Environment and Natural Resources Trust Fund
2010 Request for Proposals (RFP)

LCCMR ID: 001-A1

Project Title:

Measuring Groundwater Flow Using High-Prescision River-Flow

LCCMR 2010 Funding Priority:

A. Water Resources

Total Project Budget: $ $176,050

Proposed Project Time Period for the Funding Requested: 3 years, 2010 - 2013

Other Non-State Funds: $ $112,700

Summary:

Demonstration of accurate measurement of the groundwater available for sustained human and aquatic-habitat use employing new, innovative techniques for measuring Mississippi River flows in the Minneapolis river gorge.

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Sponsoring Organization: Metropolitan Council

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Web Address: www.metrocouncil.org

Location:

Region: Metro

County Name: Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, Washington

City / Township:

_____ Knowledge Base _____ Broad App. _____ Innovation

_____ Leverage _____ Outcomes

_____ Partnerships _____ Urgency _____ TOTAL

PROJECT TITLE: Measuring groundwater flow using high-precision river flow measurements

I. PROJECT STATEMENT

The amount of groundwater available for sustainable use does not depend on the volume of water in an aquifer system, but rather depends on the amount of water *flowing through* the system. In order to accurately determine the amount flowing through an aquifer system, either the inflow or outflow needs to be measured. On a large scale, measuring the inflow to an aquifer system is nearly impossible because of large variations in soils, land cover, climate, etc. Groundwater outflow from an aquifer system typically occurs as seepage to surface waters and as water pumped from wells. Relatively accurate records of pumping from wells are currently maintained. An accurate measurement groundwater outflow to large rivers would be especially useful to managers because, when added to withdrawals from wells, it provides a good measure of how much groundwater is flowing though (available from) all aquifers in an area.

Accurately measuring groundwater outflow to short reaches of large rivers is nearly impossible using traditional techniques because measuring large flows result in large errors. Groundwater outflow is often a small percentage of large river flow over short reaches, often smaller than the flow measurement errors.

This project will demonstrate that the amount of groundwater flowing through deep aquifers can be accurately measured using new, high-precision gauging of river flow. Flow through a 6-mile reach of the Mississippi River in the Minneapolis river gorge will be combined with other data to produce the groundwater-flow measurement. If these technique proves useful, an extension to this proposal will be submitted to measure the entire stretch of the large rivers in the Twin Cities metropolitan area. The data and analysis included in this pilot study will also define the river conditions needed for an accurate measurement elsewhere in the state. Accurate measurement of groundwater flow will:

- provide water managers with the total amount of groundwater available for human and aquatic-habitat use
- provide real-world groundwater flows with which to calibrate groundwater models.
- greatly improve the accuracy of the recently developed Metropolitan Area Groundwater Model 2.0. Without these measurements, important aquifer properties like the hydraulic conductivity and the amount of areal recharge become linked in models, making them non-unique and less reliable.

II. DESCRIPTION OF PROJECT RESULTS

Result 1. Data needed to measure groundwater flow **Budget:** $95,088

We will gather all data needed to accurately measure groundwater flow to the Minneapolis river gorge. This section of the Mississippi River is ideal for this demonstration because flow is more easily measured there and human-flow manipulations are relatively few. Measurements and their precision will include stream flow at 4 sections, stream level and surface area, groundwater levels, storm-sewer, tributary, and spring flows, and weather data. The precision with which these measurements can be made will show under what circumstances the new techniques are transferable to measuring groundwater flow to other large river reaches.

Deliverable	Completion Date
1. A set of data and error estimates needed to measure groundwater flow to the Mississippi River in the Minneapolis river gorge.	November 30, 2012

Result 2. Infrared images needed to locate warm water entering large rivers **Budget:** $7,000

Thermal infrared images will be taken of the 80-mile reaches of the Mississippi, Minnesota, and St. Croix Rivers in the Twin Cities area. These images will help identify areas where warm water, such as storm-water and groundwater, flows into cool river water in the autumn.

Deliverable	Completion Date
1 Thermal infrared images and high resolution photographs of river reaches in geo-referenced GIS format.	November 30, 2012

Result 3. Analysis of data to produce groundwater-flow measurement **Budget:** $73,962

A water-balance of inflows minus outflows will be used to measure groundwater flow. River inflows, river outflows, creek, spring, and storm-water inflows, in-river storage changes, and river-surface evapotranspiration will be measured as accurately as possible. The difference in the inflows and outflows will be interpreted as groundwater discharge. This water balance will be measured and calculated for the entire reach and in sub-reaches. The estimated minimum amount of groundwater flow that can be detected by these methods is about 9 cubic feet per second. This is about 30 percent of the current estimate used to calibrate groundwater flow in the Metropolitan Area Groundwater Model 2.0 in this reach.

Deliverable	Completion Date
1. A report documenting the data collection techniques, error analysis, calculation of the groundwater flow in the study area, and an analysis of stream conditions conducive to such a measurement throughout the Twin Cities metropolitan area.	July 30, 2013

III. PROJECT STRATEGY

A. Project Team/Partners

This project will be conducted as a collaboration between the Metropolitan Council and the U.S. Geological Survey. Team members: Metropolitan Council—Chris Elvrum, Lanya Ross; USGS—Tim Cowdery, Erich Kessler, James Fallon, and Dave Lorenz. Results 1 and 3 will be performed by the USGS, who can fund up to 40% of project costs that it performs. Result 2 will be managed by the Metropolitan Council.

