

2009 Project Abstract

For the Period Ending June 30, 2012

PROJECT TITLE: South-Central Minnesota Groundwater Monitoring of the Mt. Simon Aquifer

PROJECT MANAGER: James A. Berg

AFFILIATION: Minnesota Department of Natural Resources

MAILING ADDRESS: 500 Lafayette Road

CITY/STATE/ZIP: St. Paul, MN 55155

PHONE: 651-259-5680

E-MAIL: jim.a.berg@state.mn.us

WEBSITE: <http://www.dnr.state.mn.us/index.html>

FUNDING SOURCE: Environment and Natural Resources Trust Fund

LEGAL CITATION: ML 2009, Chap.143, Sec. 2, Subd. 3 (b)

APPROPRIATION AMOUNT: \$1,875,000

Overall Project Outcome and Results

Most data collected for the Mt. Simon – Hinckley aquifer Phase 2 study were derived from 16 wells installed at 10 locations to depths of 100 to 695 feet in McLeod, Wright, Hennepin, Sherburne, Anoka, and Isanti counties. In the Phase 2 area chemical residence time indicators from the Mt. Simon aquifer indicate groundwater ages less than approximately 1,000 years in eastern Wright and Sherburne counties and northern Isanti County. These relatively young groundwater ages are consistent with water level and stratigraphic information that indicate both direct and indirect connection of surface water to the Mt. Simon- Hinckley aquifer through localized focused recharge.

This project has shown that the most critical recharge area for the Mt. Simon-Hinckley aquifer and Minneapolis-St. Paul metropolitan area water supply includes portions of Wright, Sherburne, and Isanti counties. Protection of this region from water pollution should be a high priority for all levels of government. Continued monitoring of wells installed for this investigation will create a long term record that can be used to interpret changes in local and regional water supply due to water use or climate changes.

The County Geologic Atlas, Part B, portion of this project supported the completion of three and the initiation of six Part B atlases in the County Geologic Atlas series that the DNR prepares in collaboration with the Minnesota Geological Survey. Each Part B atlas provides groundwater maps, data describing aquifer properties and use, analytical results of groundwater chemistry sampling including age-dating samples, and interpretation of pollution sensitivity. All of these maps and data are used to meet many environmental information and protection needs, including resource protection planning, water resource management, water appropriation permitting, contamination mitigation, education, among others. The Todd, Carlton, and Benton Part B atlases were

completed and the Carver, McLeod, Chisago, Blue Earth, Nicollet, and Sibley Part B atlases were initiated.

Project Results Use and Dissemination

The reports from this project have been available on the DNR website since the summer of 2012. The Mt. Simon project was presented as a poster at the Midwest Groundwater Association meeting in Minneapolis in October 2012. We are currently producing a short (15 minute) video highlighting some of the results of the project for presentation at future meetings and for general viewing on the internet. In addition, a summary of the project will be submitted to the Minnesota Groundwater Association for inclusion in the quarterly newsletter.

The well log and well construction information is currently available in the project report and the Minnesota Department of Health County Well Index (<http://mdh-agua.health.state.mn.us/cwi/cwiViewer.htm>). The wells have become part of the DNR observation well network. Water level data is currently available at: http://climate.umn.edu/ground_water_level/

Publication of Part B atlas reports include preparation and printing of the County Geologic Atlases, Part B, and delivery of printed reports to the county; preparation and delivery of Part B materials to MGS for inclusion in a DVD version of each completed project that incorporates geographic information system (GIS) files, database files, pdfs, and additional digital products. When each atlas Part B is completed a training workshop for the county and local users is held to explain the results and how the maps, data, and other information can be used to assist local water resource programs. To reach other users and audiences program staff contributed newsletter articles and presented talks and posters at conferences. Completed digital products are posted on DNR webspace at http://www.dnr.state.mn.us/waters/groundwater_section/mapping/status.html . Printed reports are available for sale through MGS Map Sales at <http://www.mnqs.umn.edu/mapsales.html> .

