2008
WESTERN SOUTH DAKOTA
HYDROLOGY CONFERENCE

Program and Abstracts

April 17, 2008
Rushmore Plaza Civic Center
Rapid City, South Dakota

TABLE OF CONTENTS

2008 Western South Dakota Hydrology Conference

This program and abstracts book has been produced in conjunction with the 2008 Western South Dakota Hydrology Conference, held at the Rushmore Plaza Civic Center on April 17, 2008. The purpose of this book is to provide summaries of the presentations made during the conference.

The purpose of the 2008 Western South Dakota Hydrology Conference is to bring together researchers from Federal, State, University, local government, and private organizations and provide a forum to discuss topics dealing with hydrology in western South Dakota. This conference provides an opportunity for hydrologists, geologists, engineers, scientists, students, and other interested individuals to meet and exchange ideas, discuss mutual problems, and summarize results of studies. The conference consists of four technical sessions and three keynote speakers. The topics of the technical sessions include science management issues, surface-water issues, mining issues, and flooding.

ACKNOWLEDGMENTS

Many people have contributed to this conference. The many presenters are thanked for their contributions. The moderators are thanked for their help in streamlining the technical sessions. The help by many students from the South Dakota School of Mines and Technology with presentations and lights is greatly appreciated. The keynote speakers, Dr. John Marburger, Dr. Jose Alonso, and Dr. Scott Kenner, are thanked for their time and perspectives. Registration help by Sheri Meier and Barbara Rowe (USGS) is greatly appreciated. Brenda Athow (USGS) provided computer support for the conference.

The sponsoring organizations are thanked for support: South Dakota Department of Environment and Natural Resources, South Dakota Engineering Society, South Dakota School of Mines and Technology, U.S. Geological Survey, and West Dakota Water Development District. Powertech (USA) and Howard R. Green are thanked for sponsoring the refreshment breaks. The chairpersons for this conference were J. Foster Sawyer (South Dakota Department of Environment and Natural Resources), Arden D. Davis (South Dakota School of Mines and Technology), Scott J. Kenner (South Dakota School of Mines and Technology), Mark T. Anderson (U.S. Geological Survey), Janet M. Carter (U.S. Geological Survey), Daniel G. Driscoll (U.S. Geological Survey), Van A. Lindquist (West Dakota Water Development District), and Jenifer Sorensen (South Dakota Engineering Society). Nancy Anderson-Smith (South Dakota School of Mines and Technology) is thanked for her input.

2008 WESTERN SOUTH DAKOTA HYDROLOGY CONFERENCE PROGRAM

Thursday, April 17, 2008
Alpine/Ponderosa Rooms
Rushmore Plaza Civic Center

7:00 – 7:50 a.m.	**REGISTRATION**	
7:50 – 9:20 a.m.	**Plenary Session 1 in Alpine and Ponderosa Rooms – Science Management Issues (1.5 PDH)** **Moderator – Mark Anderson**, Director of the U.S. Geological Survey South Dakota Water Science Center, Rapid City, SD	
7:50 – 8:00 a.m.	Welcome, general information	**Mark Anderson** and **Daniel Driscoll**, U.S. Geological Survey
8:00 – 8:40 a.m.	Reflections on the Science and Policy of Energy and Climate Change (INVITED KEYNOTE ADDRESS)	**Dr. John H. Marburger, III**, Director, Office of Science and Technology Policy, Executive Office of the President
8:40 – 9:00 a.m.	Plans and progress at the Sanford Underground Lab at Homestake (INVITED KEYNOTE ADDRESS)	**Dr. Jose Alonso**, Sanford Laboratory
9:00 – 9:20 a.m.	Characterization of the Precambrian aquifer at Homestake	**Larry Stetler** and **Arden Davis,** South Dakota School of Mines and Technology
9:20 – 9:50 a.m.	**REFRESHMENT BREAK**	
9:50 a.m. – 12:10 p.m.	**Concurrent Session 2A in Alpine Room – Hydrology Potpourri (2.5 PDH)** **Moderator – Derric Iles**, State Geologist, South Dakota Department of Environment and Natural Resources, Geological Survey Program, Vermillion, SD	**Concurrent Session 2P in Ponderosa Room – Surface-Water Quality Issues (2.5 PDH)** **Moderator – Joyce Williamson**, U.S. Geological Survey South Dakota Water Science Center
9:50 – 10:10 a.m.	*Assessing septic system and municipal sewer system risks* **– Paul Nabholz**, P.E.	*An update to the watershed assessment for the lower Cheyenne River watershed* **– Cory Foreman**, RESPEC, and **Scott Kenner**, South Dakota School of Mines and Technology
10:10 – 10:30 a.m.	*Characterization of effects of on-site wastewater disposal systems overlying fractured or solution-enhanced aquifers, Black Hills of South Dakota* **– Larry Putnam, Galen Hoogestraat**, U.S. Geological Survey, **J. Foster Sawyer**, South Dakota Department of Environment and Natural Resources	*Sediment source tracking of the lower Cheyenne River* **– Keshav Gnawali, Scott Kenner, Joshua Valder**, South Dakota School of Mines and Technology, and **Cory Foreman,** RESPEC
10:30 – 10:50 a.m.	*Rainwater harvesting in Uganda and South Dakota* **– Thomas Fontaine**, South Dakota School of Mines and Technology, and **Mark Costello**, South Dakota Department of Environment and Natural Resources	*Water quality monitoring and BIT tool to develop pathogen TMDL for the Lower Cheyenne River watershed* **– Suresh Mynam** and **Scott Kenner**, South Dakota School of Mines and Technology
10:50 – 11:10 a.m.	*Geochemical investigation of ground-water flow paths in the Madison aquifer, Wind Cave National Park, South Dakota* **– Jennifer Back**, National Park Service, and **Andrew Long**, U.S. Geological Survey	*Improving rangeland health in the Belle Fourche River watershed* **– Matthew Stoltenberg**, RESPEC
11:10 – 11:30 a.m.	*Estimating mixing ratios for source waters in the Madison aquifer based on water chemistry, Wind Cave National Park, South Dakota* **– Josh Valder, Andrew Long,** U.S. Geological Survey, **Jennifer Back**, National Park Service, and **Scott Kenner**, South Dakota School of Mines and Technology	*Development of a mercury TMDL for South Dakota lakes and reservoirs* **– James Stone, Larry Stetler, Pallaoor Sundareshwar**, South Dakota School of Mines and Technology, **Steve Chipps**, U.S. Geological Survey, **Michael Penn**, University of Wisconsin-Platteville
11:30 – 11:50 a.m.	*Understanding pore networks and chemical transport in karst aquifers—Spatial and temporal analyses of ground-water tracers* **– Andrew Long,** U.S. Geological Survey	*Environmental impacts associated with antimicrobial compounds Tylosin and Chlortetracycline usage within swine CAFO facilities* **– Erin Dreis, Laura Porath, James Stone**, South Dakota School of Mines and Technology, **Sharon Clay**, South Dakota State University, and **Garth Spellman**, Black Hills State University
11:50 a.m. – 12:10 p.m.	*South Dakota water rights do not protect head loss* **– Perry Rahn** and **Arden Davis**, South Dakota School of Mines and Technology	*Improving information management of storm water drainage systems using GIS—Rapid City, South Dakota* **– Jenifer Sorensen** and **Ray Bettmeng**, FourFront Design

12:10 p.m. – 1:30 p.m.	**LUNCH with Keynote Speaker in Rushmore H Room – Dr. Scott Kenner (1.0 PDH)** South Dakota School of Mines and Technology *Stormwater Quality Management in Rapid City*	
1:30 – 3:10 p.m.	**Concurrent Session 3A in Alpine Room – Inyan Kara/Uranium Mining (1.5 PDH)** **Moderator – Dr. Arden Davis**, South Dakota School of Mines and Technology	**Concurrent Session 3P in Ponderosa Room – Flooding (1.5 PDH)** **Moderator – Van Lindquist**, Administrative Manager, West Dakota Water Development District, Rapid City, South Dakota
1:30 – 1:50 p.m.	*Characteristics and vulnerability of the Inyan Kara aquifer: Blackhawk quadrangle, South Dakota* **– Elizabeth Francisco, Alvis Lisenbee** and **Arden Davis**, South Dakota School of Mines and Technology	*Rainfall totals from the Hermosa flash flood of August 17, 2007* **– Meagan Holm** and **Melissa Smith**, National Weather Service
1:50 – 2:10 p.m.	*In situ recovery of uranium at the Dewey Burdock project: Permitting issues, baseline results, and status* **– Mark Hollenbeck**, Powertech	*Peak flows associated with the August 17, 2007, thunderstorm near Hermosa, South Dakota* **– Daniel Driscoll** and **Joyce Williamson,** U.S. Geological Survey
2:10 – 2:30 p.m.	*Inyan Kara and the case for confined conditions: Dewey-Burdock in situ uranium project in Custer and Fall River Counties, South Dakota* **– Crystal Hocking and Dan Hoyer**, RESPEC	*The Hermosa flood of August 17, 2007: Extent, effects, and comparison to FEMA flood insurance rate map* **– Alvis Lisenbee** and **Christopher Pellowski**, South Dakota School of Mines and Technology
2:30 – 2:50 p.m.	*The process of in situ recovery of uranium at the Dewey-Burdock project* **– James Munro**, Powertech	*A mixed population approach for peak-flow frequency analysis for the Black Hills of western South Dakota* **– Daniel Driscoll, Steven Sando,** and **Charles Parrett**, U.S. Geological Survey
2:50 – 3:10 p.m.	*Three-dimensional geologic modeling of Dewey-Burdock in situ uranium project in Fall River County, South Dakota* **– Matthew Minnick** and **Crystal Hocking**, RESPEC	*Results of a reconnaissance-level paleoflood study for the Black Hills area, South Dakota* **– Daniel Driscoll** and **Jim O'Connor**, U.S. Geological Survey
3:10 – 3:35 p.m.	**REFRESHMENT BREAK**	
3:35 – 5:15 p.m.	**Concurrent Session 4A in Alpine Room – Abandoned Uranium Mine Issues (1.5 PDH)** **Moderator – Janet Carter**, U.S. Geological Survey South Dakota Water Science Center, Rapid City, SD	**Concurrent Session 4P in Ponderosa Room – Surface-Water Issues (1.5 PDH)** **Moderator – Daniel Driscoll**, U.S. Geological Survey South Dakota Water Science Center, Rapid City, SD
3:35 – 3:55 p.m.	*Surface water and sediment investigation concerning abandoned uranium mines within the South Cave Hills region, Harding County, South Dakota* **– Emmanuel Tuombe, Larry Stetler,** and **James Stone**, South Dakota School of Mines and Technology	*Belle Fourche irrigation district online irrigation consultant* **– Jared Oswald**, RESPEC, and **Hal Werner**, South Dakota State University
3:55 – 4:15 p.m.	*Results of a groundwater pumping test near abandoned uranium mines in the North Cave Hills, South Dakota* **– Larry Stetler, Arden Davis,** and **James Stone**, South Dakota School of Mines and Technology	*Development of operational charts for unautomated irrigation* **– Jeremy Sanson** and **Scott Kenner**, South Dakota School of Mines and Technology
4:15 – 4:35 p.m.	*Bacterial diversity associated with abandoned uranium mines in South Dakota* **– Gurdeep Rastogi, Rajesh Sani, Nicole Keegan, Larry Stetler,** and **Todd Menkhaus**, South Dakota School of Mines and Technology	*Hydraulic model of the Belle Fourche irrigation district north canal using EPA SWMM 5.0* **– Lacy Pomarleau** and **Scott Kenner**, South Dakota School of Mines and Technology
4:35 – 4:55 p.m.	*Interactions of uranium with iron minerals and environmental bacteria* **– Rajesh Sani, Gurdeep Rastogi**, South Dakota School of Mines and Technology, **Brent Peyton**, Montana State University, **Timothy Ginn**, University of California-Davis, **Nicolas Spycher**, Lawrence Berkeley National Laboratory, and **Alice Dohnalkova**, PNNL	*Trends in streamflow in the Missouri River Basin from 1957 to 2006* **– Parker Norton** and **Mark Anderson**, U.S. Geological Survey
4:55 – 5:15 p.m.	*Sorption of metals onto soil minerals near abandoned uranium mines in the South Cave Hills, Harding County, South Dakota* **– Gregory Kipp, Larry Stetler, James Stone,** and **Arden Davis**, South Dakota School of Mines and Technology	*Dean's Lake hydrology and hydraulic analysis* **– Jonathan Kusa** and **Mike Ryan**, HR Green

