Water Resources Research Center

Annual Technical Report

FY 1998

Introduction

Research Program

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Effectiveness of Remotely-sensed Lineaments and Outcrop-scale Fractures in Identifying Bedrock Aquifers in New England
Project Number	C-01
Start Date	09/01/1996
End Date	08/31/2000
Research Category	Ground-water Flow and Transport
Focus Category #1	Groundwater
Focus Category #2	Water Supply
Focus Category #3	Methods
Lead Institution	University of Massachusetts

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Stephen B. Mabee	Assistant Professor	University of Massachusetts/Amherst	01

Problem and Research Objectives

The Massachusetts Water Resources Authority is constructing a new water supply tunnel through eastern Massachusetts. Construction began in the summer of 1997. The 28 km-long tunnel will traverse two accreted geologic terranes at an average depth of 70 m below ground. This will provide an unparalleled opportunity to make detailed observations of fracture features and groundwater flow conditions in the subsurface. Measurements made in the tunnel will provide a unique database of fracture information against which surface geophysical, borehole, geochemical, remotely-sensed lineament and outcrop-scale fracture data can be rigorously compared.

The purpose of this proposed research is to: 1) document the location, orientation, physical characteristics, and approximate yield of water-bearing discontinuities within an initial, 10-15 km section of the tunnel; and, 2) use these measurements to; a) assess the reliability of using remotely-sensed lineaments to predict zones of high groundwater yield within the bedrock, and, b) compare the geometry and physical characteristics of fracture features observed in surface outcrops with those observed in the tunnel. Results of this work will not only quantify the relationship between lineaments and subsurface fractures but will also evaluate whether or not fracture characteristics observed in surface outcrops can be extrapolated into the third dimension with any degree of certainty.

Methodology

The project consists of seven tasks as follows: 1) Map the tunnel exposure and document the rock types, lithologic contacts, and structural elements (folds, faults, foliations, and fractures; emphasis will be placed on describing the physical characteristics of fractures), and note all water-bearing features and their approximate yield; 2) Map lineaments along the entire length of the tunnel using a variety of scales and types of imagery (color infrared and black and white aerial photography, topographic maps, and SLAR imagery); 3) Gather existing borehole data, available surficial geologic mapping, and topographic maps showing the type and extent of surficial deposits, location of wetlands, ponds, lakes, streams, and rivers along the trace of the tunnel; 4) Map all bedrock exposures within 1 km of the tunnel (focusing on the initial 10-15 km section) and record the same features as described in item 1 above (i.e., rock type, structural features, fracture characteristics, etc.); 5) Compare lineaments with subsurface water-bearing features by& a) quantifying the number of lineaments that actually correspond to highly productive zones in the tunnel; and, b) examining other geologic factors that may influence the association between lineaments and yield such as bedrock type, topographic setting, the type and thickness of the overburden, proximity to surface water bodies or structural setting; 6) Compare the orientations and physical characteristics of fracture features observed in surface outcrops with the orientations and physical characteristics of water-bearing features observed in the subsurface; and, 7) Prepare summary maps and journal articles to disseminate the findings of the project.

Principal Findings and Significance

From September 1998 to September 1999, nine km of tunnel were mapped and evaluated. A total of 413 fracture features, including faults, have been characterized in the tunnel to determine the orientation of major sets and the extent of subsurface fracture domains. A subset of 156 fracture features was used to evaluate fracture characteristics such as planarity, trace length and spacing. In addition, every feature in the tunnel exhibiting flow was identified and characterized. An estimate of their yield was also provided. A total of 30 water samples were obtained in the fall of 1998 from flowing structures within the tunnel and compared with 10 water samples obtained from surface water bodies above the tunnel. At the surface, 1513 fracture measurements were made at 21 outcrops located within 3 km of the trace of the tunnel to determine major fracture sets and surface fracture domains. Spacing, trace length and