B. Timeline Requirements

The project will be 3 years in duration. Because the river flow measurements must be made at very low flow, this timeline provides 3 autumn periods for low flow to occur. It is possible that the project could be completed in two years if adequate low flow occurs the first autumn.

C. Long-Term Strategy

This project is conceived as a proof-of-concept study for a larger effort aimed at quantifying groundwater flow throughout the area of the Metropolitan Area Groundwater Model 2.0. The results of this pilot project will show what scale of the effort needed to measure groundwater flow in this rest of the Twin Cities and what the accuracy of this larger measurement will be. Groundwater managers need this information to more accurately predict the impacts of groundwater withdrawals in the Twin Cities. If the method proves that a relatively accurate measurement can be made, a follow-up proposal to measure the remaining reaches of the large rivers in the region will be developed. The measurement techniques will be applicable to measuring groundwater flow to large rivers throughout the state.

Project Budget

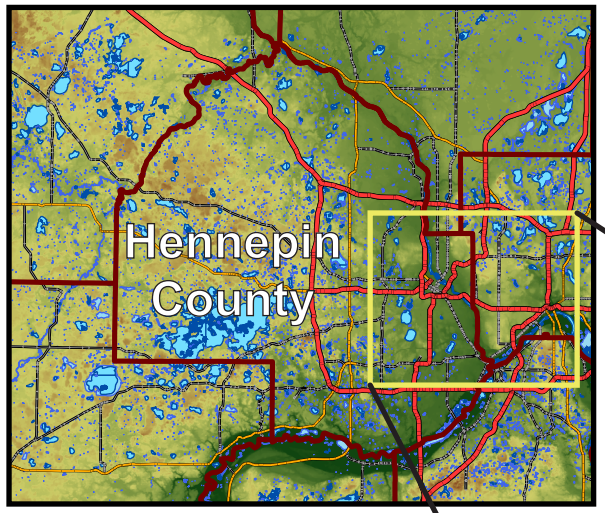
IV. TOTAL PROJECT REQUEST BUDGET for 3 years

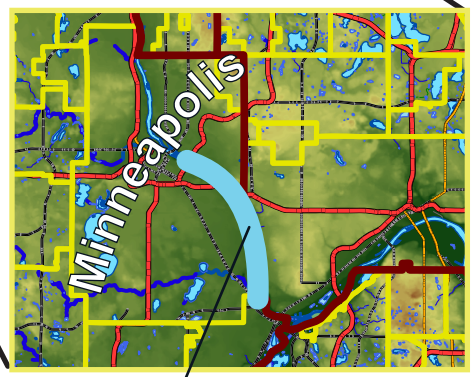
BUDGET ITEM	AMOUNT	
Contracts: *U.S. Geological Survey, Minnesota Water-Science Center*	$	169,050
Personnel: 75% salary, 25% benefits	$131,729	
Hydrologists: 4.2 months of time among 4 employees	$73,962	
Hydrologic technicians: 3.6 months of time among 18 employees	$57,767	
Equipment/Tools/Supplies:	$8,875	
Pressure transducer rental (2 x 2 months)	$2,000	
Acoustic doppler current profiler (1 x 2 months)	$1,250	
Boat rental (3 x 3 days)	$3,000	
Generators and lights rental	$1,250	
Survey-grade GPS rental	$1,375	
Travel: motel & per diem for 9 out-of-town hydrologic technicians	$10,436	
Additional Budget Items:	$18,010	
Vehicles, 4 for out-of-town 2 for local employees	$2,392	
Shipping of rental equipment	$250	
Contingency at 10%	$15,368	
Contracts: *Bill Anderson, thermal infrared imaging*	$	7,000
Personnel: 70 hours to collect and process images	$5,800	
Equipment/Tools/Supplies: infrared camera rental	$1,200	
TOTAL PROJECT BUDGET REQUEST TO LCCMR	$	176,050