THURSDAY, APRIL 17, 2008
SESSION 1
7:50 – 9:20 A.M.

SCIENCE MANAGEMENT ISSUES

Characterization of the Precambrian Aquifer at Homestake

Dr. Larry D. Stetler
Associate Professor, Department of Geology and Geological Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *larry.stetler@sdsmt.edu*

Dr. Arden D. Davis
Professor, Department of Geology and Geological Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *arden.davis@sdsmt.edu*

Reduction of water levels inside the former Homestake gold mine at Lead, SD, will be measured using pressure sensors and analyzed to define permeability and storativity of the Precambrian aquifer at the site. Hydrologic properties of the Precambrian aquifer are mostly unknown. Pre-closure research has shown that about 2/3 of the current 750 gal/min inflow rate originate from flow through the fractured aquifer rocks. Bulk permeability has been estimated, based on inflow rates and the volume of mine openings, at about 10^{-6} to 10^{-7} cm/sec. Conversion of the mine into the DUSEL presents a unique opportunity to measure water level decline in a large 3-dimensional block of Earth's crust. Groundwater was pumped continuously from the Precambrian aquifer during the operation of the mine and pumps were turned off in 2003 after the mine closed. Post-closure flooding has resulted in more than 3000 ft of water rise. Levels are currently between the 4850-ft level and the 5000-ft level. Pumps will be turned on in early 2008 to reduce the water level to the 5300-ft level. Pressure sensors will be lowered into the water column at the No. 6 shaft, at either the No. 3 shaft which extends to the 5000-ft. level or the service shaft which extends to the 6800-ft level, at the No. 4 shaft which extends to the 7400-ft. level, and at the No. 5 air intake shaft which extends to the 6200-ft. level. Analysis of water-level data will be achieved using various models and tested for appropriateness of hydraulic conductivity determinations, including modifications for fracture flow and other factors. Models designed for flow into tunnels will also be used. The results can provide new information about the hydrology of fluid flow within a volume of the crust and in determination of hydrologic properties of the local Precambrian aquifer.

THURSDAY, APRIL 17, 2008
SESSION 2A
9:50 A.M. – 12:10 P.M.

HYDROLOGY POTPOURRI

Assessing Septic System and Municipal Sewer System Risks

Paul Nabholz, P.E.
13161 Cougar Pass Rd., Hot Springs, SD 57747, email: *pnabholz@gwtc.net*

Septic systems are often cited as a potential source of waterborne illness. To assess this risk and that of municipal sewer systems, the Center for Disease Control Surveillance reports for Waterborne Disease Outbreaks from 1985-2004 were reviewed. Annual death rates related to septic system and municipal sewer system failures were compared to rates of more common risks.

Compared to common risks the risk of death from drinking water related illnesses or poisonings is quite small. Septic systems were found safer than municipal sewer systems overall and when compared by per capita use.

Outbreaks that caused illnesses, but not necessarily death, were also reviewed. As one might expect, there were more reported outbreaks related to septic systems than municipal sewer systems, but those outbreaks caused fewer cases of illness. Because of the huge number of people made ill in the Milwaukee cryptosporidium outbreak, septic system related illnesses were a small fraction of those attributed to municipal sewer systems overall and when compared by per capita use.

Characterization of Effects of On-Site Wastewater Disposal Systems Overlying Fractured or Solution-Enhanced Aquifers, Black Hills of South Dakota

Larry D. Putnam
U.S. Geological Survey, South Dakota Water Science Center, 1608 Mountain View Road, Rapid City, SD 57702, email: *ldputnam@usgs.gov*

Galen K. Hoogestraat
U.S. Geological Survey, South Dakota Water Science Center, 1608 Mountain View Road, Rapid City, SD 57702, email: *ghoogest@usgs.gov*

J. Foster Sawyer
S.D. Department of Environment and Natural Resources, 2050 W. Main St., Rapid City, SD 57702, email: *Foster.Sawyer@state.sd.us*

The potential effects of on-site wastewater disposal systems (septic tanks with drain fields) on surface- and ground-water quality is an important water-resource concern for the Black Hills area of South Dakota. The hydrogeology of the area includes fractured or solution-enhanced bedrock, which is less effective at attenuating contaminants than other formations. In 2006, the U.S. Geological Survey, in cooperation with the South Dakota Department of Environment and Natural Resources and West Dakota Water Development District, initiated a study to characterize potential effects of on-site wastewater treatment systems. Study areas include developments overlying alluvium, terrace deposits and the underlying Spearfish Formation, the Minnekahta Limestone, and Precambrian rocks. One hundred and eleven ground-water samples from 61 wells and 26 surface-water samples were analyzed for nitrate, chloride, bromide, boron, and fecal indicators. Concentrations of nitrate + nitrite (NO_2+NO_3) in ground-water samples ranged from 0.009 to 24.3 milligram per liter (mg/L) with concentrations in 58 percent of samples greater than 2 mg/L and 13 percent of concentrations greater than 10 mg/L. Concentrations of NO_2+NO_3 in 22 surface-water samples ranged from 0.008 to 1.6 mg/L. The average of nitrogen isotope ratios from 13 samples with NO_2+NO_3 concentrations greater than 2 mg/L was 10 per mil, indicating warm-blooded animals or humans as the primary nitrate source. Twenty-six percent of ground-water samples indicated the presence of fecal indicators. Analysis of selected samples for 65 organic wastewater chemicals indicated that only a few samples had detectable concentrations and those values were only slightly greater than detection limits.

Rainwater Harvesting in Uganda and South Dakota

Thomas A. Fontaine
Department of Civil and Environmental Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *Thomas.Fontaine@sdsmt.edu*

Mark D. Costello
South Dakota Department of Environment and Natural Resources, 22839 Gateway Rd., Box Elder, SD 57719, email: *Costello@goldenwest.net*

Rainwater harvesting has been used in areas with dense population and limited water sources for many centuries. It is also becoming more common as a supplemental water source in places like Australia and the south western USA, and is even required by building codes in some cases. Advantages of rainwater harvesting systems include simplicity, low installation and operation costs, low energy requirements, and the ability to install independent, small scale water supplies in undeveloped areas. Harvested rainwater can be used for household, irrigation, livestock, and wildlife water supplies. Other benefits include the reduction of storm water runoff and the replenishment of soil moisture. The concept is relatively simple, involving a catchment (a roof or a pond), storage tank(s), and a gravity driven pipe system. The design must balance water demand, seasonal variability and volume of the rainfall supply, catchment area, and required storage volume. Other design details include reliability of rainfall, catch efficiency, gutter design, losses, treatment of rainwater, consequences of failure, aesthetics, and economics. The design of a typical rainwater supply system is illustrated based on a project in 2007 at the Malongo Boarding School in a rural region near Masaka, Uganda. An evaluation of alternative water sources for the 22 acre school compound indicated that no other source would be feasible. The design will provide water for 200 resident students by collecting rainfall from 19 buildings and storing the runoff in 48 water tanks. In the Great Plains and western regions of the USA, rainfall is already being collected in a similar manner and used for water supplies. However, as population centers continue growing, and as diminishing snow pack and reservoir levels threaten existing water supplies, expanded use of small scale rainwater harvesting systems will provide simple, low energy, and cost effective solutions for preserving our water resources.