Environment and Natural Resource Trust Fund 2008 and 2009 Work Program Final Report

Date of Report: 12/18/12
Final Report

	M.L. 2008	M.L. 2009
Date of Work program Approval:	June 10, 2008	June 16, 2009
Project Completion Date:	June, 30 2011	June 30, 2012

I. PROJECT TITLES: South-Central Minnesota Groundwater Monitoring and County Geologic Atlases (2008), County Geological Atlas and South-Central Minnesota Groundwater (2009)

Project Manager: Jim Berg
Affiliation: Minnesota Department of Natural Resources
Mailing Address: 500 Lafayette Road
City / State / Zip : St. Paul, MN 55155
Telephone Number: 651-259-5680
E-mail Address: jim.a.berg@state.mn.us
FAX Number: 651-296-0445
Web Page address: <http://www.dnr.state.mn.us/index.html>

Location: Martin, Watonwan, Brown, Nicollet, Blue Earth, and Sibley Counties (2008 project). McLeod, Wright, Sherburne, Isanti, Anoka, and Hennepin Counties (Mt. Simon aquifer monitoring - 2009 project); The Part B atlases that will be funded during the project period (2009 project) will include Todd, Carlton, McLeod, Carver, Benton, and Chisago counties.

	M.L. 2008	M.L. 2009	Total
Total Trust Fund Project Budget:	\$1,600,000	\$2,695,000	\$4,295,000
<i>DNR Total</i>	<i>\$894,000</i>	<i>\$1,875,000</i>	<i>\$2,769,000</i>
<i>MGS Total</i>	<i>\$706,000</i>	<i>\$820,000</i>	<i>\$1,526,000</i>
DNR Trust Fund Appropriation	\$894,000	\$1,875,000	\$2,769,000
Minus Amount Spent:	\$894,000	\$1,697,259	\$2,591,259
DNR Equal Balance:	\$0	\$177,741	\$177,741

Legal Citation:

ML 2008, Chap.367, Sec. 2, Subd. 4 (h).

Appropriation Language (2008):

\$1,600,000 is from the trust fund for collection and interpretation of subsurface geological information and acceleration of the county geologic atlas program. \$706,000 of this appropriation is to the Board of Regents of the University of Minnesota for the Geological Survey to begin county geologic atlases in three counties. \$894,000 of this appropriation is to the commissioner of natural resources to investigate the physical and recharge characteristics of the Mt. Simon aquifer. This appropriation represents a continuing effort to complete the county geologic atlases throughout the state. This

appropriation is available until June 30, 2011, at which time the project must be completed and final products delivered, unless an earlier date is specified in the work program.

**Legal Citation: ML 2009, Chap.143, Sec. 2, Subd. 3 (b)
Appropriation Language (2009):**

\$2,695,000 is from the trust fund for collection and interpretation of subsurface geological information and acceleration of the county geologic atlas program. \$820,000 of this appropriation is to the Board of Regents of the University of Minnesota for the geological survey to continue and to initiate the production of county geologic atlases. \$1,875,000 of this appropriation is to the commissioner of natural resources to investigate the physical and recharge characteristics of the Mt. Simon aquifer. This appropriation represents a continuing effort to complete the county geologic atlases throughout the state. This appropriation is available until June 30, 2012, at which time the project must be completed and final products delivered, unless an earlier date is specified in the work program.

II and III 2008 AND 2009 FINAL PROJECT SUMMARY:

M.L. 2008

Abstract

To better understand the recharge dynamics of the Mt. Simon aquifer the western edge of this aquifer was investigated through observation well installations, water level monitoring, groundwater chemical analysis, and aquifer capacity testing. Most data collected for this study are derived from the 27 observation wells, drilled to depths of 70 to 718 feet, that were installed at 14 locations by contracted drilling companies.

The combination of chemical residence time indicators, continuous water level data from nested well locations, and a general knowledge of the regional hydrostratigraphy, shows the Mt. Simon aquifer in this region has a very slow recharge rate from a large source area located south of the Minnesota River, and a smaller source area located in the northern portion of the study area. The younger ¹⁴C residence time values of Mt. Simon groundwater (7,000-8,000 years) from this project roughly correspond to a time after the last ice sheet had receded from southern Minnesota suggesting groundwater in the Mt. Simon aquifer in this region began as precipitation that infiltrated during the post-glacial period. The stable isotope data of oxygen and hydrogen support this conclusion. A recharge estimate of the Mt. Simon aquifer south of the Minnesota River based on these minimum residence time data suggest a rate of approximately 0.49 cm/year. The resulting 1.2 billion gallons/year of recharge from the southern source area is less than the approximately 2.2 billion gallons were pumped out of the Mt. Simon aquifer in this area in 2009. Continued monitoring of the observation wells in this region should help determine if more water is being used compared to recharge. A major accomplishment of this project is the creation of a network of observation well nests along the western margin of the Mt. Simon Sandstone that is considered an important recharge area for the aquifer. Long term water level and geochemistry data from these wells will enable future hydrologists to evaluate the local and regional effects of Mt. Simon aquifer groundwater pumping in the region.