planarity were determined from scanline measurements (n=899) at each outcrop. Lineaments were drawn on three platforms: 1:250,000 Side-Looking Airborne Radar (SLAR) images, 1:58,000 Color Infrared (CIR) and 1:80,000 Black and White (BW) aerial photographs. Lineaments were drawn by three observers during two independent trials producing 18 sets of lineaments (n=9137). Three or more overlapping lineaments (azimuths within ±5° and within 1 mm at the scale of the imagery) define a single coincident lineament. This generated three sets of coincident lineaments (n=794), of these 37 cross the 9 km section of tunnel. Major findings to date are as follows: 1. Lineaments provide a reasonable means of identifying high flow zones in the bedrock but the method can not be used with 100% reliability. Some lineaments do not map high flow zones in the bedrock and many high yield zones do not correspond with mapped lineaments. The 37 coincident lineaments mapped in this study were compared with 99 water bearing structures within the 9 km tunnel section. Subsurface flowing structures that parallel coincident lineaments (all platforms) and occur within the lineament buffer zones (±1 mm at the scale of the imagery) have higher median yield (10,500 l/day) than those structures outside the buffer zones (6,600 l/day). However, this difference is significant at the 70% confidence level. The BW platform is the best at discriminating high flow zones in the subsurface. There is a 90% confidence that the median yields of flowing structures in the lineament buffer zones are higher than the median yields of those located outside the buffer zones. 2. Fracture-supported coincident lineaments do not necessarily improve the ability of lineaments to discriminate high flow zones in the bedrock. Fracture-supported coincident lineaments are those lineaments which parallel nearby surface fracture sets, mapped faults, lithologic contacts, and/or primary ductile structures. There were two occurrences where fracture-supported coincident lineaments from all three scales overlapped and were parallel. One occurrence mapped the zone of greatest fracture density in the tunnel and highest groundwater inflow (>560 l/min). The other occurrence mapped an area of high fracture density and significant subsurface flow (95 l/min). When considering all fracture-supported coincident lineaments and parallel subsurface structures, the median flow (13,600 l/day) for the mapped structures is greater than the unmapped structures (6,800 l/day). However, this difference is significant at the 60% confidence level. 3. The trends of major fracture sets in the tunnel do not show a one to one correlation with the trends of major fracture sets identified in surface outcrops. Five fracture sets were observed in the surface outcrops (14, 38, 86, 117 and 171) and seven fracture sets (13, 29, 41, 62, 132, 159 and 175) in the tunnel. The 14 and 171 fracture sets in the surface outcrops correspond well with the 13 and 175 sets in the tunnel. These are the dominant fracture sets observed both at the surface and in the tunnel. The 38 set observed at the surface includes parts of the 29 and 41 sets in the tunnel. The 86 set does occur in the tunnel but is undersampled because it is aligned with the tunnel. The 62 and 159 sets occur in the tunnel but are not seen at the surface. 4. The geographic distributions (domains) of the surface and subsurface fracture sets do not show a one to one correlation. Only the dominant fracture set domains (14 and 171 in the surface and 13 and 175 in the tunnel) show a reasonable spatial overlap. All the other sets show only a partial overlap or no overlap at all. Interestingly, the 13 and 175 fracture sets are the fractures generating most of the groundwater inflow into the tunnel. 5. Spacing and trace lengths distributions measured in surface fractures can not be extrapolated into the subsurface with much confidence. Median fracture spacing and trace lengths for the 13 and 175 fracture sets in the tunnel are significantly (at the 95% confidence level) wider and longer than the corresponding 14 and 171 fracture sets at the surface. Fracture planarities showed no significant differences between any of the surface and subsurface fracture sets. 6. Areas of high groundwater inflow into the tunnel generally correlate with high subsurface fracture density, where four or more subsurface fracture domains overlap, proximity to surface water bodies (close proximity = higher inflows), position with respect to permeable overburden deposits (sands and gravels = higher inflows), and topographic depressions, especially those with corresponding lows in the bedrock surface. In addition, subsurface structures which correlate with prominent surface fracture domains (14 and 171 fracture sets) produce the highest volume of groundwater inflow. However, these factors together still do not predict all the locations of high groundwater inflow in the tunnel. 7. The waters in the tunnel are characterized as sulfate+chloride and