Geochemical Investigation of Ground-Water Flow Paths in the Madison Aquifer, Wind Cave National Park, South Dakota

Jennifer T. Back
Water Resources Division, National Park Service, 1201 Oakridge Drive, Fort Collins, CO 80525, email: *jennifer_back@nps.gov*

Andrew J. Long
U.S. Geological Survey, South Dakota Water Science Center, 1608 Mountain View Road, Rapid City, SD 57702, email: *ajlong@usgs.gov*

The purpose of this study is to evaluate ground-water flow paths in the vicinity of Wind Cave National Park, located in the southern Black Hills of South Dakota. Wind Cave National Park is home to one of the world's most extensive and complex cave systems. Underground lakes within the cave system are a unique feature in the Black Hills and offer a rare view of ground-water flow in the Madison aquifer. Recent proposals to increase ground-water withdrawals from the Madison aquifer in the vicinity of the park are of concern. An immediate need exists to characterize source-water areas, discharge areas, and ground-water flow paths. A geochemical investigation of the Madison aquifer in the southern Black Hills was initiated to address these needs. Stable isotope, tritium, and chlorofluorocarbon (CFC) data were combined with other water chemistry data to evaluate possible ground-water flow paths. Sources of recharge to the Madison aquifer are sinking streams and infiltrating precipitation. Discharge occurs from water table springs near the outcrop area and from artesian springs south of the park. Water samples were collected from sinking streams, cave drip water, underground lakes, wells, and springs in the vicinity of the park. Sinking streams, cave sites, and nearby wells are similar in composition and represent locally recharged water. Artesian springs have a different isotopic signature than locally recharged water and may be influenced by regional flow. Enriched calcium, magnesium, and sulfate concentrations in artesian springs likely reflect dissolution of anhydrite in the Madison aquifer or overlying Minnelusa aquifer. Hydraulic connection between the Madison and Minnelusa aquifers is spatially variable. Geochemical analysis of Beaver Creek spring (artesian) indicates the presence of a large fraction of Madison or Minnelusa aquifer water that was recharged locally. CFC concentrations indicate that ground-water age at several sites, including one cave site, is likely a mixture of modern water and water that is decades old or more.

Estimating Mixing Ratios for Source Waters in the Madison Aquifer Based on Water Chemistry, Wind Cave National Park, South Dakota

Joshua F. Valder
U.S. Geological Survey, South Dakota Water Science Center, 1608 Mt. View Road., Rapid City, SD 57702, email: *jvalder@usgs.gov*

Andrew J. Long
U.S. Geological Survey, South Dakota Water Science Center, 1608 Mt. View Road., Rapid City, SD 57702, email: *ajlong@usgs.gov*

Jennifer T. Back
Water Resources Division, National Park Service, 2501 Oakridge Drive, Fort Collins, CO 80525, email: *jennifer_back@nps.gov*

Scott J. Kenner
Civil and Environmental Engineering Department, 501 East Saint Joseph Street, Rapid City, SD 57701, email: *scott.kenner@sdsmt.edu*

The U.S. Geological Survey and the National Park Service are conducting a study of the Madison aquifer in Wind Cave National Park in the southern Black Hills of South Dakota. Wind Cave, which is within the karstic Madison Limestone, provides a unique insight into ground-water flow in the Madison aquifer because the cave contains underground lakes, drips, and flowing water. The purpose of the study is to better understand ground-water flow through the Madison aquifer and to characterize source-water areas for different sample locations based on water chemistry. This karst environment is a complex system to model because of fracture enlargement from dissolution reactions between ground water and the surrounding limestone. Therefore, to identify potential recharge areas or other source waters for the study area, an end member mixing model, utilizing principal component analysis, is used to estimate the water chemistry of probable end members (source waters). End-member chemistries are estimated using two different methods. The first method involves the estimation of end-member chemistry assuming that none of the samples represent any specific end member. The second method determines which samples most likely represent end members through statistical evaluation. Possible end members include local outcrop recharge and regional ground-water flow from west of the Black Hills. The mixing proportions of these end members are estimated for several sampling sites. Samples collected from 20 locations in 2007 were analyzed for major ions, arsenic, nitrate, and stable isotopes. Results of this study can be applied to better characterize ground-water flow through the complex karst environment and can provide insight about probable areas where the Madison aquifer is more susceptible to ground-water contamination in the southern Black Hills.

Understanding Pore Networks and Chemical Transport in Karst Aquifers—Spatial and Temporal Analyses of Ground-Water Tracers

Andrew J. Long
U.S. Geological Survey, South Dakota Water Science Center, 1608 Mt. View Road, Rapid City, SD 57702, email: *ajlong@usgs.gov*

Some karst aquifers are characterized by an organized network of passages that strongly influence ground-water flow and chemical transport. This network may include main conduits that are hydraulically connected to an annex system of smaller dissolution passages or fractures. Ground-water age can be estimated based on age-dating tracers such as chlorofluorocarbons (CFCs), SF_6, tritium, ^{14}C, and ^{36}Cl. When several proximal sites are sampled, spatial anomalies of young ground water may indicate fast moving, focused flow and thus the likely presence of conduits. This occurs when samples near conduits have a larger fraction of modern water than do samples farther from conduits. Knowledge of tectonic features (e.g., faults, anticlines, synclines) also may help to interpret these spatial distributions because tectonics can influence the genesis of dissolution features.

For a particular well or spring, the distribution of ground-water age in samples may indicate how the karst pore network affects chemical transport. This age distribution can be estimated by convolution modeling of age-dating tracers, which are particularly useful if the age distribution spans decades. Convolution modeling is a useful method for understanding how the geochemical signal in recharge water is influenced as this water moves through the aquifer media, resulting in a particular geochemical response at a well or spring. Age distributions for multi-porosity karst aquifers may be multimodal and thus characterize two or more different porosity types, such as major conduits and associated annex systems. Temporal changes in an age distribution may reveal how fluctuating recharge rates affect the chemistry of water from a well or spring.

Modeling the signals of conservative tracers that fluctuate with higher frequencies than do age-dating tracers (e.g., $\delta^{18}O$ or $\delta^{2}H$) may provide additional information concerning geologic controls that apply specifically to the modern water component. For example, transport in conduits might be distinguishable from transport in anastomosing passages based on these tracers. Also, a combination of spatial and temporal data analyses may reveal phenomena such as changes in conduit flow patterns resulting from changing climatic conditions.

South Dakota Water Rights Do Not Protect Head Loss

Dr. Perry H. Rahn
Department of Geology and Geological Engineering, South Dakota School of Mines and Technology, 501 E. Saint Joseph Street, Rapid City, SD 57701, email: *perry.rahn@sdsmt.edu*

Dr. Arden D. Davis
Department of Geology and Geological Engineering, South Dakota School of Mines and Technology, 501 E. Saint Joseph Street, Rapid City, SD 57701, email: *arden.davis@sdsmt.edu*

Current regulations concerning an application for a permit to withdraw ground water require that there is no loss of ground water from the aquifer. This is a reasonable protection for a water-table aquifer. However, ground water could be withdrawn from a deep artesian aquifer and it could still remain saturated. But the artesian pressure could be severely impacted. Currently permits are being considered by the Water Rights Division of the SD DENR where head loss in an aquifer would be severely impacted. Examples include:

(1) Butte/Meade Sanitary District has a Madison well. A Madison well to be drilled for a proposed ethanol plant in Belle Fourche was given approval in 2007.
(2) The Southern Black Hills Water Systems, Inc., applied for a permit to drill a Madison well near the big spring along Beaver Creek. A loss of head of head would have a severe impact on the spring and the discharge of water in Beaver Creek. There are surface water rights downstream on Beaver Creek. Some loss of volume of water stored in the aquifer would occur near Wind Cave. Presently this application is on hold.

The main difficulty in protecting the head in artesian aquifers is that the well owner rarely knows the head in his well. Also, it is almost impossible to have enough DENR observation wells to cover all of South Dakota. Therefore there is no easy solution to this problem.

Surface-water rights generally are over-appropriated in the Black Hills. Many streams are fed by springs whose source is the Madison Limestone. Thus, a decrease in spring flow could affect existing surface-water rights on these streams. Surface water and ground water are interconnected and do not exist separately from each other, especially in karst aquifers such as the Madison Limestone. However, South Dakota law currently does not formally recognize an interconnection between the two. This could eventually result in a confrontation over water use if a holder of a surface-water right is affected by large-scale pumping of ground water near a spring.

THURSDAY, APRIL 17, 2008
SESSION 2P
9:50 A.M. – 12:10 P.M.

SURFACE-WATER QUALITY ISSUES

An Update to the Watershed Assessment for the Lower Cheyenne River Watershed

Cory S. Foreman
Engineer, Water & Natural Resources, RESPEC, P.O. Box 725, Rapid City, SD 57709,
email: *Cory.Foreman@respec.com*

Scott J. Kenner
Professor, Department of Civil and Environmental Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *Scott.Kenner@sdsmt.edu*

A Phase I Total Maximum Daily Load (TMDL) assessment project for the Cheyenne River Watershed in western South Dakota, which focused on historic data analysis along with physical habitat assessments, was completed in the summer of 2006. Gaps in historic hydrology and water-quality data were identified as a part of the Phase I project. A Phase II Assessment Project focusing on total suspended solids (TSS) and fecal coliform bacteria began in May 2007, implementing a sampling plan focused on reducing gaps in the previous data analysis. Data collection in 2007 focused on water-quality samples collected during baseflow and storm events, discharge measurements aimed at developing stage discharge relationships for continuous flow estimates, additional physical habitat assessments at key locations, and benthic macroinvertebrate samples. Water-quality samples were collected at 19 sites during the 2007 sampling season. Several sites were dry during most of 2007, flowing only after major rain events. One site did not flow during 2007. Thirteen sites were U.S. Geological Survey (USGS) sites where real-time discharge and water quality data was available. Continuous stage recorders were installed at six sites, where stage/discharge measurements were recorded. Two sites were state Water Quality Monitoring (WQM) stations, where discharge was the only added data collection. A total of 88 baseflow samples and 79 storm events samples were collected through the end of January 2008. Additionally, a total of 49 storm events were sampled at various locations using passive sediment samplers. Sixteen additional physical habitat assessments were conducted, bringing the total between the two projects to 64 assessments.

Monthly baseflow sampling is continuing, with event sampling resuming in March of 2008. Additional Geographic Information System (GIS) analysis of land use, geology, and soil types is currently underway. Watershed modeling using the program **Hydrologic Simulation Program Fortran** (**HSPF**) is also underway.