(http://files.dnr.state.mn.us/publications/waters/south_central_mn_gw_monitoring.pdf).

A document titled “Minnesota Groundwater Level Monitoring Network-Guidance Document for network Development” was also completed as part of this project. The Guidance Document outlines how Minnesota’s current groundwater level monitoring network of approximately 750 wells should be expanded to meet monitoring needs. This expansion is necessary because large areas in Minnesota are not adequately monitored. Many areas of Minnesota are underlain by multiple aquifers, all of which must be considered in developing the long-term network that will provide adequate resource data

(http://files.dnr.state.mn.us/publications/waters/groundwater_network_guidance.pdf).

M.L. 2009

Most data collected for the Mt. Simon – Hinckley aquifer Phase 2 study were derived from 16 wells installed at 10 locations to depths of 100 to 695 feet in McLeod, Wright, Hennepin, Sherburne, Anoka, and Isanti counties. In the Phase 2 area chemical residence time indicators from the Mt. Simon aquifer indicate groundwater ages less than approximately 1,000 years in eastern Wright and Sherburne counties and northern Isanti County. These relatively young groundwater ages are consistent with water level and stratigraphic information that indicate both direct and indirect connection of surface water to the Mt. Simon- Hinckley aquifer through localized focused recharge.

This project has shown that the most critical recharge area for the Mt. Simon-Hinckley aquifer and Minneapolis-St. Paul metropolitan area water supply includes portions of Wright, Sherburne, and Isanti counties. Protection of this region from water pollution should be a high priority for all levels of government. Continued monitoring of wells installed for this investigation will create a long term record that can be used to interpret changes in local and regional water supply due to water use or climate changes.

The County Geologic Atlas, Part B, portion of this project supported the completion of three and the initiation of six Part B atlases in the County Geologic Atlas series that the DNR prepares in collaboration with the Minnesota Geological Survey. Each Part B atlas provides groundwater maps, data describing aquifer properties and use, analytical results of groundwater chemistry sampling including age-dating samples, and interpretation of pollution sensitivity. All of these maps and data are used to meet many environmental information and protection needs, including resource protection planning, water resource management, water appropriation permitting, contamination mitigation, education, among others. The Todd, Carlton, and Benton Part B atlases were completed and the Carver, McLeod, Chisago, Blue Earth, Nicollet, and Sibley Part B atlases were initiated.

IV. OUTLINE OF PROJECT RESULTS:

Result 1: Groundwater level monitoring guidance document

Description: The purpose of this document is to create a strategic plan for developing a statewide network of water level monitoring wells (observation wells). The document, created by DNR Waters, will review the current state of Minnesota's network, monitoring frequency, database protocols, costs, data uses, and limitations. The document will include a review of networks in other states or countries that may have advantageous approaches that the Minnesota DNR could consider. Finally, the document will make recommendations for how to evaluate the adequacy of the existing network and make recommendations for improving the existing network.

Summary Budget Information for Result 1:

	M.L. 2008	M.L. 2009	Total
Trust Fund Budget:	\$33,000	\$0	\$33,000
Amount Spent:	\$33,000	\$0	\$33,000
Balance:	\$0	\$0	\$0

<u>Deliverable</u>	<u>Completion Date</u>	<u>Budget</u>	<u>Status</u>
1. Existing sources of information from other states and countries.	1/05/09	\$1,000	complete
2. Information and status of the Minnesota observation well network.	7/1/09	\$1,000	complete
3. Information and methods used by other government entities	12/1/09	\$11,000	complete
4. Final Report: Information and recommendations for Minnesota groundwater monitoring	5/31/11	\$20,000	complete

Completion Date: M.L. 2008: 5/31/11

Final Report Summary (guidance document):

Minnesota's environmental and economic future depends on a continued and available supply of groundwater that is managed sustainably. The Minnesota Department of Natural Resources is responsible for managing the quantity of groundwater use through appropriation permits and monitoring water levels. Groundwater quantity estimates for management purposes depend on a historical record of water level measurements. However, the state's current groundwater level monitoring network does not provide adequate statewide groundwater quantity information because many areas and groundwater resources are unmonitored.

