Book of Abstracts

Minnesota Water Resources Conference

October 18–19, 2022

Saint Paul RiverCentre
175 West Kellogg Boulevard
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Tuesday October 18, 2022

Concurrent Session I, Track A
Engineering Solutions – Sand Filters

Pricey or Practical? Implementation and operation of pumps and automation in sand filters
Alex Schmidt, Houston Engineering; *Kyle Axtell*, Rice Creek Watershed District; *Mike Behan*, Dakota County

Urban stormwater managers face a challenge when looking to implement stormwater treatment practices to meet their pollutant load reduction goals. The challenge is that landscapes are fully developed, leaving little room for treatment systems, or forcing systems underground, which becomes expensive. Pumps have often been avoided in stormwater treatment given their stigma of being expensive, impractical, and requiring more effort to operate and maintain.

Houston Engineering has supported the evaluation and implementation of stormwater treatment sites with pumping and automation for multiple organizations (including the Rice Creek Watershed and Dakota County). A multitude of automation and flexibility options in the design of these pumping systems allows for innovative applications of traditional stormwater management practices such as the dry-wet cycling required for iron-enhanced sand filters (IESF), even within the context of continuous flow. This flexibility can overcome many obstacles to effectively capture dissolved phosphorus in stormwater runoff. During feasibility phases, pumping and automated systems were compared and contrasted with more typical passive treatment systems, and evaluated for treatment performance, cost-effectiveness, relative footprint size, and operation and maintenance needs. The results of the system comparisons will be shared along with practical aspects related to their design, construction and operation.

Pollutant Removal and Maintenance of Underground Sand Filters
Todd Shoemaker, Stantec

The purpose of this study is to evaluate the stormwater management effectiveness of installed underground sand filters in the Twin Cities Metro Area. The Minnesota Stormwater Manual includes guidance for the design and pollutant removal efficiency of surface and one type of underground sand filters. The most popular variety of underground sand filter, however, does not offer clear access to the sand media layer and is not included in the Minnesota Stormwater Manual. Maintenance is extremely limited by this design, which calls into question whether they can actually achieve the same removal efficiency as their aboveground counterparts, and whether those efficiencies degrade over time. There is limited data regarding performance of in situ underground sand filters to assist in this evaluation.

This presentation will summarize research data collected during 2020 and 2021 for six underground sand filters. The data will give some indication whether these systems meet performance goals and if these systems should continue to be considered a viable water quality BMP.

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Experimental Field Trial of Media for a Modified Iron-Enhanced Sand Filter
Josh Kirk, Andy McCabe, Keith Pilgrim, Janna Kieffer, Barr Engineering Co.

A drawback of many iron enhanced sand filters (IESFs), which are being constructed across Minnesota, is the slow filtration rates (approx. 3-4 inches per hour) and the corresponding effect that the filters need to be large when receiving runoff from large watersheds. To reduce external phosphorus loading to Lake Cornelia, the Nine Mile Creek Watershed District, in partnership with the City of Edina, is constructing an active stormwater filtration best management practice (BMP) located in Rosland Park. Because the BMP needs to treat large volumes of water, but have a small footprint to preserve greenspace within the park, the design solution was to employ fast filtering media and site the BMP directly adjacent to a holding pond upstream of Lake Cornelia to serve as the water source.

A column study was conducted on-site to simulate BMP operation and identify media that could rise to the challenge of rapid phosphorus treatment. This field study evaluated 10 media and media combinations, including calcium, iron, and aluminum-based media. The removal efficiencies of total phosphorus, dissolved phosphorus, and orthophosphate were evaluated for each media at three different hydraulic residence times (HRT).

Results from this column study will be presented. In general, this study demonstrated that high removal efficiency can be achieved with high filtration rates. Phosphorus removal efficiencies varied widely between the tested media, with highest removals observed for media with zero-valent iron (e.g., iron-enhanced sand) and activated alumina. These results served as the basis for the selection of media installed in the full-scale filtration BMP.

Can Biofilters Capture Phosphate and Grow Plants?
Andy Erickson, Katie Kramarczuk, Jessica Kozarek, St. Anthony Falls Laboratory, University of Minnesota

Biofilters can be used to treat stormwater runoff from urban landscapes, but some media used in biofilters can release phosphate or limit plant growth. As such, stormwater professionals struggle to choose media for biofilters. To address this question, thirty outdoor biofiltration mesocosms comprising nine different media mixes were compared to clean washed sand for capture (or release) of phosphate, plant growth, and filtration rate. Media components included food residue compost, leaf compost, sphagnum or reed sedge peat, biochar mixed with leaf compost, spent lime mixed with leaf compost, iron mixed with leaf compost, sphagnum peat mixed with leaf compost, and compost layered over iron. This presentation will share the near-final performance results from four rainy seasons of simulated runoff events including new-for 2022 road-salt-laden events to simulate spring snowmelt in Minnesota. With the information from this study, stormwater practitioners will be able to design better biofiltration practices that capture phosphorus and support healthy vegetation while also maintaining adequate filtration rates.

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Concurrent Session I, Track B
Agriculture Water – Soil

Advancing Water Quality and Conservation through Climate Smart Bridge Payments to Farmers
Brad Jordahl Redlin, Danielle Isaacson, Minnesota Department of Agriculture --Water Quality Certification Program

The developing arena of agriculture and climate mitigation is dynamic, and in many respects unsettled relative to the efficacy of certain agricultural practices, the performance of private marketplaces, and the federal government's role in new programs. The Minnesota Agricultural Water Quality Certification Program's (MAWQCP) Climate Smart Farms Project recognizes the connection between water quality protection and climate benefits and responds to this relationship with a model of one-to-one personal service and support to producers exploring climate actions on their farms. This new program provides $1,000 annual bridge payments for up to 5 years to producers who receive an MAWQCP Climate Smart Endorsement. Endorsed producers must successfully complete a climate audit to be sure their practices meet climate smart baselines. The purpose of the bridge payments is to support producers in exploring and implementing new practices that could be introduced on farm to reduce emissions, with support from MAWQCP staff. In addition to learning about and utilizing new management practices, enrolled producers will have access to information about carbon markets and other environmental trading opportunities that will prepare the climate-smart endorsed producers to participate in carbon credit markets. Sharing these resources, documenting existing practices, and incentivizing new practices sets the Climate Smart Farms Project up to help producers increase the climate benefits their operations provide.

The successes and lessons learned from the Climate Smart Farms Project will inform future policy around incentivizing agricultural practices that reduce emissions, sequester carbon, and protect water quality, contributing to a more resilient agricultural system in the face of climate change. By understanding new opportunities and documenting current practices we will ensure no loss of existing climate and water benefits while facilitating the implementation of new ones.

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Cover Crops and Living Mulches Effects on Irrigated Corn-Soybean Production Systems: An Integral Nutrient, Water, and Environmental Management Strategy

Eduardo Garay Lagos, Fabián Fernández, University of Minnesota

The state of Minnesota, USA has over 240,000 ha of irrigated glacial outwash sands that are predominantly under corn and soybean cultivation. While highly productive and important to Minnesota's economy, these soils are highly vulnerable to concomitant losses. Therefore, farmers are encouraged to go beyond a traditional production approach by implementing the use of sustainable cultural practices such as cover cropping. Nevertheless, there is limited research aiming to holistically understand their effect on N cycling (N availability, nitrate leaching, nitrous oxide emissions and ammonia volatilization) and competition with corn and soybean for resources under irrigated conditions. This study was established in 2011 in an irrigated sandy loam soil at Westport, Minnesota. Three adjacent blocks of continuous corn (CC), corn-soybean (CSb) and soybean-corn (SbC) cropping systems were used. Treatments included N fertilizer rates of 0, 100, 200, 250 and 300 kg N ha-1 split-applied at V2, V6, and V10 development stages of the CC and CSb while no N was applied in the SbC. Each N rate had winter-rye (Secale cereale) and winter fallow. Kura clover (Trifolium ambiguum M. Bieb.) living mulch was present in the 0, 200 (CSb only) and 250 (CC only) kg N ha-1 rates. Results from this comprehensive assessment will include nitrate leaching concentrations and load, nitrous oxide and ammonia emissions, season-long soil N availability, crop N uptake, and grain yield. This study aims to discover improved strategy in nutrient and water management to optimize agronomic production while substantially minimizing agricultural environmental impact.

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Enhancing the Prioritize, Target, and Measure Application (PTMApp) User Experience

Scott Kronholm, Houston Engineering Inc.; *Matt Drewitz*, Minnesota Board of Water and Soil Resources

The Prioritize, Target, and Measure Application (PTMApp), supported by BWSR, underwent a major update in the latter half of 2020. This update saw a shift away from the six generic BMP treatment groups (e.g., storage, filtration, etc.) to 24 NRCS-based practice types (e.g., WASCOB, riparian buffer, etc.). The increased specificity allows users to more clearly define suitable areas on the landscape and estimate water quality benefits specific for each individual practice type.

Subsequent enhancements have been implemented to support common uses of the vast amount of PTMApp data. Several stand-alone tools have been created to help users utilize existing PTMApp data or to expand the existing functionality of the PTMApp toolbar. One of the new tools allows users to condense and summarize data for a specific subwatershed or planning area, streamlining the process of targeted watershed planning. A second tool was built using watershed-specific PTMApp data to summarize expected water quality benefits of implemented practices based on the simple user input of total treated acreage per practice type. The beta version of this tool is currently presented as an interactive Microsoft Excel spreadsheet. The final tool allows users to input digitized GIS polygons representing existing or future practices into the PTMApp architecture to estimate benefits of those practices using the underlying PTMApp data and processing framework.

The interactive PTMApp-Web application simultaneously made the shift to NRCS-based practices where updated watershed data are available. And a new PTMApp-Web scenario builder widget was created that allows users to generate targeted implementation scenarios with user defined screening criteria for various parameters.

These enhancements were made with the end-user in mind in an effort to streamline and simplify PTMApp data extraction, manipulation, and interpretation and to reduce barriers to entry when using the PTMApp software and data.

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The potential for improving water-quality and habitat in Minnesota by repurposing unprofitable cropland with perennial vegetation

Jason Ulrich, Shawn Schottler, Science Museum of Minnesota, St. Croix Watershed Research Station

Our current agricultural conservation approaches have not met Minnesota's water-quality or habitat goals. In fact, despite investing millions of dollars in best management practices, water-quality has not improved demonstrably. At the same time, increases in corn and soybean acres and changes in agricultural practices have resulted in dramatic declines in grassland habitat critical for migratory birds and pollinators.

Replacing corn and soybeans with perennial vegetation systems such as alfalfa, wetlands or restored prairie is a very effective means of improving both water-quality and habitat, but thus far has been economically impractical to implement at scale because it usually requires taking profitable cropland out of production.

However, based on Midwestern studies, it is likely that 1 million acres or more of cropland in Minnesota has been unprofitable (i.e., broke-even or lost farmers money) in some or all of the last 5 years. Thus, targeting these unprofitable cropland areas is potentially the cheapest way to increase perennial vegetation in Minnesota.

Our study explored this concept by mapping the probable extent of unprofitable cropland in the southern one-third of Minnesota over the last 5 years, and estimating both the water-quality and habitat benefits of converting different fractions of these areas to perennial vegetation.

The study results underscore the importance of targeting unprofitable cropland for cost-effective conservation approaches. Further, the concept could be used to develop future policy incentives to significantly increase perennial vegetation in Minnesota's agricultural areas.

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Concurrent Session I, Track C
Wetlands Workshop

This workshop will build collective wetland knowledge and increase understanding of how wetlands integrate with overall water resources management throughout the Midwest. The presentations of this year's workshop could include topics about the storage dynamics of peatlands, nutrient influence of wild rice, and updates from the Minnesota Board of Water and Soil Resources. The workshop was developed in coordination with the Minnesota Wetland Professionals Association.

BWSR Updates
Ben Meyer, Minnesota Board of Water and Soil Resources

The Minnesota Board of Water and Soil Resources (BWSR) is responsible for promulgation of the Wetland Conservation Act (WCA) Rules. The WCA Rules are codified in Minnesota Rules Chapter 8420 based on the standards and authorizations contained in state statute. WCA took effect with an interim program in 1992 and began operating under formally adopted rules in January 1994. The Legislature has passed numerous amendments to WCA since its original passage and the rules have undergone multiple revisions. The current WCA Rule was adopted in 2009 and multiple statute changes have occurred since adoption.

Rulemaking in Minnesota follows the procedures outlined in the Minnesota Administrative Procedure Act (APA), Minnesota Statutes, Chapter 14. The current WCA Rulemaking process was initiated in 2015 when an initial request for comments was published in the State Register. A supplemental request for comments was published on January 20, 2022. BWSR staff will present updates on the rule making process including: timelines, stakeholder input opportunities and expected outcomes.

Dynamic Storage in Peatland Catchments
David J. Adams, Salli F. Dymond, University of Minnesota Duluth

Analysis of the catchment water balance often relies on the assumption that changes in storage are generally static from year to year and therefore negligible. However, interannual variability in catchment storage may be a key component of the water balance in particularly wet or dry years. This study aims to assess dynamic water storage at the Marcell Experimental Forest (MEF) in three ways; (1) analyze the effect of annual variability in precipitation on annual storage flux, (2) analyze the effect of antecedent annual precipitation on catchment dynamics in subsequent years, and (3) analyze the extent to which particularly dry or wet years influence storage flux in subsequent years. These questions will be addressed via statistical analysis of long-term hydrologic data sets using the R statistical software environment. It is expected that positive and negative variations around mean annual precipitation will result in positive and negative growth in storage respectively while past precipitation will exert a lagged influence on storage flux in subsequent years. It is also expected that any lag effect will be more pronounced following particularly wet or dry years. This project is being conducted in partial fulfillment of the requirements for the degree of Master of Science at the University of Minnesota; preliminary results are expected in the Fall of 2022 with a projected completion date of May 2023.