Sediment Source Tracking of the Lower Cheyenne River

Keshav R. Gnawali
Student, Department of Civil and Environmental Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street , Rapid City, SD 57701,
email: *mrgnawali@yahoo.com*

Scott J. Kenner
Professor, Department of Civil and Environmental Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *Scott.Kenner@sdsmt.edu*

Joshua F. Valder
Doctoral Candidate, Department of Atmospheric and Environmental Science, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *valderj@rushmore.com*

Cory S. Foreman
Engineer, Water & Natural Resources, RESPEC, P.O. Box 725, Rapid City, SD 57709,
email: *Cory.Foreman@respec.com*

The overall goal of the Lower Cheyenne River Total Maximum Daily Load (TMDL) Assessment Project is to collect biological, physical and chemical data on eight stream sections of the Lower Cheyenne River. The 2006 South Dakota Integrated Report for Surface Water Quality assessment listed twenty six Cheyenne River segments as impaired water bodies which require a TMDL study. The outcome of this project will be the TMDL assessment reports for the impaired river sections along with sediment source tracking and Best Management Practices (BMP) recommendations for each of the impaired sections .The sediment source tracking study will provide a recommendation of the sampling sites, sampling methods and analysis techniques for further detailed sediment source tracking study.

Water chemistry and suspended sediment samples were collected at nineteen locations for base flow and event flow sampling. Suspended sediments were collected using passive samplers. Geological and soil analysis of the watershed was conducted using ArcGIS to determine major rock types and soil types of the Cheyenne River watershed. Mineralogical information of the major rock units were found in previously published materials. Relevant previous studies have shown sediments are carried toward the stream by pulsations generated by frequent rainfall with the exception of large flood events. Flood plain deposits and terrace deposits contain a mixture of minerals and soils representing the contributing watershed. . In addition, sediments closer in proximity to the stream have a greater assortment. The complete mixture of sediments in each stream indicates the need of a mixing model for accurate identification of sediment sources. Potential modeling methods include a multi variate mixing model and a mineralogical analysis of both, suspended solids and surface sources. Analysis of the suspended sediment data of the Cheyenne River and its tributaries collected during the summer of 2007 were used as a preliminary investigation tool to establish the relationship between suspended sediments and source areas. Preliminary analysis of the suspended solids has shown the Badlands as a major contributor of the sediments.

Water Quality Monitoring and BIT Tool to Develop Pathogen TMDL for the Lower Cheyenne River Watershed

Suresh Kumar Mynam
Student, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701, email: *sureshkumar.mynam@sdmines.sdsmt.edu*

Dr. Scott J. Kenner
Professor, Department of Civil and Environmental Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *Scott.Kenner@sdsmt.edu*

The main focus of the research on the Lower Cheyenne River is to identify potential point and non-point sources that are contributing fecal coliform load and to suggest best management practices (BMP's) for impaired water bodies. About 208 stream miles on the lower Cheyenne River, from the confluence of Rapid Creek to the mouth of the River were listed as impaired due to exceedances of fecal coliform published in the 2006 South Dakota Integrated Report for Surface Water Assessment. Fecal coliform bacteria are used as an indicator of potential human health risk in the waterbody.

Samples collected at 19 sites throughout the Watershed from May through September 2007 were analyzed for fecal coliform concentration. Two sets of samples at 4 sites were analyzed using molecular source tracking methodology. The results from the former are reported in terms of cfu/100 ml (colony forming units) and the results from the latter are reported in terms of presence or absence of certain species (cow, human, deer and bird).

The land use of the entire watershed has been classified into four types; built-up, cropland, pasture/range land and forested. Wildlife and livestock counts, on a county basis, have been obtained and are being distributed across the watershed based on land use classification. The data from the distribution of wildlife and livestock is used as input to estimate the monthly accumulation of fecal load per sub-watershed. The Bacterial Indicator Tool (BIT) analysis is used to estimate the accumulation rate of fecal coliform based on the four land uses and the distribution of wildlife and livestock. The output from the BIT tool is used as an input to WinHSPF and Hydrologic Simulation Program Fortran (HSPF) to simulate pathogen loadings and evaluate implementation of best management practices.

Improving Rangeland Health in the Belle Fourche River Watershed

Matthew B. Stoltenberg
Rangeland Scientist, RESPEC, P.O. Box 725, Rapid City, SD 57709,
email: *Matt.Stoltenberg@respec.com*

The Belle Fourche River is identified in the 1998 and 2002 South Dakota 303(d) Waterbody Lists and the 2004 Integrated Report for Surface Water Quality Assessment as impaired because of elevated total suspended solids (TSS) concentrations. Properly functioning riparian areas can significantly reduce nonpoint source pollution by intercepting surface runoff; by settling, filtering, and storing sediment and associated pollutants; and by stabilizing banks. The goal of this project is to bring Belle Fourche River and Horse Creek in compliance with TSS standards by the Year 2014 by implementing Best Management Practices (BMPs) recommended by other in-progress Total Maximum Daily Loads (TMDL) studies for waterbodies within the watershed. One of the methods for reaching this goal includes working with local producers within the Belle Fourche River Watershed to develop improved riparian and upland grazing plans that positively impact TSS in the river. Rangeland planning includes the use of off-site water, cross fences, exclusion fences, and scheduled grazing to improve riparian and upland health; in, turn reducing TSS in the river. Along with planning, assistance in finding funding sources for the projects was given to the producers. To date, the project has resulted in over 100,000 acres of range planning, including 12,000 acres of improved riparian planning. Implementation projects began last fall and will continue into next summer. In addition to planning and implementation, a research project tying range condition to runoff in the watershed is also being conducted. Results from this research project will be beneficial in helping monitor improvements in the watershed and in helping assess problem areas in the future.

Development of a Mercury TMDL for South Dakota Lakes and Reservoirs

Dr. James Stone
Assistant Professor, Department of Civil and Environmental Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD, 57701,
email: *james.stone@sdsmt.edu*

Dr. Larry Stetler
Associate Professor, Department of Geology and Geological Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *larry.stetler@sdsmt.edu*

Dr. Pallaoor Sundareshwar
Assistant Professor, Institute of Atmospheric Sciences, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *Pallaoor.Sundareshwar@sdsmt.edu*

Dr. Steve Chipps
U.S. Geological Survey, South Dakota Cooperative Fish & Wildlife Research Unit, Department of Wildlife and Fisheries Sciences, South Dakota State University, Brookings SD 57007,
email: *Steven.chipps@sdstate.edu*

Dr. Michael Penn
Professor, Department of Civil Engineering, University of Wisconsin-Platteville,
1 University Plaza, Platteville, WI 53818-3099, email: *mrpenn@uwplatt.edu*

Currently seven lakes and reservoirs within South Dakota are EPA 303(d) listed as mercury impaired waterbodies. In cooperation with the South Dakota Department of Environment and Natural Resources (SD-DENR), a series of interdisciplinary studies will commence during Summer 2008 to better understand mercury loading and cycling processes within South Dakota air and watersheds, with the goal of providing information to complete a state-wide mercury TMDL for South Dakota waterbodies as mandated by EPA 303(d) requirements. The project approach includes an assessment of existing surface water quality, mercury fish tissue data, and watershed characteristics, and collection of additional water quality data. Combined wet and dry atmospheric mercury deposition fluxes will be estimated through the deployment of passive bulk mercury deposition monitors at six locations throughout South Dakota. Lake and reservoir sediment cores will also be collected and analyzed for mercury and lead-210 to provide quantitative estimates of current and historical mercury fluxes. These data will further the understanding of mercury fate and transport processes responsible for elevated mercury fish tissue concentrations within South Dakota lakes and reservoirs.

Environmental Impacts Associated with Antimicrobial Compounds Tylosin and Chlortetracycline Usage within Swine CAFO Facilities

Erin Dreis
M.S. Student, Department of Civil and Environmental Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701, email: *Erin.Dreis@mines.sdsmt.edu*

Laura Porath
B.S. Student, Department of Environmental Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701, email: *Laura.Porath@mines.sdsmt.edu*

Dr. James Stone
Assistant Professor, Department of Civil and Environmental Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701, email: *james.stone@sdsmt.edu*

Dr. Sharon Clay
Professor, Department of Plant Sciences, South Dakota State University, Box 2140C Room 245C, Brookings, SD 57007, email: *SHARON_CLAY@SDSTATE.EDU*

Dr. Garth Spellman
Research Faculty, CCBR/Westcore, Black Hills State University, 1200 University Street, Unit 9053, Spearfish, SD 57799-9053, email: *garthspellman@bhsu.edu*

Tylosin and chlortetracycline (CTC) are two of the most commonly administered antimicrobial compounds within confined animal feedlot operations (CAFO) for the enhancement of swine growth rates, and to prevent, control, and treat swine related health problems. Both chemicals are excreted in bioactive forms. The purpose of this multi-disciplinary research is to better understand the effects of tylosin and CTC on manure degradation within CAFO manure handling systems by using simulated batch experiments designed to model anaerobic lagoon treatment processes. The scope of this problem is not only relevant to the agriculture industry, but also to the environmental engineering discipline on furthering the understanding of how “emerging contaminants” may be removed from both agricultural and municipal waste treatment processes. Combined urine and manure samples from pigs were given dietary corn-soybean meal treatments containing 100 g kg^{-1} of complete feed for tylosin, 22 mg kg^{-1} body weight CTC, and no treatment, were collected, homogenized, and stored at 4ºC at the South Dakota State University (SDSU) swine research facility. Batch manure treatment experiments at the South Dakota School of Mines (SDSM&T) were designed to assess changes in biological manure degradation as a function of antimicrobial concentration. A total of five treatments were incubated at 20ºC, used to simulate temperatures common to the upper midwestern United States. The treatments include: control with no antimicrobial agents, tylosin, CTC, and duplicate controls containing sodium azide to discern abiotic from biotic effects. Triplicate reactor vials were sacrificed (daily for initial 14 d and weekly for remaining 180 d) and analyzed for pH, alkalinity, conductivity, methane, hydrogen sulfide, carbon dioxide, SCOD, VSS, TSS, and VFA. In addition, changes in microbial community populations and diversity among treatments were monitored using terminal restriction fragment length polymorphism (T-RFLP; at Black Hills State University WestCore genomics facility). Results suggest the presence of CTC increased rates of SCOD (hydrolysis) and decreased methane and carbon dioxide production compared to control treatments, while tylosin treatments were unchanged. T-RFLP profiles from three restriction enzyme digests (MseI 103, AluI 341, and AluI 441) from time 0 through 95 days show significant differences in microbial diversity among both treatments suggesting acetoclastic and hydrogentrophic methanogen populations were inhibited compared to control treatments.