calcium+magnesium. Results from statistical analyses indicate that alkalinity, calcium, sodium, and potassium vary as a function of rock type and that these differences are significant at the 95% confidence level. 8. Preliminary results of oxygen isotope and nitrate analyses also suggest that some of the fault zones in the tunnel may have a rapid and direct hydraulic connection to the surface. Results show elevated levels of nitrate in two water producing fault zones (>10 mg/l for some samples) and may result from accidental contamination during sampling, the use of explosives at discrete locations in the tunnel, or from leaking septic systems. Preliminary oxygen isotope data indicate that two large water producing fault zones are isotopically enriched (average d18 O = -7.75) relative to other water producing features in the tunnel (average d18 O = -8.96). The d18 O values obtained from all surface water bodies located above the tunnel average -7.56 whereas those values in surface ponds immediately above the fault zones averages -6.71. 9. Overall, lineaments can, in some instances, predict water-bearing subsurface structures in poorly exposed, glaciated, metamorphic terrain that has a high degree of suburban development. However, although the tunnel sections with the greatest fracture density and highest groundwater inflows are successfully mapped by fracture-supported coincident lineaments, not all water-bearing zones are delineated. Other factors such as proximity to surface water bodies (close proximity = higher inflows), position with respect to permeable overburden deposits (sands and gravels = higher inflows), and topographic depressions, especially those with corresponding lows in the bedrock surface must be considered along with lineament analysis to improve the ability to locate high yield zones in the bedrock. Inclusion of all these factors including overlapping surface fracture domains certainly aid prediction but do not guarantee finding all the water-producing zones. 10. Although the density of surface outcrops over the trace of the tunnel was sparse, their geographic distributions (domains) and their characteristics, specifically spacing and trace length distributions, observed in surface outcrops can not be extrapolated into the 3rd dimension with a high degree of confidence. Fracture sets occur in the tunnel that do not appear in surface outcrops, domains of surface fractures do not always show a one to one spatial correlation with the domains of subsurface fractures and spacing and trace length distributions for those fracture sets that do correlate are significantly different. Thus, some caution is advised when using surface outcrop data as a guide to subsurface conditions. However, the most prominent fracture sets mapped at the surface (14 and 171) do show a reasonable spatial correlation with their counterparts in the tunnel (13 and 175). These latter fracture sets also are the fractures generating the greatest groundwater inflow into the tunnel. Two abstracts have been published this year. In addition, five abstracts have been submitted for the upcoming national Geological Society of America Meeting in Denver during the fall of 1999. Copies of those five abstracts are attached to this report. The lineament analysis results are currently being prepared for submission to Geology. It is expected that this manuscript will be submitted by the end of August 1999. Finally, a subsequent proposal is being prepared for submission to the National Science Foundation in December, 1999, to continue the investigation of lineament analysis as a tool for locating high-yield water-bearing zones in the bedrock. Three students are completing their Master's degrees with this project. Patrick Curry is examining the lineament analysis. Katherine Williams is studying the relationship between surface and subsurface fracture characteristics. Rebecca Weaver is reporting on the results of the geochemical sampling in the tunnel and in surface water bodies. A student at Amherst College will also be continuing the water quality investigation as part of her senior thesis.

Descriptors

Hydrogeology, Bedrock Fluid Flow, Leneament Analysis, Water Resources Planning

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Williams, K.W., S.B. Mabee, K.C. Hardcastle, and P.J. Curry. 1999. Surface and subsurface fracture characterization and correlation along a cross-strike transect in eastern Massachusetts. American Geophysical Union Spring Meeting 1999, Boston, MA, v.80, no.17, p.S152.

Other Publications

Curry, P.J., K.W. Williams, S.B. Mabee, and K.C. Hardcastle. 1998. Comparison of lineaments with bedrock structures along a cross-strike transect in eastern Massachusetts. Geological Society of America Annual Meeting, Abstracts with Programs, v.30, no.7, p.A278.

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Comparison of Contingent Valuation and Conjoint Analysis for Measuring the Total Economic Value of Water Resources
Project Number	C-03
Start Date	10/01/1997
End Date	08/31/1999
Research Category	Social Sciences
Focus Category #1	Economics
Focus Category #2	Management and Planning
Focus Category #3	Methods
Lead Institution	University of Massachusetts/Amherst

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Thomas H. Stevens	Professor	University of Massachusetts/Amherst	01
Cleve Willis	Professor	University of Massachusetts/Amherst	02

Problem and Research Objectives

Controversy has focused on how to measure the economic value of water quality. Contingent valuation, which is usually the only technique used to measure both use and non use values, is frequently viewed with skepticism. In part, this is because contingent valuation, CV, involves construction of a hypothetical market that asks individuals, in either a survey or experimental setting, about their willingness to pay, WTP, to preserve or protect natural resources. Problems associated with CV include but are not limited to: (a) individuals may not be very familiar with the commodity being valued; (b) WTP depends in part on the information that is (or is not) provided in the contingent valuation survey; and (c) results may be very sensitive to the described method of payment or to the format of the questionnaire.