This Guidance Document outlines how Minnesota's current groundwater level monitoring network of approximately 750 wells should be expanded to approximately 7000 groundwater level monitoring wells to meet monitoring needs. This expansion is necessary because large areas in Minnesota are not adequately monitored. Many areas of Minnesota are underlain by multiple aquifers, all of which must be considered in developing the long-term network that will provide adequate resource data. A more complete and integrated network of groundwater level monitoring wells will provide

stakeholders, local government officials, and groundwater resource managers with the information needed to:

- Understand the status of groundwater quantity throughout the state
- Formulate management responses to changing water levels
- Plan for the future based on current scientific data

This document is intended to provide the DNR with a guide to build the backbone network that will support the state's current and future groundwater level monitoring information needs. Network wells will become long-term assets used to fully understand, manage, and assess Minnesota's groundwater resources. As described in this document, this is an unprecedented expansion project that will vastly improve the understanding of Minnesota's groundwater resources. The envisioned expansion is a very significant undertaking, estimated to require 30 years to complete and cost \$94.7 million. The continued operation and maintenance of the network assets as the network expands is also a significant undertaking, requiring on-going support to acquire, analyze, and interpret groundwater level data and to make the data readily available to a wide variety of users.

The Minnesota groundwater level network as it develops into the future is intended to meet information needs for sustainable management of water resources. The existing network, while limited, provides invaluable data for resource managers; the expanded network will provide greatly improved data resource to understand groundwater system response to change and provide the groundwater quantity data needed to make informed decisions to protect Minnesota's groundwater resource for the future.

Result 2: Test drilling, monitoring well installation, sampling, laboratory analysis, water level measurement

Description: Monitoring wells (observation wells) will be drilled and completed at 14 locations in the 2008 project area and approximately 10 locations in the 2009 project area. The monitoring well installations will be completed with contracted drilling services hired and coordinated by the DNR. Each location will consist of a two-well nest with a deep well completed in the lowermost bedrock aquifer (Mt. Simon Formation), and another well completed in a shallower unconsolidated sand and gravel aquifer. The well nests will be located on public property and completed to depths of approximately 100 to 1000 feet. Drill cuttings (ground-up rock and sediment brought to the surface by the drilling process) will be collected at 5-foot intervals by DNR staff and archived for analysis by the Minnesota Geological Survey. DNR or MGS staff will complete downhole geophysical surveys after the full depth of the deep borehole has been drilled. A reverse circulation/dual rotary drilling method will be used as much as possible to generate high quality drill cuttings. These high quality samples will significantly improve stratigraphic interpretations of glacial and bedrock materials. This drilling method advances an 8 - inch diameter steel casing during the drilling process. The wells will be pumped prior to sampling providing some specific capacity information. The specific capacity test will provide some information regarding the aquifers producing capacity.

Most of the test holes will be completed as 4-inch diameter water level monitoring wells (observation wells) in the lowermost bedrock aquifer (Mt. Simon Sandstone) and shallower aquifers, to help track long-term groundwater level trends. The wells will be sampled by DNR staff for general chemistry, trace elements, tritium, carbon 14 and stable oxygen and deuterium isotopes to determine the residence time of the ground water in the formations. In addition, DNR staff will instrument the wells with continuous water level recording equipment to track short and long term changes in water levels. The chemistry and water level information will help determine the sustainable limitations for future use of this aquifer.

Summary Budget Information for Result 2:

	M.L. 2008	M.L. 2009	Total
Trust Fund Budget:	\$861,000	\$990,325	\$1,851,325
Amount Spent:	\$861,000	\$990,325	\$1,851,325
Balance:	\$0	\$0	\$0

Deliverable	Completion Date	Budget	Status
1. All the drilling sites will have been chosen and several of the wells will have been installed, instrumented and sampled. The drilling logs, geophysical logs, flow logs, locations, well construction diagrams, and water level data from the wells that have been installed by this date will be available.	12/01/08	\$250,000	complete
2. Same as above with several more sites completed (M.L. 2008)	7/1/09	\$250,000	complete
3. Same as above with several more sites completed (M.L. 2008). Sites have been chosen for M.L. 2009 and contractor bidding, SHPO reviews and access permission requests are underway. Several of the wells will have been installed.	12/1/09	\$250,000 (2008) \$250,000 (2009)	complete
4. All the monitoring wells will have been installed, instrumented, and sampled. During the remaining one-year period The data loggers will downloaded and maintained on a regular basis. Remaining data compilation and interpretation will continue and creation of final report will begin (M.L. 2008). Several more well nests for the M.L. 2009 will have been completed and associated data loggers installed.	7/1/10	\$37,000 (2008) \$300,000 (2009)	complete
5. Same as above with more data compilation and progress toward completion of final report (M.L. 2008).	12/1/10	\$37,000 (2008) \$300,000	complete

