

This project has been completed, and the final report was submitted. It has been posted on the web (http://mtac.sws.uiuc.edu/mtacdocs/finalreports/DenitrificationMTACFinalReport.pdf) and is available in limited quantities as a hard copy, or on CD upon request. We submitted a copy of this report with an earlier quarterly report.

***Interactive Guides to Creating Source Water Protection Plans for Region V Public Water Supplies***
Kevin Kundert
Montana State University

This project has been completed. The Indiana SWP program was completed in cooperation with the Indiana Department of Environmental Management utilizing a "Best Management Practices" approach they requested. This can viewed online at http://tacnet.info/swp/in/. The Ohio SWP Guide is complete and can be viewed online at http://tacnet.info/swp/oh/.

***The Effects of Different Modes of Coagulation as Pretreatment to Membrane Filtration for Drinking Water Production in Small Systems***
Dr. Isabel C. Escobar
University of Toledo

This project has been completed, and the final report was submitted. It has been posted on the web (http://mtac.sws.uiuc.edu/mtacdocs/finalreports/CoagulationMTACFinalReport.pdf) and is available in limited quantities as a hard copy, or on CD upon request. We submitted a copy of this report with an earlier quarterly report.

## *Development of Low-Cost Treatment Options for Arsenic Removal in Water Treatment Facilities*

Gary R. Peyton and Dr. Thomas R. Holm
Illinois State Water Survey

### Introduction

The goal of this project was to develop a simple inexpensive treatment process for arsenic removal from ground water by using Fenton chemistry ($Fe^{2+} + H_2O_2$) to oxidize As(III) to As(V), followed by sorption of the arsenic onto the resulting $Fe(OH)_3$ precipitate and removed by filtration. Results from previous laboratory flow experiments were in reasonable agreement with batch experiment results and showed that As(III) could be oxidized to arsenic (V) using low doses (20 μM = 0.7 mg/L) of hydrogen peroxide, and that most of the dissolved arsenic was removed when more iron (10-30 mg/L) was added to the water. Based on these results, design and assembly of the pilot-scale flow system was begun, as described in the previous quarterly report.

### Results Obtained this Quarter

Data collection and data analysis for the final report were completed, and the final report was written and submitted to MTAC. A plot of pilot data for experiments performed at a hydrogen peroxide dose of 27 μM showed a dramatic quasi-linear drop in the arsenic concentration in the final effluent versus iron added at very low iron doses, turning into an exponential-looking curve at higher iron doses. Total arsenic was removed down to 6 μg/L using a 6 mg/L dose of Fe(III). Chemical costs calculated for these doses were about $0.06/kgal for the iron and $0.007/kgal for hydrogen peroxide. The results of more detailed data analysis were consistent with the generally-accepted mechanism in which oxidation of arsenic makes it more readily sorbed and addition of iron provides more sorption sites. Results also show the same trend as predicted by sorption modeling, and are in reasonable quantitative agreement.

### Plans for Next Quarter

A) The pilot plant has been left at Danvers for the time being, in case further data analysis indicates that additional data collection is necessary.
B) Outlining of a manuscript for a peer-reviewed paper has begun. This manuscript will be written primarily by John Shim, in order to fulfill the thesis requirement for a Master's Degree in Environmental Engineering at the University of Illinois.
C) An abstract has been accepted for presentation of the results at the 2005 Ground Water Summit held this April in San Antonio by the National Ground Water Association.

D) Additional laboratory experiments are being designed to better clarify the effects of various ground water solutes on the sorption of arsenic during the treatment process, in order to improve the modeling of the process.
E) Experiments are also being designed to determine the speed of the initiation process (iron reacting with peroxide), to better characterize the reactor requirements for the peroxide addition step. This should allow more flexibility in the application of the process in existing plants by more firmly establishing how quickly the initiation step is completed, and therefore at which points in the treatment train peroxide can be effectively added. For example, it was demonstrated in this project that peroxide addition directly to the aerator (essentially a stirred-tank reactor) was not effective. This appears to rule out the use of the chemical addition lines which enter directly after the aerator in the Danvers plant. Such studies could tell us whether the peroxide can be added just before the aerator, or if it must be added at the well head to allow more time for reaction.

**Next Quarter:** Final report has been submitted, but we are delaying posting on the web pending submission of patent paperwork. We will forward a copy of the report at that time.

## *Applied Research:*

### *Applied Research: Countywide Projections of Community Water Supply Needs in the Midwest*

Tom Bik, Dr. Ben Dziegelewski
Southern Illinois University, Carbondale

The completed report has been received and was submitted with the MTAC 2003 Annual Report. It has been posted on the MTAC web site (http://mtac.sws.uiuc.edu/mtacdocs/finalreports/FinalReportMidwestCWSProjections.pdf), and is available in limited quantities as a hard copy or as on a CD upon request. This report will help identify the information systems need to collect for long-term planning, and assist them in developing plans to accommodate future needs identified.

### *Applied Research: Control of Microbial Contaminants and Biological Agents in Small Systems*

Benito Marinas
University of Illinois, Urbana

This project has been completed. Conclusions reached by this work are discussed below. The final report (http://mtac.sws.uiuc.edu/mtacdocs/finalreports/2003_ThesisMainSporesFinalReport.pdf) is posted on the MTAC web site.

**Conclusions:**

The primary inactivation of *B. subtilis* spores by free chlorine was characterized by a lag phase in which no significant inactivation occurs followed by a pseudo first-order inactivation phase. Both of these phases were highly dependent on pH and temperature. Free chlorine disinfection efficacy improved as temperature increased and as pH decreased. The primary inactivation kinetics of *B. subtilis* spores by UV light was first-order and was independent of pH and ionic strength. In addition, the application of UV light prior to free chlorine did not change the free chlorine disinfection kinetics, indicating that the model developed for primary disinfection with free chlorine could still provide accurate predictions after UV pretreatment. The cumulative inactivation achieved by the UV/free chlorine sequential disinfection process revealed that multi-barrier protection against spores can be achieved with high enough *CT* values in the lower pH and higher temperature ranges.

Small utilities concerned about bioterrorism issues would benefit considerably by upgrading to a UV/free chlorine sequential disinfection system. Applying a UV dose of 40 $mJ/cm^2$ upstream of free chlorine addition would provide significant protection against spores that would not be achieved by primary disinfection with free chlorine under traditional operating conditions. For utilities seeking multi-barrier protection against spores, the options are to increase free chlorine contact time significantly and/or to control pH such that free chlorine disinfection is optimized. Multi-barrier protection becomes increasingly more costly as pH increases.

In addition, the strain of *B. subtilis* used in this study (ATCC 6051) was significantly more resistant to free chlorine disinfection than the strain used by previous researchers (ATCC 6633). It was also less resistant to UV disinfection. Since different *B. anthracis* strains may exhibit similar variability, different *B. subtilis* strains should be used in UV and free-chlorine disinfection studies in order to challenge each technology with the most resistant strain. In addition, these observations of variability may have interesting implications for mechanistic studies of the inactivation of *B. subtilis* spores with UV light and free chlorine. Genetic and structural differences between the strains ATCC 6051 and 6633 may be directly associated with both UV and free chlorine resistance.

### *Applied Research: Cylindrospermosis raciborskii*

ERTC, Biology Department
Southern Illinois University, Edwardsville

This project has been completed, and the final report was submitted. It has been posted on the web (http://mtac.sws.uiuc.edu/mtacdocs/finalreports/2003_MTACAlgaeFinalReport.pdf) and is available in limited quantities as a hard copy, or on CD upon request. We submitted a copy of this work in a previous report.

## Outreach Activities

***Vulnerability Assessment of Water Utilities for Small Communities***
Robert Whitworth
Director, ERTC-SIUE

ERTC developed a workshop using VSAT software to assist small public water systems in evaluation of their water plant security systems. ERTC conducted six, 7.5-hour workshops. This project is completed and was commented on in more detail in the first quarterly report this year.

***Distance Learning Special Topics Workshops***
Robert Whitworth
Director, ERTC-SIUE

ERTC presented two small water system workshops. Each of these workshops was offered three times, at different community colleges or universities simultaneously, via distance learning technology equipment. This project is completed and was commented on in more detail in the first quarterly report this year.