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Wild rice populations recover quickly in mesocosms in response to lower sulfate loads in surface water

Nathan Johnson, John Pastor, Brad Dewey, Leah Higgins, University of Minnesota Duluth;
Sophie LaFond-Hudson, Oak Ridge National Lab

Numerous observations from field scale to mesocosm scale to lab scale have established that sulfate in surface water limits the growth of wild rice in lakes and rivers. The conversion sulfate to sulfide in sediment interferes with the ability of wild rice to take up nitrogen and has led to population declines over 3 to 10 years in self-sustaining outdoor mesocosms, depending on the level of sulfate addition. In this presentation, we report the preliminary results from an experiment that removed sulfate from the surface water of mesocosms that had experienced 5 to 10 years of sulfate loading and observed the response of wild rice recovery. In mesocosms amended with 300 mg/L sulfate in surface water, plant populations recovered to biomass levels and seed mass similar to control mesocosms in 3 to 4 years. In mesocosms amended with 150 mg/L sulfate in surface water, plant populations recovered in only 1 to 2 years. This relatively rapid recovery occurred with no addition of new seeds and apparently was initiated by a latent seed stock in the sulfate-impacted sediment. The concentration of porewater sulfide in mesocosm sediment dropped precipitously in response to lower sulfate loads from surface water but still remained above the levels found in control mesocosms and lower sulfate amendments. Solid phase sulfide remained elevated during the recovery phase of the mesocosm experiments, suggesting that the total mass of sulfide in sediment is less important than the activity of sulfide in sediment porewater. Though the pace of recovery could be different in field conditions, these preliminary results suggest that lowering sulfate loads to surface waters could result in relatively rapid re-establishment of wild rice populations, even in waterbodies where sediment has been heavily impacted by historic sulfate loading.

Phragmites Reporting Tool and Management

Julia Bohnen, University of Minnesota

WPA Updates

Keller Leet-Otley, Kimley-Horn; Jack Distel, City of Bloomington

The Minnesota Wetland Professionals Association (WPA) will provide a 10-minute update on our group's history and mission statement, as well as share about upcoming forums, trainings, and field trip opportunities with the WPA. We will discuss how the WPA can collaborate with the Minnesota Wetland Professional Certification Program (MWPCP) in the future.

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Concurrent Session I, Track D

Special Session: Transforming Water Management through the Arts

Abby Moore, Mississippi Water Management Organization; *Sarah Nassif,* Artist; *Christine Baeumler*, Artist; *Lindsay Schwantes*, Capitol Region Watershed District

This session will focus on integrating art and artists into community engagement strategies to achieve clean water goals. A panel will highlight recent examples of how this collaboration is enriching and transforming their work. Following the panel, attendees will have an opportunity to explore together how art and artists may enhance their programs and projects. The session will end with an artist-led project and something for all attendees to take with them.

Tuesday October 18, 2022

Concurrent Session II, Track A
Stormwater Management--Policy Admin

MS4 Program Management, Everything Is Better With Apps
Nico Cantarero, Stantec

For those in the MS4 world, the umbrella permit can put you front and center to a lot of different and exciting things in the water resources field. But it's universally known that the documentation, tracking, and annual reporting are quite a drag. Luckily, everything is better with apps!

This presentation will highlight different tools available to MS4 program managers that can be used to digitize and streamline their program, and ultimately put that data to good use. And with the built-in tools, you can automate reports to make reporting easy. All the tools highlighted in this presentation are publicly available and widely used (e.g. ESRI Survey123/Field Maps/Dashboards, Smartsheets, Fulcrum) and are not proprietary to Stantec.

Some of the specific examples that will be covered:

- ESC inspections and reporting (using ESRI Survey123 and Field Maps)
    - Use analytics to create feedback loops
- BMP inspections and reporting (using ESRI Survey123 and Field Maps)
    - Answer the questions: Where am I going? What do I do when I get there? What happens next?
- Digital MS4 SWPPP (using Smartsheets)
    - Delegate tasks, set up reminders, and create live dashboards
- Pond inspections and sedimentation analysis (using ESRI Survey123 and Field Maps)
    - Make super cool and informative maps
- Outfall inspections (using Fulcrum)
    - Inspection data at your fingertips
- Facility Pollution Prevention Plans (using ESRI Survey123 and Field Maps)
    - Save your operations staff time

These tools are time efficient, economical, and help to maintain documentation and permit compliance. Plus, it opens up a whole world of other dashboards and web maps to take your programs to the next level. Did I mention…NO SPECIAL CODING REQUIRED?!

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Optimism, Ignorance or Foolishness: Are We Setting Practical Water Quality Goals?
Mark Deutschman, Charles Fritz, International Water Institute

Our work as resource professionals - whether striving to improve habitat for game species, manage runoff to reduce flood damages or improve water quality to restore beneficial uses - requires establishing goals. A well-crafted goal clearly describes the expected resource outcome(s) and corresponding benefit(s). Goals are the foundation for assessing the success of resource programs.

Whether it is One Watershed One Plan, a Total Maximum Daily Load, or a state-wide strategy to reduce nutrients in runoff, developing well-crafted goals is challenging. Well-crafted goals are: 1) technically feasible; 2) described in terms of specific outcomes and the expected public benefits; 3) achievable within a reasonable amount of time; 4) attainable given the available human and technical resources; and 5) affordable. Well-crafted water quality goals lead to sound resource management decisions, credibility within the lay community and continued public support to improve water quality.

Our presentation focuses on developing good, robust water quality goals for improving water quality. We highlight the resource implications of common challenges associated with setting lake and stream water quality goals. We describe a robust process for establishing water quality goals based on defining success, the amount of scientific uncertainty, the level of public transparency, the ability to track progress, local implementation capacity and the available fiscal resources. The presentation includes examining the value of using the recommended approach.

Metropolitan Council's Priority Waters List: A Tool for More Effective Water Resources Management
Emily Resseger, Erik Herberg, Henry McCarthy, Metropolitan Council
The Metropolitan Council recently adopted a Priority Waters List to guide its water resources partnerships and work efforts. The Met Council works with city, county, watershed, state, and federal partners in the Twin Cities metro area to manage water resources through monitoring, assessment, planning, and implementation of projects. Given the large number of waterbodies in the region, it is infeasible for the Met Council and its partners to effectively monitor and evaluate all waterbodies regularly. The Priority Waters List allows the Met Council to focus its resources on waterbodies that offer the greatest benefit to the region.

The Priority Waters List updates the Met Council's previous Priority Lakes List by expanding it to include rivers and streams and by considering a broader range of benefits. The new list prioritizes waterbodies determined to be regionally significant based on the benefits they provide in seven categories: Drinking Water Protection, Recreation and Tourism, Healthy Habitat, Tranquil Connection, Equity, Industry and Utility, and Science and Education. Waterbodies were scored in the seven categories using over 70 datasets that were either publicly available or created for the project.

By focusing the Met Council's resources on waterbodies that provide the greatest benefit, the Priority Waters List will allow the Met Council to do its work more effectively and efficiently. The list is anticipated to be used in the near term to focus planning efforts in Met Council's upcoming 2050 Water Resources Policy Plan, guide Met Council monitoring and assessment work, be considered in Met Council's environmental reviews and grant selection process, and be a resource for local partners. This talk will outline the innovative approach used to establish the Priority Waters List, present the overall list as well as sub-lists showing priorities in individual categories, and discuss potential uses for the list, both by the Met Council and its partners.

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Thousands of BMPs? How to Best Manage and Prepare for Maintenance
Laura Wehr, AE2S; Kristin Seaman, City of Woodbury

Today's BMPs provide increased water quality benefits but also require different maintenance. This presentation will walk through how one community updated their BMP program to meet the maintenance needs of new BMP types. The overall goal of the presentation is to better educate individuals how to set up or modify existing maintenance programs that ensure all BMPs types are included.

Woodbury is one of the fastest growing cities in Minnesota. As part of the development process, the City requires stormwater management best practices (BMPs) to be installed, which has led to over 1,700 city owned BMPs within Woodbury. As the City's BMP system has expanded so have the stormwater regulations and the complexity of BMPs being used. These changes created an opportunity for the City to step back from regular pond dredging projects and reconsider the system in its entirety. The result was the Woodbury BMP Maintenance Plan which takes a holistic approach at managing every part of the public stormwater system to meet the requirements within the current MS4 permit, manage the resources responsibly, and do so cost efficiently.

City staff from various departments worked together over the course of a year to understand the system, identify any challenges, and review best practice recommendations from external and internal sources to create this plan. The presentation will share specific examples about findings from these collaborations.

Developed in collaboration with this plan are three guides for the City to use: an Inspection and Maintenance Framework and Guides for each BMP type, a public engagement plan, and a cost estimation model. The findings from these guides will be shared in order to show how plan concepts can be turned in to usable materials.

The Plan was published in October 2021 and the City completed their first annual BMP maintenance project using the plan in Winter 2021/2022. Results from the initial use of the plan will be included in the presentation.

Tuesday October 18, 2022

Concurrent Session II, Track B
Climate

Soil Health of New Construction Soils in Roseville and Lessons in Compost Topdressing
David Bauer, Alliant; *Ryan Johnson*, City of Roseville

Roseville recently built a new city trail on fill soils. It became the perfect place to start a 3-year soil health study, in partnership with Ramsey County and the Ramsey/Washington Recycling & Energy Center, on the effects of compost topdressing. The first year of the study established the soil properties of a new construction soil as well as tested methods of compost application. The city hopes the compost will improve infiltration and vegetation resilience in drought, establish another use for a waste product, and increase carbon sequestration.

The Universities of Minnesota and Nebraska (Kearney) each tested the soil for fertility and organic matter. Nebraska used the Haney Test to measure soil health, which includes a measurement of microbial respiration. Infiltration was measured in the field using an Amoozemeter.

The initial testing confirmed some common beliefs of about the degraded nature of new construction soils, but also revealed a couple of surprises. These new soils were relatively low in organic matter, high in nutrients, low in soil microbes, and low in infiltration. In the month between grading and testing, organic matter had already migrated enough to show differences when measured at the bottom of the slopes and top of the slopes.

It took less than two hours for 16 volunteers to spread a truckload of compost, using two different styles of hoppers and wheelbarrows. Two half-inch rain events pushed the fine compost into the blanket, leaving woody fibers on the surface.

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Linn Grove Dam: A tale of adapting design to existing infrastructure, climate change, and community expectations

Derek Lash, Emmons & Olivier Resources, Inc. (EOR)

The Linn Grove Dam is located on the Little Sioux River in Buena Vista County, Iowa (approximately four hours southwest of Minneapolis). Originally built in 1875 to divert water to an old mill, the dam and associated infrastructure have been damaged and repaired numerous times in response to flood events, which are expected to continue to increase in frequency as climate change continues. The 1600 square mile drainage area flowing to the dam has caused undue stress on the dam as it has aged, and the recent events were no different. In late 2018 and early 2019 the Little Sioux River in Linn Grove experienced record setting floods. These floods were so great, a new river channel was cut around the low head dam at Linn Grove Dam Park, rendering the dam and park useless. Peak flows were more than 21,000 cfs, with the dam and entire 1/4-mile-wide floodplain under significant water. It is estimated at the time of the flooding, the river stage upstream was 18 feet higher than baseflow conditions and there was more than eight feet of water flowing over the dam. Today the dam sits high and dry, and the river is unusable due to the low water levels and the amount of tree debris and sand that was deposited during the flood. This presentation will discuss the first phase of work focusing on the engineering studies and designs that intend to repair damages to the channel and infrastructure and increase dam and channel stability during flood events. We will discuss the historical records reviewed, as well as the recent due diligence completed to determine the dam condition and a preferred route for repairs. Design elements discussed will include sheet pile cutoff walls, rock arch rapids, streambank stabilization, and numerous park improvements to reintroduce the community to the dam and the river. The discussion will also include challenges with the design, permitting, funding, and determining a suitable timeframe for construction.

Calibrating the Cannon River: Gridded Precipitation and HEC-HMS Modeling in a Lake-laden Watershed

Brady Nahkala, Roberta Cronquist, Bolton & Menk, Inc.

The upper lobe of the Cannon River Watershed stretches west of Faribault through significant portions of Rice and Le Sueur Counties. Towns along the river, including the City of Waterville, have experienced repeated flooding within the past 10 years due to increasing intensity and timing of storms as rainfall patterns continue to change in the region. The purpose of the current study is to better define existing flood risk along the Cannon River and within the watershed, with future plans to develop recommendations for regional flood improvements and/or regional watershed management strategies to improve flood resiliency in the region, and install a new flood forecast gage upstream of Waterville.

As part of the study, an existing conditions HEC-HMS model was calibrated to assess flood flows and reservoir levels along the river. Influencing the hydrologic and hydraulic regime of the ~330 sq. miles draining to Faribault are 17 jurisdictional dams, numerous other hydraulic structures, and significant natural storage within the basin. The model was calibrated and validated to four sets of gridded storm data for severe events occurring between 2011 and 2017 within the watershed. Prior modeling efforts by the USACE were leveraged and built upon to add resolution to hydrologic and hydraulic inputs, including modeling an additional 18 reservoirs and/or reservoir outlet structures along the river and its contributing basins. Dams and other structures were found to have significant influence on basin hydrology, requiring the iterative development of HEC-RAS models and the gridded HEC-HMS model for adequate calibration. This presentation discusses those efforts in what the USACE previously described as the “most complicated subbasins to model.”

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Adapting Stormwater Infrastructure in the face of Climate Change

Noah Gallagher, Andy Erickson, John Gulliver, St. Anthony Falls Laboratory, University of Minnesota

Extreme rainfall events changing rainfall distributions and recurrence frequency have significant impacts to urban landscape design, stormwater runoff management, and flood control. This presentation will cover the near-final results and recommendations of a research project on Climate Change Adaptation of Urban Stormwater Infrastructure. The objectives of the project involve predicting future climate impacted design rainfall events and optimizing the cost-effectiveness of adaptations to stormwater infrastructure. To optimize the cost-effectiveness of stormwater infrastructure adaptations, the U.S. EPA's SWMM software was used to model stormwater infrastructure in existing Minnesota watersheds under past, current and predicted future design storms (TP-40, Atlas 14, and several Global Climate Change model predictions). Various adaptation strategies were incorporated into the model for comparison: upsizing storm sewer pipes, adding wet ponds, retrofitting existing stormwater ponds to be "smart" ponds, adding rain gardens, and others. In addition to flood mitigation effectiveness, the project team also considered the relative cost of the adaptation strategies so stormwater managers can make informed decisions about how to re-design stormwater infrastructure for future rain events.

