Environment and Natural Resources Trust Fund
2018 Request for Proposals (RFP)

Project Title: **ENRTF ID: 076-B**

Protecting Fish Habitat in Streams From Groundwater Withdrawal

Category: B. Water Resources

Total Project Budget: $ 93,391

Proposed Project Time Period for the Funding Requested: 2 years, July 2018 to June 2020

Summary:

We propose a method to withdraw groundwater near streams without damaging fish habitat. A construction manual will be delivered. This project will allow pumping, e.g., for irrigation, without damaging fish.

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Web Address

Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

A plan view is shown with a trout stream, a pumping well, and an injection well to prevent temperature rise.

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____%

Environment and Natural Resources Trust Fund (ENRTF)
2018 Main Proposal
Project Title: Protecting Fish Habitat in Streams From Groundwater Withdrawal

I. PROJECT STATEMENT

Groundwater withdrawal near streams, for example for irrigation, causes the stream water temperature to increase, which damages fish habitat. We propose a method to withdraw groundwater near streams without damaging fish habitat. After completion of the project, design guidelines and a manual will be available for creating a system that prevents damage to the fish habitat in streams near wells.

Groundwater withdrawal near streams reduces the flow of groundwater into the streams. As groundwater is colder than surface water during the summer months, this reduction results in an increase in stream temperature, damaging fish habitat. We propose to increase the groundwater withdrawal slightly, and inject this surplus water back into the ground, but much closer to the stream than the discharge well that extracts the water. The effect of a well on a stream decreases with increasing distance from the stream. Therefore, recharging the aquifer close to the stream has a relatively large effect. This practice of recharging an aquifer near a boundary (the stream bank in this case) has been applied successfully to mitigate seawater intrusion into aquifers by recharging the aquifer near the coast.

The approach we suggest requires the well owner to hire a consultant to design the system, based on the guidelines for the proposed design. The cost, however, will be minor relative to the potential damage resulting from mandatory termination of pumping, for example, causing a farmer to loose valuable production.

The overall goal of the project is to present a method for preventing stream temperatures to rise as a result of groundwater withdrawal. Achieving this goal is important for all areas in Minnesota where water withdrawal may result in damage to fish in streams. The method we propose is cost-effective, because the expenses are small relative to the gains. A well pumping in an aquifer with a stream will reduce the flow into the stream; the magnitude of this reduction depends mainly on the pumping rate, the natural flow in the aquifer (usually toward the stream), and the distance between well and stream. The decrease of flow into the stream due to pumping can be computed by elementary means, and is a fraction of the total discharge of the well, because the well usually gets most of its water from elsewhere. We propose to increase the discharge of the pumping well by an amount, roughly equal to the reduction of flow into the stream, and to re-inject this into the stream, either via recharge wells, or via an underground recharge drain.

We propose to carry out calculations to design systems for both recharge wells and recharge drains, make cost estimates of the two approaches, study the performance of the system over time, and study the heat flow to make sure that the system indeed will maintain temperature levels in the stream at the desired level.

Our proposal was prompted by the case of a farmer who feared to loose his pumping permit because his irrigation well affected a nearby trout stream, Rock Creek, Minnesota. He contacted the PI in 2016 for advice, and we will use the setting of that case as an example of the kind of case that occurs in the field, but will not investigate or consider his case in detail.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Creating the design manual, based on steady flow conditions **Budget: $ 46,229**

This activity is concerned with the design of a system of mitigation, based on injection of part of the discharge of the well back into the aquifer near the stream, either by (a) small recharge well(s), or by a subsurface irrigation drain. The work includes defining what data need to be collected to design the system, and development of a method to determine the amount that the discharge well must pump in order to protect the fish habitat in the stream.

Outcome	Completion Date
1. A design manual for two cases of recharge, wells and a recharge drain below surface.	6/30/2019

Activity 2: Developing an optimal design of the system based on outcome 1, validation of the procedure for conditions that change over time. **Budget: $ 47, 163**

This activity consists of using the method developed under activity 1 to determine the optimum design for a variety of possible scenarios, including the number of irrigation wells, e.g., many small well points versus one or more larger ones, and recharge drains at various elevations and distances from the stream. This activity includes transient conditions which will be modeled, with existing methods, to ensure that the system will work well over time. If necessary, time variation will be included in the model, affecting the design procedure.

Outcome	Completion Date
1. Final version of the design manual, with assessment of the efficiency of various designs. The design manual will include a full report of the computations carried out to validate the efficiency of the proposed designs.	6/30/2020

III. PROJECT STRATEGY

A. Project Team/Partners

The project team consists of the Principal Investigator and a graduate research assistant. The PI is responsible for the project and will guide the graduate research assistant during the project. The PI will write the manual, together with the graduate research assistant. The PI expects to spend a minimum of two months on the proposal, at no cost to the project.

B. Project Impact and Long-Term Strategy

The long-term impact of the project is the availability of the option for a well owner to take action to avoid losing his pumping permit. In most cases, special permission will need to be applied for to be able to recharge water into the aquifer, but as recharge will be close to a stream, will end up in the stream, and will consist of water that comes directly from the aquifer upstream from the stream, we believe that a permit is likely to be granted, but certain conditions will have to be met to protect the aquifer. A detailed report and design manual will enable a qualified consultant to design the system at relatively low cost since the procedure to be followed will be clearly outlined, and only minimal groundwater modeling will be required, most likely by simple analytic element modeling.