***Disinfection Profiling Workshops***
Robert Whitworth
Director, ERTC-SIUE

The Environmental Resources Training Center held three workshops entitled Disinfection Profiling. This project is completed and was commented on in more detail in the first quarterly report this year.

# FY03 Projects

## Competitive Grants

MTAC issued a Request for Proposals (RFP) in July 2003. The complete RFP is available at the following address: http://mtac.sws.uiuc.edu/rfp2003.asp. MTAC received a total of eleven proposals from several different states. These proposals underwent a rigorous peer review process, with each proposal having a minimum of three reviewers. The highest rated proposals were selected based upon the recommendations of an additional review panel. The quarterly project updates submitted by the Principal Investigators are included for each of the projects below.

***System Development Charge Development Project***
C. Gary Carroll, William Jarocki
Northwest Environmental Finance Center
Boise State University

## Introduction

The Environmental Finance Center at Boise State University (EFC) is developing a computer software tool that can be used by a small water system's in-house staff to develop accurate and justifiable system development charges. The work is being performed under a grant awarded by the University of Illinois through the Midwest Technology Assistance Center for Small Public Water Systems (MTAC). The project schedule is from March 1, 2004 through February 28, 2005 as established in the grant contract.

This progress report is the second quarterly progress report submitted to MTAC. This report summarizes work to date on the System Development Charge Development Project.

## System Development Charge Software Model

The design of the System Development Charge (SDC) software model is in progress. The logic for the model to follow has been determined and the programmer is using this logic to lay out the Excel spreadsheets and determine the programming needs to calculate the SDC for both the Growth-related Cost Method and the Equity Method. The model will utilize the infrastructure "accounts" that the EFC developed for the CAPFinance software (capital asset inventory and financial planning software) to list assets and capital improvements. (The accounts are for different types of water system assets such as pumping equipment, supply wells, supply mains, reservoirs, etc.)

## Training Workshops

The outline for the Training workshop and the Train-the Trainer workshop is also presently being developed. The workshop outline is based on the successful workshops the EFC has conducted on water rate setting and financial planning for capital asset renewal and replacement.

The Principal Investigators have requested a no-cost extension through may 31, 2005.

## *Simultaneous Removal of Viruses and Arsenic from Ground Water by Granular Media Coated with Nanoporous Aluminum Oxide*

Gregory W. Harrington, Marc A. Anderson
University of Wisconsin-Madison

Experiment 1 was carried out with fixed beds of granular media operated under continuous-flow conditions at a pilot plant located on the University of Wisconsin campus. The plant was configured in the manner shown in Figure 1. Madison city tap water was spiked with $10^5$ of bacteriophage MS2 and 50 g/L of arsenate.

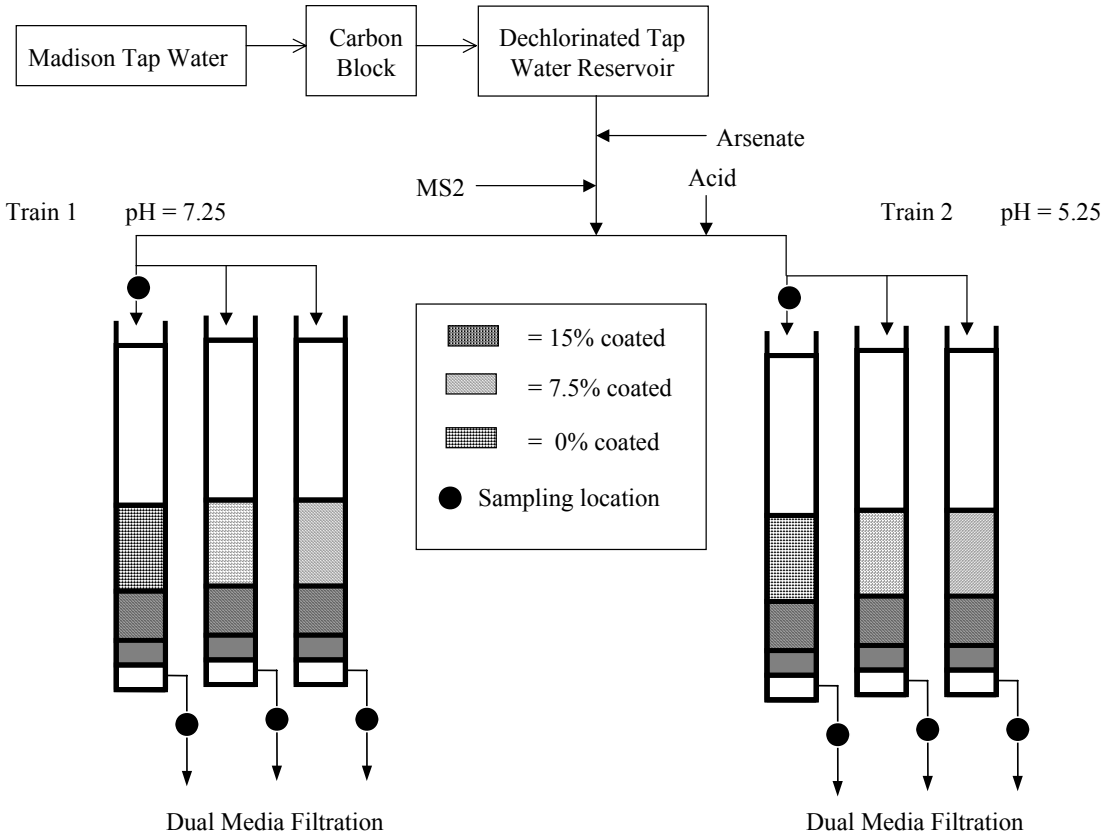



Figure 1. Schematic of pilot-scale experiment.

The experiment was conducted at pH 5.3 in train 1 and pH 7.3 at train 2. A constant filtration rate of 4 gpm/ft$^2$ and an empty bed contact time of 5 minutes were maintained. Interpretation of results is not yet completed. Figures 2 and 3 show the effect of the nanoparticles aluminum oxide coating on arsenate and MS2 removal. At pH 7.3, with a 36 hour filter run time, the average log removal of MS2 was 1.2 for uncoated GAC, 1.4 for 7.5% coated GAC, and 1.9 for 15% coated GAC. The average arsenate concentration in the filter effluent was 64 g/L for uncoated GAC, 49 g/L for 7.5% coated GAC, and 26 g/L for 15% coated GAC.

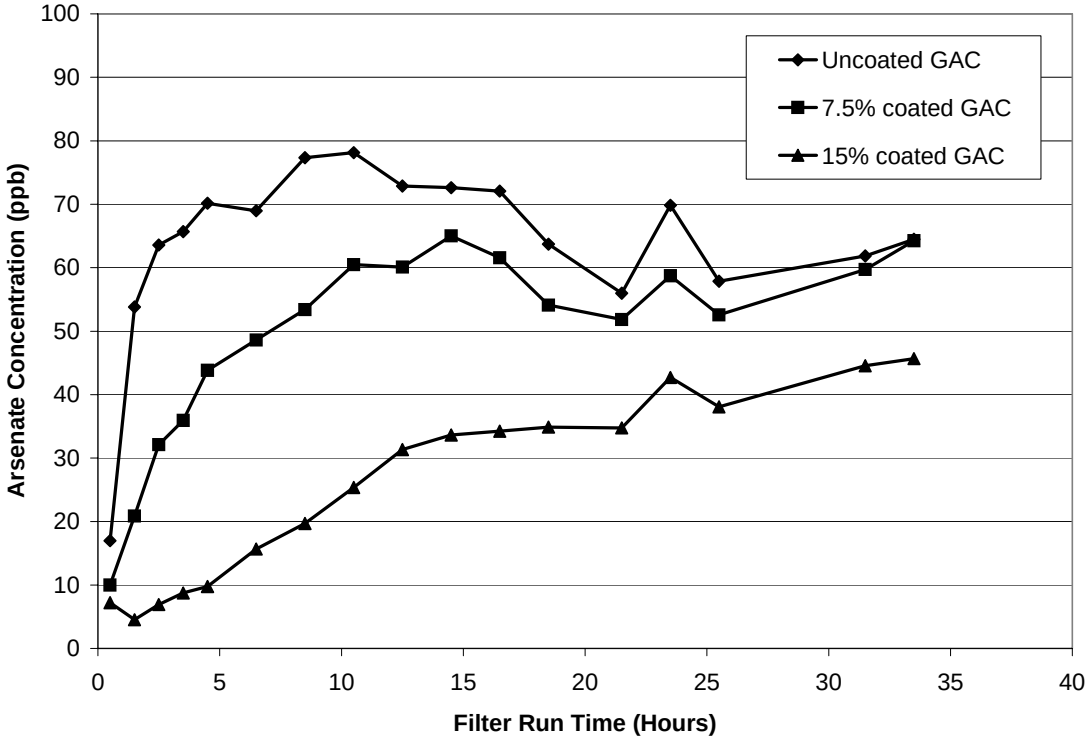



Figure 2. Removal of arsenate using uncoated and coated GAC.

