

**Environment and Natural Resources Trust Fund  
2019 Request for Proposals (RFP)**

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**Project Title:**

**ENRTF ID: 054-B**

Improving Drinking Water for Minnesotans through Pollution Prevention

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**Category:** B. Water Resources

**Sub-Category:**

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**Total Project Budget: \$** 345,778

**Proposed Project Time Period for the Funding Requested:** June 30, 2022 (3 yrs)

**Summary:**

This research will reduce exposure of Minnesotans to toxic, cancer-causing chemicals by identifying and curbing key pollutant sources in the Upper Mississippi River watershed and improving drinking water treatment.

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**Name:** Raymond Hozalski

**Sponsoring Organization:** U of MN

**Title:** Professor

**Department:** Science and Engineering / Civil, Environmental, and Geo- Engineering

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Minneapolis MN 55455

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**Email** hozalski@umn.edu

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**Location**

**Region:** Metro

**County Name:** Ramsey, Hennepin

**City / Township:** Minneapolis, St.Paul, Roseville, Edina, Bloomington, Mendota Heights

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**Alternate Text for Visual:**

Cancer-causing toxins are formed when chlorine disinfectants react with precursors in Mississippi River water. Precursor sources, likely human/animal waste discharges, will be identified and curbed to limit toxin exposures.

|  |                    |                          |                   |                          |                       |                          |                          |   |
|--|--------------------|--------------------------|-------------------|--------------------------|-----------------------|--------------------------|--------------------------|---|
| <input type="checkbox"/>   | Funding Priorities | <input type="checkbox"/> | Multiple Benefits | <input type="checkbox"/> | Outcomes              | <input type="checkbox"/> | Knowledge Base           |   |
| <input type="checkbox"/>   | Extent of Impact   | <input type="checkbox"/> | Innovation        | <input type="checkbox"/> | Scientific/Tech Basis | <input type="checkbox"/> | Urgency                  |   |
| <input type="checkbox"/>   | Capacity Readiness | <input type="checkbox"/> | Leverage          | <input type="checkbox"/> |                       | TOTAL                    | <input type="checkbox"/> | % |
| <input type="checkbox"/> If under \$200,000, waive presentation? |                    |                          |                   |                          |                       |                          |                          |   |



**PROJECT TITLE: Improving drinking water for Minnesotans through pollution prevention**

**I. PROJECT STATEMENT**

The upper Mississippi River, the water supply for ~1 million Minnesota residents, is under constant assault by a variety of chemical and microbiological contaminants. A contaminant of emerging concern in Twin Cities drinking water supplies is the **highly toxic and potent cancer-causing chemical N-nitrosodimethylamine (NDMA)**. NDMA itself is not present in the river water but the chemical is formed by the reaction of so-called ‘precursors’ in the water with chloramines, a form of chlorine added to the water for disinfection. Although NDMA currently is not a regulated contaminant, many states are considering regulations and California has established a notification level of 10 ng/L (10 parts-per-trillion). Initial testing has shown high levels of precursors in Upper Mississippi River water, with the potential to form more than 50 ng/L of NDMA. A preliminary sampling campaign completed with the aid of St. Paul Regional Water Services personnel has identified the Crow River as a major contributor to NDMA precursor levels in the Upper Mississippi, but the sources of these precursors to the Crow River are not known. NDMA precursors are associated with municipal wastewater discharges and include some industrial chemicals and pharmaceutical compounds such as ranitidine, a medicine used to treat acid reflux. Another potential source in the Crow River watershed is animal waste from agricultural operations. To protect drinking water consumers from NDMA and other toxic nitrosamines, it is critical to first identify and then curb the main sources of precursors. **The main impact of the proposed project is to reduce exposure of Minnesotans to the toxic chemical NDMA by recommending pollution prevention strategies to the MN Pollution Control Agency (MPCA) and the MN Department of Health (MDH) and treatment options to water utilities.** This will be done by:

- Assessing seasonal variability in NDMA precursor levels in the Upper Mississippi and Crow Rivers;
- Identifying the major sources of NDMA precursors to the Crow by sampling along the length of the river from the confluence and working upstream along the North and South Forks as well as Buffalo Creek; and
- Investigating options to reduce NDMA formation during water treatment.

