**Environment and Natural Resources Trust Fund**

**Research Addendum for Peer Review**

**Project Manager Name: Princesa VanBuren Hansen**

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**Project Title: Understanding Groundwater Sustainability in the I-94 Growth Corridor**

**Project number: 031-B**

1. **Abstract - Summarize the research and its essential qualities including a clear statement on the purpose of the research.**

The proposed project will assess groundwater sustainability in the Interstate I-94 growth corridor between the Twin Cities and St. Cloud to characterize water resource limitations and inform decision-making. This collaborative effort between the Minnesota Environmental Quality Board (EQB) and the U. S. Geological Survey (USGS) will provide a sound foundation to inform local agency partners and communities in planning for future land and water use. The project builds on Minnesota Environmental and Natural Resources Trust Fund (ENRTF) investments in the County Geologic Atlas program and on emerging technology, as described in Activity 1 below. Because of these recent advances in scientific understanding, characterization of water quantity can now be assessed by measuring flows in the Mississippi River and in groundwater systems.

Assessing groundwater resources from the Twin Cities to St. Cloud is a priority because of the corridor's expected growth, inherent natural limits of groundwater in the area, and the vulnerability of that resource to contamination due to its sandy soils and proximity to the land surface. Further, at some point in the not-too-distant future, some areas in the growth corridor will need to invest in costly regional water-supply treatment and distribution systems that use a combination of surface water and groundwater supplies. Given these factors, local governments must carefully consider their plans for the corridor and water managers must incorporate a new understanding of the system and its limits into their management framework. The information developed by the project will build a foundation to ensure that corridor communities meet the needs of the growing population sustainably.

2. **Background - Provide the basic information and other relevant work that are the context for this research.**

This project will leverage and capitalize on work being done by the Minnesota Geological Survey (MGS) and by the Minnesota Department of Natural Resources (DNR) as part of the County Geologic Atlas Program. Using wells and test holes from Atlas efforts, the USGS will conduct an aquifer test in a buried aquifer to measure the aquifer's hydrologic properties as well as those of overlying confining layer. The aquifer test will use wells completed as part of the Atlas program, in an area where the effects of vertical flow through confining layers can be measured. Properties from this and other aquifer tests will then be extrapolated over the study area using data from test borings from the Atlas program. In addition, and in cooperation with the Minnesota Department of Health (MDH), vertical flow will be assessed from overlying glacial confining layers to the Mt. Simon aquifer by analyzing data collected for an aquifer storage project near St. Michael-Albertville. Finally, new technology developed by the USGS will be used to measure base-flow gains in the Mississippi River. This technology, termed an Acoustic Doppler Current profiler, allows for more precise measurements of streamflow that with previous streamflow equipment.

**3. Hypothesis - State the premise or propositions set forth to explain and achieve the described outcome of the research.**

The working hypothesis for the base-flow measurement in the Mississippi River is based on the law of conservation of mass. That law states that the total volume in minus the total volume out plus the change in storage is zero and applies because the density of water is constant so volume of water is a surrogate for mass. For the base-flow contribution to the Mississippi River, a section about six miles long will be identified. The total volume of inflow at the upper end and the total volume of outflow at the lower end will be measured using acoustic Doppler methods over an 8-hour period. Additional inflow will be measured at all small tributaries between the upper and lower ends. Outflow due to evaporation will be estimated by the Penman equation for losses of open bodies of water. The change in volume will be determined by integrating the change in stage measurements at several locations along the reach given the measured width of the river. The base flow will be the additional inflow required for the law of conservation of mass. The estimated total error (about 10 cubic feet per second) is smaller than the expected base-flow (about 20- 30 cubic feet per second).