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Concurrent Session II, Track C
Lakes and Nutrients

Geochemical Augmentation with Alumina for Phosphorus Attenuation and Cyanobacteria Bloom Suppression in Lakes and Reservoirs: Summary of Project Results in Five Basins

David Austin, Roger Scharf, Jacobs

Geochemical augmentation with alumina enriches basins with hydrous aluminum (Al) oxide complexes in solution to scavenge phosphate from water and sequester it in sediments. The dosing protocol maintains basin total Al concentrations below the US EPA (2018) chronic toxicity threshold as determined by the US EPA model from inputs of basin pH, dissolved organic carbon, and total hardness.

Project data for alumina dosing (2015-2021) include a stormwater-fed urban lake (Kansas), a river reservoir (South Carolina), and three reuse reservoirs (Georgia). These projects inject alumina into bubble plumes at the basin bottom. Results for all basins are similar, lowering total phosphorus (TP) to the 10 to 60 µg/L range from initial concentrations as high as 250 µg/L at a rate near 1 µg/L/day. Concentrations of total Al remained well below chronic toxicity thresholds despite continual dosing. Additionally, project data demonstrate that geochemical augmentation with alumina suppresses cyanobacteria.

There is a Minnesota origin of geochemical augmentation. Saint Paul Regional Water Services has successfully used geochemical augmentation with ferric iron to lower TP for over three decades in Pleasant Lake and Vadnais Lake. Aeration or oxygenation keeps iron in an oxidized (ferric) state that binds phosphate in sediments. A stormwater pond in Shorewood has used geochemical augmentation with alum since 1997, consistently achieving pond TP near 40 µg/L. Alumina is redox insensitive and does not need to be paired with aeration or oxygenation to scavenge phosphate from water and permanently sequester it in sediments.

Geochemical augmentation with alumina is a powerful, low cost, and ecologically safe engineering method to control eutrophication in-basin. These basins can be stormwater ponds, lakes, or reservoirs. Evidence from projects across the United States unequivocally demonstrate efficacy. This presentation will describe the basics of how to do it and discuss supporting data.

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Sediment Core Collection Optimization for Internal Loading Management
Anne Wilkinson, Katie Kemmit, Conor Dougherty, Dendy Lofton, Stantec, Inc

Lake sediment chemistry has long been viewed as a critical component of nutrient cycling in lakes, in particular because of its relationship to internal phosphorus loading. Sediment cores are routinely collected for sediment physical and chemical characteristics from lakes as a component to internal loading studies. This presentation will highlight the importance and relevance of commonly collected sediment parameters for internal loading management. Another component of sediment core analysis for internal loading management, is the vertical sectioning of the cores, commonly every 2 cm, for chemical analysis. The sectioning of these cores can be costly and increases the turnaround time for results. Reducing the number of sediment core sections can save time and project cost without compromising the accuracy of the prescribed management dose. Stantec has collected sediment cores from over 100 lakes across the state of Minnesota for internal loading feasibility studies. Based on our sediment core database, we have identified trends in sediment core depth profiles to direct sediment core collection optimization and strategies. We will present strategies for the optimal core sectioning and the cost-benefit for internal loading management.

Internal Phosphorus Loading in Lakes: What is it and how do we manage it?
Dendy Lofton, Stantec

Phosphorus (P) loads to lakes are characterized by watershed (external) sources and within-lake (internal) sources. Decades of excess external P loads often leads to accumulation and burial within lake sediments, which can then be recycled among biological and physical components of the lake ecosystem. In cases where internal loading is a large portion of the total load, that source of P can sustain algal growth and poor water quality conditions even if external loads are reduced significantly. Consequently, internal loads need to be managed along with watershed load reduction actions to improve water quality. There are four primary pathways of internal P loading in lakes: diffusive flux, sediment resuspension, bioturbation and macrophyte senescence. Of those, diffusive flux of P typically comprises the largest proportion although the other pathways are more difficult to quantify. Multiple biogeochemical and geochemical factors regulate diffusive P flux including organic matter quantity and quality, hypolimnetic and sediment oxygen demand, and sediment mineral content among other processes. A deep understanding of these factors is critically important for determining whether sediment phosphorus inactivation using alum or other chemicals is an appropriate lake management technique. Using recent case studies, this presentation will describe the basics of sediment P chemistry and data requirements for calculation of an alum or Phoslock® dose, two chemicals commonly to lakes for mitigation of sediment P diffusion.

Tuesday October 18, 2022

The role of aluminum sulfate (alum) treatments in the restoration of Lake Riley, Minnesota

Joseph Bischoff, Barr Engineering Co.; *Josh Maxwell, Terry Jeffrey*, Riley Purgatory Bluff Creek Watershed District; *William James,* University of Wisconsin Stout

Lake Riley is a 297-acre recreational lake in the southwest suburbs of Minneapolis. The lake historically demonstrated poor water quality with nuisance algae blooms and poor water clarity. Although Lake Riley is a deep lake (maximum depth 49 feet), there were concerns regarding the impacts of common carp in the chain of lakes, existing populations of Curly-leaf pondweed and Eurasian watermilfoil, and establishment of a zebra mussel population. Since 2016, the Riley Purgatory Bluff Creek Watershed District (RPBCWD) has focused restoration efforts on the chain of lakes including carp control, efforts to reduce Curly-leaf pondweed, and nutrient management in the watershed and lake sediments. Following carp and Curly-leaf pondweed control, the final step in the restoration of the lake was an alum treatment to control sediment P release. However, there remained some concerns regarding the use of alum due to its large watershed and continued need to reduce watershed nutrient loading. Because of the long timeframe needed to implement watershed practices, Lake Riley was treated with alum in May 2016 and June 2020 to improve water quality while work continues in the watershed and upstream lakes. Anaerobic sediment P release was reduced by 83% between 2016 and 2021 resulting in summer average chlorophyll-a concentrations consistently below 10 µg/L and Secchi depths exceeding 15 feet. Aluminum bound P (Al-P) increased significantly following the second alum treatment suggesting future treatments may be more effective at converting mobile P to Al-P thereby reducing the cost of future alum treatments. While the water quality improvements were a success, continued tracking of the alum treatment will continue while watershed and upstream lake improvements continue. The success of the Lake Riley restoration demonstrates that significant improvements in water quality can be achieved and maintained while continued watershed and upstream lake nutrient reductions are pursued.

Tuesday October 18, 2022

Concurrent Session II, Track D

Special Session: Growing Prospects for Winter Annual Crops in the Upper Midwest

Axel Garcia y Garcia, Grace Wilson, Natalie Hunt, Jeffrey Strock, Amit Pradhananga, William Lazarus, Colin Cureton, University of Minnesota; *Brent Dalzell, Lucia Levers*, USDA-Agricultural Research Service; *Margaret Wagner, Jeffrey Berg*, Minnesota Department of Agriculture; *Anne Schwagerl*, Minnesota Farmers Union

This session will discuss the latest on the prospects for placing winter annual crops on the Minnesota landscape. Speakers will share recent research on the agronimcs and environmental impacts of winter crops, new data on the economic and social barriers to their adoption, and emerging developments in markets for winter oilseeds. A panel of industry, government, and scientific leaders will discuss the prospects for accelerated change in the coming years.

Tuesday October 18, 2022

Concurrent Session III, Track A
Stormwater

Stormwater Pond Management Pilot Study
Jesse Carlson, Connor Johnson, City of Savage; *Bill Alms*, WSB

Communities are tasked with managing their constructed stormwater ponds so they can function at their highest potential. Ponds were originally constructed based on the critical design principles (Depth, Length-Width Ratio, Volume) that aimed to maximize the treatment effectiveness. We have learned that stormwater ponds have taken on a life of their own and act more like a natural system, and many ponds that are decades old have fallen out of balance due to a lack of oxygen, healthy aquatic plant life, excess organic matter accumulation and nutrient cycling. The City of Savage has been collecting water quality data for 7 stormwater ponds since 2018-2019. Most of the ponds have shown depleted dissolved oxygen levels and elevated phosphorus concentrations. The city determined that additional measures are needed to help improve the water quality and maximize the life cycle of the constructed ponds that they manage. This led to a pilot study starting in the summer of 2021, which investigates alternative treatments that include alum dosing, biological microorganisms, and aeration. The city has been doing water quality testing of these ponds both before and after treatment and will share the results of that work during the presentation.

Tuesday October 18, 2022

Minneapolis Pond Survey, Maintenance Assessment, and Internal Loading Analysis
Nico Cantarero, Stantec; *Shahram Missaghi*, City of Minneapolis

The City of Minneapolis conducted a stormwater pond assessment to identify maintenance actions as part of its Stormwater Maintenance Program. This assessment provides the City with the information to better understand the current condition of its ponds and plan accordingly for recommended maintenance actions. This also provided an opportunity for the City to gather missing pond survey data, assess the ponds pollutant removal performance, conduct a detailed assessment of internal phosphorus release, and provide recommendations for operational practices to maximize their effectiveness. The City also partnered with the MPRB to coordinate additional water quality monitoring within the ponds.

The project evaluated 20 wet ponds and included:

- Pond surveys
    - Basin bathymetry, basin associated infrastructure, sediment accumulation, and surrounding topography.
- Sediment Coring and Analysis
    - Pond sediment chemistry, physical characteristics, anoxic P release rates.
- Water Quality Monitoring
    - Dissolved oxygen dynamics and the extent and persistence of anoxia in the ponds. The MPRB also conducted water quality monitoring on several of the ponds.
- Basin Analysis
    - Physical Properties
        - Determine the “as-built” conditions, degree of sedimentation, and create record drawings.
    - Sediment P release
        - Estimate the potential sediment P release and the extent of anoxia enabling such release.
    - Condition Summary and Prioritization
        - Compiled all field, laboratory, and calculated data into an overall summary for each pond to prioritize and identify recommendations.
- Recommendations
    - Provide clear and actionable pond management recommendations, planning of capital improvement projects, develop planning level cost estimates for dredging and phosphorus inactivation activities, and create specific monitoring recommendations based on all analysis.

Tuesday October 18, 2022

Evaluation of Wet Detention Pond Performance and Application of the General Lake Model
Caitlin Lulay, Anthony Parolari, Brooke Mayer, Walter McDonald, Marquette University

Urbanization degrades surface water quality through increased nutrient accumulation and transport in stormwater runoff. Wet detention ponds (WDP) are a means of mitigating non-point source pollutants such as phosphorus (P) through sediment settling and biological uptake. WDPs serve as a nutrient sink and potentially as a nutrient source due to P release back into the water column through algal decay and sediment resuspension. Existing models used for design and regulatory evaluation do not consider algal P dynamics or sediment resuspension. These gaps may explain widespread WDP effluent P concentrations that exceed water quality standards. To better understand WDP P dynamics toward improved design and analysis models, we studied the temporal variation and biogeochemical controls of P in 2 WDPs over a 4-month period (July – Oct 2021) that included eleven storm events. DO, conductivity, temperature, and water level were recorded as well as pH, conductivity, temperature, and ORP profiles. P and total suspended solids were measured in bi-weekly grab samples and storm influent/effluent. Pond P was consistent over time, while influent concentrations and loads were elevated in the early summer and fall. Effluent concentrations and loads were lower relative to influent for most storms, except those in October when effluent loads were higher. Elevated effluent loads were associated with higher TSS and particulate P, indicating either washout of algal biomass or resuspension of pond sediments. These results indicate marked seasonal variability in the P removal efficiency of SW ponds. Using the General Lake Model, a sensitivity analysis was performed which showed that P removal was most sensitive to pond volume and maximum sediment-P flux. These findings support the value placed on dredging as a maintenance mechanism of WDPs. This knowledge is important for improving WDP design and maintenance strategies that optimize nutrient removal to mitigate water quality degradation.

Pond Treatment with Spent Lime to Control Sediment Phosphorus Release
Greg Wilson, Barr Engineering Co.

Sedimentation ponds that accumulate particles and phosphorus from stormwater runoff are a standard, widely applied best management practice. However, aging ponds have potential to release more phosphorus than is captured during summer months. Recent monitoring efforts from the Twin Cities Metro area have confirmed that sediment phosphorus release is an increasingly significant concern for many stormwater ponds that are relied upon for meeting Total Maximum Daily Load requirements for phosphorus wasteload allocations. In addition, there is also significant interest in spent lime treatment as an option to address internal phosphorus load in lakes. Dredging is an expensive option to improve pond performance, while areal applications of alum and iron can control phosphorus release but incur raw material production costs. Using MSRC/CWF funds and in-kind contributions from RWMWD, VLAWMO, SPRWS and City of White Bear Lake, Barr studied spent lime applications to ponds to reduce sediment phosphorus release. SPRWS currently spends one million dollars a year to transport spent lime to agricultural producers, confirming that there is significant financial incentive for utilities that use lime for water softening to find cheaper alternatives for beneficial reuse. Results of this study, which includes both laboratory and field-scale components intended to validate the efficacy of spent lime applications to control sediment phosphorus release, will be presented. The laboratory component included spent lime addition to pond sediment cores to evaluate pH effects and optimize spent lime dosing, while the field component included spent lime addition to two ponds and post-treatment monitoring to evaluate the water quality benefits. This talk will also address proof-of-concept issues, including cost-effective methods for areal application, permit considerations and cost-benefit comparisons with other control options such as dredging, alum treatment and the application of iron filings.