As debate about the validity of contingent valuation continues, alternatives to the CV method are being investigated, and recent research suggests that conjoint analysis, wherein respondents rate rather than price alternative resource programs, may have several advantages over the traditional CV approach. Higher response rates and fewer protest zero bids have been associated with conjoint analysis. Moreover, conjoint results may be more reliable because individuals are more familiar with making decisions in the conjoint format and the tradeoff process used in conjoint encourages respondent introspection. Since price is treated as just one of several attributes, conjoint analysis may be particularly appropriate for valuing multi-attribute environmental amenities associated with water resources.

Despite the potential advantages of the conjoint format, very little comparative analysis of the CV and conjoint methods has been conducted. Although conjoint has been frequently used in market research, its validity for valuing nonmarket commodities, such as water quality, has not been adequately tested. The objective of this research is to compare the conjoint and CV techniques for measuring both the use and non use values associated with groundwater quality in Western Massachusetts. The final result will be an improved method for measuring the total economic value of groundwater resources.

Methodology

Contingent valuation and conjoint surveys were developed and pretested during the fall and winter 1998-1999. The pretest procedure had three stages. First, protocol analysis was used whereby individuals completing the draft survey gave feedback about how they interpreted the survey questions. The questionnaires were then modified and a mail pretest was sent to 100 randomly selected residents of a nearby town. The survey results were then analyzed and final changes were made. The completed survey employed a split sample approach whereby 2,000 randomly selected households in western Massachusetts were asked to complete one of two different versions of the mail survey& CV and conjoint. The survey was mailed in the spring of 1999 and nonrespondents were contacted several times. Data analysis began in early summer 1999 and is continuing.

Principal Findings and Significance

The survey has been administered and the data are now being analyzed. Results will be available early fall, 1999.

Descriptors

Groundwater, Contamination, Economics, Benefit/Cost Analysis

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications

Information Transfer Program

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Watershed Assessment Training Program: A Partnership in Service to New England Communities
Description	A partnership to help volunteer water quality monitors perform focused assessments and to increase the use of watershed monitoring tools.
Start Date	10/01/1997
End Date	08/31/1999
Type	Library And Database Services
Lead Institution	University of Massachusetts/Amherst

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Jerome R. Schoen	Professional Staff	University of Massachusetts/Amherst	01
Geoff Dates	Professional Staff	River Watch Network	02
Jeffrey Schloss	Professional Staff	University of New Hampshire Cooperative Extension	03
Linda Green	Professional Staff	University of Rhode Island Cooperative Extension	04
Richard Winter	Professional Staff	University of Maine Public Affairs Dept.	05
Esperanza	Professional Staff	University of Maine Cooperative Extension	06

Stancioff	Professional Staff	University of Maine Cooperative Extension	05

Problem and Research Objectives

The Watershed Assessment Training Program, a collaboration of: the Water Resources Research Center, University of Massachusetts; Cooperative Extensions of the Universities of Rhode Island, New Hampshire and Maine; University of Maine Public Affairs; the River Watch Network; and the Merrimack River Watershed Council, was initiated in 1997 with grant funds received from the National Institute of Water Resources and the US Geological Survey. The training program was established to address the growing training needs of volunteer water monitoring programs that are proliferating in New England. Reduced federal, state and municipal funding sources increase the need for community based volunteer monitoring programs which continue as a cost-effective means to collect credible information used in screening, assessment, base-line documentation, and community decision making. Many volunteer programs have mastered basic sampling techniques and are now at the stage where they require assistance to go the next step. They are requesting guidance on how to expand their monitoring to tackle nonpoint source pollution at the source and how to better integrate their programs to address community concerns in the context of a watershed approach.

Project collaborators (collectively named the New England Regional Monitoring Collaborative, or NERMC) sought to help volunteer groups perform focused assessments that produce credible information relevant to important regional environmental problems; and to increase the use of relatively low cost and user-friendly watershed monitoring tools throughout New England by making training and related services more accessible.

