Nebraska Water Center
Robert B. Daugherty, Water for Food Institute

Annual Technical Report
2019

NEBRASKA 2019 USGS 104B ANNUAL REPORT

PRODUCTS:

2016NE189B –
2019 Nebraska Water and Natural Resources Tour preparatory trip (May 2019)
2019 Nebraska Water and Natural Resources Tour-Wyoming/Montana (September 2019)
2019 Nebraska Water Conference in Norfolk, NE
Fall 2019 NWC Advisory Board Meeting
2020 NIWR Annual Meeting
Spring 2020 NWC Advisory Board Meeting
2020 August Mini-Conference
Fall 2020 NWC Advisory Board Meeting
Fall 2020 NWC Faculty Retreat

2016NE289B –
33 News Releases
2017-2018 NWC Annual Report
Summer 2019 Nebraska Water Current
Fall 2019 Nebraska Water Current
Spring 2020 Nebraska Water Current
Summer 2020 Nebraska Water Current
Fall 2020 Nebraska Water Current
Water Sciences Laboratory brochure
6 Spring 2020 Water Seminars (YouTube)
1 Virtual Tour Video
1 Water Sciences Laboratory Brochure
1 Project Video
Special Seminar – Water Management: An Illinois Perspective
Electronically we use Facebook, Twitter, and YouTube along with our website

2018NE312B –

Eubanks, M. A., J.S. Bricker, S.L. Bartelt-Hunt, D.D. Snow. 2018. Microplastic Pollution in Nebraska's Water Systems: Quantity and Composition. Poster with Abstracts 2018 NIWR Regional Symposium "Water Resources of the U.S. Great Plains Region: Status and Future," October 24-26 at Nebraska Innovation Campus in Lincoln, NE.

Eubanks, M. A., J.S. Bricker, S.L. Bartelt-Hunt, D.D. Snow. 2019. Microplastic pollution in Salt Creek surface waters: quantity and composition. PROGRAM and PROCEEDINGS - THE NEBRASKA ACADEMY OF SCIENCES: 139th Anniversary Year, One Hundred-Twenty-Ninth Annual Meeting, April 12, 2019, Nebraska Wesleyan University, Lincoln, NE.

Nebraska Wesleyan Undergraduate courses - Field sampling methodology and lab analysis techniques developed and streamlined during this research project are being integrated into the majors-level ecology course (BIO 4980: Ecology) taught fall 2019 semester at Nebraska Wesleyan University. Microplastic presence in the environment has gained increasing coverage in the popular press and makes an excellent topic to connect human activities to ecologic networks. BIO 4980 students will sample localities in the Lancaster County, Nebraska, that weren't included in the current study. This will

allow us to expand our understanding of the scope of microplastic pollution in Nebraska waterways. Field sampling methodology and lab analysis techniques developed and streamlined during this research project are being integrated into the majors-level ecology course (BIO 4980: Ecology) taught fall 2019 semester at Nebraska Wesleyan University. Microplastic presence in the environment has gained increasing coverage in the popular press and makes an excellent topic to connect human activities to ecologic networks. BIO 4980 students will sample localities in the Lancaster County, Nebraska, that weren't included in the current study. This will allow us to expand our understanding of the scope of microplastic pollution in Nebraska waterways. Field sampling methodology and lab analysis techniques developed and streamlined during this research project are being integrated into the majors-level ecology course (BIO 4980: Ecology) taught fall 2019 semester at Nebraska Wesleyan University. Microplastic presence in the environment has gained increasing coverage in the popular press and makes an excellent topic to connect human activities to ecologic networks. BIO 4980 students will sample localities in the Lancaster County, Nebraska, that weren't included in the current study. This will allow us to expand our understanding of the scope of microplastic pollution in Nebraska waterways.

2019NE163B –

Thompson, M., Moussavi, S., Li, S., and Dvorak, B. (2020). *Environmental LCA of small wastewater treatment facilities: Comparisons of activated sludge systems and non-discharge lagoons with and without agricultural water reuse* [Conference Presentation]. ACLCA 2020 Conference.