Improving Information Management of Storm Water Drainage Systems Using GIS – Rapid City, South Dakota

Jenifer Sorensen, P.E., Ph.D., GISP
FourFront Design, Inc., 517 Seventh Street, Rapid City, SD 57701,
email: *jsorensen@4front.biz*

Ray Bettmeng, P.E.
FourFront Design, Inc., 517 Seventh Street, Rapid City, SD 57701,
email: *rbettmeng@4front.biz*

Drainage basin design plans for twenty watersheds in and around Rapid City have been written over the last 18 years to assist drainage management. Together, these plans cover an area of 65 square miles and include about 900 individual drainage features. Each plan uses the results from a hydraulic model to determine water flows and storage capacity through a watershed based on the size of the drainage features and the impacts of current and future development. The plans were written by a variety of authors, differ in the information provided, and for the most part are only available as hard copy documents.

For this project, pertinent tabular information from these plans was added as attributes in GIS data layers. Information compiled included status (existing or proposed), type, description, recommendations, and design flows at build out. The drainage features were represented as either lines for surface flow or polygons for detention, and were mapped in the GIS using existing digital hydrology data, aerial photos, GPS, and field observation. Drainage features were then assessed in the field and photographed.

GIS analysis of the resulting data provides information on the number of existing vs. proposed features, their condition, which features require further improvement, approximate lengths and areas of features, and other summary statistics. The City can now quickly review the locations and attributes of drainage features in a watershed before going into the field in response to citizen calls or other inspections. Future possibilities include using the data to prioritize drainage infrastructure maintenance and construction, provide a means to track maintenance and citizen complaints, further assist with NPDES Phase II permit implementation, and assist with storm water management master planning.

THURSDAY, APRIL 17, 2008
LUNCHEON
12:10 P.M. – 1:30 P.M.

STORMWATER QUALITY MANAGEMENT IN RAPID CITY
(RUSHMORE H ROOM)

THURSDAY, APRIL 17, 2008
SESSION 3A
1:30 – 3:10 P.M.

INYAN KARA/URANIUM MINING
(ALPINE ROOM)

Characteristics and Vulnerability of the Inyan Kara Aquifer: Blackhawk Quadrangle, South Dakota

Elizabeth Francisco
Geology and Geological Engineering Department, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *elizabeth.francisco@mines.sdsmt.edu*

Dr. Alvis L. Lisenbee
Department of Geology and Geologic Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD, 57701,
email: *alvis.lisenbee@sdsmt.edu*

Dr. Arden D. Davis
Department of Geology and Geologic Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD, 57701,
email: *arden.davis@sdsmt.edu*

Exposures one-half to two miles wide of sandstone and mudstone of the Fall River Fm. and the Lakota Fm. (the Inyan Kara aquifer recharge area) occur in the NNW-trending, pine-covered hills (the “Cretaceous hogback”) east of Interstate 90 in the Blackhawk quadrangle. These units are generally east-dipping strata, folded by the Piedmont anticline. In the prairie area east of the ridges, this is the first aquifer reached in drilling, with depths varying from a few feet near the outcrop to 1,200 feet in the northeastern corner of the quadrangle.

Based on driller’s logs, electric logs, measured sections, and geologic cross sections, thickness of the Lakota Fm averages 130 ft (60% sandstone) and the Fall River 180 ft (20% sandstone) of marine estuarine and continental channel and flood plain deposits. Sandstone porosity ranges from 23-28% and sandstone bodies (the actual aquifer) have greater lateral continuity and thickness in the Lakota Fm. The hydraulic gradient in the Blackhawk area is 0.012, the estimated hydraulic conductivity is one to three ft/day, and the estimated infiltration rate in the outcrop area is one to three in/yr.

Aquifer susceptibility was assessed qualitatively using a modified KARSTIC method, rating hydrologic units in terms of aquifer material, overlying material, and secondary structures – applied particularly to the sandstone portions. The resulting ratings are medium for the Fall River Fm and high for the Lakota Fm, based upon the greater continuity and thicknesses of sandstone components in the latter unit.

Aquifer vulnerability is the risk of ground water contamination by land use (e.g., on-site septic systems, roads, agricultural lands, and development). On-site waste water systems have proliferated here in the last 30 years (13 in 1953, 15 in 1971, 193 in 1998, and 310 in 2004). The concentration of home sites is greater than 40 per square mile in some areas, and numerous blacktop and graded roads cross the recharge area. Alluvial-covered areas along Little Elk Creek are assigned Extremely High vulnerability ratings as a result of abundant septic systems in alluvium of the flood plain in the Piedmont area upstream immediately west of the quadrangle.

In Situ Recovery of Uranium at the Dewey Burdock Project: Permitting Issues, Baseline Results, and Status

Mark Hollenbeck
Project Manager, Powertech (USA) Inc., P.O. Box 812, Edgemont, SD 57735,
email: *mhollenbeck@powertechuranium.com*

Running hard against the southwest flank of the Black Hills lies the 11,000-acre Dewey-Burdock site located on private land 12 miles northwest of Edgemont, South Dakota. Powertech USA implemented comprehensive baseline environmental monitoring efforts to satisfy federal and state regulations. Baseline conditions will allow assessment of the impacts of construction, operation, and closure of the project on human and environmental health.

Preliminary results from 6 months of surface, groundwater, and radiological monitoring are available. Eight surface water stations located upstream and downstream on one river and two creeks were sampled monthly for 2 consecutive quarters. The Upper Cheyenne River station exceeds radiological standards for uranium and gross alpha particles, indicating the presence of a uranium source near this site. The results of quarterly sampling from the groundwater wells indicate that most wells exceed drinking water radiological standards as these wells are in the ore body. Nine particulate hi-vol filters have been composited for gravimetric and radiological analysis.

Direct gamma, ambient radon, and radon flux measurements were obtained across the 11,000-acre project area, which includes the former open pit mines along the eastern edge of the property. As expected, direct gamma and ambient radon are elevated near the former pit areas and along rock outcrops. Radon flux measurements are within normal ranges for the western United States.

Ecological studies identifying soil types and vegetation communities and characterizing wildlife species continue. In addition, wetland areas have been identified and delineated for potential impact evaluation. Preliminary field work indicates that no threatened or endangered plant or wildlife species are present within the property. Bald eagles have been sighted on the property, but no significant impacts are anticipated since area habitat is adequate. The archaeological survey of the entire property found numerous sites which are being evaluated for historical significance.

Inyan Kara and the Case for Confined Conditions: Dewey-Burdock In Situ Uranium Project in Custer and Fall River Counties, South Dakota

Crystal M. Hocking
Geologist, RESPEC, P.O. Box 725, Rapid City, SD 57709,
email: *Crystal.Hocking@respec.com*

Dr. Dan Hoyer
Vice President, RESPEC, P.O. Box 725, Rapid City, SD 57709,
email: *Dan.Hoyer@respec.com*

Powertech (USA) Inc. has proposed to conduct in situ solution mining within a uranium roll front deposit in the Inyan Kara aquifer. As part of the permitting process, proof that the mined aquifer is confined must be presented. Confinement is necessary to control the vertical movement of mining fluids and prevent contamination of other aquifers. In the Dewey-Burdock area, there are three main lines of evidence that all indicate the Inyan Kara is a confined aquifer: geologic, chemical, and hydrologic.

The Inyan Kara aquifer, made up of the Fall River and Lakota Formations, is dominated by interbedded near-shore sandstone, siltstone, and shale deposits. Along the eastern edge of the Dewey-Burdock property, the Inyan Kara outcrops but becomes overlain by as much as 500 feet of Cretaceous shale along the western edge of the property. Below, 50 to 100 feet of low permeability Morrison shale separate the Inyan Kara from the Sundance aquifer.

In an effort to understand the current groundwater geochemistry, historical Tennessee Valley Authority (TVA) data collected in 150 wells from 1979 through 1984 was analyzed and compared to regional water quality in other aquifers. Chemically, the water quality in the Inyan Kara is different from other aquifers.

Results from TVA pump test analysis indicate that the Inyan Kara aquifer is best modeled by Theis confined conditions, although internal leakage between lenses occurs. Water levels in Inyan Kara wells also stand above the top of the aquifer with some wells in the property vicinity being flowing artesian wells.

The Process of In Situ Recovery of Uranium at the Dewey-Burdock Project

Dr. James Munro
Senior Process Design Engineer, Powertech (USA) Inc., P.O. Box 812, Edgemont, SD 57735,
email: *jmunro@powertechuranium.com*

This paper describes the process to be used to mine uranium using the In Situ Recovery technique at the 11,000-acre Dewey-Burdock project located 12 miles northwest of Edgemont, South Dakota. Oxidation of uranium from its reduced state solubilizes the uranium ion causing it to go into solution in the ore-bearing aquifer. Once solubilized, the uranium can be pumped to the surface where it is removed via an ion exchange process.

Typically, the well field consists of a network of injection wells surrounding centralized production wells. Overpumping the production wells maintains a cone of depression surrounding the network, preventing the loss of lixiviant outside the intended area of concern.

The lixiviant is prepared using natural groundwater fortified with oxygen and, if necessary, carbon dioxide and/or bicarbonate. The lixiviant is pumped into the injector wells, pulled through the aquifer containing the mineralized zone, and extracted by the production well. A bleed of 1–2 percent is shunted to a holding pond to maintain positive pressure on the aquifer. Production flow rates are estimated at 20–30 gallons per minute per well.

At the surface, the pregnant lixiviant flows through ion exchange columns and the uranium is transferred to resin beads. The resin beads will be trucked to a central processing facility for further refinement into yellowcake—the final product for the first stage of the uranium fuel cycle.

The lixiviant is refortified with oxygen and bicarbonate and recirculated through the aquifer's mineralized zone to minimize usage of native groundwater and maximize uranium production.