Methodology

1) Produce a set of written and videotaped training materials for several different watershed assessment methods designed for New England volunteer environmental monitoring groups. The surveys are: * Macroinvertebrate sampling for river systems. * Habitat assessment for river systems. * "Following the Flow": a non-point source pollution site assessment method that uses an "expert system" approach to allow observers to determine the actual or potential extent of pollution generation and delivery from a site to a receiving water of some kind be it a wetland, lake, river stream shoreland or estuary. * Watershed Natural Resource Inventory Method: an extension of a currently used Community Natural Resource Inventory Guide which focuses more in-depth on the water resources aspects and bases the inventory unit on a watershed level. * An introductory videotape will describe the methods, to assist viewers in determining the types of surveys suitable for their programs.

2) Set up a delivery system to provide these materials and relevant training to groups throughout the region. This includes conducting a series of workshops that cover topics discussed in the videos and manuals.

3) Initiate a communications system and planning process among service organizations to provide comprehensive cost-effective assistance on an on-going basis to citizen monitoring programs.

Instructional materials and workshops were or will be developed with a focus on a "training the trainers" approach. The target audience includes program leaders, educators, and others who are or will themselves become trainers of volunteer watershed monitors.

Principal Findings and Significance

Training materials Written training materials in the form of manuals and protocols have been created and/or revised for this project. These include: * "Following the Flow" assessment manual and trainers packet materials have been completed These will be used at upcoming Watershed Academy, August 16 – 21, 1999. * Added material to final draft of Watershed Natural Resource Inventory guide – to be completed and produced by September GWPCC workshop * Benthic invertebrate and habitat assessment training materials have been completed.

Videos The Watershed Resource Inventory video will now be incorporated into the introductory video, which introduces the full NERMC video series. After some consideration, it was deemed inappropriate as a separate video, because it would contain too many static shots to suit the video format. Most of the filming has been completed for this video, but editing tasks remain.

The benthic macroinvertebrate training video is now complete. It is 24 minutes long and contains detailed explanations of how to carry out river and stream benthic monitoring, in step-by-step demonstrations. It shows both streamside and intensive sampling and analysis procedures.

The second video, Following the Flow, is nearing completion and will be ready for distribution by the third week in August. It is 17 minutes long, and also contains detailed advice and demonstrations not available on video before, on methods of tracking the flow of non-point source pollutants from a site to a water resource.

Filming on the habitat assessment video is nearly complete. Some shots which require specific climate conditions remain to be filmed. Some editing is will then be required to complete the video.

Three of the NERMC partners (UMaine Public Affairs, UNH Extension, and River Watch Network) spearheaded development of these videos. Additional assistance and participation was received from several students at UNH, from the Houlton Band of Maliseet Indians, several faculty members in biological sciences at the University of Maine, and from the North American Benthological Society.

Completion of all videos is not expected until fall of 1999. For this reason, a no-cost extension of the project is being requested. See attached letter.

Workshops, delivery system

NERMC partners have compiled lists of potential NERMC trainers, who receive invitations to NERMC workshops via mail, and email. Workshop schedules are also posted on the NERMC web site. Mailings include a NERMC fact sheet describing the project and a survey. The survey continues the program assessment completed in 1998 by asking potential trainers which workshops they are interested in attending, but are unable and why. It also asks what other types of training are wanted. Results indicate that the current set of workshops have broad appeal, but that summer is simply too busy a period for many people. Workshop schedules were revised to accommodate these preferences. Workshops conducted:

* NERMC introductory workshops were presented at the Volunteer Environmental Monitoring Conference, November 14, 1998 and at the New England Association of Environmental Biologists meeting in Ascutney VT March 10-12, 1999. Objective of workshops was to inform audiences of NERMC services available and to receive feedback on our plans for NERMC operations in the coming year. * A ½ day Following the Flow workshop was conducted in northern New England (Bonnyvale

Environmental Education Center, Brattleboro VT; May 7, 1999) as part of a Project Wet facilitator training conference. * Streamside Benthic Macroinvertebrate workshop was presented at the Annual New England Lakes conference (sponsored by NE chapter of North American Lakes Management Society) held in Auburn Maine (June 19 –20, 1999).