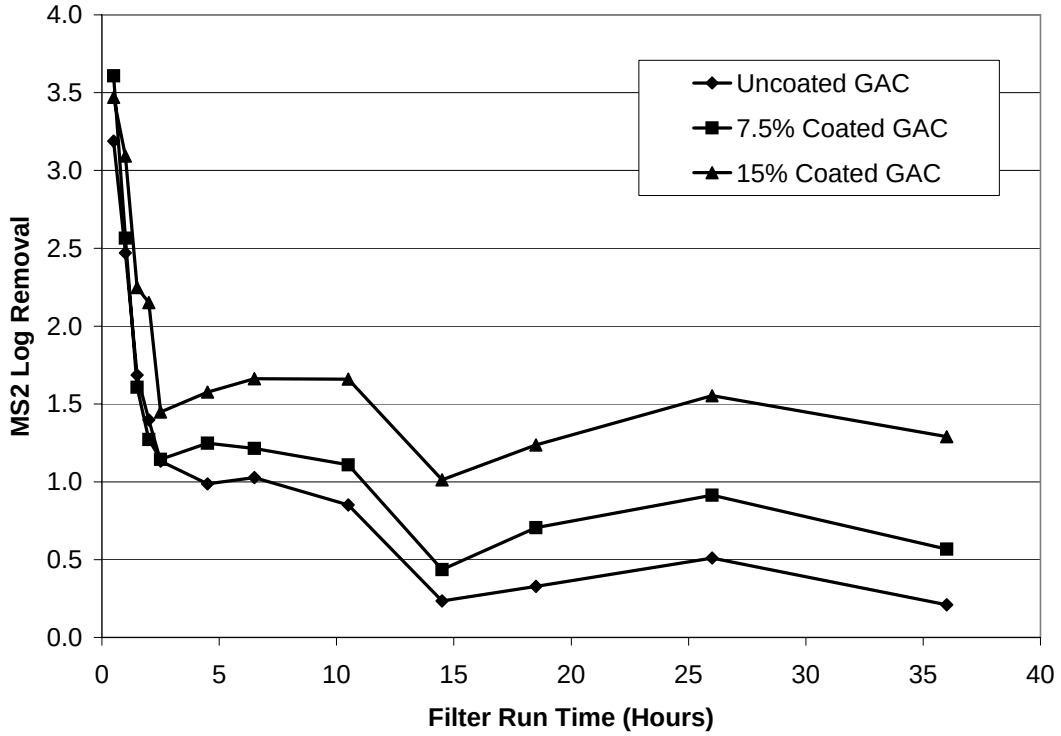



Figure 3. Removal of MS2 using uncoated and coated GAC.

BET surface area analysis and surface charge analysis (Task 2), anthracite is the filter media for Experiment 2. As mentioned in the first quarter progress report, the coating increased the isoelectric pH of anthracite from pH 4.0 to pH 6.9. The nanoporous aluminum oxide coating produced a surface area of 21 $m^2$/g on the anthracite. This is larger than surface areas of about 1.5 $m^2$/g previously reported for anthracite (Collins *et al*., 1996).

Media preparation for Experiment 2 (Task 5): a sufficient quantity of alumina sol was prepared and coated onto the anthracite for Experiment 2.

Experiment 2 (Task 6), uncoated and coated granular activated carbon (GAC) previously used in the eight fixed-bed columns were replaced with new uncoated and coated anthracite. Other materials and supplies are also ready for the experiment to be conducted.

**Next Quarter**

Ongoing characterization of surface charge and surface area. (Task 2)
Experiment 2 will be conducted. (Task 6)
Final report will be prepared. (Task 8)

### *Watershed Modeling to Evaluate Water Quality at Intakes of Small Drinking Water Systems*

Deva K. Borah, Edward C. Krug
Illinois State Water Survey

Work on the project began in March 2004. Progress before this period included: selection of the study watershed (Little Wabash River watershed in Southern Illinois), review of literature on watershed background conditions and hydrologic characteristics and information, selection of watershed modeling tools for long-term continuous and storm event simulations of hydrology and water quality, preliminary calibration of the long-term hydrologic model simulating monthly distributed flows for the period 2000-2002 in the Little Wabash River watershed, simulations of monthly water quality parameters for this period, simulations of storm event flows for an intense storm period in the summer of 2000, and a field trip to the Wayne City water treatment facility and reaches of the Skillet Fork and the Little Wabash River. These were presented at the ASAE International Annual Meeting, August 1-4, 2004, Ottawa, Canada and at the Illinois Water 2004 Conference, October 13-14, 2004, Urbana, IL.

Progress during this period (October-December 2004) includes validation of the continuous model for the period 1995-1999 using USGS daily flow data available at their web site and IEPA instantaneous water quality data available in IEPA (2003) report. Simulated and observed daily and monthly flow hydrographs were compared. Correlation graphs were prepared. Correlation coefficients were found to be much higher than the calibration (2000-2002) period. For water quality simulation, we started with comparing simulated and observed total phosphorous concentrations. Comparison of sediment results with observations are in progress.

We held a meeting with USGS Illinois Water Science Center staff to discuss collaborations and acquire all their monitoring data in the Little Wabash River watershed, including 15-minute flow data at the four active gages: Effingham, Clay City, Wayne City, and Carmi for calibration and validation of the storm event modeling component. Using these data, calibration and validation of the storm event component are in progress.

We are conducting detailed investigations of our study watershed using MODIS Satellite Images, which are helpful in locating major hydraulic structures and their current conditions and functions, as well as land use patterns. We are also developing detailed maps of the seven small public water supply facilities (Neoga, Altamont, Olney, Flora, Clay City, Wayne City, and Fairfield) using DOQ maps and Public Water Supply Intakes data from the IEPA and ISWS. These maps will be useful to locate the active intakes and measuring dimensions of the hydraulic structures and the river reaches.

### *Understanding and Minimizing Impacts of Agricultural Pesticides on Small Water Systems Using Surface Water*

Jane Frankenberger
Purdue University

Work to date has focused on the first objective, helping small water systems that use surface water, their customers, state agencies, and the public become more aware of and better understand the level of atrazine in their source water. We have successfully acquired, organized, and graphed atrazine concentration data from four different sources. The sources include (1) compliance data required for the Safe Drinking Water Act, (2) monitoring from the Acetochlor Registration Partnership, an assessment program in the late 1990s that monitored both raw and finished water at a number of systems, (3) monitoring carried out by Syngenta as part of the atrazine reregistration agreement, and (4) monitoring carried out by individual systems.

This task has almost been completed. The most difficult part has been acquiring and organizing the disparate data sources. Work is being carried out primarily by Bertin Mbongo, a PhD student in the Department of Agricultural and Biological Engineering. We are cooperating closely with the Office of the Indiana State Chemist (the pesticide regulatory agency in Indiana) on this task.

## Outreach Activities

### *Vulnerability Self Assessment Tool (VSAT) Software Assistance*

Harlan H. Bengtson
Director, ERTC-SIUE

ERTC personnel provided assistance in use of the VSAT software and preparation and submission of vulnerability self-assessment reports to numerous communities who attended VSAT workshops. This was done at no additional charge to the communities.