Tuesday October 18, 2022

Concurrent Session III, Track B
Engineering Solutions—Flooding

Parallel Floodplains: A regional public-private partnership
Mat Cox, Kimley-Horn and Associates

What do you get when you mix 3 different developers with 2 new public roadway segments, 1 potential future roadway expansion and extension, a creek crossing of a designated trout stream, 2 creek crossings of a delineated FEMA floodplain (1 with floodway) and a combination of both public and private wetland impacts? An opportunity to evaluate and design the separate projects in a more thoughtful manner and result in a more effective and efficient design that meets the needs of the developers while addressing the water resources standards of the City of Lakeville and paves the way for the future roadway extension to implemented without significant changes to the overall system. This presentation will discuss how the projects that started down independent paths came together and how the partnership between the public and private owners collaborated to develop a system that not only met the requirements but went above-and-beyond in terms of water quality treatment. The nature of the independent projects required analysis of several different phasing approaches depending on when each of the parts would be constructed. The presentation will also discuss floodplain modeling efforts to result in no-rise certifications for the crossing of both creeks and the development of detailed XP-SWMM site modeling for the separate projects within the larger regional XP-SWMM model.

Wood Lake Lift Station - From Feasibility to Construction
Bill Alms, *Kendra Fallon*, WSB;, City of Richfield

Wood Lake in the City of Richfield has routinely experienced high water levels in the recent past which inundates and has washed out trails around Wood Lake in the Richfield Nature Center. The City commissioned a feasibility study to analyze options for addressing the high water levels of Wood Lake. The proposed improvements analyzed and recommended needed to address the following:

- Reduce and/or regulate the water levels in the lake
- Be easy to implement by City Public Works Staff
- Meet the goals of several stakeholders including the City of Richfield engineering and nature center staff, MnDOT and private utility companies

Several alternatives were analyzed in the feasibility study and the selected alternative was to increase the pumping capacity of the existing lift station from Wood Lake to provide the ability to draw down Wood Lake quicker than the lift station currently allowed. As the lift station discharges into MnDOT trunk storm sewer, design and construction of the improvements required extensive coordination and permitting with MnDOT. There were multiple challenges during construction that were overcome including access coordination with commercial property owners adjacent to the construction site, construction timeline adjustments due to utility company coordination, and installing the sensor and associated electrical work for switching the additional pumps on and off based on available capacity within the MnDOT trunk sewer. The improvements were constructed in the Summer of 2021 and have been utilized and monitored from that time on.

Tuesday October 18, 2022

City Regulation of Local Flood Areas
Zuleyka Marquez, City of Edina

The City of Edina undertook a stormwater modelling effort that allowed for visualization of local and regional flooding issues throughout the city. These GIS tools are published internally and externally. Internally, they are used to inform stormwater and floodplain development policy decisions and are critical for permit review. Externally, existing and prospective residents and builders/developers can assess the flood risk in the neighborhood. Model updates are continuous and can be informed by ongoing redevelopment. Mapping has allowed for more consistent and thorough permitting review and inspections. Additionally, as we think through these flooding and drainage during permit review, we have opportunities to identify future solutions, such as City projects and revised standards.

Everest Lane Stream Stabilization Project
Kendra Fallon, Jake Newhall, WSB; *Derek Asche*, City of Maple Grove

The City of Maple Grove's Everest Lane Stream Stabilization Project is located directly upstream of Elm Creek which is currently listed as impaired by the MPCA. The projects goals were to:

- Stabilize roughly 800 linear feet of a ravine showing signs of heavy erosion and channelization to reduce sediment loading to Elm Creek and reduce sloughing safety concerns to adjacent properties.
- Provide energy dissipation within the ravine while maximizing bioengineering techniques to maintain the natural drainage way
- Replace failed infrastructure with long term solutions to reduce future maintenance for the City

A combination of regrading, hard armoring, and bioengineering were used to help stabilize the eroded side slopes of the channel while ditch checks and plunge pools were strategically placed to maximize energy dissipation within the channel. A SMS SRH-2D hydraulic model was created to assist in the design and help determine the best locations for different stabilization techniques based on anticipated velocities and shear stresses within the channel.

Sustainability was considered throughout the project from design to construction. Some of the large trees which had either already fallen into the ravine or were removed during construction to help ground level revegetation efforts were used for onsite stabilization. Tree trunks were anchored into the toe of the slope as a form of toe stabilization or were used in combination with riprap to form some of the ditch checks. The grading, bank stabilization, and infrastructure construction has been completed and vegetation establishment efforts for the Everest Lane Project are still ongoing. Final restoration is anticipated to be completed Spring 2022.

Tuesday October 18, 2022

Concurrent Session III, Track C
Invasives and Aquatics

A Field Study of Maximum Wave Height, Total Wave Energy, and Maximum Wave Power Produced by Four Recreational Boats on a Freshwater Lake

Jeffrey Marr, Andrew Riesgraf, William Herb, Matthew Lueker, Jessica Kozarek, St. Anthony Falls Laboratory University of Minnesota; *Kimberly Hill*, Department of Civil, Environmental, and Geo-Engineering, University of Minnesota

Recreational boating on inland lakes is an increasingly popular activity that continues to evolve with the introduction of new types of boats and tow sports. The emergence of wakesurf boats and the sport of wakesurfing introduces a completely new mode of boat operation, where the goal is to produce a large wake that is suitable to surf on. There is growing concern over boat-generated waves and their environmental impacts to lakes and rivers. The research discussed here was motivated by a need to better understand the characteristics of wake waves produced by common recreational boats. In this talk we present results from a recent field-based study that characterized the size, energy and power of the wake waves generated by four types of recreational boats. Two of the boats were more traditional recreational boats that are commonly used for tow sports like tubing and waterskiing, and the other two boats were wakesurf boats specifically designed for the sport of wakesurfing. Five wave monitoring stations were deployed on Lake Independence (Maple Plain, Minnesota) at various distances from the shoreline. Testing involved operating each boat at four distances from the shoreline (225 ft, 325 ft, 425 ft, and 625 ft) under various conditions (e.g., speed, ballast weight, trim setting, etc.). The results show clear differences in the wake wave characteristics between the more traditional boats and wakesurf boats. Notably, when operating in surf conditions wakesurf boats produce wake waves that are substantially larger and contain more energy and power than traditional recreational boats. The research findings can be used to inform boat operational distances necessary to attenuate wake wave heights, energies, and powers to levels deemed acceptable. Moreover, the findings can help us begin to understand the possible impacts of recreation boating activities on shorelines and lake bottoms.

Tuesday October 18, 2022

Effectiveness and costs of aquatic invasive species spread prevention in Minnesota

Nichole Angell, Nicholas Phelps, Valerie Brady, Amy Kinsley, Josh Dumke, University of Minnesota; *Tim Campbell*, Wisconsin Sea Grant; *Reuben Keller*, Loyola University Chicago; *Adam Doll*, Minnesota Department of Natural Resources

Efforts to prevent the spread of aquatic invasive species (AIS) have been widely implemented on local and regional scales to mitigate the economic and environmental harm associated with these organisms. Watercraft inspection and decontamination, along with boater education and outreach, are popular prevention strategies; however, few studies have investigated the effectiveness and cost effectiveness of these approaches. In this study, we aim to fill these knowledge gaps to inform management decision-making by providing more nuanced information about watercraft inspection effectiveness and by using program cost data to estimate prevention benefits for specific monetary investments. Effectiveness of AIS prevention strategies will be estimated by evaluating boaters and watercraft inspectors during experimentally controlled boat inspections. During these inspections we will realistically stage a boat with fresh macrophytes and dead or preserved AIS. Participants will be asked to inspect and remove any items as they would after a typical outing on a lake. Both the types of organisms and the amount removed from the boat will be used to estimate effectiveness for any one inspection. We pilot tested these methods in the Fall of 2021. Preliminary results suggest that boating frequency is positively correlated with effective removal by boaters and differences likely exist between types of AIS. In addition, costs of all evaluated prevention strategies will be determined by reviewing existing literature and interviews with AIS managers. This work is ongoing and preliminary results will be presented. Ultimately, these data will be incorporated into the online decision support tool, AIS Explorer (www.aisexplorer.umn.edu) to guide future management decisions.

Spatial patterns and environmental drivers of horizontal, diel, and seasonal distribution of the invasive zooplankton Bythotrephes in a Minnesota Reservoir

Megan Corum, Donn Branstrator, University of Minnesota Duluth

Understanding the distribution of invasive zooplankton like Bythotrephes cederstroemii is essential for accurate population estimates. Island Lake Reservoir (Duluth, MN, USA) is a tannin-stained lake that supports a persistent population of Bythotrephes despite tannin-stained waters limiting visibility. In order to describe the horizontal, diel, and seasonal distributions of Bythotrephes, a nearshore to offshore transect was sampled at four depth sites (2 m, 8 m, 12 m, and 16 m). Samples were collected monthly during the day and again the same night from June to October. Bythotrephes density and biomass during the nighttime exceeded the daytime at all sites. The intermediate sites (8 m and 12 m) supported the most biomass across all months. Contrary to expectations, Bythotrephes density was highest at the 2 m site on several sampling dates. These results are interpreted alongside simultaneous measurements of prey abundance, temperature, and dissolved oxygen. These results begin to fill gaps surrounding the distribution of the Bythotrephes population on different scales.

Tuesday October 18, 2022

Boot, Root, & Boogie (carp booted, plants rooted, staff boogied

Jeff Anderson, Shauna Capron, Elizabeth Froden, Prior Lake-Spring Lake Watershed District

Carp Removal as an Approach to Increase Submerged Aquatic Vegetation

The impaired waters of Spring and Upper Prior Lakes in the Prior Lake-Spring Lake Watershed District were identified in TMDL reports as having excess internal nutrient loading, with common carp activities as one of its main contributors. Since 2014, with support from MPCA , DNR, and BWSR grants, PLSLWD employed novel approaches to remove carp biomass from these lakes that have led to significant improvements in water quality. The District created an Integrated Pest Management Plan (IPM Plan) for Common Carp. The IPM Plan provides long-term guidance for data collection that informs decision making and implementation activities, along with guidance for monitoring of ecological changes within Spring and Upper Prior Lakes.

The overarching goal of the IPM Plan is to improve water quality by reducing total phosphorus (TP) and chlorophyll-a (Chl-A) concentrations and increasing Secchi depth to meet site specific standards. Between the years of 2019 and 2021, carp biomass was reduced in Spring Lake by 19,154 pounds, and internal TP loads were reduced by 198 pounds/year. In Upper Prior Lake, 39,367 pounds of carp were removed and internal TP loads were reduced by 499 pounds/year. Given the reduction in carp biomass and improved water quality, the District anticipated, and experienced, an increase in submerged aquatic vegetation. Point intercept surveys and vegetation density mapping have shown increases for nine new species in Spring Lake. Submerged aquatic vegetation percent area coverage increased from 18 percent to 60 percent in Spring Lake and from 11 percent to 52 percent in Upper Prior Lake.

This presentation will share pre-implementation conditions, carp reduction methodologies, and post-implementation water quality and aquatic vegetation findings.

Tuesday October 18, 2022

Concurrent Session III, Track D
Special Session: (continued) Growing Prospects for Winter Annual Crops in the Upper Midwest

Axel Garcia y Garcia, Grace Wilson, Natalie Hunt, Jeffrey Strock, Amit Pradhananga, William Lazarus, Colin Cureton, University of Minnesota; *Brent Dalzell, Lucia Levers*, USDA-Agricultural Research Service; *Margaret Wagner, Jeffrey Berg*, Minnesota Department of Agriculture; *Anne Schwagerl*, Minnesota Farmers Union

This session will discuss the latest on the prospects for placing winter annual crops on the Minnesota landscape. Speakers will share recent research on the agronomics and environmental impacts of winter crops, new data on the economic and social barriers to their adoption, and emerging developments in markets for winter oilseeds. A panel of industry, government, and scientific leaders will discuss the prospects for accelerated change in the coming years.

Wednesday October 19, 2022

Concurrent Session IV
Track A: Green

The Potential Water Quality and Other Co-Benefits of Solar Energy
Patrick Hamilton, Adam Heathcote, Science Museum of Minnesota

The default mode often is the construction of large solar arrays over hundreds of acres, but what if many, smaller solar arrays were encouraged? Smaller solar arrays deployed across our rural areas would cause less visual impact, and would distribute the financial benefits of solar to more landowners.

Irregularly-shaped fields can be cumbersome for farmers to cultivate. Converting these fields to solar would enable farmers to square off their fields and focus their efforts on their best lands while receiving financially attractive annual lease payments from solar. Smaller solar arrays placed on irregularly-shaped croplands along waterways and seeded with pollinator-friendly perennials would yield big water quality and other co-benefits.

Planting pollinator-friendly perennials under solar arrays would result both in the production of carbon-free electricity but also the sequestering of atmospheric carbon back in soils in the form of organic plant material. If a price was put on the carbon emissions that are worsening climate change, then farmers could derive income both from their new crops of clean electricity and also from sequestering carbon.

The idea is that farmers voluntarily choose to use some of their less valuable croplands to produce a valuable new crop – zero-carbon electricity. But would this really do much good? The Science Museum of Minnesota's modeling of a small agricultural watershed where irregular croplands adjacent to waterways were converted to solar with pollinator-friendly perennials resulted in combined reductions of nitrate, phosphorus and sediment of nearly 60 percent.

Solar arrays are likely to crop up on hundreds of thousands of Minnesota's rural acres in coming years. This may seem like a lot of land but it is a tiny share of the over 20 million acres of cropland in the state. But thoughtfully sited, solar could demonstrate how the emerging clean energy economy could fuel multiple water, environmental and rural economic co-benefits.

Wednesday October 19, 2022

Adventures in Establishing Linear Reconstruction GI: 3 Years of Designing and Building Practices Before the Stormwater Ordinance

Katie Kowalczyk, Allison Bell, City of Minneapolis

This presentation will cover the approach taken by the City of Minneapolis to prepare for the ordinance update requiring Green Stormwater Infrastructure (GSI) on linear projects. This will focus on some of the specific design elements such as inlet details and slopes, and broadly cover some of the programmatic approaches, such as training, supplementing staff resources, outreach to internal stakeholders, and O&M tools.

Required updates to the City of Minneapolis Stormwater Management Ordinance were expected to drastically impact linear projects constructed throughout the city. For the first time, these projects would be subject to the ordinance, requiring stormwater management facilities to retain runoff volume, improve water quality, and provide rate control, all within the confines of the developed, crowded ROW. Per the regulatory requirements, and in line with various City policies and goals, the preferred methods to meet the ordinance require GSI features such as bioretention cells. Three years ahead of the anticipated deadline, the city began to prepare for the inclusion of GSI features in the ROW to meet the new requirements.