*This research project will benefit Minnesotans by providing critically important information for policy makers regarding which waste streams to target to reduce inputs of NDMA precursors to surface waters and for water utilities regarding potential treatment strategies for reducing NDMA formation when precursors are present.*

**II. PROJECT ACTIVITIES AND OUTCOMES**

**Activity 1:** *Assess seasonal variability in the quantities of NDMA precursors in the Crow River and the Mississippi River both upstream and downstream of the Crow.* **Budget: \$ 112,724**

Known precursors include nitrogen-containing organic compounds with specific structures called secondary and tertiary amines. Such precursors are often associated with municipal wastewater discharges, but the main sources to the Crow River are not known and may include human waste, animal waste, or both. Additional work is needed to assess seasonal variability in precursor levels in the Crow River and the Upper Mississippi River.

| Outcome  | Completion Date    |
|--|--------------------|
| 1. Collect water samples from the Crow River and Mississippi River upstream and downstream of the Crow at least 4 times over a one-year period.    | August 31, 2020    |
| 2. Analyze the river water samples for NDMA precursor levels using the uniform formation conditions (UFC) test.                                    | September 31, 2020 |
| 3. Analyze the river water samples for total organic amine levels and specific known precursor compounds (e.g., ranitidine, selected antibiotics). | December 31, 2020  |

**Activity 2:** *Identify NDMA precursor sources by sampling along the length of the Crow River during the season where precursor levels are highest as determined from Activity 1.* **Budget: \$ 96,541**

We will collect samples at roughly ten-mile intervals working upstream along the Crow, North and South Forks



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of the Crow, and Buffalo Creek to identify where precursor levels increase significantly. Subsequent trips will involve sampling with increasing spatial resolution in river reaches with large precursor increases to hone in on specific sources. Sampling and testing of specific waste streams will be used to confirm precursor sources.

| <b>Outcome</b>  | <b>Completion Date</b> |
|---|------------------------|
| 1. Collect river water and wastewater samples along the Crow River, North and South Forks of the Crow, and Buffalo Creek during the season with highest precursor levels. | August 31, 2021        |
| 2. Analyze the river and wastewater samples for NDMA precursor levels using UFC test.   | September 31, 2021     |
| 3. Analyze the samples for total organic amine levels and specific known precursors (e.g., ranitidine, selected antibiotics).   | December 31, 2021      |

**Activity 3: Investigate the effects of chlorine and ozone concentration and exposure time on destruction of precursors. Budget: \$ 98,685**

There is some evidence that pre-oxidation of the precursors with free chlorine or ozone prior to addition of chloramines reduces the subsequent formation of NDMA. We will investigate the effects of chlorine and ozone concentration and exposure time on destruction of precursors. Mississippi River water samples will be treated with either free chlorine or ozone over a range of typical concentrations and contact times and subjected to testing before and after treatment to determine NDMA precursor levels and treatment effectiveness.

| <b>Outcome</b>  | <b>Completion Date</b> |
|---|------------------------|
| 1. Collect Mississippi River water samples and pretreat using chlorine or ozone.                            | April 30, 2022         |
| 2. Analyze the river water samples before and after treatment for NDMA precursor levels using the UFC test. | September 31, 2022     |

**Activity 4: Disseminate findings to Minnesota’s public water utilities, MDH, and MPCA. Budget: \$ 37,828**

| <b>Outcome</b>   | <b>Completion Date</b> |
|--|------------------------|
| 1. Presentations at in-state scientific conferences (on-going/continuous)  | June 30, 2022          |
| 2. Meetings with stakeholders to disseminate results (on-going/continuous) | June 30, 2022          |

**III. PROJECT STRATEGY**

**A. Project Team/Partners**

The project team will be led by Raymond Hozalski (University of Minnesota; Dept. of Civil, Environmental, and Geo- Engineering) and William Arnold (UMN; CEGE). Dr. Hozalski is a water treatment expert with more than 20 years of experience working with water utilities to improve drinking water quality while Dr. Arnold is an expert in environmental chemistry with extensive experience in the analysis, fate, and transport of organic contaminants. Drs. Hozalski and Arnold will oversee the project, including meetings with stakeholders. A graduate student and two undergraduate students will also work on the proposed project. Their duties will include collecting and analyzing water samples, data analysis, and presenting the results at in-state scientific conferences. Additional partners include the water utilities of Minneapolis and St. Paul, MDH, and MPCA.

**B. Project Impact and Long-Term Strategy**

The main goals of the proposed research are to identify significant sources of NDMA precursors to the Upper Mississippi River and to develop pollution prevention strategies for reducing precursor inputs. For example, if it is found that a certain class of antibiotics given to farm animals is an important precursor, then one possible **strategy** would be to ban that class of antibiotics for animal use. The **project impact** will be improved drinking water quality and protection of the health and safety of Minnesotans, particularly those in the Twin Cities and surrounding suburbs served by the Minneapolis and St. Paul water utilities.