Upcoming NERMC workshops (to be conducted within the grant period): * Streamside Benthic Assessment, South Kingstown, Rhode Island, August 14, 1999.

* NERMC is a co-sponsor of the "Watershed Academy- Working at a Watershed Level" 5 day workshop sponsored primarily by the USEPA and the Council of State Governments, August 15 - 21 in Durham NH. Presentations by NERMC cooperators will include: Watershed Assessment Approaches, A Following the Flow demonstration/field trip, and an Introduction to Watershed Natural Resources Inventory Applications. Additionally, a NERMC Following the Flow trainers workshop will be conducted at this event August 20-21.

* Watershed Resource Inventory Approaches and Applications, September 21, 1999, Newport Rhode Island. This ½ day workshop will be held in conjunction with the Ground Water Protection Council's (GWPC) annual forum in Newport, Rhode Island September 19 - 22, 1999.

Planned for Spring 2000 (to be conducted after this grant period). * Intensive macroinvertebrate sampling and habitat assessment. Spring conditions are needed for the habitat workshop, and the intensive macroinvertebrate workshop requires participants to attend for 4 days. Earlier attempts to recruit participants for a commitment of this nature met with indifferent success, so NERMC partners will work on logistical planning and participant recruitment over the fall and winter of 1999 - 2000.

3) Communication system, planning process

A NERMC Web site has been developed: . It describes the NERMC project, the watershed assessment tools developed by NERMC partners, and lists scheduled workshops.

NERMC partners post NERMC information on their Web sites, as well, and use their own meetings and workshops as a means to distribute NERMC surveys, materials and workshop announcements. NERMC partners continue to meet and conduct monthly conference calls. Several new partners have joined these discussions, including representatives of UMass Extension and the USEPA. In early 1999, a grant application to the USEPA was approved, for $25,000, to continue long-range planning and service development. This will allow additional workshops to be produced in 2000, and to incorporate new tools and services into the NERMC repertoire. Under consideration (pending additional funding, which NERMC partners are pursuing):

- A macroinvertebrate monitoring protocol for wetlands, which has been developed by Anna Hicks of UMass Extension. This is being further tested and modified with support from Massachusetts Coastal Zone Management. NERMC plans to assist in adapting training materials for this tool, so that the format will be compatible with NERMC materials. In addition, we are exploring the possibility of producing a video and additional workshops on the topic.

- Guidance manuals and related workshops on writing Quality Assurance Project Plans, currently being developed by the UMass Water Resources Research Center, with support by the MA Department of Environmental Protection. NERMC may produce additional workshops outside of Massachusetts.

- A NPS Pollution in NE Watersheds video, adapted from UNH's FTF training slide set.

- A CD-ROM Demo of UNH's Watershed Natural Resources Inventory using GIS technology.

- A "Neighborhood Survey FTF Method" video, which would complement the NERMC FTF video now in production.

- A guidance manual and training workshops on Data Management, Interpretation and Reporting expanding upon materials prepared by RWN, UNH CE and UMaine CE for coastal monitoring groups.

In addition, NERMC assessment tools have been cited by the Massachusetts Executive Office of Environmental Affairs (EOEA) in its guidance to volunteer monitoring groups and Regional Service Providers (RSPs) in a new program of support for volunteer monitoring, initiated in MA FY 1999. Grant programs for volunteer monitors and RSPs totaling $250,000 were approved in FY 1999, and an additional $300,000 is anticipated in FY 2000. The new RSP network encourages use of NERMC methods. Several NERMC partners (MassWWP, RWN, and MRWC) worked closely with EOEA to develop the current support system.

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Schloss, J. 1999. "Applications of a Watershed Natural Resources Inventory in a Multi- jurisdictional Watershed" in NOAA publication: Proceedings of the Tijuana River Watershed Workshop. May 1999.

Other Publications

Schloss, J. and A. Ammann, 1999, "Following the Flow" Training Guide,UNH Cooperative Extension Publication, Durham, NH. Schloss, J., 1998, GIS Applications for Lake Management (Overview of Watershed Natural Resource Inventory Method) in Our New England Waters: Watershed Stewardship for the Next Millenium. June 26-28 1998 University of New Hampshire, Durham, NH. UNH Cooperative Extension. p 10. Schloss, J., 1999, GWPC conference in Newport RI- "Developing and Implementing a Watershed Natural Resources Inventory Sept 1999.