This presentation will provide background on the 3 years before the stormwater ordinance updates went into effect in 2022, and walk through the lessons-learned, successes and challenges.

Unearthing an Approach to Vegetation Establishment in Urban Green Infrastructure

Allison Bell, City of Minneapolis; *Britta Hansen*, EOR

Establishing vegetation within Green Infrastructure (GI) facilities in an urban, developed city with substantial winter maintenance processes, such as application of chlorides and sands, is a significant challenge. Healthy vegetation is an integral part of the success of GI and is a clear demonstration of the multiple benefits offered by such facilities. Plants help improve physical and mental well-being and are a tool for improving quality of life and safety in urban environments.

The City of Minneapolis has partnered with EOR to develop standard plans and practices for successfully planting and maintaining a variety of vegetation types within GI facilities in a highly urban setting. The presentation will discuss the history and necessity of the city's green infrastructure program, early challenges in getting plants established in GI, and the essential elements for successfully establishing vegetation within GI facilities including:

- Plant Species Selection
- Installation Methods
- Construction Oversight
- Maintenance Guidance
- Public Outreach

In addition, presenters will discuss opportunities for collaboration with residents in the implementation of green infrastructure, and methods and tools for doing outreach before, during, and after planting takes place. This presentation will make the case for planting native vegetation in urban environments and will give attendees a better of understanding of how to do so effectively. It will also cover a pilot of native sod applications in the city.

Wednesday October 19, 2022

North and East St. Paul Target Store Stormwater Retrofits

Paige Ahlborg, Ramsey-Washington Metro Watershed District; *Katie Turpen-Nagel*, Barr Engineering Co.

Ramsey-Washington Metro Watershed District (RWMWD) has budgeted grant funds to partner with commercial sites near priority water bodies or in underserved parts of the district to install stormwater retrofits in an initiative to improve water quality and help achieve water quality goals. This Targeted Retrofit Program looks for opportunities to develop partnership to install best management practices (BMPs) at properties with high impervious surface coverage and no plans for future remodels that would trigger stormwater permit requirements.

In 2018, staff began discussions with the stormwater division of Target Corporation about their green infrastructure initiatives and how we could work together to achieve the stormwater treatment goals of both organizations. Target was open to installing a variety of BMP types and allowing the loss of parking spaces to keep BMPs above ground for not only ease of maintenance but also so Target guests could appreciate the efforts. RWMWD collaborated with Target Corp to install seven rain gardens and one tree trench feature within the parking lot at the East St. Paul Target store in 2020 and then installed four rain gardens and two tree trench features in 2021 at the Target store in North St. Paul. RWMWD is now working with Target to install educational project signage and is developing operations and maintenance tools to help achieve long-term treatment goals. Inspired by the success of this partnership, Target Corp is hoping to take what they have learned and implement similar retrofit projects at other stores across the country.

Wednesday October 19, 2022

Concurrent Session IV, Track B
Agricultural Assessment and Evaluation

Assessing the implications of chloride from land application of manure
Matthew Belanger, Erin Cortus, Melissa Wilson, University of Minnesota

Rising chloride contamination in ground and surface waters is a growing concern in Minnesota. Previous studies estimate 87% of the chloride load to originate from road salts, fertilizers, and wastewater treatments plants with 6% originating from manure fertilizers. However, these estimates may be outdated as the livestock industry and manure application practices have evolved since these estimates were calculated in 2004. It also remains unclear the effect varying manure and soil types have on chloride leaching following manure application. The aim of this study is to understand the movement of manure-based chloride through a series of intact core leaching studies. In-tact soils cores with a depth and diameter of 30.4 cm will be taken from fields containing fine and medium textured soils around Minnesota in Fall 2021. For the first round of experiments, each core will be surface applied with either liquid manure, solid manure, or potassium chloride; cores with no nutrient application will serve as the control. Core leachate will be analyzed to measure total chloride concentration following a series of wetting events, each amounting to 50.8 mm of simulated rainfall. Future attempts in creating chloride-based mass balances will benefit from this study.

Minnesota's state of soil health: research and outreach update from the Minnesota Office for Soil Health
Anna Cates, A. Marcelle Lewandowski, University of Minnesota

Established in 2018, the Minnesota Office for Soil Health (MOSH) is a University-government collaboration to increase the capacity of local professionals around the state to support adoption of soil friendly practices. The Office is housed at the UMN Water Resources Center (WRC) with base funding from the Board of Water and Soil Resources (BWSR) and WRC. After 4 years in operation, MOSH has strengthened and built collaborations for research and outreach. The presentation will highlight current projects as well as plans for future work.

Soil health training is delivered formally, through UMN Extension, NRCS, BWSR events, as well as informally, though statewide networks of soil health educators with local government and Extension. These trainings and networks inform soil health research by MOSH and partners. Funded by a CIG grant, Blair recently led a survey of soil health indicators in the Red River Valley, the Minnesota River Valley, Stearns and Mower counties, and is building a publicly accessible database. This database will help farmers and their advisors interpret soil health indicators. MOSH is also actively investigating intersections between soil water management and soil health, via soil moisture monitoring, rainfall-based sampling, and rainfall simulation to evaluate response to climate change. Recent research at newly installed drainage plots in Crookston, MN, revealed soil organic matter pools can change deep in the profile in response to drainage, which has implications for farm management and climate modeling.

Going forward, MOSH is developing a soil health curriculum for agricultural lenders, deepening collaborations with agricultural retailers and co-ops, hosting a regional Soil Health Nexus training for educators, and continuing research at the intersection of soil and water.

Wednesday October 19, 2022

Assessing agricultural producers' motivations to participate in the Minnesota Agricultural Water Quality Certification Program

Amit Pradhananga, Derric Pennington, University of Minnesota; *Daniela Miteva, Samuel Cheng*, Ohio State University

Non-point source pollution from diffusely distributed sources including agricultural landscapes is a major concern in Minnesota. Farmers' use of conservation practices and participation in conservation programs provide important ecological benefits including improved water quality and soil health, and enhanced wildlife habitat. The Minnesota Agricultural Water Quality Certification Program (MAWQCP), administered by the Minnesota Department of Agriculture, promotes voluntary adoption of conservation practices among farmers. While the program has more than 1,000 participants, the motivations for and barriers to farmer participation are not yet known. To increase farmer participation rates, it is important to understand the drivers of and barriers to participation.

This study examines the social-psychological factors that influence farmers' participation in MAWQCP. We developed and applied a social science-based theoretical framework to assess factors that affect future likelihood of participation. We conducted a statewide survey of 2000 farmers, who are not currently participating in the program, and analyzed the data using structural equation modeling. Study findings show that beliefs about water pollution and conservation practices are important predictors of program participation. This study offers strategies for program administrators and resource professionals to best design programs that appeal to farmers' motivations and address constraints to program participation.

Improving Minnesota's strategies and tools for nutrient reduction in local and downstream waters

David Wall, Minnesota Pollution Control Agency

Minnesota's Nutrient Reduction Strategy (NRS) has been used for eight years to help guide Minnesota's efforts to reduce nitrogen and phosphorus pollution of local waters, in addition to waters downstream of our state borders. The NRS outlines large-scale goals, practices and programs to achieve goals, and tracking systems to evaluate progress. The NRS and watershed nutrient loss reduction efforts rely on understanding the effectiveness of various best management practices (BMPs) in reducing nutrients at field and watershed scales. Minnesota is working together with other Midwest states to re-assess BMP efficiencies and effectiveness, so that the most promising BMPs for achieving large-scale nutrient reduction goals can be identified. The best practices for Minnesota's conditions will be determined as we update and improve our state NRS for the 2025-35 decade. The BMP science synthesis will also be used to update watershed decision support tools, thus improving our nutrient reduction scenarios for achieving goals at state lines and within our borders. One such tool, known as HSPF Scenario Application Manager (SAM), estimates typical watershed nutrient load reductions from various combinations of BMPs. Recently, a user-friendly web-based representation of SAM results was completed to help watershed planners readily obtain typical nutrient and sediment load reduction information from 30 different BMPs at HUC12 and HUC8 watershed outlets. This tool will be described and demonstrated. Additionally, the process of incorporating BMP science synthesis results into an improved NRS and watershed decision support tools will be described.

Wednesday October 19, 2022

Concurrent Session IV, Track C
Nutrients and Wastewater

Efficacy of Membrane Bioreactor in Wastewater Treatment Utilizing Fathead Minnow (Pimephales Promelas) Exposure

Charles Christen, Alissa VanDenBoom, Molly Lovsness, Heiko Schoenfuss, St. Cloud State University

Wastewater comes from a variety of sources from industrial, commercial, and residential areas. Each source adds contaminants of emerging concern (CECs) that can interact with an organism's cellular pathways and metabolic processes. Wastewater treatment plants (WWTP) are built to remove macro pollutants and bacterial nutrients through two-stage processes but are not optimized for CEC removal. Secondary treatment technologies range from well-established oxidative treatments to more recently developed membrane bioreactors (MBR). Oxidative treatments use agitators to promote bacterial growth and nutrient removal, while MBRs uses a similar biological treatment but add membrane filtration. Previous research on CECs removal in oxidative treatments such as the one installed at the Hutchinson, MN WWTP documented that some CECs are passing through treatment into the environment (Lee et al., 2011). What is not known is how well MBR treated wastewater removes CECs. Since the previous study, the Hutchinson WWTP has split its influent and added a MBR treatment to parallel the oxidative treatment allowing for direct comparison of the efficacy of CEC removal by the two treatment processes using analytical chemistry and fish exposures. The objective of this study was to compare the CEC removal efficacy of MBR to that of oxidative treatment through 21-day exposure of fathead minnows (Pimephales promelas) assessing endpoints related to contaminant exposure. Fathead minnows were exposed for 21-days via a flowthrough system to four treatments including a negative control, oxidative treatment, MBR effluent, and an influent captured past the primary treatment. Following exposure, plasma, liver, gonad, gills, and digestive tract were collected. Tissues were analyzed for indicators of CEC stressors in cellular pathways and metabolic processes. The entire experiment was repeated once.

Wednesday October 19, 2022

Municipal wastewater plants meet low-level mercury limits by controlling effluent suspended solids
Nathan Johnson, Kelsey Hogan, Adrian Hanson, University of Minnesota Duluth; *Scott Kyser*, Minnesota Pollution Control Agency; *Geordee Spilkia*, Water Resources Science Program, University of Minnesota

Hundreds of municipal wastewater treatment plants (MWWTPs) in Great Lakes states, Ontario, numerous tribal nations and non-Great Lakes states have received low-level mercury effluent limits (2 ng/L). Despite the widespread need for low-level mercury treatment design information, little research or practical guidance addresses low-level mercury treatment strategies for municipal wastewater. We collected samples at 15 MWWTPs located in the Great Lakes watershed and scoured the MPCA's historic database to find over 1800 records from MWWTPs that have incorporated a variety of secondary and tertiary treatment technologies to remove mercury to permitted levels. The filter-passing mercury in MWWTP effluent was consistently between 0.4 and 0.8 ng/L, while particulate mercury varied widely and was covariate with TSS in most cases. Though filter-passing mercury comprises a substantial fraction of the discharge limit, effective particulate control (2 mg/L) typically left mercury at 1.8 ng/L. Some MWWTPs with only secondary biological treatment were able to remove mercury to 1.8 ng/L, but most plants with tertiary treatment removed both TSS and mercury effectively. In MWW effluent, the sulfur content of filter-passing dissolved organic and inorganic sulfide and spectrophotometric characterization and elemental composition of dissolved organic matter suggests that the net effect of wastewater treatment on dissolved organic matter may impose a lower limit on the quantity of filter-passing mercury. The analysis of historic data from over 150 treatment plants gives an empirical picture of which technologies are most effective in removing mercury to low levels. Additionally, our analysis of dissolved organics, sulfur, and mercury across a variety of conditions in municipal wastewater points to a persistent, but not prohibitive quantity of filter-passing mercury that makes effective particulate removal essential to meeting Great Lakes mercury discharge limits.

Measuring the gross solids in Stormwater and the Associated Nutrient Loading
Aaron Pietsch, John Chapman, Jacques Finlay, Larry Baker, Grace Wilson, University of Minnesota

In 2020 we began a study of gross solid materials washing off urban watersheds to better understand how these materials impact stormwater management. We hypothesize nutrients in gross solids, which are mostly not measured in conventional water quality sampling protocols, are an important part of watershed nutrient loading. This effort is looking at the total annual dry mass of material generated from watersheds and the associated nutrient content in the gross solids. Our methodology uses sample bags to trap material, which is collected about every two weeks, throughout the unfrozen months. This material is characterized by physical measurement of mass, particle size, settling velocity, loss on ignition, and nutrient analysis. We will discuss preliminary findings from the data collected in 2021 and 2022 in 14 urban watersheds and the potential impacts of course solids from highly vegetated areas to management of urban stormwater systems.

Wednesday October 19, 2022

Using Satellite Derived Water Quality Data from an Automated High Performance Computing Environment for Spatial/Temporal Trend Analysis of 10,000+ Minnesota Lakes

Leif Olmanson, David Porter, University of Minnesota

Using Landsat imagery, we have been assessing lake water clarity in Minnesota, USA for over 25 years. For early assessments we used empirical methods and in situ Secchi calibration data. Recent advances in satellite technology (improved spatial, spectral, radiometric and temporal resolution) and atmospheric correction, along with cloud and supercomputing capabilities, have enabled development of automated regional-scale measurements of water quality. These new capabilities provide opportunities to improve lake and fisheries management by measuring more variables (chlorophyll, colored dissolved organic matter (CDOM) and total suspended matter, the main determinants of water clarity) more frequently. Combining these new capabilities with earlier assessments, we created a 36-year (1985-2021) satellite-derived late summer water clarity database for long-term trends. To explore seasonal patterns, we create monthly water quality (clarity, chlorophyll, CDOM) data using all available May-Oct Landsat 8 and Sentinel 2 imagery from 2017 to 2021 for 10,000+ lakes. These maps and auxiliary data such as USGS Land Change Monitoring, Assessment, and Projection (LCMAP), weather and USDA National Agricultural Statistics Service (NASS) data were used for spatial/temporal analysis to explain regional differences in water quality. Areas dominated by forest/wetland had higher water clarity than agricultural/developed areas and shallower lakes had lower clarity than deep lakes with similar land cover. Changes in water clarity were attributed to changes in land use and climatic factors. Clarity increased in many urban lakes which was attributed to BMPs and development of agricultural lands. Clarity decreases were attributed to changes in precipitation, temperature and crop types. Differences in CDOM were related to precipitation and predominant land cover, with wetland/forested area associated with higher CDOM than agricultural areas.