**C. Timeline Requirements**

The proposed project will be completed in a three-year period. The sample collection and chemical analyses are time-consuming and will require detailed quality assurance/quality control.

## 2019 Proposal Budget Spreadsheet

**Project Title: Improving drinking water for Minnesotans through pollution prevention**

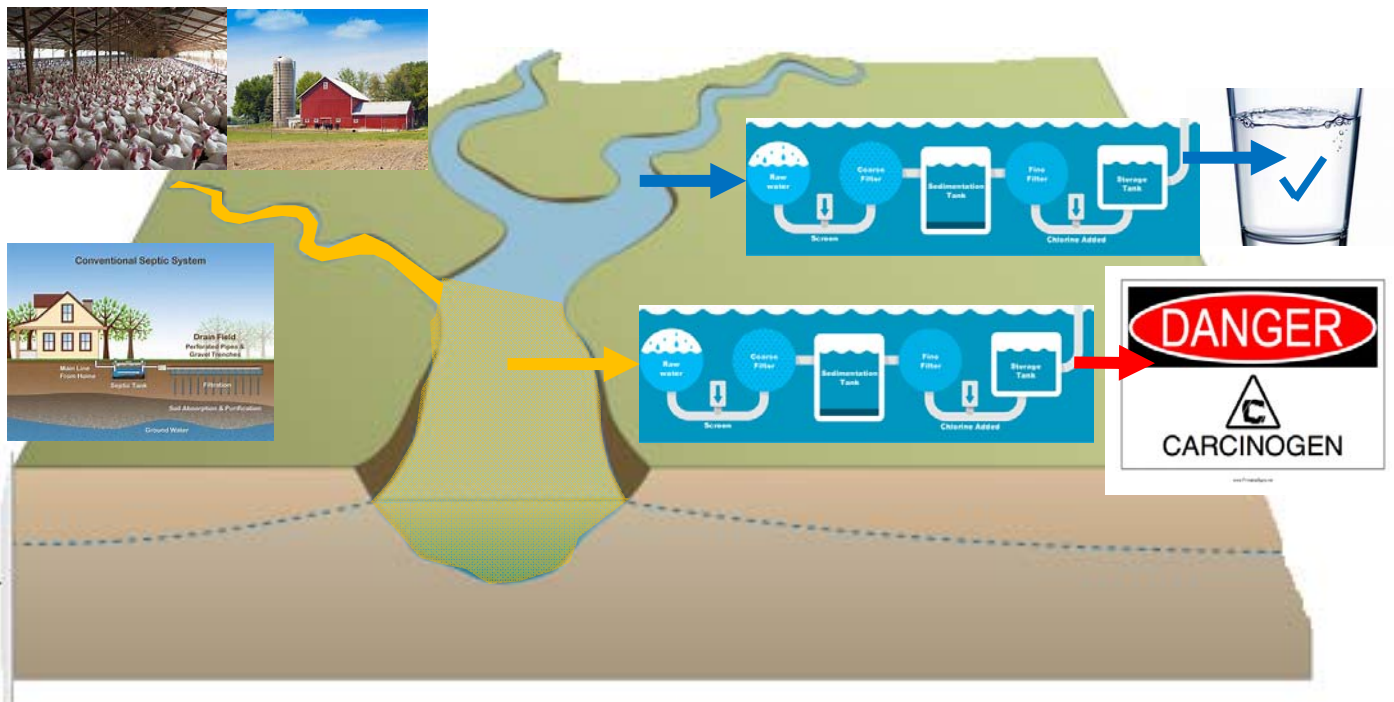
### IV. TOTAL ENRTF REQUEST BUDGET 3 years