C. Timeline Requirements

The majority of the work is the optimization of water supply into the recharge wells or recharge drain as a function of time, depending on circumstances. Although the activities are listed as being sequential, the PI will begin analysis early on to outline the process to be followed by the graduate research assistant, and there is flexibility in the sequence of execution of the tasks.

2018 Detailed Project Budget

Project Title: Protecting Fish habitat in Streams From Groundwater Withdrawal

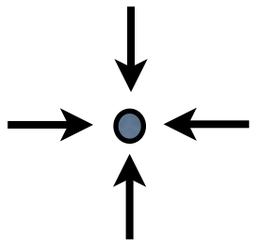
IV. TOTAL ENRTF REQUEST BUDGET *2* **years**

BUDGET ITEM	AMOUNT
Personnel: 24 months research assistant at 50% time	$93,191
Professional/Technical/Service Contracts: N/A	
Equipment/Tools/Supplies: computer supplies	$ 200
Acquisition (Fee Title or Permanent Easements): N/A	$ -
Travel: N/A	$ -
Additional Budget Items: N/A	$ -
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 93,391

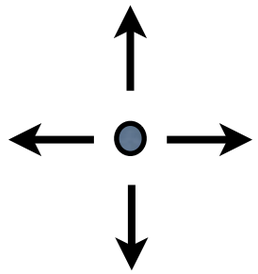
V. OTHER FUNDS *(This entire section must be filled out. Do not delete rows. Indicate "N/A" if row is not applicable.)*

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period: N/A	$ -	
Other State $ To Be Applied To Project During Project Period: N/A	$ -	
In-kind Services To Be Applied To Project During Project Period: 1% Cost Share for Otto Strack ($1009 salary, $338 fringe per year or 1%) 54% F&A waived $34,156 savings	$ 36,851	
	$ -	
Other Funding History: N/A		

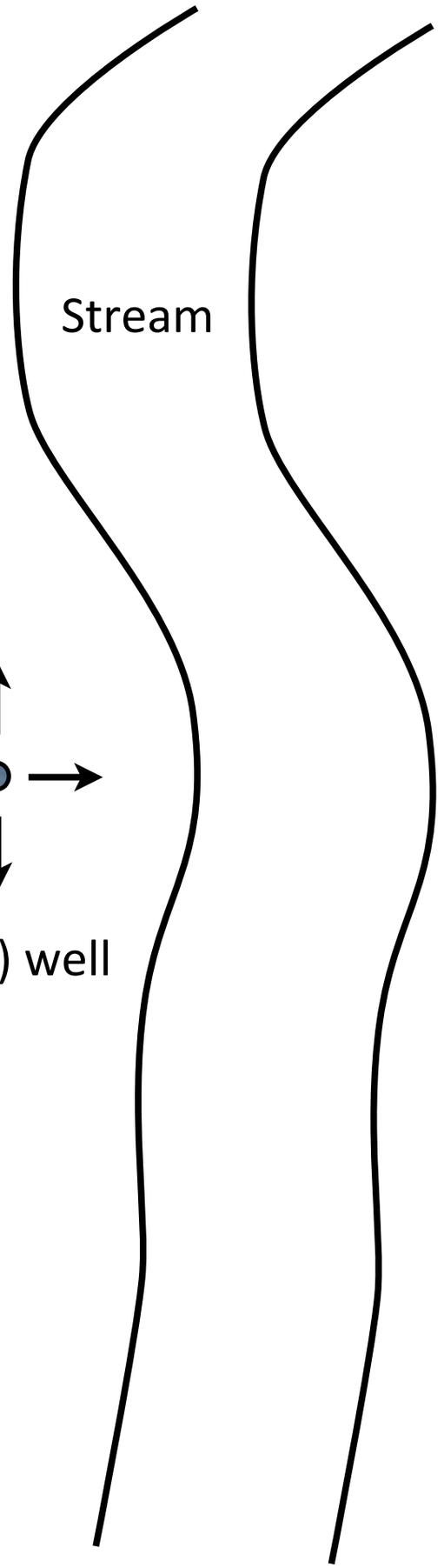
The small injection well near the stream reduces the effect on the stream of the discharge well sufficiently to maintain the stream water temperature at sufficiently low levels



discharge well



Injection (recharge) well



plan view

Project Manager Qualifications & Organization Description

Biographical sketch

Dr. Strack received his PhD from the Technical University of Delft in 1973. He joined the Department of Civil Engineering of the University of Minnesota in 1974, where he is currently a Professor. Dr. Strack is the original developer of the Analytic Element Method, which is now the second most popular method in groundwater modeling. He is the author of the textbook *Groundwater Mechanics*, Prentice-Hall, 1989 (732 pp.) and the textbook *Analytical Groundwater Mechanics,* in press, Cambridge University Press. He has authored numerous papers, is the third recipient of the Lifetime Achievement Award, granted by the Minnesota Groundwater Association, and is a Correspondent (foreign member) of the Royal Dutch Academy of Sciences. Professor Strack has taught groundwater flow for over 45 years and has over 45 years of experience as a consultant. He is the author of the computer programs MLAEM and SLAEM.

Duties and responsibilities of the project manager

The project manager will bear the full responsibility for the quality of the final products and for their suitability for the goals specified in the proposal. The project manager is responsible for the testing of the concept explained in the proposal, and for the writing of the guidelines. The project manager will meet with his student several times a week, and will schedule regular meetings to assess progress. The weekly groundwater seminars, organized at the Department of Civil, Environmental, and Geo- Engineering, University of Minnesota, will serve as a platform for discussions regarding the project; members of the professional groundwater community regularly participate in these meetings, and will be asked for their professional opinion regarding progress and quality of the work.