Three-Dimensional Geologic Modeling of Dewey-Burdock In Situ Uranium Project in Fall River County, South Dakota

Matthew D. Minnick
Engineer, RESPEC, P.O. Box 725, Rapid City, SD 57709,
email: *Matthew.Minnick@respec.com*

Crystal M. Hocking
Geologist, RESPEC, P.O. Box 725, Rapid City, SD 57709,
email: *Crystal.Hocking@respec.com*

Powertech Uranium Corporation has proposed to conduct in situ mining within a uranium-enriched ore deposit on the proposed permit area known as the Dewey-Burdock project. The project is located on the southwest flank of the Black Hills, approximately 12 to 15 miles north-northwest of Edgemont, South Dakota, and spans northern Fall River and southern Custer Counties. The proposed permit area consists of approximately 11,180 acres of private land and federal minerals.

A comprehensive understanding of the geology is required for permit requirements, conceptual geohydrologic model, mine design, ore reserve calculations, and public relations visualization. A three-dimensional (3D) geologic model for the proposed permit area was built in Mining Visualization Systems (MVS), a 3D visualization software package by C Tech Development Corporation. Historical Tennessee Valley Authority (TVA) data consisting of approximately 4,000 exploration holes with geophysical logs and interpreted ore grade maps, augmented with data from the current exploration process, was used to build the models.

The model targets the consolidated sedimentary rocks of Jurassic and Cretaceous age that comprise and bound the Inyan Kara group which hosts the uranium ore. A general 3D stratigraphic model over the proposed permit area of the Morrison, Lakota, Fuson, Fall River, Skull Creek, Mowry, and Belle Fourche Formations was built. A general geohydrologic model consisting of the sandstone and aquitard lithologies of the Fall River and Lakota Formations bound by the shales of the Morrison, Fuson, and the overlying Graneros Group was also built. Similar detailed geohydrologic lithology models were built along the trend of the roll front ore bodies in individual mining unit blocks.

A 3D grid was generated from the results of the geohydrologic model containing material attributes for numerical groundwater modeling. Results from the numerical modeling were then input into MVS for visualization of groundwater flow paths.

THURSDAY, APRIL 17, 2008
SESSION 3P
1:30 – 3:10 P.M.

FLOODING
(PONDEROSA ROOM)

Rainfall Totals from the Hermosa Flash Flood of August 17, 2007

Megan Holm
Meteorologist, NOAA/National Weather Service, 300 E. Signal Dr., Rapid City, SD 57701,
email: *meagan.holm@noaa.gov*

Melissa Smith
Hydrologist, NOAA/National Weather Service, 300 E. Signal Dr., Rapid City, SD 57701,
email: *melissa.smith@noaa.gov*

During the evening of 17 August 2007, heavy rain over north-central Custer County produced a flash flood in Hermosa, SD. At 6:00 pm, an intense thunderstorm developed along the eastern foothills of the Black Hills in central Custer County and remained stationary for at least 2 hours. Southeasterly low-level winds fed moist air into the storms causing heavy rain to fall in and around Hermosa. By 9:00 pm, approximately 19 square miles had received over 6 inches of rainfall and over 10 inches of rain fell in a 1 square mile area just west of Hermosa. The large amount of precipitation from this storm in such a short period of time caused flash flooding across north-central Custer County. According to the Rapid City Journal, the storm damaged 60 to 70 homes around the Hermosa area. At least a half mile section of railroad tracks and the embankment, as well as several roads and vehicles, were damaged. This presentation will focus on the meteorological aspects associated with this storm.

Peak Flows Associated with the August 17, 2007, Thunderstorm near Hermosa, South Dakota

Daniel G. Driscoll
U.S. Geological Survey, South Dakota Water Science Center, 1608 Mt. View Road, Rapid City, SD 57702, email: *dgdrisco@usgs.gov*

Joyce E. Williamson
U.S. Geological Survey, South Dakota Water Science Center, 1608 Mt. View Road, Rapid City, SD 57702, email: *jewillia@usgs.gov*

During the evening of August 17, 2007, intense rainfall occurred along the eastern flanks of the Black Hills of western South Dakota. A major thunderstorm system developed in the vicinity of Hermosa, and remained stationary for about 2 hours. Rainfall totals were estimated from a post-event survey of area residents along with analysis of Doppler radar imagery. Approximately 19 square miles received about 6 inches of rainfall during this 2-hour period, and rainfall totals of slightly more than 10 inches were documented in a 1- to 2-square-mile area just west of Hermosa.

This intense storm caused substantial flooding and resulted in a peak stage of 16.14 feet (flood stage is 8.0 feet) at the U.S. Geological Survey gaging station 06406000 (Battle Creek at Hermosa). This stage has been exceeded only by a stage of 17.72 feet on June 10, 1972, when a massive thunderstorm caused severe flooding along Battle Creek and several other major drainages north and along the front range of the Black Hills. Indirect measurements of peak flow for the August 2007 event were made for (1) the gage location, which is located just downstream from Highway 79; (2) Grace Coolidge Creek at the Highway 36 crossing just upstream from the confluence with Battle Creek; and (3) Battle Creek at the Highway 40 crossing, just upstream from the confluence with Grace Coolidge Creek. Sediment movement and debris accumulations provided obvious evidence of exceptionally large flows in many small tributary drainages. Thus, field measurements for indirect estimation of peak flow also were performed in several relatively small drainages, as much as several square miles in size. This presentation will focus on providing an overview of peak flows for selected locations along Battle Creek, Grace Coolidge Creek, and selected small tributaries.

The Hermosa Flood of August 17, 2007: Extent, Effects, and Comparison to FEMA Flood Insurance Rate Map

Dr. Alvis Lisenbee
Department of Geology and Geologic Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *alvis.lisenbee@sdsmt.edu*

Christopher J. Pellowski
Department of Geology and Geological Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *Christopher.pellowski@hardrockers.sdsmt.edu*

On the late afternoon and early evening of August 17, 2007, a strong storm cell stalled over the eastern edge of the Black Hills, centered on the lower five to six miles of the Battle Creek and Grace Coolidge Creek drainage basins west of the village of Hermosa. In about two hours, four to 11 inches of rain fell in ~23 mi^2 of Battle Creek drainage basin and four to eight inches fell in ~11 mi^2 of Grace Coolidge Creek drainage basin.

In short order, extensive sheet wash affected hill slopes and all drainages were in flood. Depths reached 16 ft in the narrowest portion of Battle Creek canyon two miles west of Hermosa, 17.5 ft at the railroad bridge south of town, and six to 14 feet adjacent to sections of the meandering stream east of the hills.

The flood plains of the two creeks contain terraces at elevations of (1) 4-6 ft, (2) 11-12 ft and, east of Hermosa, (3) 17-29 ft above the normal stream level. Flooding affected the lower terrace level along Grace Coolidge Creek and terraces one and two along Battle Creek west of Hermosa: East of the village, waters from the Billover Creek drainage area covered portions of the upper terrace (3) as well.

Flow indicators on the flood plains (bent grass and twigs, trapped debris, scoured surfaces, floated objects, e.g., cars, etc.) show that the earliest and latest flows during flooding were restricted to, and paralleled, Terrace 1. During greater flow, terraces 2 and 3 were covered to depths of two to three feet, with enough water pressure to float and move houses: Flow generally paralleled the wider canyon walls and was not directed by the meandering pattern of the underlying stream.

The FEMA FLOOD INSURANCE RATE MAP shows two general categories for the flood plain area: Zone A for the predicted 100 yr flood area: Zone B for the predicted 100-500 yr flood area. Along Grace Coolidge Creek, the flood occupied only a portion of Zone A (terrace 1). Along Battle Creek, flooding covered all of Zone A: portions of Zone B were flooded as well, in areas immediately downstream of abrupt (90^o or greater) meander bends. Flooding produced extensive damage to fences, houses, barns, roads, etc., in areas of predicted flooding shown on the FEMA map.

A Mixed Population Approach for Peak-Flow Frequency Analysis for the Black Hills of Western South Dakota

Daniel G. Driscoll
U.S. Geological Survey, South Dakota Water Science Center, 1608 Mt. View Road, Rapid City, SD 57702 email: *dgdrisco@usgs.gov*

Steven K. Sando
U.S. Geological Survey, Montana Water Science Center, 3162 Bozeman Ave., Helena, MT 59601, email: *sksando@usgs.gov*

Charles Parrett
U.S. Geological Survey, California Water Science Center, 6000 J St., Sacramento, CA 95819-6129, email: *cparrett@usgs.gov*

Large topographic relief in the Black Hills area of western South Dakota can cause intense orographically-influenced storms and rapid concentration of peak flows. These conditions result in sporadic unusually large peak discharges. Maximum peaks for some gages have approached or exceeded 1,000 cubic feet per second per square mile and can be orders of magnitude larger than the next largest peak within the period of record for some gages. However, primarily due to differences in periods of record and the fact that the unusually intense storms often are spatially limited, unusually large peaks appear to be underrepresented for many other gages. Thus, flood-frequency analyses for many gages have large uncertainties, and large inconsistencies frequently exist among drainages with similar physical characteristics in a relatively small geographic area.

To address the complexities in Black Hills flood hydrology, a regional mixed-population approach was used. All independent annual peak discharges for 36 gaging stations in the Black Hills area were examined for the presence of unusually large values (high outliers, as determined by the Grubbs-Beck high-outlier test). Those determined to be high outliers were scaled (normalized) on the basis of drainage area so that the scaled data could be grouped, and a regional, high-outlier frequency curve was fit to the scaled peak-discharge data. This regional high-outlier curve was considered to be applicable to all gaged sites in the Black Hills. For application to each site, the drainage area was used to re-scale the regional, high-outlier frequency curve, and it was combined with the frequency curve fit to the population of ordinary flood peaks (all recorded peaks minus the high outliers) at each site using joint-probability theory. Methods and results will be documented in a USGS report that provides a statewide update of peak-flow frequency estimates for streams in South Dakota.

Results of a Reconnaissance-Level Paleoflood Study for the Black Hills Area, South Dakota

Daniel G. Driscoll
U.S. Geological Survey, South Dakota Water Science Center, 1608 Mt. View Road, Rapid City, SD 57702, email: *dgdrisco@usgs.gov*

James E. O'Connor
U.S. Geological Survey, Oregon Water Science Center, 10615 S.E. Cherry Blossom Dr., Portland, OR 97216, email: *oconnor@usgs.gov*

Intense orographic storms and extreme flooding, sometimes with unit discharges exceeding 1,000 cubic feet per second per square mile, can occur in the Black Hills of South Dakota. Such flooding is highly variable, both spatially and temporally, and maximum peaks for some streamflow-gaging stations can be orders of magnitude larger than: (1) the next largest peak at a station, or (2) maximum recorded peaks for nearby stations on hydrologically similar streams. Consequently, estimating flood frequency using only at-site or even regional streamflow-gaging records can result in large uncertainties and discrepancies between gaging stations.