**4. Methodology - Describe the methodology to be employed to carry out the proposed research. Including descriptions of the sample design(s), if applicable.**

**Activity 1: Assess flows through surficial aquifers in the corridor**

Flow through aquifers characterizes the amount of water that can be appropriated on a long-term sustainable basis. Groundwater recharge and discharge to the Mississippi River will be measured and estimates of water use, evapotranspiration, and irrigation and septic-system return flow in the growth corridor will be made. Work elements include:

- Conduct high-precision Mississippi River groundwater discharge measurement along a 6-mile reach from Clearwater to Becker
- Collect continuous groundwater recharge hydrographs and precipitation data during the non-freezing part of the year using existing sites and installations
- Compile water use information and determine variability of corridor groundwater use
- Analyze data to produce a groundwater mass balance for the surficial aquifer, including seepage run data

**Activity 2: Characterize hydraulic properties in the corridor**

Sustainable groundwater management requires information about the properties of buried aquifers and the confining layers through which water flows. Therefore, flow in and from buried aquifers will be estimated. Increased pumping from buried aquifers can induce flow from the overlying hydrologic system leading to a situation where the overlying water may no longer be available to sustain important surface waters. Understanding these flows will allow estimates of the effects of increased withdrawals from buried aquifers on other parts of the overall hydrologic system. This is a key step in understanding the sustainability of current and future groundwater withdrawals.

This activity will leverage and capitalize on work done through the ENRTF county atlas program:

- Conduct an aquifer test in a buried aquifer to measure the aquifer's hydrologic properties and those of its overlying confining layer
- Extrapolate properties from this and other aquifer tests to other buried aquifers in the study area
- Assess vertical flow from overlying glacial confining layers to the Mt. Simon aquifer in cooperation with the Minnesota Department of Health

**Activity 3: Develop decision-making tool for sustainable water use**

A decision-making tool for defining land and water interactions will be developed for the corridor based on existing data and information. Under this activity, staff will work with other agency staff (e.g. DNR, MDH, Minnesota Department of Agriculture, Minnesota Pollution Control Agency and others) to compile information on water quality in the project area. Additionally, staff will work with the Board of Water and Soil Resources and local entities to evaluate current and future water and land use plans. This information will be brought together with findings on water flows generated in the first two activities and merged with other characteristics of the system (e.g. protected features, etc.).

The outcome of this tool is to provide a foundation to local governments and other corridor water users for understanding how the groundwater system works, what its limits may be, and how future local plans and activities throughout the corridor collectively will affect the resource. During the second year, work will include the characterization of current and future land use plans, current and future water use and drinking water quality. In year three, the first phase of a model to represent corridor land and water use demands and expected groundwater system responses will be prepared. This tool will help communities understand the model's implications for, and its role in, sustainable land and water management throughout the corridor.

**5. Results and Deliverables** - Describe in detail the expected outcomes of each of the results and deliverables.

**Activity 1: Assess flows through surficial aquifers in the corridor**

Just as appropriations from the Mississippi River are limited by the river's flow, flow through aquifers determines the amount of water that people can safely appropriate over time. Under this activity, groundwater recharge and discharge to the Mississippi will be measured and estimates of water use, evapotranspiration, and irrigation and septic-system return flow in the growth corridor will be made.

**Activity 2: Characterize hydraulic properties in the corridor**

Sustainable groundwater management requires information about the properties of buried aquifers and the confining layers through which water flows. Flow in and from buried aquifers will be estimated as part of this activity. Increased pumping from buried aquifers can induce flow from the overlying hydrologic system leading to a situation where the overlying water may no longer be available to sustain important surface waters... These flows will be described. This understanding will be useful to water managers in estimating the effect of increased withdrawals from buried aquifers on other parts of the overall hydrologic system-a key step in determining the sustainability of current and future groundwater withdrawals.

**Activity 3: Develop decision-making tool for sustainable water use**

A decision-making tool for defining land and water interactions in the corridor will be developed. Information on water flows generated in the first two activities will be merged with other characteristics of the system (e.g. water quality, protected features, planned growth, etc.). This will provide a foundation to local governments and other corridor water users for understanding how the groundwater system works, what its limits may be, and how future local plans and activities throughout the corridor collectively will affect the resource.