Thompson, M., Moussavi, S., Li, S., and Dvorak, B. (2020). *Environmental LCA of small wastewater treatment facilities: Comparisons of activated sludge systems and non-discharge lagoons with and without agricultural water reuse* [Conference Presentation]. NWEA/NSAWWA 2020 Joint Fall Conference.

Thompson, M., Moussavi, S., Li, S., Bartha, P., and Dvorak, B., (2021). *"Environmental Life Cycle Assessment of Small Water Resource Recovery Facilities: Activated Sludge and Pond Treatment Systems"* for draft manuscript for possible publication in *Science of the Total Environment*

2019NE164B –

One of the students associated with the project produced a poster and written report describing her work on the project. Both were internally presented, but will form the bases for future conference presentations and external publications. Both the paper and poster were titled 'Detecting Seasonal Trends in Ion Speciation at Glacier Creek Preserve'.

2019NE165B –

The funding was used to provide research training for a PhD student who contributed to the assembly of membrane fabrication set up and characterization. The student was further trained to evaluate the surface chemistry of these membranes. The following two manuscripts are directly related to our effort toward creating membranes with desired chemical functionality and transport properties.

Poly(Homopiperazine–Amide) Thin-Film Composite Membrane for Nanofiltration of Heavy Metal Ions ACS Omega 2020, 5, 44, 28749–28759 Publication Date: October 26, 2020

Integration of Zwitterionic Polymer Nanoparticles in Interfacial Polymerization for Ion Separation ACS Appl. Polym. Mater. 2020, 2, 4, 1508–1517 Publication Date: March 20, 2020

INFORMATION TRANSFER PROGRAM:

2018NE312B – N/A

2019NE163B –
With COVID-19, the opportunities for information transfer to clientele were limited. A presentation on the work was given to the Nebraska Water Center Advisory Board in June 2020, and a presentation was given to the Nebraska Water Environment Association Annual Conference (wastewater engineers and operators) in November 2020.

2019NE164B –
Two students received lab/field training during the grant period. Originally, the work would have been presented at the Glacier Creek Preserve Research Conversations where members of the public are invited to Glacier Creek to hear about research at the Preserve. Due to the pandemic, this was cancelled in 2020. This work will be presented there when the Research Conversations is held, likely in March 2021.

2019NE165B – N/A

STUDENT SUPPORT:

2016NE189B – N/A

2016NE289B –
One undergraduate student from Civil and Environmental Engineering
One undergraduate student from Hospitality, Restaurant and Tourism Department

2018NE312B –
Two part-time Nebraska Wesleyan senior undergraduate students were supported on this project.

2019NE163B –

Ph.D. student, Civil Engineering
Ph.D. student, Civil Engineering
Undergraduate student worker, Civil Engineering
Undergrad researcher, Construction Engineering

2019NE164B –

Two undergraduate students were partially supported with funds from the grant. Both completed field and laboratory work associated with sample collection and analysis. One of them used this project as part of a senior research project.

2019NE165B –
Graduate student was funded and trained to conduct research on the surface chemistry of these developed membranes.

NOTABLE ACHIEVEMENTS AND AWARDS:

2016NE189B – N/A

2016NE289B – N/A

2018NE312B – N/A

2019NE163B –
Daugherty Water for Food Global Institute 2020-2021 Fellowship to Matthew Thompson to expand the analysis.

2019NE164B – N/A

2019NE165B – N/A

Sustainability Assessment Of Small Nebraska Wastewater Treatment Systems

Project Type: Annual Base Grant
Project ID: 2019NE163B

Project Impact:

A synopsis of primary findings and/or impact (no more than 250 words).
Assessment of the environmental impact of small Nebraska wastewater treatment systems was explored using 26 case studies. The construction phase of both main technology groups, Mechanical WRRFs and Lagoons systems were identified as significant (up to 75% of the total environmental impact) and highly variable due to specific components including: excavation, cast iron piping, concrete, reinforcing steel, and stainless steel. Non-discharge lagoons assuming a 20-year lifespan, exhibited an overall lower life cycle environmental life cycle impact compared to mechanical WRRFs in all categories with exception to the smog, fossil fuel depletion, and carcinogen impact categories. The measured life cycle environmental impact is highly sensitive to system lifespan due to the high relative contribution of the construction phase and influences whether significant differences are observed between technologies in select impact categories.