All of the well nests will have been completed, associated data loggers installed, and water samples collected and submitted for lab analysis (M.L. 2009).		(2009)	
6. Project completion (M.L. 2008) and final report to include maps summarizing thickness and extent of Mt. Simon aquifer in project area. Interpretation of collected water level data and chemistry and implications for sustainable use of Mt. Simon aquifer. Recommendations for future investigations and/or monitoring. Routine downloading of data loggers, data compilation, interpretation and report preparation (M.L. 2009)	6/30/11	\$37,000 (2008) \$33,750 (2009)	complete
7. Routine downloading of data loggers, data compilation, interpretation and report preparation (M.L. 2009)	7/1/11	\$33,750 (2009)	complete
8. Same as above (M.L. 2009)	12/1/11	\$33,750 (2009)	complete
9. Project completion (M.L. 2009) and final report to include maps summarizing thickness and extent of Mt. Simon aquifer in project area integrated with 2008 project results. Report will include interpretation of collected water level data and chemistry and implications for sustainable use of Mt. Simon aquifer. Recommendations for future investigations and/or monitoring.	6/30/12	\$39,075 (2009)	complete

Completion Date M.L. 2008: 6/30/11
M.L. 2009: 6/30/12

M.L. 2008 Final Report Summary:

Drilling, well installation, groundwater sampling, and data logger installations have been completed at all the 2008 project sites (Phase 1) for a total of 27 wells at 14 sites in 5 counties. All wells drilled have been mud logged and gamma logged. In addition, rock and sediment samples have been sent to the Minnesota Geological Survey for analysis. The wells were sampled for chemical constituents such as tritium and carbon-14 that helped determine the residence time or age of the groundwater in this aquifer and overlying aquifers. The wells were also instrumented with equipment to continuously record groundwater levels.

M.L. 2009 Final Report Summary:

A total of seven Mt. Simon Sandstone observation wells and nine wells in other geologic units were drilled and completed at 10 locations in five counties. Staff from the Minnesota DNR Ecological and Water Resource Division coordinated the installation of these wells. . All wells drilled have been mud logged and gamma logged. In addition, rock and sediment samples have been sent to the Minnesota Geological Survey for analysis. Drilling in the northern portion of the investigation area (Phase 2) began in the fall of 2009. The wells are completed in the Mt. Simon and Hinckley sandstones, the Fond du Lac Formation, and shallower units on public property in the project area to depths of 100 feet to 695 feet. The wells were sampled for chemical constituents such as tritium and carbon-14 that helped determine the residence time or age of the groundwater in this aquifer and overlying aquifers. The wells were also instrumented with equipment to continuously record groundwater levels.

Result 3 (to be completed by the MGS who will be providing separate work program updates): Initiate Part A County Geologic Atlases for Blue Earth, Nicollet, and Sibley Counties. Note: all components listed below may not be completed within the time frame and budget of this project, but substantial progress in all three counties is anticipated.

Result 4 (to be completed by the MGS): MGS support for DNR Drilling Program
Description: MGS will process, examine, interpret, and archive samples from the DNR test drilling. MGS will also conduct downhole geophysical logging of selected test holes to observe aquifer properties.

Result 5 (to be completed by the MGS): Production and Printing of the Benton and Chisago County Geologic Atlases

Result 6: Acceleration of County Geologic Atlas Part B reports.

Description: Initiate and complete the Benton and Chisago county geologic atlas Part B projects. Support initiation of three (Carlton, McLeod, Carver) and completion of four (Todd, Carlton, McLeod, Carver) county geologic atlas Part B projects. Progress on Part B atlas development includes ground water sample collection and analysis; geophysics field data collection and analysis; aquifer mapping and technical analysis of ground water systems. Publication of Part B atlas reports include preparation and printing of the County Geologic Atlases, Part B and delivery of printed reports to county; preparation and delivery of Part B materials to MGS for DVD version of each, along with geographic information system (GIS) files, database files, pdfs, and additional digital products. Digital products will be posted on DNR webpage.