V. OTHER FUNDS

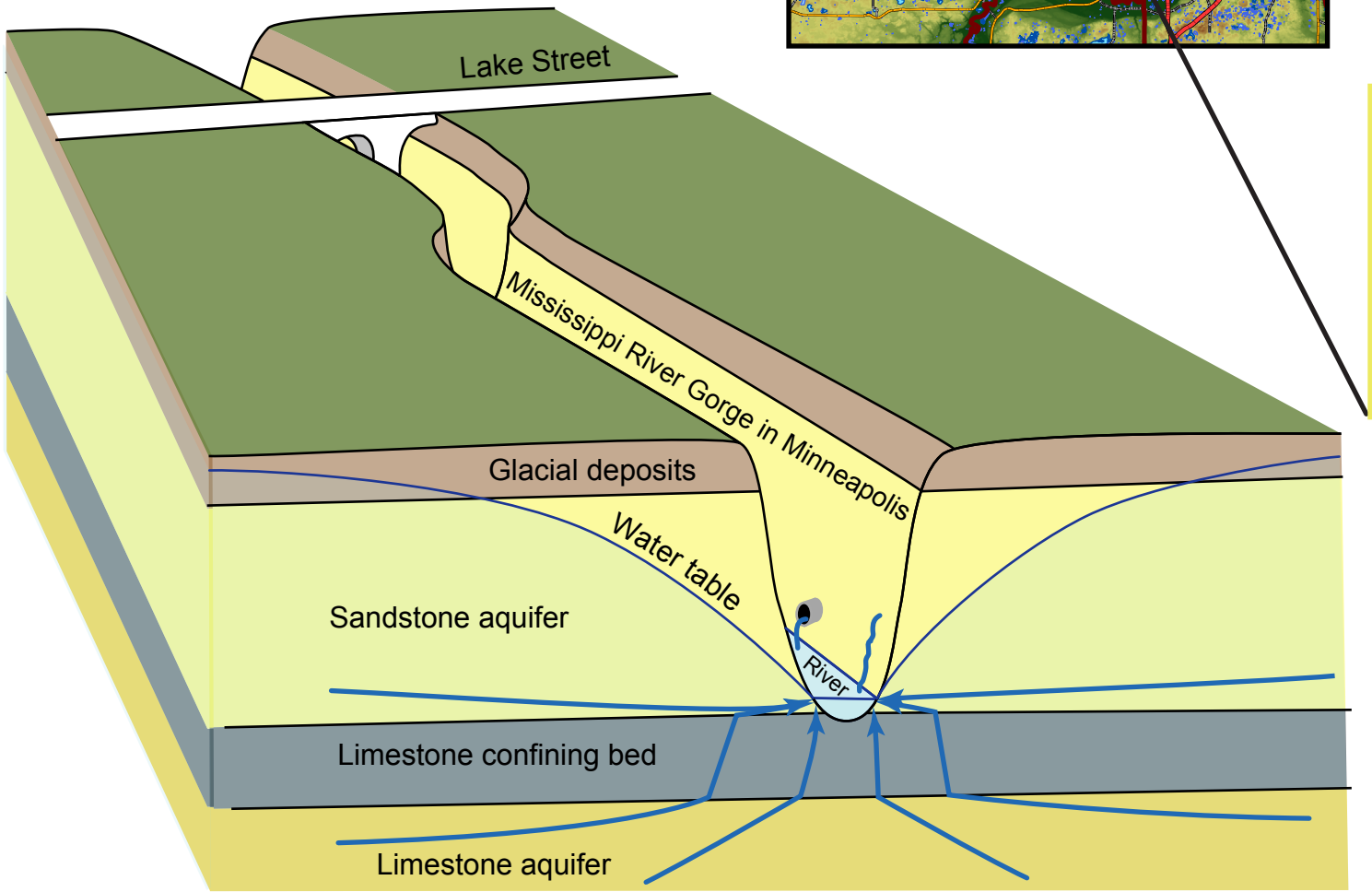
SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ Being Applied to Project During Project Period: U.S. Geological Survey Cooperative Matching Funds for 40% of USGS portion of project cost.	$ 112,700	pending federal appropri-ation
Other State $ Being Applied to Project During Project Period: *Indicate any additional state cash $ (e.g. bonding, other grants) to be spent on the project during the funding period. For each individual sum, list out the source of the funds, the amount, and indicate whether the funds are secured or pending approval.*	$ -	
In-kind Services During Project Period: Metropolitan Council project management and participation	$ 15,000	
Funding History: *Indicate funding secured prior to July 1, 2010 for activities directly relevant to this specific funding request. State specific source(s) of funds.*	$ -	

Groundwater flow to the Mississippi River in the Minneapolis River gorge





Study Area



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Chris Elvrum is the manager of water supply planning for the Metropolitan Council. He has a bachelor's and master's degrees in geology and is registered professional geologist in Minnesota. Chris has worked in water resource management for the past 15 years and has been at the Metropolitan Council for the past 10 years where he has managed many water-resource projects including the development of the Metropolitan Area Master Water Supply Plan.

The Metropolitan Council (Council), in cooperation with the Minnesota Department of Natural Resources and the Metropolitan Area Water Supply Advisory Committee and other stakeholders, developed the metropolitan area master water supply plan which identifies the issues that need to be addressed to ensure supplies are available for current and future generations. As part of this effort, the Council constructed a Twin Cities metropolitan area groundwater flow model (Metro Model 2) with the cooperation of Barr Engineering Company, a technical workgroup and other stakeholders. This modeling effort builds upon the Minnesota Pollution Control Agency's (MPCA's) 2000 Metro Model. The Metro Model 2 is assisting Council staff and stakeholders assess current and projected groundwater withdrawals, future water availability, and to identify alternatives in areas facing possible future water supply limitations.

The Metropolitan Council is the regional planning agency serving the Twin Cities seven-county metropolitan area and providing essential services to the region. The Metropolitan Council provides cost-effective transit and wastewater services, coordinates orderly and economic development, and assists communities as they plan for anticipated growth.