Work will also include the characterization of current and future land use plans, current and future water use and drinking water quality. Finally, a model representing land and water use demands and expected groundwater system responses will be developed. This tool will help communities

understand the model's implications for, and its role in, sustainable land and water management throughout the corridor.

This project is designed as the second of three needed to develop the science and tools required to manage the corridor's water resources sustainably. In the first, the MGS is providing necessary geologic data under the ENRTF-supported county atlas program. This project, described above, characterizes groundwater sustainability in the corridor. Both sets of information will need to be combined with surface water, ecological and economic data in a third project to be proposed in 2015. That project would produce the full set of tools and understanding needed to sustainably manage the corridor's water and land resources, to be incorporated in an expanded modeling tool. Also in the third phase local governments and other interests would be engaged in demonstrating applications to resource decision making.

**6. Timetable - Layout the proposed times for completing the proposed research including proposed dates for individual results and deliverables.**

This project is designed as the second of three needed to develop the science and tools required to manage the corridor's water resources sustainably and will take three years to complete. Quarterly progress reports will describe progress and interim results and findings. A final interpretive report or journal article, published at the completion of the project, will summarize and integrate the results of the three activities.

**7. Budget Update- The budget sheet from the original proposal based on the amount of funding recommended. Additional details can be added to the budget sheet to more fully describe the budget (The budget sheet is expandable so that additional information can be provided). Additional narrative on the budget can also be provided to more fully explain how the funds will be spent. The "Other Funding" section of the budget sheet should also be updated and include sufficient detail so that the source and amount of contribution is clear.**

The budget sheet is attached. The total fiscal commitment, by the LCCMR is $450,000. In addition, the U. S. Geological Survey is contributing $240,000 of Federal cooperative funds to this project. The EQB will be providing $75,000 in staff resources to support this effort.

**8. Credentials - Provide brief background of the principal investigators and cooperators who will carry out the proposed research and selected publications (targeted/abbreviated resumes are acceptable).**

Environmental Quality Board staff: Princesa VanBuren Hansen and John Wells -model development and project management.

U.S. Geological Survey: Tim Cowdery, Erich Kessler, James Fallon, and Dave Lorenz; data collection and technical analysis (Activities 1 and 2).

The Department of Natural Resources and the Minnesota Geological Survey (MGS) will be particularly important non-funded project collaborators, along with other EQB member agencies and the University of Minnesota.

Resumes are attached.

**9. Dissemination and Use – Describe how the findings of the research will be disseminated and describe the expected audience and potential use.**

This project is designed as the second of three needed to develop the science and tools required to manage the corridor's water resources sustainably. In the first, the MGS is providing necessary geologic data under the ENRTF-supported county atlas program. This proposal characterizes groundwater sustainability in the corridor. Both sets of information would be combined with surface water, ecological and economic data in a third project to be proposed in 2015 to produce the full set of tools and understanding needed to sustainably manage the corridor's water and land resources, to be incorporated in an expanded modeling tool. Also in the third phase local governments and other interests would be engaged in demonstrating applications to resource decision making. Quarterly progress reports will describe progress and interim results and findings. A final interpretive report or journal article, published at the completion of the project, will summarize and integrate the results of the three activities.

# 2011-2012 Detailed Project Budget

## IV. TOTAL TRUST FUND REQUEST BUDGET 3 years

| BUDGET ITEM | AMOUNT |
|---|---|
| **Personnel:** EQB personnel - Graduate research assistant (0.5 FTE) to support elements of Activity 3 (beginning in year 2) and communicate project findings with local, state and federal partners under the activity. | $ 50,000 |
| **Contracts:** The Environmental Quality Board will contract with the U.S. Geological Survey for work under activities 1 and 2 to determine groundwater characteristics and sustainability of the I-94 Growth Corridor. | 360,000 |
| **Contracts:** EQB also will contract with the Minnesota Geospatial Information Office, or a contractor, for the development of a model to represent the corridor's land and water activities and to communicate the project's groundwater sustainability findings. | $ 38,000 |
| **Equipment/Tools/Supplies:** N.A. | |
| **Acquisition (Fee Title or Permanent Easements): NA** | $ - |
| **Travel:** *This project will require some travel by EQB staff throughout the Twin Cities to St. Cloud corridor.* | $ 2,000 |
| **Additional Budget Items:** N.A. | $ - |
| **TOTAL ENVIRONMENT & NATURAL RESOURCES TRUST FUND $ REQUEST** | $ 450,000 |