Wednesday October 19, 2022

Concurrent Session IV, Track D

Special Session: The Minnesota Drought of 2021

Pooja Kanwar, Luigi Romolo, Dan Miller, Ellen Considine, Amanda Yourd, Carmelita Nelson, Minnesota Department of Natural Resources

This special session will cover the story of the 2021 drought through the Minnesota Department of Natural Resources' (DNR) perspective, by the exploration of science, planning and effects. The session will describe the climatology and chronological events of the drought, and the planning and communication processes that occurred to help coordinate across internal and external groups. Effects of the drought will be shared, including permit suspensions, well interferences and water conservation measures that were implemented. The session will highlight a case study in northwestern Minnesota that illuminates the complexities of groundwater and aquifer management as a result of the water shortages from the drought. The presenters will discuss lessons learned as well as challenges and opportunities moving forward. The session will end with a group discussion and question and answer panel including the audience and DNR experts.

Wednesday October 19, 2022

Concurrent Session V, Track A
Pollutant Removals and Stormwater

Designing a Lower Salt Futur
Connie Fortin, Tim Olson, Bolton & Menk

Excessive salt use on winter roads has become an emerging problem in recent decades. Now more than ever, it is time to take a hard look at infrastructure design to drive down salt use during winter months. In this presentation, we will identify infrastructure design problems and explore the future of cold climate infrastructure design to support winter maintenance professionals in the reduction of salt.

Materials for Maximizing Phosphorus Removal from Stormwater
Nigel Pickering, Geosyntec Consultants; Md. *Arafat Ali*, University of Buffalo

Phosphorus (P) is the limiting nutrient in most freshwater ecosystems. Although P is an essential nutrient for plant life, excessive loading to receiving surface waters can result in algal blooms, toxic algae, large extents of macrophytes, and eventual eutrophication. Many stormwater management controls can remove particulate P easily through sedimentation and filtration processes, but dissolved P is much harder to remove.

This laboratory study systematically investigated a large spectrum of materials to improve dissolved P removal from biofiltration and bioswale systems. The project evaluated dissolved P removal efficiency of 40 different adsorptive materials through jar tests and adsorption isotherm kinetics, column tests that emulate biofiltration systems, and channel tests to emulate bioswales. The media evaluated in this study included metal-based materials, shell-based products, wood-based products including biochar, peat and compost materials and proprietary products.

The 40 materials evaluated using jar tests yielded 12 candidates for further testing using complete adsorption isotherms. Seven of these 12 materials were tested extensively in the columns and the 3 best materials from that study were chosen for the channel study. This presentation will show results based on completed laboratory experiments on the phosphorus adsorption, column studies, and bioswales experiments. The most suitable materials for P removal will be highlighted and future research directions suggested.

Wednesday October 19, 2022

Leveraging Minnesota's Stormwater Monitoring Data to Better Understand Drivers of Urban Runoff Pollution

Ben Janke, Jacques Finlay, Bruce Wilson, St. Anthony Falls Laboratory, University of Minnesota;
Mike Trojan, Minnesota Pollution Control Agency

We will present preliminary results of a project that analyzes available stormwater and spatial data collected by Minnesota cities, agencies, and watershed managers to understand how watershed and climate factors influence stormwater composition and loading for Minnesota's cities. We have assembled data from nearly 100 piped storm drain sites across the Twin Cities Metropolitan Area, including 80 with complementary hydrology data collection and 27 with data records spanning 10 or more years, which represent the efforts of over a dozen cities and watershed management organizations. Building on previous work we examine spatial and temporal variation in major urban stormwater pollutants such as phosphorus, nitrogen, sediment and metals as a function of factors including tree canopy cover, traffic density, and development age. Initial results suggest that variation in nutrient, sediment and metal concentrations are associated with different urban features, and show diverse but often improving temporal trends. Project outputs, which will be publicly available, will provide robust and locally-relevant stormwater characterization for urban watersheds in Minnesota, benefiting assessment, planning, and modeling of water quality management of urban watersheds, both for current and future scenarios of land management and climate. Information from this project will be incorporated into MPCA guidance and tools used by stormwater practitioners to calculate pollutant loading and reductions in loading associated with BMPs.

Simultaneous removal of phosphate and nitrate from urban runoff using mixtures of taconite byproduct and wood-waste-derived biochar

Tadele Haile, Bridget Ulrich, Natural Resources Research Institute, University of Minnesota Duluth;
Karina Wellborg, Joe Magner, University of Minnesota

Biofiltration systems that utilize adsorptive filter media have the potential to remove multiple biological and chemical contaminants from urban stormwater. Utilization of filter media derived from waste material is a particularly attractive cost-effective approach. This study evaluated the efficiency of Minnesota-sourced iron ore mining byproduct (taconite tailings e.g., siderite and hematite) and waste-wood-derived biochar as biofiltration media for simultaneous removal of phosphate and nitrate from stormwater. Columns amended with biochar or taconite tailings were intermittently dosed with synthetic stormwater containing dissolved organic matter, and contaminant removal performance was evaluated relative to unamended sand columns. Enhanced phosphorous removal was observed for filter media mixtures containing siderite or hematite and observed phosphate breakthrough times for relatively high concentrations (5 mg/L) suggest that phosphate removal capacity could potentially be maintained for over a decade under typical phosphorous loadings. Furthermore, media mixtures containing siderite better maintained high filtration rates over time relative to biochar or hematite, attributed to its angular grain shape and particle size. Improved treatment of nitrate relative to other configurations was achieved by the siderite/biochar and hematite/biochar mixtures, though highly variable removal (likely due to fluctuating temperatures) resulted in mean removal rates of 51.7% and 37.5%, respectively. This suggests that while temperature fluctuations can negatively impact nitrate removal, biochar can provide performance benefits in terms of water holding capacity and resiliency to intermittent saturation. Our findings suggest that taconite tailings can be used as an alternative for iron-enhanced media for the effective removal of phosphorous, and that wood-derived biochar may improve resiliency of nitrate removal under unsaturated intermittent flow conditions.

Wednesday October 19, 2022

Concurrent Session V, Track B
Groundwater and Drinking Water

Understanding Motivations for and Barriers to Well Water Testing

Amelia Kreiter, Mae Davenport, Crystal Ng, Scott Alexander, Amit Pradhananga, University of Minnesota; *Jeff Broberg*, Minnesota Well Owners Organization

How do private well owners view their own drinking water in agricultural landscapes? What drives and constrains well-water testing? In Minnesota, 75% of residents, or more than 4 million people, rely on groundwater for their drinking water and 25% rely on private wells. In this project, we aim to understand risk perceptions and motivations for well-water testing in two high risk areas: Pineland Sands and Karst agro-eco regions of Minnesota. Groundwater management strategies in these areas have emphasized source water protection, but problems with nitrate and pesticide contamination persist. Some private well owners have been resistant to testing, and testing program leaders have suggested that they may not have a clear understanding of the risks or may even distrust the water testing process. Recent monitoring efforts indicate that up to one-third of Minnesota households routinely drink contaminated well water in high risk areas. A mail survey of 800 private well owners reveals varied perceptions of drinking water and offers insights into existing physical and psychological constraints to testing. This interdisciplinary research integrates climate, social, and water sciences to develop a practical communication toolbox to empower private well-owners to take action to protect their households.

Wednesday October 19, 2022

Finally, Financial Assistance for Private Well Testing and Treatment: The Experience of Two Pilot Grants

Emily Berquist, Minnesota Department of Health; *Caitlin Brady*, Olmsted Soil and Water Conservation District; *Jessica Peterson*, Horizon Public Health

A safe and reliable source of drinking water is an essential condition for healthy communities. About 1.2 million Minnesotans get their drinking water from a private well. Unlike people who get their water from a public water system, private well users (PWU) are responsible for ensuring their water is safe to drink by regularly testing and treating the water and maintaining their well. Arsenic, nitrate, manganese, coliform bacteria, and lead are common contaminants in private well water and can lead to short- and long-term health effects. A 2016 survey of Minnesota PWU found that less than 20% of PWUs regularly test their water; 34% did not take action to reduce exposure to elevated arsenic; and 15% cited cost as a barrier to treatment. To help protect the health of PWU, Horizon Public Health (HPH) and Olmsted County Soil and Water Conservation District (Olmsted SWCD) developed new partnerships with county organizations, SWCDs, and the private sector to establish local programs to promote well testing and provide financial assistance to reduce contamination. This presentation will share these grant-funded-programs' results, promising practices, and lessons learned.

HPH's program focused on counties where over 25% of private wells have arsenic detections above 10 ppb (the amount allowed in public drinking water): Grant (38%), Stevens (30%), and Traverse (27%). Olmsted SWCD's program focused on six southeastern counties with elevated nitrate concentrations and active karst geology. Each program featured innovative approaches, such as media campaigns, well screening clinics, and distributing well test kits through local early-childhood, Veteran, and social services programs and provided financial assistance for water treatment, well repair, or well construction. These programs can serve as a framework for local and statewide private well testing and treatment programs to serve the 1.2 million Minnesotans who get their drinking water from a private well.

Wednesday October 19, 2022

High Nitrate! Part 2: The City of Fairmont's Implemented Projects to Contribute to the Solution
Becca Vermace, Brendan Dougherty, Michelle Stockness, Kurt Leuthold, Barr Engineering Co.;
Troy Nemmers, Tyler Cowing, City of Fairmont; *Kerry Holmberg, Joe Magner*, University of Minnesota

Over the last three years, the city has collaborated with multiple stakeholders to share data, develop long term strategies, and secure grant funding for water quality improvements and fish habitat creation within the Dutch Creek watershed. Collaborating agencies include Martin Co. SWD, MPCA, MDH, MDA, and the University of Minnesota. Dutch Creek drains 9,000 acres of agricultural land west of Fairmont in SW Minnesota. The creek is one of the largest tributaries to the city's chain of lakes, which is the public drinking water source, and nitrate levels have been increasing. In 2019 the city was awarded a grant to design and install a bioreactor to remove nitrates from cold spring runoff. Nitrate levels are typically high in the Spring, and bioreactors generally are less effective when the runoff is cold. The bioreactor design includes a greenhouse to passively heat the runoff before flowing through the bioreactor. A second grant was awarded to create northern pike spawning habitat. Northern pike prey on young carp and can effectively control carp numbers, a fish notorious for degrading water quality. Both projects were substantially complete in 2021, and final completion is scheduled for June 2022.

This presentation will update attendees on initial monitoring and operational data. The bioreactor was designed with monitoring in mind and has several features that allow for adjustments to water levels and flow rates. Temperature probes have been installed to determine if the innovative passive heating is effective. Samples are being taken upstream and downstream of the bioreactor to measure nitrate concentrations and determine bioreactor effectiveness. If the passively heated bioreactor design proves to be effective, the design can be scaled up and installed throughout the watershed. Observations of the fish species and fish activity within the created wetland will also be discussed. The goal of both projects is to provide safe drinking water and improve water quality.

Wednesday October 19, 2022

Groundwater Governance in the Great Lakes Region

Carrie Jennings, Eileen Kirby, Freshwater; *Terin Mayer,* University of Minnesota

Water is life, and though hidden, groundwater plays an increasingly important role in sustaining communities and ecosystems, particularly in a changing climate. In this engagement-centered foundational research, we describe the current status of groundwater governance and threats to groundwater in Environmental Protection Agency Region 5, encompassing six Great Lakes states and 35 federally recognized tribes with trust lands that share the geography. Informed by extensive interviews with state, federal, and tribal agencies involved in groundwater management in addition to document review, we examine the hydrogeological setting of the region, including what types of data exist and where, who is producing it, and if and how it is communicated. We develop a relational network database describing the connections and interactions of actors, policy institutions, and policy outcomes in the region, looking not only at state and tribal agencies that have formal roles in groundwater regulation, but also at the various local and regional governments that exist in the groundwater and adjacent policy domains. We provide a delineation of authority and responsibility to regulate, assign property rights, assess penalties, give payments, and recruit into voluntary programs. We also enumerate the types of intergovernmental interactions that exist, with particular attention to the unique challenges faced by Native Nations in protecting and governing water which often crosses jurisdictional boundaries, and identify where gaps and missing links in groundwater policy processes exist. Governance structures vary widely across the region, as does the quality and density of monitoring data. The project will conclude in October 2022 following a relationship-building convening of people involved in groundwater governance intended to generate more collaborative and informed governance processes.

Wednesday October 19, 2022

Concurrent Session V, Track C
Miscellaneous

Identifying Incremental Changes to Reservoir Operations to Reduce Flooding Impacts on Agricultural Lands in a Heavily Regulated System
Brett Hultgren, U.S. Army Corps of Engineers

Straddling the boundary between Canada and North Dakota, the Souris River reservoir system serves as an important water supply source while also providing flood protection for downstream communities and landowners. Due to its unique hydrology, geomorphology, and economic setting, priorities of those living and working in the basin vary significantly depending on their location along the river. To assess the pros and cons of various operating alternatives in the International Joint Commission's Souris River Plan of Study, the study team developed a robust reservoir model along with a suite of performance indicators related to water supply, flood control, and agricultural, environmental, and cultural impacts. While the reservoir system is very physically constrained, strong relationships with landowners throughout the basin along with sophisticated statistical analyses and data visualization techniques allowed the study team to identify areas of the operating plan that could be modified to better serve agricultural producers along the river while still meeting the overarching water supply and flood control goals of the reservoir system. Sharing the techniques and challenges of not only analytically evaluating alternatives but also communicating the results of a complex reservoir model to those living and working in the basin will help future studies analyze alternatives and achieve buy-in from stakeholders.