Summary Budget Information for Result 6:

	M.L. 2008	M.L. 2009	Total
Trust Fund Budget:	\$0	\$884,675	\$884,675
Amount Spent:	\$0	\$706,934	\$706,934
Balance:	\$0	\$177,741	\$177,741

Deliverable	Completion Date	Budget	Status
1. Additional staff hired (2 hydrologists; research analyst; half-time editor) to support additional atlas projects to be developed and completed during the project. Support continuation of ongoing projects: Todd County. Support publication of Todd County Part B.	12/01/09	\$205,333	complete
2. Support continuation of ongoing work. Start Benton, and Chisago counties. Support start of Carlton, McLeod, and Carver Counties.	7/1/10	\$153,333	complete
3. Continue ongoing projects.	12/1/10	\$123,333	complete
4. Continue ongoing projects. Support publication of Carlton County Part B.	7/1/11	\$147,333	complete
5. Continue ongoing projects. Support publication of Part B for McLeod and Carver counties	12/1/11	\$133,334	complete
6. Publish Part B for Benton and Chisago counties.	6/30/12	\$122,009	Benton published; Chisago 85-90% complete

Completion Date M.L. 2009: 6/30/12

M.L. 2009 Final Report Summary:

Four additional staff were hired to accelerate completion of County Geologic Atlases, Part B. These personnel included two hydrologist 2's, an Information Officer 2 (editor), and a Research Analyst (GIS). During the final six months of the project, a temporary hydrologist 1 was hired to assist water sample collection for three projects. By the end of the project three Part B atlases were published, including Todd, Carlton, and Benton. Six Part B atlases were initiated, including Chisago, McLeod, Carver, Blue Earth, Nicollet, and Sibley, substantially meeting the project acceleration goal. Each project includes ground water sample collection and analysis; geophysics field data collection and analysis (if needed); technical analysis of ground water systems and groundwater flow; assembly of available data describing aquifer properties and water use; and preparation of interpretive maps of aquifer pollution sensitivity. At the completion of each Part B project a report is published describing aquifers, groundwater conditions, natural water chemistry, groundwater age-dating, and pollution sensitivity.

A substantial balance for Result 6 is the result of delayed initial hires for three staff; in two cases, multiple interviews were required to identify viable candidates. One of the hydrologists that was hired was released from state service after six months and the vacancy could not be filled for nine months. This resulted in a delay in project and report preparation work, with the result that not all the planned publication budget could be used. The three-week state shut-down in July 2011 also contributed to the unspent balance.

V. TOTAL TRUST FUND PROJECT BUDGET:

M.L. 2008

DNR Staff or Contract Services:

Hydrologist 3, unclassified, 1.0 FTE x 2years (results 1 and 2)	\$132,000
Drilling contractors	\$694,474
Laboratory analysis of 30 ground water samples tritium, deuterium and 18 oxygen	\$7,989
Archeological site assessment (SHPO)	\$6,799

DNR Equipment:

Down-hole geophysical logging tool (gamma, magnetic induction)	\$0
Field computer	\$4,267
Submersible sample pump, reel, tubing and cable (or contracted sampling services)	\$8,645

Continuous water level monitoring equipment for 27 wells	\$18,298
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DNR Other:

Overnight expenses	\$9,253
Mileage	\$9,835
Supplies	\$2440

SUBTOTAL DNR PROJECT BUDGET: \$894,000

SUBTOTOTAL MGS (see MGS WP) PROJECT BUDGET: \$706,000

TOTAL TRUST FUND PROJECT BUDGET: \$1,600,000

M.L. 2009

DNR Staff or Contract Services (Result 2):

Hydrologist 3, unclassified, 1.0 FTE x 2years	\$110,092
Drilling contractors	\$812,151
Laboratory analysis of 17 ground water samples cations, anions, trace elements, tritium, stable isotopes, and 14 carbon	\$33,236
Archeological site assessment (SHPO)	\$5,325
Well pumping equipment for aquifer tests and sampling	\$5,896

DNR Staff or Contract Services (Result 6):

Hydrologist 2, unclassified. 2.0FTE x 2.5 years	\$302,275
Hydrologist 1, unclassified, 1.0FTE x 0.5 years	\$14,000
Rotosonic core drilling – MGS	\$50,000
Research Analyst (GIS), unclassified 1.0 FTE x 2.5 years	\$158,600
Information Officer 2, unclassified 1.0 FTE x 2.5 years	\$160,600
GIS training for 3 new hires (2-Hydrogeologist 2's, 1-Research Analyst (GIS)	\$763
Printing	\$38,000