## V. OTHER FUNDS

| SOURCE OF FUNDS | AMOUNT | Status |
|---|---|---|
| **Other Non-State $ Being Applied to Project During Project Period:** USGS will contribute $240,000 to the project | $240,000 | Secured |
| **Other State $ Being Applied to Project During Project Period:** N.A. | $ - | |
| **In-kind Services During Project Period:** EQB will provide project management and guidance throughout the project's life. A number of other state agencies will participate in the project and donate in-kind services. | $75,000/25,000 | Secured/Pending |
| **Remaining $ from Current ENRTF Appropriation (if applicable): N.A.** | $ - | |
| **Funding History:** *N.A.* | $ - | |

## Team Member Qualifications

**Project Manager– Princesa VanBuren Hansen, Environmental Quality Board**

Princesa VanBuren Hansen is a Principal Planner with the Environmental Quality Board. Her background is in Biosystems and Agricultural Engineering, and she has recently been working on projects that integrate her technical expertise with planning and interdisciplinary coordination functions. Her work activities demand a strong ability to lead interagency coordination specific to water quantity and quality, as well as integrate considerations for land use and the potential impacts of climate change. She is leading the 2010 EQB State Water Plan effort, is active in the University of Minnesota sustainable water framework development, and provides leadership to a number of interagency technical and policy work teams.

In 2008 she led development of a novel GIS prototype tool to provide context for relative intensity of water use in Minnesota[i] in support of the EQB effort to construct a policy and data framework for evaluating the impacts of high water-using industries as described in the report, "*Managing for Water Sustainability*", released December 2008. Prior to that she was involved in the development of "*Protecting Minnesota's Waters: Priorities for the 2008-2009 Biennium*," the Clean Water Cabinet and EQB's report on state water priorities. In 2007 she led the technical assessment effort that contributed the foundation to the EQB 2007 study, "*Use of Minnesota's Renewable Water Resources: Moving toward Sustainability*," an interagency assessment of the availability of water to meet the state's future demands. This was the state's first regional-scale assessment of ground and surface water sustainability.

Prior to joining the EQB, Princesa was staff member of the University of Minnesota's Department of Bioproducts and Biosystems Engineering. She was brought on in 2005 to coordinate and oversee a large team of researchers working on Total Maximum Daily Load activities for the Minnesota Pollution Control Agency and the Environmental Protection Agency. She was also an instructor for the University's Erosion and Sediment Control Certification Program, providing education to those working with the MPCA and the Minnesota Department of Transportation on construction sites.

She also has experience working in the private sector with Delta Environmental Consultants and for the federal government through the U.S. Department of Agriculture, Agricultural Research Service. In the ten years before the USDA assignment, she worked on projects ranging from water quality in watersheds of Karst geology, evaluation of surface tile inlet designs and effectiveness, depression-focused recharge, erosion control stabilization for MN/DOT, wetland delineation, TMDL development for southeastern Minnesota, septic system installation certification, mine land tailing stabilization, mobilization of heavy metals in plant materials, supercomputer modeling, and nitrogen cycling in alfalfa.

**John Wells, Environmental Quality Board**

John Wells has played leadership roles in the development of each of Minnesota's state water plans, beginning with *Toward Efficient Allocation and Management*, the 1979 Water Planning Board effort that called for a new role in local planning and the establishment of a new state board to champion these efforts. John helped bring these ideas to fruition with his work to secure passage of the Comprehensive Local Water Management Act of 1985 and the law establishing the Board of Water and Soil Resources in 1987. He also coordinated development of the Minnesota Ground Water Protection Act of 1989, which grew out of a series of water planning discussions in the decade following adoption of the 1979 plan.