Sediment source delineation for the Little Fork River Basin using sediment fingerprinting and sediment budgeting techniques
Anna Baker, Faith Fitzpatrick, Shelby Stearner, U.S. Geological Survey; *Mike Kennedy, Jesse Anderson, Kevin Stroom*, Minnesota Pollution Control Agency; *Sam Soderman*, Koochiching County SWCD; *Phil Norvitch*, North St. Louis Soil and Water Conservation District; *Andy Kasun, Karen Gran*, University of Minnesota Duluth

Excess sediment is a leading cause of habitat degradation in our rivers and streams. Sediment can also serve as a vector for phosphorus which may in turn play a role in driving harmful algal blooms in downstream waters. The Little Fork River in northern Minnesota is a disproportionate source of sediment to the Rainy-Lake of the Woods Basin and has been a focal point for monitoring and management by the Minnesota Pollution Control Agency (MPCA) over the past decade. To address excess sediment and associated phosphorus in the Little Fork, the MPCA identified a need for improved understanding of the sources of sediment and sediment bound phosphorus to the basin. To address this question, the U.S. Geological Survey is working in collaboration with MPCA, Koochiching Soil and Water Conservation District, and North St. Louis Soil and Water Conservation District to delineate sources of sediment and sediment bound phosphorus for the Little Fork Watershed using geochemical sediment fingerprinting and sediment budgeting and techniques. In 2021, sediment samples were collected to support geochemical fingerprinting and rapid geomorphic assessments were conducted to support sediment budget development. The sediment samples represent potential sources including upland sources such as mature and recently harvested forests, agricultural fields, wetlands, and roadways, and near-channel sources such as streambanks, eroding valley sides, and ravines. In this presentation we will detail the sediment fingerprinting methods being implemented, the preliminary findings of our sediment budget, and progress toward delineation of the sources of fluvial suspended sediment for the Little Fork.

Wednesday October 19, 2022

Sustainable nutrient removal by immobilized cell bioreactor performing denitrifying anaerobic methane oxidation coupled with ammonia oxidation

Susma Bhattarai Gautam, Chan Lan Chun, Christopher Filstrup, Natural Resources Research Institute

Exploration of novel and economic ways to remove excess nutrients from wastewater and agriculture runoff is required to achieve sustainable nutrient management. This work aims to investigate a novel process of denitrification coupled with anaerobic methane oxidation (N-DAMO) in combination with annamox processes for development of a stable and cost-effective nitrogen removing technology. Given the slow growth rates of microbial consortia involved in the process and low solubility of methane in water, an immobilized cell bioreactor was used to carry out the process. A mixture of zeolite and siderite-rich minerals was selected as a biocarrier based on their porous surface and high sorption affinity of ammonia and nitrate. Initially, batch bioreactors with the biocarrier were inoculated with methane-enriched cultures of biomass from anaerobic digestors, thickened activated sludge, and wetland sediments. The bioreactors were fed with methane as the sole carbon sources and incubated at 30oC with controls (no culture and blank without biocarrier). Microbial activities were monitored over 200 days by measuring nitrogen species. Bioreactors with biomass from the anaerobic digestor and activated sludge showed denitrification and ammonia removal with 150-200 µM nitrate /day and 50-100 µM ammonia /day respectively after a 40-day lag time with methane as a sole carbon source. To confirm active anaerobic methanotrophs, denitrifiers, and anaerobic ammonia oxidation, microbial community analysis and quantification of their associated functional genes are in progress. Further investigation and upscaling of this novel process for engineered treatment systems will be a promising solution to inexpensively remove nitrogen from waste streams (e.g., landfill leachate, municipal and agricultural wastewater).

Precipitation and Landforms as the Main Drivers of Baseflow in the Upper Midwest

Satish Gupta, University of Minnesota; *Kari Wolf*, University of Wisconsin River Falls; *Andrew Kessler*, Houston Engineering

Baseflow depends upon water infiltration and subsequent redistribution within the soil profile. Factors controlling infiltration and redistribution are the landforms; surface and subsurface topography, soil type and sub-surface geology. In this study, we used daily streamflow data from 22 Iowa and 3 Minnesota rivers covering six landforms with varying tile drainage to characterize climate, landform, and tile drainage effects on several flow metrics. The flow metrics were streamflow, baseflow, baseflow ratio, area normalized discharge exceedance probabilities and recession variables. Considering climate variability and thus water availability at the soil surface, both streamflow and baseflow varied exponentially with annual precipitation. Baseflow and baseflow ratios were lower in rolling to steeper landform watersheds such as in Iowa Southern Drift Plain than watersheds in low relief Des Moines Lobe. This suggests that more water was infiltrating through depressions in Des Moines Lobe watersheds compared to more surface runoff from rolling to steep Drift Plain watersheds. Baseflow ratios were nearly similar from early 1940s to early 2010s for the Des Moines Lobe landscape even though tile drainage has increased substantially; further suggesting that the landform features and not the increased tile drainage is controlling baseflow through the Upper Midwest landscapes. Variations in flow duration curves over several decades were similar between the non-tiled and tiled watersheds thus suggesting that the variations are a reflection of varying climate and not an effect of tiled drainage. The presentation further discusses the differences in recession variables in the context of infiltration and percolation between different landforms.

Wednesday October 19, 2022

Concurrent Session V, Track D

Special Session: Climate Change, Agricultural Drainage and Water Storage in Minnesota

Joe Magner, Gary Sands, University of Minnesota; *Nadia Alsadi*, MCEA; *Rita Weaver*, BWSR; *Chuck Brandel*, ISG; *John Kolb*, Rieke Noonan

In Minnesota – USA, drainage activity is governed by Minnesota (MN) Statue 103E. There are many facets addressed in the law, but one that is raising concern for a variety of folks today is the issue of "adequate outlet". For old drainage systems installed decades ago, no one really asked the question more than a half-century ago because aquatic life and water quality were less of a concern compared to today's concern based on data gathered mostly by the MN Pollution Control Agency (MPCA).

Given a relatively young glacial landscape, southern MN has been drained via ditches and subsurface pipe which have increased the watershed contributing drainage area. Sediment and nutrients have been transferred downstream impacting the environmental and ecological integrity of streams and rivers. The MPCA defines this aquatic stress as "altered drainage" in their Watershed Restoration and Protection Strategy plans. Plans have been written to restore the water quality of many MN streams and rivers by calling for more water storage.

This creates a problem for landowners who have noted an increase in precipitation over the last and wettest decade in MN history. Many landowners see a need to improve drainage to keep their cropland viable. Older drainage systems require maintenance over time, but many systems are undersized today and require more than maintenance but improvements. Under MN Statue 103E, an improvement requires a set of legal actions by a petitioner to implement the drainage improvement, including – is there and adequate outlet that will not cause downstream damage. Given a wetter climate, can Minnesotan's find solutions to store excess water and manage cropland that requires drainage to be viable?

Wednesday October 19, 2022

Concurrent Session VI, Track A
Bank Stabilization and Stream Restoration

St. Croix River Riverbank Stabilization and Riverwalk Project
Angly Ulschmid, AMI Consulting Engineers, PA; *Shawn Sanders*, City of Stillwater Public Works

The project is located along the Saint Croix National Scenic Riverway, in Washington County, Minnesota. The City of Stillwater project includes the stabilization and restoration of approximately 3700 linear feet of eroded riverbanks along the western shoreline of the St. Croix River. Incorporated within the shoreline, a new Riverwalk will serve as key connection section to the exiting St. Croix Valley trail system. AMI Consulting Engineers and the City of Stillwater worked with multiple stakeholders including federal, state, and local agencies. Strict environmental and regulatory compliance was required, two areas of environmental sensitivity were defined to preserve and protect important and unique cultural and natural resources within the project boundaries, including threatened and endangered species discovered during the environmental review process. Design modifications were made to avoid impact to the multiple species, and to include conservation measures and create special habitat features beneficial to the aquatic and terrestrial species, one of them found for the first time since the listing, making it a marvelous discovery of great environmental significance.

The project is currently under construction, estimated completion summer 2022. Along with the stabilization of the shoreline, improved public safety and connectivity to the Stillwater historical district; the implementation of traditional and green infrastructure features will provide water quality improvements; a comprehensive stormwater management plan and stormwater pollution prevention plan was developed in adherence to the Lower St. Croix Watershed district rules, authorization was granted by the U.S. Army Corps of Engineers under the Clean Water Act and MN Department of Natural Resources among other agencies.

Phosphorus Load Reduction Using Streambank Stabilization - A Ten Year Follow Up
Amy Anderson, WSB
In 2010 the City of Princeton, Minnesota entered into a phosphorus reduction agreement as a condition of a permitted expansion to the municipal wastewater treatment facility. The City agreed to stabilize five eroding streambank sites with a goal of reducing phosphorus loading to the Rum River by 10,000 pounds annually. Phosphorus trading was a cost-effective alternative to point-source reductions of phosphorus that also addressed water quality on the Rum River which is listed as impaired for phosphorus. Stabilization treatments included engineered log jams, tree revetments, bank grading, and installation of native seeding and live stakes. This project is only the third point/non-point trading project approved within the state of Minnesota by the Minnesota Pollution Control Agency (MPCA). Construction for the project began in 2012 and was completed in 2015.

Ten years after the phosphorus reduction agreement was finalized and five years after the final project was accepted by regulatory agencies, the City of Princeton now monitors the five stabilization sites on a monthly basis during the growing season and submits an annual report to the MPCA on the condition of the sites as part of its wastewater permitting activities. City staff and WSB staff have partnered to improve stabilization and maintenance activities in order to maintain bank stability while decreasing costs to the City budget. Project team members will present on details of specific stabilization activities used, permitting and regulatory requirements, and lessons learned during maintenance and inspection activities.

Wednesday October 19, 2022

Norway Lake Dam Removal & Rock Riffle Installation Project, City of Pine River, Cass County, MN
Brent Johnson, Jammi Ladwig, Dustin deFelice, Bryan Drown, Andrew Beadell, Bolton & Menk, Inc.

The Norway Lake Dam was removed and replaced with a rock-arch rapids in 2022 by the City of Pine River. Removal of the dam and construction of the rapids restored fish passage and connectivity between the Pine River and the Whitefish Chain of Lakes and reconnected 134 lakes and 80 miles of river and stream corridors benefitting fish, mussels and many game and non-game animal species. Replacing the high hazard dam with a rock riffle improved safety. The riffle pools and meandering low flow channel also enhance aesthetics, public access and recreational opportunities for fishing and paddling.

A historic resource, the Pine River Swimming Area, was previously determined eligible for listing in the National Register of Historic Places (NRHP) and is located adjacent to the project area. Despite project designer's best efforts, it was not possible to meet a no adverse effect determination to the historic resource while still meeting the needs of the project. A Memorandum of Agreement (MOA) was developed between the lead Federal agency (US Army Corps of Engineers) and the State Historic Preservation Office (SHPO) which outlined mitigation measures for the adverse effect the project would have upon the resource. An interpretive sign will be installed near the Pine River Swimming Area by June 30, 2022, to fully satisfy the mitigation stipulations in the MOA.

The presentation will outline the project goals and achievements and will describe aspects of the planning, funding, engineering, environmental and cultural review, and construction.

Use of sand budgeting and transport modeling to infer historical geomorphic impacts in the Little Fork River Basin, MN
Andy Kasun, Karen Gran, University Minnesota Duluth

Anthropogenic disturbances from logging or agriculture can increase runoff and sediment delivery to streams. A geomorphic sediment budget can quantify sediment loading, yet budgets rarely incorporate coarse sediment (sand) due to complexities related to sediment delivery and transport times. These complexities, however, may be utilized to understand longer timescale geomorphic impacts from past land use change. The Little Fork River in northern Minnesota was logged historically and has been identified as a significant contributor of sediment to the Rainy-Lake of the Woods Basin. The Minnesota Pollution Control Agency recently set turbidity targets and need information on sediment sources across the basin. This project seeks to augment a fine sediment budget being conducted by U.S. Geological Survey (USGS) (Baker, A., et al.) for the Little Fork by adding a sand component, defining sand sources and estimating transport times. The USGS-led team conducted a field-based erosion inventory that included rapid geomorphic assessments (RGAs) and sediment sampling of source areas for elemental fingerprinting and grain size analyses. In addition to USGS efforts, sand-targeted sampling was completed for ravines, floodplains and road crossings, and grain size distributions measured to characterize sand inputs and/or storage across the basin. Remote analyses of lidar topography, land cover, and geology are being used to extrapolate erosion rates to determine basin-wide sediment contributions. Sediment data are being combined with stream reach characteristics to feed a sand transport model. Initial findings indicate erosion in the riparian corridor is most correlated to high slopes near the channel, with main-stem bank erosion correlated with valley geometry. Sand is likely sourced from the stream corridor, with sand storage composing roughly a third of floodplain deposition in the lower reaches. Additional results, including transport modeling, will conclude by August 2022.

Wednesday October 19, 2022

Concurrent Session VI, Track B
City Planning and Visionary Planning

Cumberland, WI – The Little Town With A Big Vision
Jay Michels, Derek Lash, EOR, INC; *Tom Schroeder*, Beaver Dam Lake Management District

In 2010 the City of Cumberland, in partnership with the Beaver Dam Lake Management District, set out to implement an ambitious Lake Management Plan that aimed to clean up the priceless recreational amenity of Beaver Dam Lake and re-orient the historic downtown district to Library Lake which has suffered major environmental degradation over the last 50+ years. This effort has produced significant results to date including the reduction of tons of sediment and lbs. of phosphorus to Beaver Dam Lake and Library Lake each year, as well as improvements in open space and habitat around each lake. This presentation will tell the story of our 10 year, ongoing, effort that links science and engineering with enthusiastic community support to create a success story for other small communities to study and emulate.