Laboratory analysis of 80 groundwater samples/county for cations, anions, trace elements, tritium and several 14 C	\$133,000
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DNR Equipment:

(Result 2):

Continuous water level monitoring equipment for 17 wells	\$12,003
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(Result 6):

Three GIS Workstations	\$5,672
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DNR Other:

(Result 2)

Overnight expenses	\$4,976
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Mileage	\$4,759
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Supplies	\$1,887
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(Result 6)

Overnight expenses (70 days @ \$100/day)	\$6,126
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Mileage (4,167 miles @ \$.48/mile)	\$4,000
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Supplies	\$11,639
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SUBTOTAL DNR PROJECT BUDGET:	\$1,875,000
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SUBTOTOTAL MGS (see MGS WP) PROJECT BUDGET:	\$820,000
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TOTAL TRUST FUND PROJECT BUDGET (2009):	\$2,695,000
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Explanation of Capital Expenditures Greater Than \$3,500 (2008):

Down-hole geophysical logging tool (gamma, magnetic induction)

This tool is essential for any borehole subsurface investigation. The tool measures the natural gamma radiation and electrical conductivity (or resistivity) of the various downhole formations. A continuous profile of these downhole properties is created from this data that allows the geologist to determine what types of sediment (sand, silt, clay) or layers of bedrock sandstone, shale etc.) exist at that location. Formations have characteristic profiles that aid in their identification and correlation. The physical properties of the aquifers (porosity and permeability) can also be estimated from this data. The use of this tool requires supporting equipment (truck, winch, cable computer, software) that the DNR currently possesses. At the end of this project this equipment will continue to be used as part of the DNR ground water level monitoring program and other related activities.

Field computer

Downloading the data from the data loggers requires regular use of a portable computer that can be used under all types of weather conditions and can survive occasional drops and bumps. This is a special laptop computer that has been manufactured to withstand moisture and shocks that would destroy other laptops. The extra toughness increases the cost compared to a standard laptop but we consider it essential for protecting our priceless data.

Submersible sample pump, reel, tubing and cable

One of the objectives of this project is to characterize the ground water residence time of the Mt. Simon aquifer through laboratory analysis of ground water samples. This data will represent an essential component for understanding the recharge characteristics of this aquifer and limits for sustainable use. Many of the ground water samples will be collected from depths greater than 50 feet below ground surface, which requires the use of a submersible pump. At the end of this project this equipment will continue to be used as part of the DNR county geologic atlas program and other related activities.

Continuous water level monitoring equipment for project wells

Another method for understanding the recharge characteristics of this aquifer and limits for sustainable use is to track water levels continuously over an extended time period. Fluctuations in water levels not caused by nearby pumping might be evidence of aquifer recharge. Tracking water levels with dedicated equipment is efficient and creates scientifically valid information versus manually gathering this data on a much less frequent basis. At the end of this project this equipment will probably remain on all the wells for water level data acquisition as part of the DNR ground water level monitoring program.

Explanation of Capital Expenditures Greater Than \$3,500 (2009):

GIS Workstations for three new atlas projects hires

Ordinary desktop computers do not have sufficient memory, hard drive, or graphics card capability to meet the intensive GIS needs of the hydrologist or GIS positions. The delayed hire will cover the costs. Software is departmental standard software. These computers will continue to be used as GIS workstations for future County Geologic Atlas projects.

VI. OTHER FUNDS & PARTNERS/ PROJECT STRATEGY:

A. Project Partners

M.L. 2008

Minnesota Geological Survey, total from appropriation	\$706,000
Nicollet County (well location verification)	in-kind contribution
Blue Earth County (well location verification)	in-kind contribution
Sibley County (well location verification)	in-kind contribution

M.L. 2009

Minnesota Geological Survey, total from appropriation	\$820,000
Anoka County (well location verification)	in-kind contribution
Wright County (well location verification)	in-kind contribution

B. Other Funds proposed to be spent during the Project Period (2008 and 2009):

The report from Result 1 (Groundwater level monitoring guidance document) will be reviewed and edited by several senior staff at the DNR and other state and federal agencies. The project will be managed by existing DNR staff with salary paid through the general fund.