Today, John serves as the Minnesota Environmental Quality Board staff leader for water planning and sustainable development activities. He co-chairs the federal-state Minnesota River Basin Integrated Watershed Study and leads the board's efforts to design a new state approach to community assistance. He led interagency initiatives that produced the 2007 and 2008 EQB reports, *Use of Minnesota's*

*Renewable Water Resources: Moving toward Sustainability* and *Managing for Water Sustainability*, which identified strategic opportunities for improving the state's management of water supplies. He also coordinated development of the *Protecting Minnesota's Waters* series of biennial state water policy reports, including *Priorities for the 2008-2009 Biennium*, the most recent Clean Water Cabinet and board report.

He serves a one of three co-chairs of the national Sustainable Water Resources Roundtable, is vice chair of the policy committee of the American Water Resources Association, and serves on the USGS stakeholder committee to assist in design of the National Water Census.

John received his M.S.P.H. with an emphasis in environmental management from the University of North Carolina, School of Public Health, at Chapel Hill, and his B.S. in chemistry from the University of Wisconsin at Madison.

**Tim Cowdery, U.S. Geological Survey**

Tim Cowdery is a hydrogeologist with the U.S. Geological Survey in Mounds View, Minnesota. He currently serves as a chief for several projects at the Water-Science Center in Minnesota. He earned a master's degree from the University of Minnesota in groundwater geology in 1997. His research interests include groundwater/surface-water interactions, numerical groundwater modeling, and groundwater recharge analysis.

Tim joined the USGS in 1992 as the groundwater specialist for the Red River of the North National Water-Quality Assessment, conducting groundwater-quality research at many spatial scales in that basin. He has designed and executed to two groundwater modeling studies at local and regional scales in southwestern Minnesota and in the southern Twin Cities Metropolitan area. He has developed systems for automated groundwater data collection, telemetry, and processing and has used these data to estimate the spatial and temporal variability of groundwater recharge.

Since 2002, Tim has managed the Glacial Ridge Hydrologic assessment, a groundwater/surface water interaction study that documents changes in the hydrology of a large area in northwestern Minnesota undergoing extensive wetland and prairie restorations. He continues to manage several other projects involving groundwater modeling, water-quality sampling, and groundwater recharge.

**Dave Lorenz, U.S. Geological Survey**

David Lorenz is a hydrologist with the U.S. Geological Survey in Mounds View, Minnesota. He currently serves as Surface Water Specialist for the Water Science Center in Minnesota and as Technical Lead for S-PLUS support within the Water Discipline of the USGS. His background is in Civil Engineering with a strong emphasis in statistical analysis.

Since starting with the USGS in the early 1980s, David Lorenz has been involved in several state-wide hydrological analysis studies. Those studies include a low-flow study in 1987; three regional flood-frequency studies in 1987, 1997, and 2009; and a groundwater recharge map in 2007. He has also been involved in local studies such as a groundwater-surface water interaction study in the Glacial Ridge area in northwestern Minnesota and Red River and Upper Mississippi River National Water Quality Assessment (NAWQA) studies.

Most of his recent work has been in U.S. regional trend studies of nutrients and pesticides. He has authored or co-authored several reports on those studies. Related to that work, he also regularly teaches two USGS sponsored classes, one in general statistics and another on trend and load analysis.

**Erich Kessler, U.S. Geological Survey**

Erich Kessler is a hydrologist with the U.S. Geological Survey in Mounds View, Minnesota. He works in the Hydrologic Networks and Data Section and is responsible for the collection and review of stream flow data. He is a recent graduate of the University of Minnesota with a degree in civil engineering. Recently, he completed his first hydrologic study, a low-flow analysis of the Mississippi River near Anoka, Minnesota. Through that study, he has gained considerable knowledge of the characteristics of the Mississippi River in the I-94 growth corridor.

[i] http://www.eqb.state.mn.us/eqb_w/