| BUDGET ITEM (See "Guidance on Allowable Expenses")   | AMOUNT            |
|--|-------------------|
| <b>Personnel:</b> Raymond Hozalski, Project Manager (75% salary, 25% fringe benefits). 7.7% FTE (4 weeks effort) for years 1-3. Project coordination, dissemination of results, meeting with stakeholders. \$57,645. William Arnold, co-Project Manager (75% salary, 25% fringe benefits). 5.8% FTE (3 weeks effort) for years 1-3. Project coordination, dissemination of results, meeting with stakeholders. \$50,979. Graduate student Research assistant (59% salary, 41% fringe benefits). 50% FTE for years 1-3. Sample collection, processing, chemical analyses, data analysis, dissemination of results. \$143,580. Two Undergraduate Researchers (100% salary). Each at 25% FTE for years 1-3. Assist with field sampling, processing of samples, data analysis. \$38,574. | \$ 290,778        |
| <b>Equipment/Tools/Supplies:</b> Supplies (chemical and isotopically-labelled standards, chemical reagents for treatment experiments, glassware, solvents, consumable supplies, laboratory notebooks, software licenses; \$20,000 total). Analytical instrument time for compound quantification (\$15,000). Operating costs for laboratory instruments required for analyses and experiments; costs portioned based on usage by project (\$5,000). Estimated 300 water samples to be analyzed for a wide variety of chemical constituents including NDMA precursors, total organic amines, and specific trace contaminants (pharmaceutical compounds).  | \$ 40,000         |
| <b>Travel:</b> Mileage or equivalent costs for travel to collect water samples. Hotel/meal charges if overnight stay required. Attendance for students at in-state conferences to disseminate project findings to water treatment and environmental interests. Travel for meetings with stakeholders and project partners.   | \$ 15,000         |
| <b>Additional Budget Items:</b>  | \$ -              |
| <b>TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =</b>   | <b>\$ 345,778</b> |

### 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          |
|--|------------|-----------------|
| <b>Other Non-State \$ To Be Applied To Project During Project Period:</b> N/A  | \$ -       |                 |
| <b>Other State \$ To Be Applied To Project During Project Period:</b> N/A  | \$ -       |                 |
| <b>In-kind Services To Be Applied To Project During Project Period:</b> Because the project is overhead free, laboratory space, electricity, and other facilities/administrative costs (54% of direct costs excluding permanent equipment and graduate student tuition benefits) are provided in-kind. Additionally, in kind sample collection will be performed by MN DNR and St. Croix Watershed Research Station. | \$ 167,067 | <i>secured.</i> |
| <b>Past and Current ENRTF Appropriation:</b>   | \$ -       |                 |
| <b>Other Funding History:</b> N/A  | \$ -       |                 |

The carcinogen NDMA is formed when chlorine disinfectants react with precursors in human and/or animal waste discharges.



## Outcomes:

1. Quantify carcinogen-forming precursor levels.
2. Identify times and places where maximum precursor inputs occur.
3. Optimize drinking water disinfection to minimize carcinogen formation.
4. Protect human health via pollution prevention.

## Project Manager Qualifications and Organization Description

### **Dr. Raymond M. Hozalski**

Professor, Environmental Engineering, Department of Civil, Environmental, and Geo-Engineering, University of Minnesota

B.ChE., Chemical Engineering, 1990, Villanova University, Villanova, PA.

M.S., Environmental Engineering, 1992, The Johns Hopkins University, Baltimore, MD.

Ph.D., Environmental Engineering, 1996, The Johns Hopkins University, Baltimore, MD.

Dr. Hozalski will serve as project manager and be responsible for overall project coordination. He is an internationally known expert in water treatment and has been conducting research in that area for over 25 years. He has worked on numerous applied research projects in collaboration with Minnesota drinking water utilities over the past 20 years. He has published more than 65 articles in top environmental engineering and science journals.

### **Dr. William Arnold**

Joseph T. and Rose S. Ling Professor and Associate Head

Department of Civil, Environmental, and Geo- Engineering, University of Minnesota

B.S., Chemical Engineering, 1994, Massachusetts Institute of Technology, Cambridge, MA.

M.S., Chemical Engineering, 1995, Yale University, New Haven, CT.

Ph.D., Environmental Engineering, 1999, The Johns Hopkins University, Baltimore, MD.

Dr. Arnold will serve as co-project manager and will assist with overall project coordination. He is an expert on the fate and transport of organic chemicals in aquatic systems. He is widely regarded both locally and internationally for his work in this area. He won the *Arcadis/Association of Environmental Engineering and Science Professors Frontier in Research Award* in 2012 and the University of Minnesota College of Science and Engineering *George W. Taylor Award for Distinguished Research* in 2011.

### **Organization Description**

The University of Minnesota is one of the largest, most comprehensive, and most prestigious public universities in the United States ([http://www1.umn.edu/twincities/01\\_about.php](http://www1.umn.edu/twincities/01_about.php)). The laboratories and offices of the PI and co-PIs contain all of the necessary fixed and moveable equipment and facilities needed for the proposed studies.