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Workshop on Best Management Practices for Airport Deicing Stormwater
Description	Development of a manual and a workshop for best management practices for airport deicing stormwater
	09/01/1999

Start Date	09/01/1998
End Date	08/31/1999
Type	Conferences
Lead Institution	University of Massachusetts/Amherst

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Michael S. Switzenbaum	Professor	University of Massachusetts/Amherst	01

Problem and Research Objectives

With the advent of new regulations concerning aircraft deicing and management of spent aircraft deicing fluids, many airports now face the challenge of maintaining public safety along with environmental protection. Each year large quantities of propylene glycol and ethylene glycol are used to de-ice aircraft. Pavement deicing materials are also used on taxi- and runways. All of these compounds exert large oxygen demands when introduced into natural waterways. In addition, there are toxicity concerns with certain glycols. As a result, the collection and treatment of these wastes is now being mandated by regulatory agencies for protection of both human health and the environment. While numerous alternatives have been proposed for deicing wastewater management, at the present time there is no firm consensus on the best means of managing this significant problem. The purpose of this project is to develop a manual and hold a workshop for best management practices for airport deicing stormwater. The manual and workshop should be useful to regulators, airport operators, and environmental engineers, scientists and managers concerned with deicing fluids management. The management of deicing wastes is a significant problem at airport facilities, and better solutions need to be developed. The manual and workshop will allow users to be more familiar with management options.

Methodology

An extensive literature review was conducted for the manual. This included traditional periodical literature, as well as government documents. In addition, information was obtained from vendors and practitioners. The manual has been completed.

Numerous advertisements and notices were placed in journals, professional societies and on the internet announcing the workshop. In addition, an extensive mailing was conducted. The workshop was held on July 28, 1999 at the Engineering Student Center at the University of Massachusetts at Amherst. Additional support for the workshop was obtained from the College of Engineering and UMass University Outreach. The workshop agenda is attached. Approximately 40 people attended the workshop (a list of participants is attached). These individuals represented a broad section of those involved with deicing wastewater management, including regulatory agencies (EPA, FAA, and various state agencies), airport operators (Bradley International Airport, Tweed New Haven Regional Airport, and Westover Air Force Base), airline companies (American Airlines), chemical manufacturers (Octagon), and consultants.

Principal Findings and Significance

The situation concerning the management of airport deicing stormwater is rapidly changing. More and more airports find themselves having to deal with these concerns. At the same time, advances are being made in use of alternative deicing agents, better containment and collection technology, as well as treatment and recovery systems.

Based on the manual developed for this project, the following bullets highlight significant issues associated with the current state of deicing system design in the United States&

- Central deicing pads provide better collection efficiencies than most at-gate types of deicing runoff collection and require minimal associated labor. However, airlines operating non-hub operations and cargo airlines are generally unwilling to support pad construction due to concerns over delays.

- Central wastewater treatment plants are almost always the most economical method of treating deicing chemical runoff, if sufficient biological loading capacity is available. Direct anaerobic discharge or anaerobic on-site pre-treatment may be economical in capacity-limited situations.

- Hybrid deicing equipment and alternate pavement deicing agents offer significant near-term BOD reductions that will almost assuredly translate to lower cost treatment systems.

- Careful crafting of permit upset provisions can significantly reduce the cost of systems.

- The EPA is currently conducting a study to determine if the regulation of deicing fluid runoff is warranted on a nationwide basis. Preliminary results of this study are due prior to December 1999. For airports currently considering large capital investments in collection and treatment systems, it is probably prudent to "wait and see" what conclusions are reached in the ongoing EPA study.

  In addition, several research and development needs were noted by participants at the workshop, including

  - What is the distribution of aircraft and pavement deicing agents after application?

  - What are the transport mechanisms and ultimate fate of these agents (and various components) after application?

  - What are the winter decay rates of these agents in receiving waters?

  - What are the impacts on wildlife from lagoon storage of airport stormwater?