### *Rate Maker Workshop*

Harlan H. Bengtson
Director, ERTC-SIUE

The workshops to introduce and facilitate the use of the Show-me Ratemaker software will take place in Spring 2005. Training will take place in three classroom style workshops and one computer lab workshop. The three classroom workshops will be located in the northern, central and southern parts of the state of Illinois with the computer lab workshop offered last at the central location. Carl Brown, of Missouri DNR's Outreach and Assistance Center and the primary developer of the software, will provide the training assisted by ERTC staff. The workshops will be advertised to mayors, city clerks, public works directors, etc. in addition to treatment plant superintendents. Two of ERTC's staff have been trained on the software and will be able to provide follow up assistance.

### *Informational Technology/Security Workshops*

Harlan H. Bengtson
Director, ERTC-SIUE

This workshop is being developed and will be taught by Dr. Bradley Noble of the Electrical and Computer Engineering Department of Southern Illinois University Edwardsville. It was scheduled to be taught on October 22, 2004, but due to very low registration, it was canceled and will be offered in spring 2005. This workshop was publicized through a mailing that also publicized the Water Short School.

### *Water Operator Short Course*

Harlan H. Bengtson
Director, ERTC-SIUE

The water short school materials were developed, and it was held October 11 – 15, at the Environmental Resources Training Center at Edwardsville, Illinois. There were 15 students enrolled in the course. Of those 15 students, 13 took a certification exam at the end and 10 of them passed. The course description is as follows:

This is an intensive training session to develop skills specific to prepare an operator to take the Class A, B, C, or D Illinois water certification exam. Process control and operation for specific level plants will be covered in breakout sessions. All aspects of plant operations, process control tests and their interpretations, process control math, records and rules will be covered. On Friday afternoon, the IEPA water certification exam was given to eligible students.

| | |
|---|---|
| Class A | Stresses lime-soda softening, taste and odor control, clarification, rules and regulations and associated math |
| Class B | Stresses filtration, ion exchange, laboratory procedures, oxidation and associated math |
| Class C | Stresses groundwater treatment, iron and manganese control, lab |

procedures, and chemical feed and associated math

Class D — Stresses distribution systems, sampling and operating reports, disinfection and associated math

***Emergency Response Planning Guide Workbook***

Laurie Dougherty
Illinois Sections AWWA

This product was completed and submitted to MTAC, and will be distributed locally to help familiarize systems and operators with the concepts involved in preparing Emergency Response Plans.

***Condensed Fact Sheet for Small Systems***

Kent Smothers, Steve Wilson
MTAC, Illinois State Water Survey

At the request of USEPA Region 5 staff, MTAC will develop a total of four one-page fact sheets targeted specifically toward rule interpretation and implementation for small systems. These fact sheets will follow the same basic format as the existing USEPA fact sheets, but will address only the requirements for small systems. They will also be posted on the MTAC Web Site, and a link will be added to the TACNET.

# FY04 Projects

## Competitive Grants

MTAC issued a Request for Proposals (RFP) in May 2004. The complete RFP is available at the following address: http://mtac.sws.uiuc.edu/rfp2004.asp. MTAC received a total of five proposals from several different states. These proposals underwent a rigorous peer review process, with each proposal having a minimum of three reviewers. The three highest rated proposals were selected based upon the recommendations of an additional review panel. The other two proposals were not deemed to merit funding by MTAC. Our original intent was to fund up to four proposals, so we will need to formulate a plan to redirect this money from our budget. Funding has being processed for these grants, and work should have begun. The title, principal investigators and alternative QAPs for these projects and our internal research efforts are included with this report. We propose directing the funding originally intended for the fourth competitive grant to an internal research project by Dr. Michael Plewa of the University of Illinois. We have included a brief write-up of this project in this section under Internal Applied Research Projects. We will forward a more detailed scope of work with a timeline and an alternative QAP by March 15th.

### *Watershed Modeling to Evaluate Water Quality at Intakes of Small Drinking Water Systems - II.*

Deva K. Borah, Edward C. Krug and Xin-Zhong Liang
Illinois State Water Survey

Description: Requesting support to further develop the modeling tool that was developed from MTAC funding last year.

### *Using Technical, Managerial, and Financial Capacity Measures in an Assistance-Oriented Approach to Comparative Performance Assessment of Small Drinking Water Utilities.*

R. Lawton, A. Desai, J. Wilhellm, & M. Stanford
Ohio State University
National Regulatory Research Institute

Description: Develop and provide comparative performance measures that improve the technical, managerial and financial capacity of small public and private drinking water utilities in Ohio, Indiana, Illinois, Missouri, Kansas, Nebraska, Iowa, and Wisconsin.

### *Demonstration of Low-Cost Arsenic Removal from a Variety of Illinois Drinking Water Sources*

Gary R. Peyton and Thomas R. Holm
Illinois State Water Survey

Description: Extend treatment capability to other source waters, and to determine the effects of water composition on treatment efficiency, in order to develop predictive models and design guidelines.

## Internal Applied Research Projects

### Arsenic Study Area (Topics 1-3)

The following projects are part of a focused effort by MTAC to thoroughly address the subject of arsenic in drinking water. These projects seek to control the concentration of arsenic in drinking water not only through optimizing removal in the water treatment plant, but also by gaining a better understanding of the geochemical processes that control the release of arsenic into the groundwater supply. A better understanding of the processes involved may allow us to recommend practices that will reduce the rate of release of arsenic before it is pumped from the aquifer.

### *Topic 1: Chemical Addition for Arsenic Removal*

Thomas R. Holm
Illinois State Water Survey

**Project Description:** The results of our recently completed MTAC research indicate that the iron to arsenic molar ratio (Fe:As) is a critical parameter in arsenic removal at water treatment plants designed to remove Fe. In ~90% of facilities with Fe:As > 100, the As concentration in finished water was 10 mg/L. On the other hand, in ~90% of the facilities with Fe:As < 100, the As concentration in finished water was >10 mg/L. We performed an experiment using finished water from the Danvers IL facility. The raw water had 27 mg/L As. Adding 0.9 mg/L Fe and filtering reduced the As concentration to 11 mg/L and higher Fe additions reduced the As concentration well below the MCL. These results suggest that adding Fe to raw water may improve As removal. A recently published paper (L. C. Roberts et al. *Environ. Sci. Technol*. 38(1), 307-315, 2004) supports this hypothesis.

The chemical form of As may affect its removal in water treatment plants. The predominant form of As in most Illinois groundwater is As(III). However, the As(V) form may be removed more efficiently than the As(III) form under some conditions. For example, we performed an experiment using raw groundwater from the Danvers facility (~40 mg/L As). Adding 1.6, 3.2, and 4.8 mg/L $KMnO_4$ and filtering resulted in As concentrations of 32, 21, and 18 mg/L. The Danvers plant typically has 25-30 mg/L As in its treated water. Clearly, $KMnO_4$ addition improves As removal.

We propose to conduct experiments using untreated water from facilities that currently do not meet the As MCL. The treatments will include $KMnO_4$, $FeCl_3$, and combinations of $KMnO_4$ and $FeCl_3$. The $FeCl_3$-only treatment will involve aeration, while in the $KMnO_4$-only and $KMnO_4$/$FeCl_3$ treatments there will be no aeration. Samples from all treatments will be analyzed for dissolved As. Selected samples will also be analyzed for As(III). The first round of experiments will be performed in the laboratory. The results of the first experiments will be used to design further in-plant experiments at selected facilities. Untreated and treated water samples will be collected from each plant for As determination. The data will be compared with the results from the first MTAC project.

**Deliverables:** Quarterly progress reports will be provided to MTAC. A final report summarizing the results of the project will be submitted to MTAC, including recommendations for optimizing iron and permanganate dosages rates. A two page fact sheet that summarizes the results, conclusions, and recommendations of the project shall be produced.

**Outcomes:** This project will provide small community water systems with guidance as to the rates of iron and permanganate addition for optimal arsenic removal and may provide a cost effective method for facilities to meet the new MCL for arsenic.