Result 6 (Acceleration of county geologic atlas Part B reports) will be supported by existing DNR staff with salary paid through the general fund. The project will be managed by existing DNR staff with salary paid through the general fund.

C. Spending History (2008 and 2009): LCMR provided funds for the Mankato State University, Water Resource Center to create and publish geologic atlases in the project area covered by this work plan.

D. Time:

E. Project Impact and Long-term Strategy (2008 and 2009):

This project will create both short and long-term benefits for the people and natural resources of the region. The information generated by this project will be immediately useful to water management scientists, planners, drillers, consultants, industrial users, and municipal officials for understanding and assessing local ground water conditions for protection and wise use. Atlas acceleration funds are part of a long-term plan to complete county geologic atlases for the entire state.

VII. DISSEMINATION:

The reports from this project have been available on the DNR website since the summer of 2012. The Mt. Simon project was presented as a poster at the Midwest Groundwater Association meeting in Minneapolis in October 2012. We are currently producing a short (15 minute) video highlighting some of the results of the project for presentation at future meetings and for general viewing on the internet. In addition, a summary of the project will be submitted to the Minnesota Groundwater Association for inclusion in the quarterly newsletter.

The well log and well construction information is currently available in the project report and the Minnesota Department of Health County Well Index (<http://mdh-agua.health.state.mn.us/cwi/cwiViewer.htm>). The wells have become part of the DNR observation well network. Water level data is currently available at: http://climate.umn.edu/ground_water_level/

Publication of Part B atlas reports include preparation and printing of the County Geologic Atlases, Part B, and delivery of printed reports to the county; preparation and delivery of Part B materials to MGS for inclusion in a DVD version of each completed project that incorporates geographic information system (GIS) files, database files, pdfs, and additional digital products. When each atlas Part B is completed a training workshop for the county and local users is held to explain the results and how the maps, data, and other information can be used to assist local water resource programs. To reach other users and audiences program staff contributed newsletter articles and

presented talks and posters at conferences. Completed digital products are posted on DNR webspace at http://www.dnr.state.mn.us/waters/groundwater_section/mapping/status.html . Printed reports are available for sale through MGS Map Sales at <http://www.mngs.umn.edu/mapsales.html> .

VIII. REPORTING REQUIREMENTS:

Periodic work program progress reports will be submitted not later than 12/1/08, 7/1/09, 12/1/09, 7/1/10, 12/1/10, 7/1/11, 12/1/11, 6/30/12

IX. RESEARCH PROJECTS:

Attachment A: Final Budget Detail for 2009 Projects

Project Manager Name: Jim Berg, DNR Ecological and Water Resources

Trust Fund Appropriation: \$ 1,875,000

Project Title: County Geological Atlases South-Central Minnesota Groundwater (2009)

Date: December 18, 2012

2009 Trust Fund Budget	Result 2 DNR Budget	Amount Spent	Balance	Result 6 DNR Budget	Amount Spent	Balance	TOTAL BUDGET	TOTAL BALANCE
	<i>Test drilling, monitoring well installation, sampling, laboratory analysis, water level measurement</i>			<i>Acceleration of County Geologic Atlas Part B reports</i>				
BUDGET ITEM								
PERSONNEL:								
wages and benefits	110,092	110,092	0	635,475	520,307	115,168	745,567	115,168
GIS training for new hires				763	700	63	763	63
Contracts								
Lab analysis of ground water samples	33,236	33,236	0	133,000	97,867	35,133	166,236	35,133
Drilling contracts	812,151	812,151	0	0	0	0	812,151	0
SHPO assessments	5,325	5,325	0	0	0	0	5,325	0
<u>P/T contract MGS for roto sonic drilling</u>				50,000	50,000	0	50,000	0
Equipment								
Well pumping supplies for aquifer test and sampling	5,896	5,896	0	0	0	0	5,896	0
Continuous water level monitoring equipment	12,003	12,003	0	0	0	0	12,003	0
(Three) GIS workstations				5,672	5,672	0	5,672	0
Travel expenses	9,735	9,735	0	10,126	10,126	0	19,861	0
Other								
Printing				38,000	10,623	27,377	38,000	27,377
Supplies	1,887	1,887	0	11,639	11,639	0	13,526	0
COLUMN TOTAL	\$990,325	\$990,325	\$0	\$884,675	\$706,934	\$177,741	\$1,875,000	\$177,741