WORKSHOP ON BEST MANAGEMENT PRACTICES FOR AIRPORT DEICING STORMWATER -SCHEDULE-JULY 28, 1999

8&30 AM Registration, continental breakfast served

8&45 AM Welcome and Opening Remarks – Mike Switzenbaum

Background and Objectives

9&00 AM Current Deicing Practices – Shawn Veltman

A. Aircraft and Runway Deicing and Anti-icing

B. Snow Removal Methods

C. Glycols and Other Chemicals

9&45 AM Break

10&00 AM Environmental Issues with Airport Deicing and Control Options - Dean Mericas

A. Environmental Consequences

B. Control Options

1. Source reduction

2. Collection/Containment

11&15 Treatment Alternatives - Mike Switzenbaum, Ted Schoenberg, and Shawn Veltman

A. Introduction

Aerobic Biological Treatment

Anaerobic Biological Treatment

12&00 noon Lunch break-lunch will be provided

1&30 PM Treatment Alternatives - Mike Switzenbaum, Ted Schoenberg, and Shawn Veltman continued

Soil Treatment

E. Distillation and Recovery

F. Comparison of Treatment Alternatives

G. Case Studies (including the Albany International Airport)

2&45 PM Break

3&00 PM System Evaluation Criteria- Dean Mericas

3&45 PM Summary and Conclusions –Mike Switzenbaum

List of Attendees Name Affiliation

Dean Audet, Fuss and O'Neill, Inc

Albert Cocci, Paques API, Inc.

James Crawford, Crawford Enterprises Unlimited, Inc.

Stephen Demski, UMass, University Outreach

Sarah Dennechuk, Edwards and Kelcey, Inc

Harch Gill, Brookwood Capital LLC

Paul Godfrey, UMass WRRC

William Halligan, Radiant Energy

Kevin Halloran, Mass Dept Env Protection

David Hazelbrouck, Fuss and O'Neill Inc

Robert Hickey, EFX Systems Inc

W. Kenneth Johnson, CHA Tech Services LLC

David Kiser, NYS Dept Env Conservation

George Lainas, Tweed New Haven Regional Airport

Robert Ladine, ADI Systems Inc

David Manugian, Edwards and Kelcey, Inc.

Jiri Marsalek, Nation Water Research Inst (Canada)

Diane Mas, UMass (CEE)

Dean Mericas, Limno-Tech, Inc.

John Morris, CHA Tech Services LLC

Ray Mueller, American Airlines

Gary Nash, TLC Consultants Inc

Greg Panthos, American Airlines

Charles Pertillo, Town of Windsor

Dan Reynolds, Bradley International Airport

Mark Rickens, Bradley International Airport

Gina Rossi, Westover AFB

Ted Schoenberg, UMass (CEE)

Ronald Schwartz, Mass Dept Env Protection

John Silva, Federal Aviation Administration

Frank Smigelski, Federal Aviation Administration

Michael Switzenbaum, UMass (CEE)

Shawn Veltman, Olver, Inc.

Michael Watson, Mass Dept Env Protection

Arnold Wiesenfeld, Octagon Processes

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Switzenbaum, M.S., Veltman, S, Schoenberg, T., Durand, C.M., Mericas, D., and Wagoner, B., 1999, "Best Management Practices for Airport Deicing Stormwater, July 1999." Publication No. 173. Massachusetts Water Resources Research Center, University of Massachusetts, Amherst, MA.

Conference Proceedings

Other Publications

USGS Internship Program

Student Support

Student Support					
Category	**Section 104 Base Grant**	**Section 104 RCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	N/A	N/A	N/A	1	1
Masters	N/A	3	N/A	N/A	3
Ph.D.	N/A	3	N/A	N/A	3
Post-Doc.	N/A	N/A	N/A	N/A	N/A
Total	N/A	N/A	N/A	N/A	N/A

Awards & Achievements

The Water Resources Research Center, through its Mass. Water Watch Program, successfully convinced the state legislature to fund a statewide program supporting volunteer monitoring efforts. In the first year (state FY1999), the program was provided $250,000 through the Environmental Affairs Secretariat. The Center was closely involved in the implementation of the program in the first year.

Publications from Prior Projects

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Fennessey, Neil M., 1998, Monthly Maps of Mean Daily Free Surface Evaporation and Reference Evapotranspiration: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, and Pennsylvania, Hydrology and Water Resources Group, Department of Civil and Environmental Engineering, University of Massachusetts, Dartmouth, MA

Conference Proceedings

Other Publications