### *Topic 2: Microcosm Experiments for Arsenic Solubility Determination*

Walt Kelly, Illinois State Water Survey
Rob Sanford, University of Illinois

**Project Description:** The recent extensive arsenic sampling in various parts of Illinois has indicated that geochemical conditions, specifically redox conditions and the availability of organic matter, exert a strong control on arsenic concentrations in groundwater. The processes

controlling arsenic solubility are complex and variable. Most aquifers, especially unconsolidated deposits in Illinois, have abundant iron oxyhydroxide minerals. Arsenic is likely associated with these iron oxyhydroxides, and the reduction of these minerals is hypothesized to be the source of arsenic in most Illinois' groundwaters. Sulfate reduction, which theoretically occurs at redox potentials lower than for iron reduction but has been commonly observed to occur in conjunction with iron reduction, is hypothesized to limit arsenic solubility by precipitation of sulfide phases. Groundwater samples with relatively high sulfate concentrations have been observed to have low arsenic concentrations, presumably due to active sulfate reduction. Elevated arsenic concentrations tend to be found in samples in which sulfate is not detected. This suggests that sulfate reduction is not active and sulfide minerals are not being precipitated and removing arsenic from solution.

We propose, in conjunction with researchers at the University of Illinois Department of Geology, to prepare a series of microcosms using native aquifer material and groundwater, to investigate some of these redox sensitive processes that may be affecting arsenic solubility. We will contact an independent well driller in Tazewell County, the area with the greatest likelihood of elevated arsenic in Illinois, and collect aquifer material during drilling of a well. Groundwater will be collected from a well with elevated arsenic in Tazewell County. Samples will be isolated from the atmosphere during collection and storage to prevent oxygen contamination. Aquifer material and groundwater will be added to glass serum bottles. The water will be amended with different concentrations of sulfate, organic carbon, and other compounds to stimulate different conditions (i.e., iron reduction, sulfate reduction, methanogenesis). Bottles will be sealed and sacrificed at different times; solutions will be analyzed for arsenic, iron, sulfate, methane, hydrogen, and various bacterial assays.

The relation between arsenic concentrations and redox conditions, whether iron reducing, sulfate reducing, or even more reducing (methanogenic), is poorly understood. Sulfate appears to be a key constituent in controlling arsenic solubility. One in situ remediation technique we hope to pursue in the future is injection of water spiked with a sulfate salt into an aquifer with elevated arsenic. Before such field experiments are attempted, however, much more information about reaction processes and rates is required. This project will allow us to evaluate the feasibility of field testing a sulfate injection program (amounts needed, rates of reaction, processes involved).

**Deliverables:** Quarterly progress reports will be provided to MTAC. A final report summarizing the results of the project will be submitted to MTAC, including recommendations for optimizing iron and permanganate dosages rates. A two page fact sheet that summarizes the results, conclusions, and recommendations of the project shall be produced.

**Outcomes:** This project will allow us to evaluate the feasibility of field testing a sulfate injection program (amounts needed, rates of reaction, processes involved). Should this project prove successful, it could provide a viable alternate to in plant treatment for arsenic removal for small systems.

### *Topic 3: Time Series Sampling and Resampling Facilities with High Particulate Arsenic to Evaluate the Variability of Arsenic Concentration in Small Community Water Supplies*

Steve Wilson
Illinois State Water Survey

**Project Description:** As part of an experiment at the Danvers water treatment plant, we collected four raw water samples over a three-hour period. The first three samples had ~40 mg/L arsenic but the fourth one had 30 mg/L. In this case all samples were above the MCL, but for other facilities a fluctuation of 10 mg/L could be the difference between compliance and non-compliance. Clearly, it is important to characterize the stability in influent arsenic concentrations to properly design a treatment system for arsenic removal and to monitor its operation.

In a recently completed MTAC project, samples of treated water were collected from 34 water utilities that had a history of arsenic above the new MCL. For each facility the sampling crew collected a sample of the water as the consumer would receive it (unfiltered sample) and they also collected another sample which they filtered through a 0.45 mm filter. For three of these facilities the arsenic concentrations in the unfiltered samples exceeded the MCL but the concentrations in the 0.45 mm-filtered samples met or were well below the MCL. Two of the facilities had two wells and the results were consistent for both wells. For these facilities, therefore, it may be possible to satisfy the arsenic MCL by improving filtration.

We propose to collect water samples over a five-hour period from five water treatment plants. We will collect unfiltered and filtered samples of untreated and treated water, as well as collect samples from wells "rested" for short lengths of time. We will also collect filtered and unfiltered samples of treated water from the facilities that seemed to have high particulate arsenic concentrations.

**Deliverables:** Quarterly progress reports will be provided to MTAC. A final report summarizing the results of the project will be submitted to MTAC, including recommendations for optimizing iron and permanganate dosages rates. A two page fact sheet that summarizes the results, conclusions, and recommendations of the project shall be produced.

**Outputs:** This information may be useful to the operators to develop a pumping strategy that reduces their overall arsenic load. Should this project prove successful, it could provide a viable alternate to in plant treatment for arsenic removal for small systems.

### *Topic 4: Assessment of the Needs, Requirements, and Available Tools for Drought Planning for Small Public Water Systems in the Midwest*

Derek Winstanley
Illinois State Water Survey

**Project Description:** The provision of adequate and secure supplies of clean water at reasonable cost is a cornerstone of social and economic development and national security. Major droughts have occurred in the past and will occur again in the future. Such droughts have two major

impacts on small public water systems: water supply is reduced (surface waters and shallow groundwater) and water demand increases. The combination of these impacts can result in major stresses on the ability of water systems to meet demand. Many Western states have experienced widespread and severe economic and environmental impacts of "worst-case" droughts in recent years, and have recognized from these experiences the importance of improved water-supply planning and management, including drought preparedness. However, it is probable that some system managers in the MTAC region have not evaluated their capability to meet water demand during major droughts, nor have in place adequate plans to deal with such emergencies.

The goal of this proposal is to review the status of drought planning, methodologies suitable for drought planning, and adequacy of databases and analytical tools needed for drought planning by small public water systems in the MTAC region.

Although most small public water supply (PWS) systems in the Midwest depend on groundwater supplies for drinking water, many systems also depend on surface water sources, particularly in areas where groundwater supplies are limited. Supplies dependent on surface water and shallow groundwater are highly vulnerable to shortages during major drought periods. Some of the surface water systems obtain water directly from rivers and streams, but, more commonly, reservoirs are constructed to store water from high flow periods for use during periods of flow less than demand.

To define the extent of potential water shortages due to climate variability and increased demand, the systems must first be identified and characterized. Evaluation of the risk of a system experiencing potential water shortages requires some basic data to develop a water budget including but not limited to: stream flow records or surrogate use of models, reservoir volume, evaporation, operation data on reservoir levels, aquifer properties, well-field operation data, and water withdrawals. It is proposed to identify within the 10-state MTAC region (Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, Ohio, Wisconsin) those small systems (serving less than 10,000 persons) dependent on surface water or groundwater; and general availability of the basic systems data necessary to evaluate water availability under various drought scenarios. On the basis of data availability, methods for evaluating water budgets and system adequacies under drought conditions will be recommended.

This project will produce an inventory of contacts and data sources for characterizing small water systems in the MTAC region: e.g. location, water supply, water withdrawal, system capacity, water demand forecasts. It will also include an identification and assessment of the availability of climatic, surface water, and groundwater data and analytical tools within the MTAC region that can be used to conduct drought analyses. A review of approaches for using real-time climate and hydrological data products to identify the thresholds for potential water supply impacts due to drought will be conducted, including:

a. Analysis of methods used to relate magnitude/duration thresholds of climatological drought to potential surface water and groundwater supply or demand impacts.
b. Examination of schema used in states in the MTAC regional for relating climate thresholds to water supply impacts in drought watch and warning systems.

**Deliverables:** Progress reports will be provided on a quarterly basis. A final report containing the results of the above studies and recommendations for conducting drought-sensitivity studies for small public water systems in the MTAC region will be produced. The report will include a plan of study for improving drought preparedness planning for small public water systems in the MTAC region. This pilot project will provide a basis for requesting funds to assist managers of small water systems to conduct detailed drought preparedness analyses. The plan also may be useful in drought preparedness studies in other regions. The authors will produce a two-page fact sheet that summarizes the results and conclusions contained in the final report.