In 2006, a reconnaissance-level study was initiated by the U.S. Geological Survey in cooperation with the South Dakota Department of Transportation (SDDOT) to assess the applicability of paleoflood-hydrology techniques to generate better information on the magnitude and frequency of floods in the Black Hills area. The overall conclusion of this study was that improved understanding of flood frequency would result from future studies using established paleoflood techniques. Flood slackwater deposits are preserved in caves, alcoves, and rock shelters in canyons of most major drainages in the Black Hills. These deposits provide stratigraphic records of large floods that can be used with radiocarbon dating and hydraulic analysis to determine the approximate timing and discharge of large floods. Investigations for Spring Creek and French Creek demonstrated high-resolution chronologies of large floods dating back about 2,400 and 1,000 years before present, respectively. The study demonstrated that similar potential exists within many other area stream reaches. Results are reported in Completion Report No. SD2005-12F available on the SDDOT Office of Research web page at: *http://www.state.sd.us/Applications/HR19ResearchProjects/oneproject_search.asp?projectnbr=SD2005-12*

THURSDAY, APRIL 17, 2008
SESSION 4A
3:35 – 5:15 P.M.

ABANDONED URANIUM MINE ISSUES

Surface Water and Sediment Investigation Concerning Abandoned Uranium Mines within the South Cave Hills Region, Harding County, South Dakota

Emmanuel Tuombe
M.S. Student, Department of Civil and Environmental Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *Emmanuel.Tuombe@sdsmt.edu*

Dr. Larry Stetler
Associate Professor, Department of Geology and Geological Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *Larry.Stetler@sdsmt.edu*

Dr. James Stone
Assistant Professor, Department of Civil and Environmental Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *james.stone@sdsmt.edu*

An assessment of off-site impacts from heavy metals and radionuclides originating from the South Cave Hills complex, Harding County, South Dakota indicates migration of contaminants is limited. Arsenic and uranium surface water and sediment concentrations down-gradient from known mining and exploration sites were sampled and determined to exceed background concentrations at several sites located at USFS – private property boundaries. In the north-central South Cave Hills, several unnamed tributaries flowing north into Dry Creek contained arsenic and uranium concentration significantly above background for both surface waters and sediments, and potential contaminant sources include the DG mine, Section 28 Bluff A mine, Section 28 Bluff B mine, Section 28 Bluff C mine, Section 28 Bluff D mine, and Section 32 Bluff A mine. For the western South Cave Hills, the Lonesome Pete mine had elevated uranium sediment concentrations on USFS land, however contaminant migration onto adjacent private lands was limited. For the south-central South Cave Hills, the Bobcat Mine contained elevated surface water uranium concentrations at the USFS boundary. For the south-west South Cave Hills, unnamed prospects were responsible for elevated uranium and arsenic in both sediments and surface waters draining into Jones Creek. However, Jones Creek downstream of this confluence was at background for both surface water and sediment. Historical uranium mines located in the North Cave Hills complex (Riley Pass) were found to be a significant source of arsenic and uranium loading within the surface water and sediments entering Campbell Creek located in the northern part of the South Cave Hills watershed. Arsenic and uranium concentrations in the surface water and sediments exiting the South Cave Hills region (~ 9 km downstream) within Hay Creek, Jones Creek, and Bull Creek were all at or below background, suggesting that contaminant migration from the South Cave Hills to adjacent watersheds is limited.

Results of a Groundwater Pumping Test Near Abandoned Uranium Mines in the North Cave Hills, South Dakota

Dr. Larry Stetler
Associate Professor, Department of Geology and Geological Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *Larry.Stetler@sdsmt.edu*

Dr. Arden D. Davis
Professor, Department of Geology and Geologic Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD, 57701,
email: *arden.davis@sdsmt.edu*

Dr. James Stone
Assistant Professor, Department of Civil and Environmental Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *james.stone@sdsmt.edu*

A pumping test of a water well located 1.9 miles NNE of the abandoned Riley Pass uranium mine in the North Cave Hills was conducted to assess the potential for past mining activity to have impacted the aquifer. The well was completed in 1979, cased with 4 inch pipe, and open-hole completed in 13 feet of brown shale and clay above a 23 foot sand lens above 3 feet of coal and clay. At the time of the well test the static water level was measured at 250.6 feet below the top of the casing, using a sonic water-level indicator. The formation of completion is unknown; the local stratigraphic profile places it either in the lower Tertiary Ludlow Formation or in the uppermost Cretaceous Hell Creek Formation. The groundwater gradient in the area is ~1° to the NNE. The well was pumped for 60 minutes having a drawdown of 16.6 feet followed by a 15 minute recovery period in which the water level rebounded to within 0.4 feet of the initial static level. Flow rates during the pumping averaged 1.53 gal/min. Drawdown and recovery data were analyzed using the Theis method and AQTESOLV software. Transmissivity (T) was calculated to be ~8 ft2/day and residual-drawdown analysis of recovery data also showed a T = ~8 ft2/day. Using this value, hydraulic conductivity equals 0.35 ft/day. Effective porosity for the Hell Creek aquifer has been estimated at ~0.06 and the resulting ground-water velocity was determined to be ~0.047 ft/day. In the 50 years since the mines have been active, contamination having reached this aquifer would have been able to travel about 860 feet, or <10 % of the distance from the mines to the well. Therefore, it appears unlikely that uranium mining in the Cave Hills has affected wells in the regional groundwater aquifers.

Bacterial Diversity Associated with Abandoned Uranium Mines in South Dakota

Gurdeep Rastogi
Department of Chemical and Biological Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *Gurdeep.Rastogi@sdsmt.edu*

Rajesh K. Sani
Department of Chemical and Biological Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *Rajesh.Sani@sdsmt.edu*

Nicole Keegan
Department of Chemical and Biological Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701

Dr. Larry Stetler
Department of Geology and Geological Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *Larry.Stetler@sdsmt.edu*

Todd J. Menkhaus
Department of Chemical and Biological Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *Todd.Menkhaus@sdsmt.edu*

Uranium contamination within soils, sediments and groundwater is an emerging, if not endemic global problem. In South Dakota, historical uranium mining operations have led an extensive contamination in the soil, water, and sediments. The regional sites including the Edgemont and North Cave Hills in the western South Dakota possess extensive uranium- and other heavy metal-contamination. We recently studied bacterial diversity in soil samples collected from two abandoned uranium mines, the Edgemont and the North Cave Hills, South Dakota by 16S rRNA gene analysis. Soil characterization by X-ray fluorescence spectroscopy revealed higher metal contamination including uranium at the Edgemont site than the North Cave Hills site. Phylogenetic analysis showed that soil collected from the Edgemont site was predominantly composed of bacteria related to phylum Acidobacteria followed by Proteobacteria while soil from the North Cave Hills site was predominated by Bacteroidetes followed by Proteobacteria. Other minor phyla detected in libraries were Actinobacteria, Cyanobacteria, Verrucomicrobia, Gemmatimonadetes, Chloroflexi, Nitrospirae, Firmicutes, and candidate divisions OP10 and WYO. Results from this molecular study showed that highly diverse and well-adapted bacterial populations are present in these uranium-contaminated sites. Diversity indices indicated that bacterial communities at the North Cave Hills site were much more diverse than those at the Edgemont site. The indigenous microbial communities already adapted to complex extreme environments including high metal concentrations could be suitable for developing more cost effective ex situ bioremediation strategies for such highly metal-contaminated sites.

Interactions of Uranium with Iron Minerals and Environmental Bacteria

Rajesh K. Sani
Department of Chemical and Biological Engineering, South Dakota School of Mines and Technology, Rapid City, SD 57701, email: *Rajesh.Sani@sdsmt.edu*

Gurdeep Rastogi
Department of Chemical and Biological Engineering, South Dakota School of Mines and Technology, Rapid City, SD 57701, email: *Gurdeep.Rastogi@sdsmt.edu*

Brent M. Peyton
Montana State University, Bozeman, MT, email: *bpeyton@coe.montana.edu*

Timothy M. Ginn
University of California-Davis, CA, email: *trginn@ucdavis.edu*

Nicolas F. Spycher
Earth Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA, email: *nspycher@lbl.gov*

Alice Dohnalkova
PNNL, Richland, WA, email: *Alice.Dohnalkova@pnl.gov*

Uranium (U) contamination is a global problem in water supply and related ecosystem health, and it is the primary radioactive metal contaminating surface and subsurface environments and is of particular concern because of its carcinogenicity. The high solubility of its hexavalent form can result in U transport to sensitive receptors including drinking water sources. One potential method of treating U contamination is by using natural dissimilatory metal reducing bacteria including sulfate reducing bacteria (SRB) to reduce soluble U(VI) to insoluble U(IV) (as uraninite, UO_2). This reduction can lead to U immobilization; however, SRB are subject to U toxicity and the stability of bioreduced U is greatly influenced by the geochemistry of soil minerals. Therefore, the initial phase of this talk will discuss the responses of SRB to U in the presence of soil minerals. Our recent published data showed that (1) SRB transformed U(VI) into colloidal uraninite (3-5 nm); (2) under lactate-limited sulfate-reducing conditions, this biogenic uraninite can be oxidized by common iron minerals such as hematite, goethite, and ferrihydrite; and (3) iron minerals oxidized uraninite; however, the reactivity of biogenic uraninite was greater with ferrihydrite as compared to the more crystalline structure of hematite. At the end of my talk, I will also discuss the microbial diversity associated with abandoned uranium mines in South Dakota. We recently collected soil samples from two abandoned uranium mines that had elevated levels of U and analyzed for bacterial diversity using 16S rRNA gene analysis. Phylogenetic analysis showed that soil collected from the Edgemont site was predominantly composed of *Acidobacteria* while soil from the North Cave Hills site was predominated by *Bacteroidetes.* In conclusion, understanding the microbial diversity and their interactions with toxic metals, and mineral surfaces will allow us to assess the potential for bioremediation under a variety of system specific conditions.