Adoption of agricultural water reuse for lagoon systems showed that significant environmental benefits can be achieved in reduced excavation (reduced lagoon volume needed), avoided electricity use from well pumping, and minor benefits in offset fertilizer production. However, there are clear tradeoffs with higher operating energy required for many agricultural reuse lagoon systems and more infrastructure for mechanical WWRF. When the comparison system boundaries were expanded to include consideration of crop productivity of transiting dryland cropland to irrigated cropland using treated wastewater, then the agricultural reuse of the wastewater generally became environmentally preferable to mechanical WRRF. Agricultural reuse was preferable when used in existing irrigation systems to replace pumped well water.

Connecting Groundwater Quality To Surface Water Quality In Intensively Managed Landscapes

Project Type: Annual Base Grant
Project ID: 2019NE164B

Project Impact:

The 6 groundwater wells were successfully installed as planned at Glacier Creek Preserve, 3 under each land use (agriculture and restored prairie). During 2020, which was locally very dry, static groundwater levels fell more under the prairie, indicating higher permeability under the restored prairie compared to agriculture. From the water samples taken over time it appears that water extracted after about 6 months since installation will likely represent formation water. Ionic concentrations are similar between the agriculture and the prairie wells, with the main exception of nitrate. The nitrate concentrations are consistently higher under the agricultural side, and the concentration increases with increasing depth below ground surface. Deep sediment cores were collected at the Prairie Ridgetop (PRRT) to 23 m and the Agriculture Ridgetop (AGRT) to 24.8 m. In the PRRT core, loess material extended to 18.4 m and was underlain by glacial till. The till is dense and fine grained from 18.4 – 22 m, at which point the till includes rounded gravels. The AGRT core was geologically more complex, including loess (0 – 8.1 m), till (8 – 12.6 m), oxidized outwash sand (12.6 – 13.8 m), calcareous outwash sand (13.8 – 19 m), strongly reduced glacial till (19 – 24.4 m), and oxidized outwash sand (24.4 – 24.8 m). The cores reveal more complex glacial deposits at the AGRT compared to the PRRT. Thus, the wells are likely sampling water from the top of the glacial till material at the PRRT, and from outwash sand under a confining dense till layer at the AGRT.

Defend And Attack Strategy To Develop Fouling-resistant Reverse Osmosis Membranes

Project Type: Annual Base Grant
Project ID: 2019NE165B

Project Impact:

Given that the challenges associated with water scarcity are among the top ten grand challenges of our time, the development of materials for water purification and contaminant removal from our groundwater resources is of high impact research. In this project we developed novel membranes with anti-fouling properties for the desalination of water resources contaminated with heavy metal ions. We showed that through careful design of the active layer of our thin film composite membranes and by integration of zwitterionic polymers within this layer we can tune the transport properties of these membranes and fabricate thin-film composite (TFC) membranes, suitable for treating impaired water sources. The fabricated TFC membranes demonstrated water permeability of 7.0 ± 0.3 L/(m2 h bar) and rejected Na2SO4, MgSO4, and NaCl with rejection values of 97.0 ± 0.6, 97.4 ± 0.5, and 23.3 ± 0.6%, respectively. The membranes exhibit high rejection values of 98.1 ± 0.3 and 96.3 ± 0.4% for Pb2+ and Cd2+ ions, respectively. The fouling experiment with humic acid followed by crossflow washing of the membranes indicates that a flux recovery ratio (FRR) of 96.9 ± 0.4% can be obtained. Next, we plan to focus on working with microbiologist to evaluate the biofouling propensity of these membranes. We expect the current findings enable us to develop novel custom-design membranes for a cascade membrane-based water purification process.