**Outcomes:** It is intended that small system operators and managers will employ the recommendations of this project to institute effective drought planning for their supply. This will help reduce the impact of a prolonged drought on those systems and allow them to continue to deliver an adequate amount of safe drinking water to their consumers.

### *Topic 5: Toxic drinking water disinfection by-products (DBPs): accelerating the generation of reliable toxicology information for small water systems*

Michael J. Plewa
University of Illinois

Disinfection of drinking water primarily uses chemical disinfectants that convert naturally occurring and synthetic organic material along with bromide and iodide in the raw water into chemical DBPs. DBPs represent an important class of environmentally hazardous chemicals that carry long-term human health implications. Approximately 600 DBPs have been isolated and identified; this represents only a fraction of the halogenated organic material that is isolated after the disinfection of raw waters. Recently the U.S. Environmental Protection Agency (EPA) carried out a Structure-Activity Relationship (SAR) analysis to identify high priority DBPs with health concerns. Using this information the EPA conducted the Nationwide Occurrence Study to determine the presence of these high priority DBPs in the nation's drinking water. Almost no toxicity information exists on these priority DBPs, which limits a well-informed approach to the regulation of DBPs by EPA.

While the awareness of adverse health risks associated with exposure to toxic drinking water disinfection by-products (DBPs) is increasing, there is not an appropriately funded program to characterize DBPs and their health hazards. Further, little information regarding DBPs has been targeted to the managers of small water systems. Thus, the general goal of this research is to accelerate the generation of reliable toxicology information about DBPs and related compounds so that managers of small water systems can make informed decisions about the options and potential health hazards related to chemical disinfection of drinking water. This project will be funded in partnership with The American Water Works Association Research Foundation.

The approach will be to generate an in vitro mammalian cell chronic cytotoxicity and acute genomic DNA damage database that will focus on priority DBPs and related compounds. This quantitative, comparative database will link the analytical chemistry and analytical biology of the priority DBPs identified in the Nationwide Occurrence Study. This mammalian cell

cytotoxicity and genotoxicity database will serve as a practical resource for small water systems disinfection facilities as they consider switching to alternatives to chlorine in order to meet more stringent government regulations.

# Outreach Activities

### *Testing of Homeland Security Implemented from Vulnerability Assessments and Emergency Response Planning*

Harlan H. Bengtson
Director, ERTC-SIUE

**Project Description:** This is a cooperative project with the Environmental Resources Training Center (ERTC) at Southern Illinois University - Edwardsville. ERTC has conducted numerous training workshops and inspections related to Vulnerability Assessment, and has provided consulting services to small systems throughout Illinois to assist them in using VAP software. ERTC will visit 8 to 10 water plants serving less than 3300 people that have VAPs to evaluate the effectiveness of their implemented security measures. This process will help the small systems and TACs assess whether or not additional resources should be directed towards improving existing VAPs.

**Deliverables:** Evaluation sheets will be confidential and made available to the tested facility, with recommendations for areas that require improvements. MTAC will receive a report of results in an anonymous form. This information will be summarized and shared with IEPA to help them evaluate the effectiveness of Homeland Security measures.

**Outcomes:** Small systems, technical assistance providers, and state regulators will have a better idea of how effective current security measures and what areas may require additional effort or resources. Ultimately, these small systems may be better prepared to prevent terrorism or sabotage as a result of this effort.

### *Cross-Connection Control for Small System Administrators*

Harlan H. Bengtson
Director, ERTC-SIUE

**Project Description:** This is a cooperative project with the Environmental Resources Training Center (ERTC) at Southern Illinois University - Edwardsville. This one day workshop will be held at three different locations; two around the state, and one out of state. The workshop will be 7.5 hours long and include the following course material: concepts of backflow, methods of prevention, jurisdictions, water purveyors, plumbing codes, fire protection, problems with program development/startup, ordinance, management, test procedures and reporting and survey of distribution lines.

**Deliverables:** Three workshops will be held to educate small system administrators on cross-

connection.

**Outcomes:** This will result in improved understanding and implementation of a cross-connection control program for the small systems represented.

## Information Dissemination
### (Ongoing for FY01, FY02, FY03 and FY04)

The MTAC web site has seen a steady flow of traffic and downloads over the last year. From January 1 – December 31, 2004, the web site had almost 98,000 hits with more than 25,400 user sessions. This was an average of 69 user sessions per day. There were 24,839 downloads during this period. We anticipate that the recent web publishing of several completed reports will significantly increase this number for next year. We have included a more detailed analysis of web traffic for 2004 in Appendix A.

MTAC has an agreement with the National Drinking Water Clearinghouse (NDWC) to assist in disseminating information regarding some of our Competitive Grants.

We have decided the logistics and expense involved in the production of a quarterly newsletter outweigh the benefit. MTAC proposes as an alternative the mass mailing of post cards to announce any upcoming training or the availability of any new products. These will be mailed to technical assistance providers and small water system operators and managers throughout the Midwest, or statewide, as appropriate. This will allow us to reach all of the target audience as opposed to a much smaller mailing list for a more elaborate newsletter. The next postcard mailing is planned for Spring 2005.

Deva Borah and Ed Krug presented a paper entitled "Watershed Modeling to Evaluate Water Quality at Intakes of Small Drinking Water Systems," for presentation in the Watershed Management I Session of the Illinois Water 2004 Conference on October 13, 1:30-3:00PM. This was based upon an ongoing project sponsored by MTAC.

Two papers reporting on the results of MTAC sponsored projects have been accepted for presentation at the 2005 National Ground Water Association meeting in San Antonio. Tom Holm and Steve Wilson will present a paper entitled: *The Effect of Chemical Factors on Arsenic Removal From Groundwater*. Gary Peyton and Tom Holm will present a paper on their work entitled: *Demonstration of Low-Cost Arsenic Removal from a Variety of Illinois Drinking Water Sources.*

## Staffing
### (Ongoing for FY01, FY02, FY03, and FY04)

Dr. John Braden is an advisor to MTAC, and continues to actively participate in Center activities. Dr Richard E. Warner is the Illinois Water Resources Center Director, and will serve as an advisor to MTAC. Dr. Warner should be listed as Principal Investigator in future grants from USEPA. The Administrative Coordinator for the program is still Jennifer Tester. The part-

time WEB administrator, Kevin Merrifield, continues maintenance of the site with assistance and input from Kent Smothers. Mark Brooks is providing computer and technical support. Kent Smothers continues to serve as Managing Director, and remains in contact with local and regional regulatory officials and technical assistance groups concerning MTAC activities. Steve Wilson has joined MTAC as researcher, and will be investigating groundwater issues with an emphasis on Arsenic problems.

## Budget

Expenditures to date include scheduled salary expenditures as indicated in the proposal budget. Some normal office expenses for supplies, copying, and mailing costs have also been charged. The bulk of the expenditures are related to the various competitive grants and directly funded outreach projects that MTAC is sponsoring. The official financial records for this project are at the University of Illinois, and they submit the official expenditure information to USEPA as required. Our internal budgeting process indicates a reasonable expenditure rate for the projects we are sponsoring. Since work is billed out after it is completed, and the paperwork takes some time to process, it sometimes appears the work is farther along than the expenditures would indicate.