Sorption of Metals onto Soil Minerals near Abandoned Uranium Mines in the South Cave Hills, Harding County, South Dakota

Gregory Kipp, P.E.
M.S. Student, Department of Geology and Geological Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *gregorykipp@aol.com*

Dr. Larry Stetler
Associate Professor, Department of Geology and Geological Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *Larry.Stetler@sdsmt.edu*

Dr. James Stone
Assistant Professor, Department of Civil and Environmental Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *james.stone@sdsmt.edu*

Dr. Arden D. Davis
Professor, Department of Geology and Geologic Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *arden.davis@sdsmt.edu*

As part of ongoing environmental investigations for the Cave Hills historical uranium mines within Custer National Forest, soil samples were analyzed to determine correlations between metals and radionuclides, grain size, and soil mineralogy in an effort to identify fate and transport mechanisms into the surrounding watersheds. Three soil samples were selected for analysis from the Lonesome Pete Mine of the South Cave Hills, and one was taken from the North Fork Grand River inlet to the Bowman-Haley Reservoir in North Dakota. Soil samples were homogenized and wet sieved through polymer screens using ethanol. Procedures minimized exposure of samples to outside metal contaminants. Soils were sieved into the following fractions: composite, 1 mm, 0.5 mm, 0.25 mm, 0.125 mm, and fines. A portion of each fraction was dried, ground, digested, and analyzed for As, Cu, Mo, Se, Pb, Th, U, and V. A separate portion of each fraction was dried, ground, and analyzed using X-ray diffraction (XRD) to identify major mineral compositions. XRD analyses indicate that the soil is composed primarily of quartz in all size fractions, with varying amounts of analcime and small concentrations of albite and illite, indicating volcanic origin. Selected samples are being examined for trace mineral composition using scanning electron microscopy in an effort to determine the correlation between trace mineral composition and metal adsorption characteristics that could control contaminant transport in these environmental systems.

THURSDAY, APRIL 17, 2008
SESSION 4P
3:30 – 5:10 P.M.

SURFACE-WATER ISSUES

Belle Fourche Irrigation District Online Irrigation Consultant

Jared K. Oswald
Staff Engineer, RESPEC Water & Natural Resources, P.O. Box 725, Rapid City, SD 57709; email: *Jared.Oswald@respec.com*

Hal D. Werner
Professor and Irrigation Extension Specialist (Retired), South Dakota State University Ag and Biosystems Engineering, P.O. 2120, Brookings, SD 57007; email*: Hal.Werner@sdstate.edu*

A Web-based, interactive irrigation scheduling consultant is being developed for producers in the Belle Fourche Irrigation District. The consultant will be customized to each producer's crop, planting date, soil type, rainfall and irrigation amounts, and method of irrigation. The consultant also will allow any producer with Internet access a secure, personalized Web page containing irrigation information for a particular field. To accomplish this, an extensive real-time weather network is being implemented. This weather network will monitor rainfall and provide the inputs to calculate daily reference evapotranspiration (ET) using the American Society of Civil Engineers (ASCE) Penman method. The reference ET values will be multiplied by locally derived crop coefficients and a plant available water coefficient. Available soils information for the area is being collected and will be used to determine the amount of water-holding capacity of the soils in each field. Irrigation orders will be entered online and added to the rainfall estimates for that location to determine the daily increase in the soil water balance. Producers will be able to track the estimated soil water balance for their individual fields and obtain a recommended irrigation schedule and amount. Readings from installed soil moisture instruments will be retrieved twice weekly and provided online as a means to track relative soil water changes throughout the irrigation season.

Development of Operational Charts for Unautomated Irrigation

Jeremy L. Sanson
Engineering Student, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701, email: *thesansons@gmail.com*

Dr. Scott J. Kenner
Department of Civil and Environmental Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *scott.kenner@sdsmt.edu*

The purpose of this research is to improve the operational efficiency in the Belle Fourche Irrigation District (BFID) by developing charts to assist ditch riders in retaining a desired water level in the irrigation canals. The study focused on two reaches in the BFID which were controlled by unautomated check structures at the downstream ends of the reaches.

Stage, flow and structure setting data at the two sites were collected during the 2007 irrigation season. This set of data was used to develop curves of flow versus stage for a given check setting. To determine the flow for other check settings, the flow through the check structure was modeled as a combination of weir and orifice flow. Weir and orifice coefficients were determined by minimizing the sum of the square errors between the measured and predicted flows.

It was found that the model could predict the flow for the Simmons Check between -4.8% and +3.8% with an average percent difference of ±2.0% and for the Fickbohm Check between -3.5% and +4.6% with an average percent difference of ±2.2%. The optimum weir and orifice coefficients varied slightly between the two reaches. It is hoped that the operational charts developed in this research will be used in the future to improve the operation of the study reaches. The method that was developed in this study could be applied to other unautomated reaches, although it is recommended that stage, flow and structure setting data be collected at each site, to calibrate coefficients and minimize errors between predicted and actual flow.

Hydraulic Model of the Belle Fourche Irrigation District North Canal Using EPA SWMM 5.0

Lacy M. Pomarleau
Department of Civil Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701, email: *lacy.pomarleau@mines.sdsmt.edu*

Dr. Scott J. Kenner
Department of Civil and Environmental Engineering, South Dakota School of Mines and Technology, 501 East Saint Joseph Street, Rapid City, SD 57701,
email: *scott.kenner@sdsmt.edu*

The Belle Fourche River total suspended solids (TSS) total maximum daily load (TMDL) study, sponsored by the Belle Fourche River Watershed Partnership, found that irrigation return flows were one of several main contributors of TSS. It was determined that the TSS exceedance in the Belle Fourche River could be improved by reducing nonused irrigation return flows from the Belle Fourche Irrigation District (BFID) which contributed approximately 20 percent of the TSS loading in the Belle Fourche River. A set of best management practices were developed to bring the Belle Fourche River back into compliance; one of which includes the development and implementation of an operational model of the BFID. The model would increase the operational efficiency of the BFID which would in turn help reduce the TSS in the Belle Fourche River by reducing the nonused irrigation return flows.

The BFID consists of two major delivery canals, the North Canal and the South Canal. Previously, the Environmental Protection Agency Storm Water Management Model (SWMM) was used to develop an operational model of the South Canal. Based on the performance of the South Canal model and recommendations made, a similar model was developed for the North Canal. Model input data was obtained from Bureau of Reclamation survey data, construction drawings, and field measurements gathered in the 2006 and 2007 irrigation seasons. Stage, flow and structure settings were measured and recorded for calibration of the model. Due to the lack of accurate flow measurement devices along the canal, rating curves for key automated check structures were developed using recorded check settings and flow data collected via an acoustic doppler current profiler in order to calibrate the model to flow and stage. These rating curves can be used to more accurately determine the amount of water being delivered along the canals. The model is capable of modeling the entire irrigation system including check structures with automated gates which were also installed to improve the operational efficiency. The goal is to model the observed data within ±5% which was obtained by the South Canal SWMM model. The model, along with the developed rating curves, are management tools that will aid the BFID in check structure adjustments and help increase the operational efficiency.

Trends in Streamflow in the Missouri River Basin from 1957 to 2006

Parker A. Norton
U.S. Geological Survey, South Dakota Water Science Center, 1608 Mountain View Road, Rapid City, SD 57702, email: *pnorton@usgs.gov*

Mark T. Anderson
U.S. Geological Survey, South Dakota Water Science Center, 1608 Mountain View Road, Rapid City, SD 57702, email: *manders@usgs.gov*

The hydrologic consequences of the late 20th century atmospheric warming are of great interest to water managers and agricultural producers in the Northern Great Plains and the Missouri River Basin (MRB). Changes in streamflow characteristics have been attributed to atmospheric warming for several other regions of North America, such as the earlier snowmelt runoff from the Sierra Nevada Mountains of California, and more winter runoff in the Desert Southwest at the expense of summer flows. We examine the streamflow record for evidence of long-term trends in the mean annual flow for all stations in the MRB with 50 years of continuous data. Minimum and maximum flows for the period were examined using stations of the Hydro-Climatic Data Network (HCDN). Trends were statistically analyzed using the Kendall Tau test for non-parametrics (Conover, 1980). For the MRB, no trends were evident for most stations presumably due to the large interannual variability that is characteristic of the northern Great Plains. Declining trends were discovered at about 55 stations distributed in Montana, Wyoming, Nebraska and Kansas. Increasing trends were found at about 26 stations distributed in North Dakota, South Dakota, Nebraska and Iowa. Annual streamflow records were analyzed for seasonality using the temporal centroid of streamflow (CT) or center of mass approach. Most stations show no significant change in the annual center of mass with the exception of 11 stations where runoff is occurring earlier in the year. Twenty-one stations in North Dakota, South Dakota and Iowa demonstrate a trend of increasing minimum flows. Three stations in Montana and Wyoming demonstrated decreasing minimum flows. In this presentation, we report the streamflow trends for the Missouri River Basin.

Dean's Lake Hydrology and Hydraulic Analysis

Jonathan Kusa
Group Leader, Howard R. Green Company, 2550 University Ave. W., Suite 400N, St. Paul, MN 55114, email: *jkusa@hrgreen.com*

Mike Ryan
Lead Technical Advisor, Howard R. Green Company, 2550 University Ave. W., Suite 400N, St. Paul, MN 55114, email: *mryan@hrgreen.com*

The Deans Lake Drainage Basin is approximately 1800 acres, includes seven basins which outlet into the Des Moines River through the Corps of Engineers levee near the Des Moines Wastewater Reclamation Facility. Occasionally the levee must be closed when the Des Moines River exceeds a set stage. The City of Des Moines has retained Howard R. Green (HRG) to design a stormwater pump station to alleviate flooding when the levee is closed. A watershed model was developed using XPSWMM software, this model allowed HRG to model multiple conveyance improvements, stormwater detention improvements, and pumping scenarios. The modeling effort resulted in a final design of a 200 cfs low head pump and various conveyance improvements throughout the seven basin system. This presentation will cover portions of this project involving the XPSWMM modeling effort.