# Appendix A

# MTAC Web Report
# January 1 – December 31, 2004

Prepared By:
Kevin Merrifield
**Illinois State Water Survey**

# Table of Contents

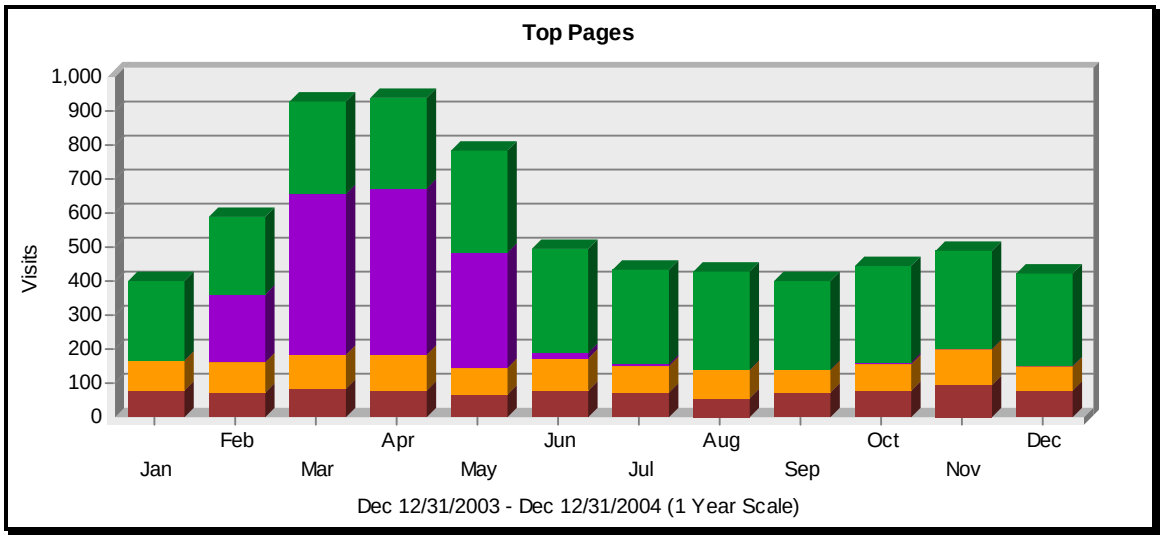
## *General Statistics*

The Visits graph displays the overall number of visits to your Web site. The General Statistics table provides an overview of the activity for your Web site during the specified time frame.

| General Statistics - Report Range: 12/31/2003 00:00:00 - 12/31/2004 23:59:59 | | |
|---|---|---|
| **Hits** | Entire Site (Successful) | 97,622 |
| **Visits** | Visits | 25,417 |
| | Average per Day | 69 |
| | Average Visit Length | 00:12:25 |
| **Visitors** | Unique Visitors | 9,066 |
| | Visitors Who Visited Once | 7,351 |
| | Visitors Who Visited More Than Once | 1,715 |

# *Top Pages*

This page identifies the most popular Web pages on your site, shows you how often they were viewed, and displays the average length of time the page was viewed.




**Top Pages**

| | Pages | Views | % of Total Views | Visits | Avg. Time Viewed |
|---|---|---|---|---|---|
| 1 | **MTAC - Home**<br>http://mtac.sws.uiuc.edu/ | 3,827 | 15.13% | 3,291 | 00:02:29 |
| 2 | http://130.126.105.85/ | 1,530 | 6.05% | 1,530 | 00:00:01 |
| 3 | **MTAC - Competitive Grants Awards**<br>http://mtac.sws.uiuc.edu/comgrant.asp | 1,163 | 4.60% | 1,030 | 00:02:10 |
| 4 | **MTAC - Regulatory Agency Links**<br>http://mtac.sws.uiuc.edu/reglinks.asp | 988 | 3.90% | 941 | 00:04:16 |
| 5 | **MTAC - Environmental Finance Centers**<br>http://mtac.sws.uiuc.edu/financec.asp | 984 | 3.89% | 881 | 00:03:12 |
| 6 | **MTAC - Expert List**<br>http://mtac.sws.uiuc.edu/expert.asp | 905 | 3.58% | 877 | 00:03:40 |
| 7 | **MTAC - Drinking Water Legislation Links**<br>http://mtac.sws.uiuc.edu/dwrules.asp | 865 | 3.42% | 830 | 00:03:16 |
| 8 | **MTAC - Training**<br>http://mtac.sws.uiuc.edu/training.asp | 843 | 3.33% | 810 | 00:03:24 |
| 9 | **MTAC - Links**<br>http://mtac.sws.uiuc.edu/links.asp | 858 | 3.39% | 808 | 00:03:07 |
| 10 | **MTAC - About MTAC**<br>http://mtac.sws.uiuc.edu/about.asp | 806 | 3.18% | 787 | 00:03:25 |
| 11 | **MTAC - Technical Education Links**<br>http://mtac.sws.uiuc.edu/teched.asp | 834 | 3.29% | 782 | 00:02:48 |
| 12 | **MTAC - Drinking Water Centers**<br>http://mtac.sws.uiuc.edu/otherc.asp | 875 | 3.46% | 775 | 00:03:35 |
| 13 | **MTAC - Contact MTAC**<br>http://mtac.sws.uiuc.edu/contact.asp | 777 | 3.07% | 743 | 00:03:15 |
| 14 | **MTAC - Conference Information** | 708 | 2.80% | 688 | 00:03:31 |

| Top Pages | | | | | | |
|---|---|---|---|---|---|---|
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| | http://mtac.sws.uiuc.edu/conference.asp | | | | |
| 15 | **MTAC - Site Map**<br>http://mtac.sws.uiuc.edu/sitemap.asp | 637 | 2.51% | 622 | 00:03:30 |
| 16 | **MTAC - Competitive Grant Final Reports**<br>http://mtac.sws.uiuc.edu/finalrep.asp | 615 | 2.43% | 572 | 00:04:08 |
| 17 | **MTAC - Quick Facts Handouts**<br>http://mtac.sws.uiuc.edu/quickfacts.asp | 462 | 1.82% | 456 | 00:03:28 |
| 18 | **MTAC - Monthly Spotlight**<br>http://mtac.sws.uiuc.edu/monthly.asp | 482 | 1.90% | 449 | 00:01:58 |
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| 30 | **MTAC - Partners**<br>http://mtac.sws.uiuc.edu/resource.asp?st=Illinois | 325 | 1.28% | 325 | 00:05:07 |
| 31 | **MTAC - Technology Links**<br>http://mtac.sws.uiuc.edu/techlinks.asp | 269 | 1.06% | 262 | 00:03:58 |
| 32 | **MTAC - Links of Interest**<br>http://mtac.sws.uiuc.edu/LOIarchive.asp | 260 | 1.02% | 251 | 00:05:33 |
| 33 | **MTAC - Emergency Planning CD**<br>http://mtac.sws.uiuc.edu/watercd/ | 362 | 1.43% | 250 | 00:03:07 |
| 34 | **MTAC - Annual Reports**<br>http://mtac.sws.uiuc.edu/pieces.asp?ref=AR | 251 | 0.99% | 236 | 00:02:06 |
| 35 | **MTAC - Request for Proposals**<br>http://mtac.sws.uiuc.edu/rfp2002.asp | 182 | 0.71% | 181 | 00:02:31 |
| 36 | **MTAC - Annual Report** | 172 | 0.68% | 168 | 00:02:43 |

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| 37 | **MTAC - Request for Proposals**<br>http://mtac.sws.uiuc.edu/rfp2003.asp | 159 | 0.62% | 155 | 00:04:11 |
| 38 | **MTAC - Native American Final Report**<br>http://mtac.sws.uiuc.edu/pieces.asp?ref=NatAmFinRpt00 | 133 | 0.52% | 126 | 00:03:47 |
| 39 | **MTAC - Emergency Planning CD**<br>http://mtac.sws.uiuc.edu/watercd/cd.htm | 101 | 0.39% | 91 | 00:03:43 |
| 40 | **MTAC Site Search**<br>http://mtac.sws.uiuc.edu/search/query.asp | 161 | 0.63% | 83 | 00:00:43 |
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| **Total For the Log File** | | **25,279** | **100%** | **N/A** | **N/A** |

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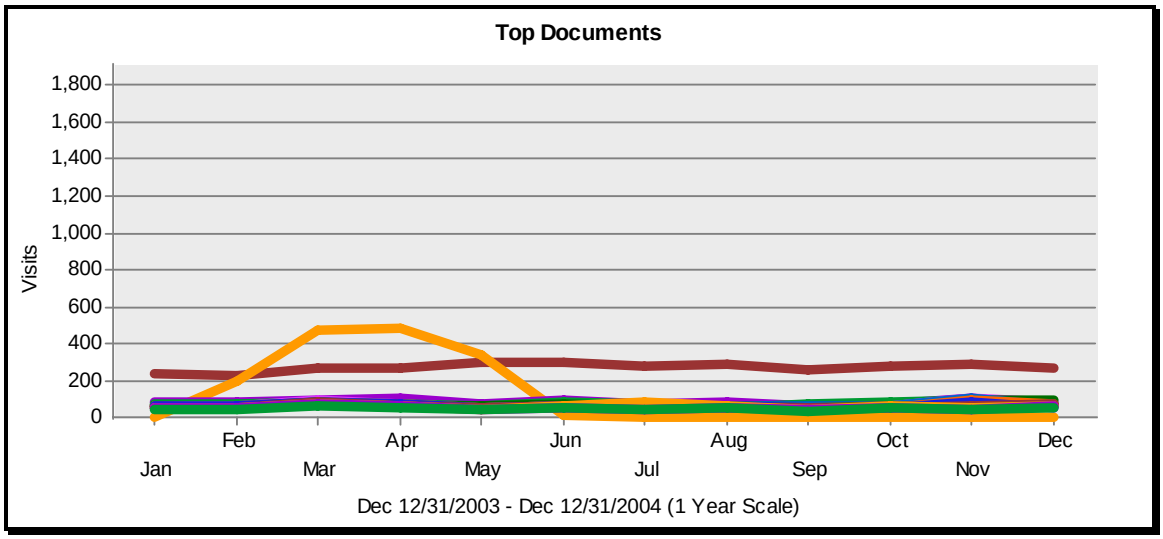


**Top Documents**

| | Documents | Views | % of Total Views | Visits | Avg. Time Viewed |
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| 4 | **MTAC - Regulatory Agency Links** http://mtac.sws.uiuc.edu/reglinks.asp | 988 | 3.91% | 941 | 00:04:16 |
| 5 | **MTAC - Environmental Finance Centers** http://mtac.sws.uiuc.edu/financec.asp | 984 | 3.89% | 881 | 00:03:12 |
| 6 | **MTAC - Expert List** http://mtac.sws.uiuc.edu/expert.asp | 905 | 3.58% | 877 | 00:03:40 |
| 7 | **MTAC - Drinking Water Legislation Links** http://mtac.sws.uiuc.edu/dwrules.asp | 865 | 3.42% | 830 | 00:03:16 |
| 8 | **MTAC - Training** http://mtac.sws.uiuc.edu/training.asp | 843 | 3.33% | 810 | 00:03:24 |
| 9 | **MTAC - Links** http://mtac.sws.uiuc.edu/links.asp | 858 | 3.39% | 808 | 00:03:07 |
| 10 | **MTAC - About MTAC** http://mtac.sws.uiuc.edu/about.asp | 806 | 3.19% | 787 | 00:03:25 |
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| 12 | **MTAC - Drinking Water Centers** http://mtac.sws.uiuc.edu/otherc.asp | 875 | 3.46% | 775 | 00:03:35 |
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| 15 | **MTAC - Site Map**<br>http://mtac.sws.uiuc.edu/sitemap.asp | | 637 | 2.52% | 622 | 00:03:30 |
| 16 | **MTAC - Competitive Grant Final Reports**<br>http://mtac.sws.uiuc.edu/finalrep.asp | | 615 | 2.43% | 572 | 00:04:08 |
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| 18 | **MTAC - Monthly Spotlight**<br>http://mtac.sws.uiuc.edu/monthly.asp | | 482 | 1.90% | 449 | 00:01:58 |
| 19 | **MTAC - Native American Links**<br>http://mtac.sws.uiuc.edu/native.asp | | 384 | 1.52% | 365 | 00:02:40 |
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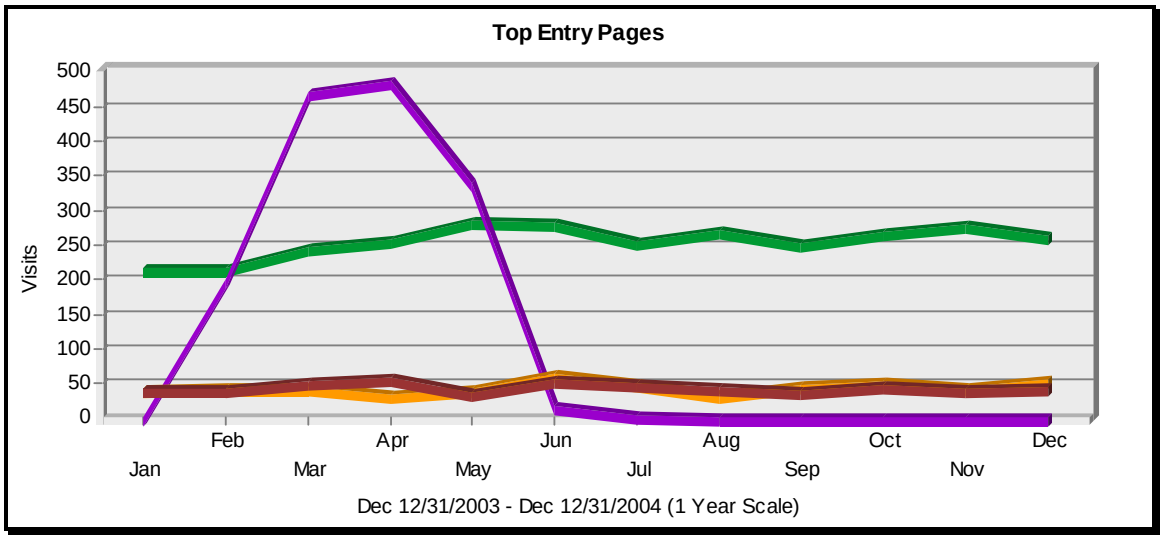


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| 2 | http://130.126.105.85/ | 10.91% | 1,528 |
| 3 | **MTAC - Regulatory Agency Links**<br>http://mtac.sws.uiuc.edu/reglinks.asp | 3.98% | 558 |
| 4 | **MTAC - Competitive Grants Awards**<br>http://mtac.sws.uiuc.edu/comgrant.asp | 3.96% | 555 |
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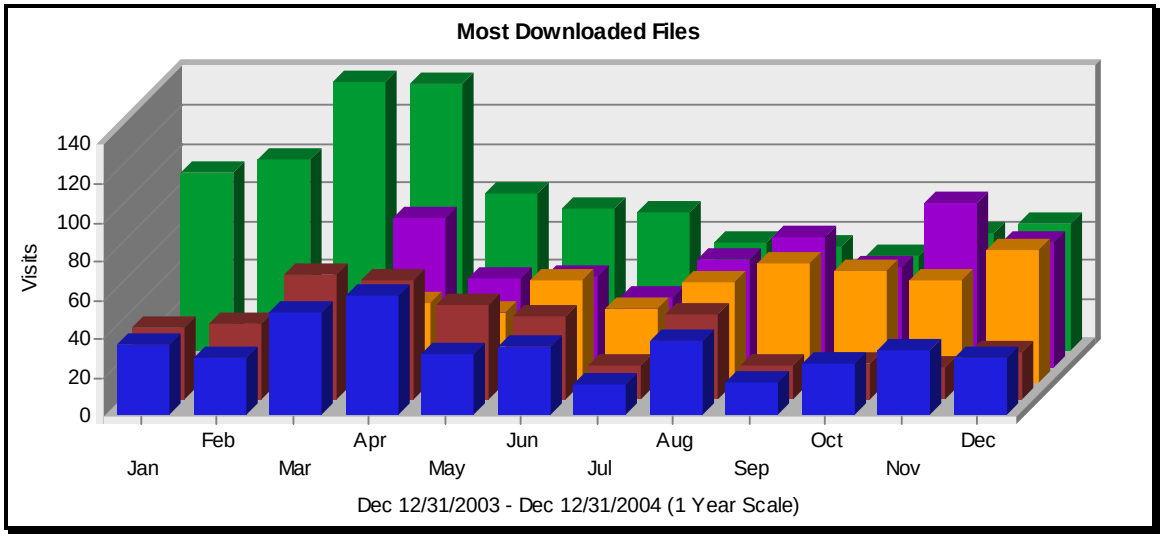


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