Understanding Diverse Water Values in the Twin Cities, Minnesota
Sarah Roth, Mae Davenport, Bonnie Keeler, University of Minnesota; *John Clark, Jennifer Kostrzewski*, Metropolitan Council
The Twin Cities Metropolitan Planning Region consists of 7 counties comprised of 187 communities, with over 100 public drinking water suppliers, 33 watershed management organizations, and 1 regional wastewater operator. This complex network of water managers, service providers, and state regulators are responsible for ensuring public health, water safety, and water sustainability. Although these groups represent a wide range of local, regional and state viewpoints, community perspectives can be missing from decision-making conversations.

When policymakers, water professionals, and community members are better informed about the cultural values or water and the value tradeoffs of water decisions, decisions become more transparent, decision makers are more accountable, and outcomes are more socially just.

The University of Minnesota (UMN) along with state and regional partners has conducted a series of surveys with Twin Cities residents to assess water values and perceptions of water problems across geographic and social variables of difference such as age, gender, cultural identity, and community attachment. Additionally, surveys inquired about residents' beliefs about water and water systems, attitudes towards water management, and water-related behaviors. Following the survey efforts, UMN and Metropolitan Council staff hosted virtual focus groups with water decision makers and professionals to reflect on and interpret survey findings and to prioritize action steps for community-centered water planning and policy. Survey findings revealed important differences among social and cultural variables in water values, beliefs, and actions. Focus group participants identified opportunity areas for applying survey findings and conducting further social science research. This study offers strategies for community-centered science, regional water planning and policy, and local water management.

Wednesday October 19, 2022

Consensus Building for a Mega-Project - the Gold Line Bus Rapid Transit
Jacques DuVal, David Filipiak, SRF Consulting Group, Inc.

The Gold Line Bus Rapid Transit (GBRT) Project will provide Bus Rapid Transit service from downtown Saint Paul to the Woodlane Drive Station Park-And-Ride facility in Woodbury. The Project corridor will consist of 7.0 miles of dedicated guideway and 3.2 miles of mixed traffic roadways primarily following the TH 94 and Bielenberg Drive corridors through the cities of Saint Paul, Maplewood, Landfall, Oakdale, and Woodbury. In addition, the Project will construct or reconstruct impacted roadways, station areas, pedestrian and bicycle access ways, and park-and-ride facilities, resulting in an estimated 92 acres of new and reconstructed impervious surface. These impacts trigger requirements of several regulatory agencies relating to water quality treatment, stormwater discharge rate control and floodplain management.

The Stormwater Management Plan for the Project corridor includes 35 BMPs, approximately 31 structural pollution control devices, over 1,200 drainage structures and more than 13 miles of storm sewer pipes. The 35 BMPs provide over 10 acre-feet of water quality volume.

The planning process for stormwater management spanned a three-year period involving coordination with staff from the various stakeholders, including the 5 municipalities, 2 Watershed Districts, and MnDOT. The process included monthly Stormwater Issues Resolution Team meetings, review of applicable BMPs via the Project's BMP Toolbox, and a survey of the various stakeholders of BMP preferences including maintenance, to develop the ultimate stormwater management plan. This presentation will focus on some of the processes the project used to build consensus with all the various stakeholders and how the team overcame a few of the design the challenges to meet project and stakeholder goals and regulatory requirements.

Groundwater Protection and Conservation: Experiences and Results at the Local Government Level
Kelly Perrine, Mark Kruse, City of Lakeville*; Travis Thiel*, Vermillion River Watershed Joint Powers Organization

Severe drought conditions like those experienced in 2021 demonstrated to our water-centric State that groundwater needs to be protected and conserved on a broader scale. A drought shouldn't be the only reason why protecting or conserving groundwater resources is considered. Many of the tools and activities used to address groundwater protection and conservation aren't well-known or well-established; funding for water quantity projects and programs is very limited; and existing policies can be confusing, are contentious, are difficult to enforce, or they simply don't exist yet in Minnesota. The City of Lakeville and Vermillion River Watershed have been working to implement activities to address this need at a local level. Activities include stormwater reuse and irrigation on public and private lands, irrigation system audits and improvements, soil amendments and decompaction at City Parks, and planting seed varieties that require less water than common turfgrass varieties. Staff will present results and data from our activities, lessons learned, and how these lessons are guiding our organizations with new programs and policies.

Wednesday October 19, 2022

Concurrent Session VI, Track C
Agriculture and Water

Using climate data to improve nitrogen fertilizer decisions
Brad Carlson, University of Minnesota Extension; *Dan Kaiser, Stefan Liess*, University of Minnesota

Best Management Practices (BMPs) for nitrogen (N) fertilizer were first adopted in Minnesota in the mid-1990's. It is important to realize that BMPs are not requirements, but recommendations that require the user to understand the "default" conditions on which they are based, and under what circumstances deviation is warranted. Changes in climate factors such as precipitation, season length, and soil temperature are increasingly challenging University of Minnesota Extension staff to clarify their recommendations from one year to the next. A wide range of climate data and trends over the last 30 years were examined and compared to climatic conditions when N fertilizer BMPs were first adopted. This information is being used to discuss N management with farmers so they can make decisions that benefit both the environment and their bottom line. Some of this information will eventually be used for a revision to Minnesota's N BMPs.

Improved Cost Estimates for Agricultural Conservation Practices
Mark Deutschman, International Water Institute

The cost to achieve water quality goals is an essential piece of information necessary for assessing whether the expected societal benefits are worthy of investment. Within the United States, taxes generate the "public money" to pay to improve water quality. State and Federal Agencies distribute the public's money to local governments and landowners as grants and cost-share to implement agricultural conservation practices ("practices"). Comparing the cost to improve water quality and the anticipated public benefit helps inform the investment decision.

The lack of a robust method for estimating the cost of practices and developing a Water Quality Strategy hampers the ability to compare cost and benefits. Within Minnesota and North Dakota, Water Quality Practitioners commonly use the Prioritize, Target, Measure Application (PTMApp) to develop strategies to improve water quality. PTMApp utilizes the Environmental Quality Incentives Program payment as a surrogate to estimate practice cost. The Environmental Quality Incentives Program payment is a percentage of the estimated cost to implement a typical practice scenario, excluding the labor to plan, design and permit the practice; inspect the practice during construction; operate and maintain the practice; finance costs; and in most cases forgone income.

We addressed the need for estimates of practice cost by developing Useful Life Total Costs (UTLCs) for 23 practices. Useful Life Total Costs incurred throughout the practice life cycle begin with planning and end with reconstruction to maintain proper function. We developed multiple ULTCs (year 2020) for each practice by bracketing the range of design variations and sizes. Legacy PTMApp costs ranged from 1% to 55% of the Useful Life Total Cost, confirming underestimation of the actual practice costs.

Cost functions developed by selecting the best-fit line between the ULTCs and a predominant practice physical characteristic are useful for developing Water Quality Strategies. The cost functions, recently incorporated into PTMApp, considerably improve the ability to estimate the actual cost to achieve water quality goals and societal benefits.

Wednesday October 19, 2022

Quantification of Water Storage Benefits at Various Levels of Cover Crop Applications
Salam Murtada, Daniel Reinartz, Steve Kloiber, Minnesota Department of Natural Resources

Climate change and land-use alterations have significantly altered Minnesota's watershed hydrology, increasing the urgency to explore water storage options to address flooding, damage to infrastructure and agriculture, water quality degradation, erosion and natural system stability. This presentation examines the benefits of soil health improvement through perennial cover crop application as a viable option for providing water storage; and reducing peak flow, discharge volume, and sediment loading.

Recent studies have shown that extensive cover crop application, through computer simulation, reduced peak flow and discharge volume by up to 30% and 40%, respectively, particularly during the non- and early growing season, when the ground was otherwise fallow.

The MNDNR simulated extensive adoption of this practice throughout the cultivated crop areas, comprising up to 70% of the total watershed for the following watersheds: North Branch Whitewater River (Olmsted, Wabasha, and Winona), Gorman Creek (Wabasha), Dobbins Creek (Mower), Shakopee Creek (Chippewa, Kandiyohi, Swift), and Huse Creek (Kandiyohi).

For this multi-watershed study, a physically-based distributive hydrologic model simulated gradual perennial crop application, in increments of 10%-20%, to develop a watershed-specific correlation between the level of application and water storage benefits. Cover crops were varied systematically and gradually using the land capability classification and productivity index to guide the spatial application using GIS. Results show that benefits of cover crop application are realized early in the process.

The performance curves showing the relationship between cover crop application and storage benefits can be used as an initial planning tool to project these benefits based on the level of soil health improvements.

Wednesday October 19, 2022

Ravine Erosion in the Minnesota River Watershed: Permanent Sediment Traps to Improve Highway Safety and Reduce Maintenance

Stephanie Rathburn, Sarah Barnett, Alliant Engineering; *Nathan Pederson*, Minnesota Department of Transportation

The Minnesota River watershed is dotted with narrow ravines that empty out onto the River's floodplain. The transition from steep, narrow ravines to flat, wide floodplain creates alluvial fan conditions at the ravine outlets. Many of these ravines experience gully erosion from erosive, high velocity flow, which is deposited onto the floodplain when the water slows down and spreads out. In locations far from homes, roads, or other infrastructure, the natural sedimentation process can generally be left alone. However, when this process occurs adjacent to infrastructure, the sedimentation can be a safety hazard or create costly and time-consuming maintenance for public agencies.

Outside of Morton, MN along Trunk Highway 19, a small ravine experiencing large amounts of gully erosion emptied into the ditch between the highway and the Minnesota Prairie Line Railroad. The sediment deposition from the ravine regularly filled in the entire ditch, covered the tracks, and plugged the culvert beneath the highway. Alliant worked with MnDOT District 8 to develop a permanent solution to improve the safety of the highway and the railroad, as well as simplify the maintenance of sediment removal. The Alliant / MnDOT team worked closely with the project stakeholders and adjacent property owners, from concept development through construction. This presentation will provide an overview of this successful project.

Wednesday October 19, 2022

Concurrent Session VI, Track D

Special Session: Climate Change, Agricultural Drainage and Water Storage in Minnesota

Joe Magner, Gary Sands, University of Minnesota; *Nadia Alsadi*, MCEA; *Rita Weaver*, BWSR; *Chuck Brandel*, ISG; *John Kolb*, Rieke Noonan

In Minnesota – USA, drainage activity is governed by Minnesota (MN) Statue 103E. There are many facets addressed in the law, but one that is raising concern for a variety of folks today is the issue of "adequate outlet". For old drainage systems installed decades ago, no one really asked the question more than a half-century ago because aquatic life and water quality were less of a concern compared to today's concern based on data gathered mostly by the MN Pollution Control Agency (MPCA).

Given a relatively young glacial landscape, southern MN has been drained via ditches and subsurface pipe which have increased the watershed contributing drainage area. Sediment and nutrients have been transferred downstream impacting the environmental and ecological integrity of streams and rivers. The MPCA defines this aquatic stress as "altered drainage" in their Watershed Restoration and Protection Strategy plans. Plans have been written to restore the water quality of many MN streams and rivers by calling for more water storage.

This creates a problem for landowners who have noted an increase in precipitation over the last and wettest decade in MN history. Many landowners see a need to improve drainage to keep their cropland viable. Older drainage systems require maintenance over time, but many systems are undersized today and require more than maintenance but improvements. Under MN Statue 103E, an improvement requires a set of legal actions by a petitioner to implement the drainage improvement, including – is there and adequate outlet that will not cause downstream damage. Given a wetter climate, can Minnesotan's find solutions to store excess water and manage cropland that requires drainage to be viable?

Wednesday October 19, 2022

Poster Presentations

Assessing the effects of agricultural management systems on soil architecture and soil moisture in southern Minnesota

Bailey Tangen, Anna Cates, Bill Lazarus, Gregg Johnson, Jeff Vetsch, Emily Krekelberg

Soil Health Management systems, with reduced physical disturbance, are touted to improve soil hydraulic functions. Here, we investigated the response of soil aggregates to rainfall under different agricultural management systems. Rainfall can cause physical slaking of aggregates, but it's not clear how quickly they may re-form, or whether pore connectivity and microbial activity promoted in soil health systems, can minimize breakdown. Mechanisms aside, this process is of avid interest to farmers in temperate regions, where soil health farmers often claim they can get into the field earlier after a rain due to improved soil structure. During 2020 and 2021, we worked with 3 on-farm pairs representing conventional and soil health systems in southern Minnesota and at Southern Research and Outreach Center in Waseca, MN on clay loams and silt loam soils. We monitored moisture content and soil aggregate distribution 24 hours before, 24 hours following and 3 days following several rain events. Long-term on-farm soil health systems had consistently more large aggregates, while aggregate distribution did not differ across replicated tillage and cover crop treatment plots at the Southern Research and Outreach Center. Response to rainfall varied across sites, but in some treatments, microaggregates and unaggregated particles were increased after rain compared to pre-rain samples. Further analysis will include potentially mineralizable carbon, permanganate oxidizable carbon, infiltration data, and pore distribution. Using these metrics, we hope to link soil health indicators to meaningful soil functions, finishing the analysis in Spring 2023.

Microplastic Transport in an Agricultural Watershed

Claire Simmerman, John Baker, Pam Rice

Microplastics (plastic particles < 5mm) are an emerging environmental threat to wildlife and human health. It is widely known that urban areas are large contributors to plastic pollution in the wild, but what is less known is the potential contributions from agricultural lands due to certain practices such as the use of plastic mulch and encapsulated pesticides. In this study, microplastics were analyzed in daily water samples using an automated ISCO sampler, and in monthly wet/dry deposition samples using a commercial deposition sampler in an agriculturally dominated watershed in Southeastern Minnesota. River outflow and atmospheric depositional loads of microplastic were calculated, and mass balance equations were used to model changes in storage of microplastics in the watershed over time. The results thus far reveal concerning loads of serious magnitude of microplastics are being transported in the water and local atmosphere of an agriculturally dominated watershed. Changes in storage over time show accumulation and export of microplastics with a seasonal influence.

Wednesday October 19, 2022

Advancing Cover Crop Adoption – Advice from the Field
Kimberly Musser, Anne Sawyer

Many conservation partners are working across the state to engage farmers and encourage soil health practice adoption. Currently, there is no resource available to help them understand what approaches have been successful in other parts of the state. By aggregating and sharing tips for advancing cover crop adoption, local partners will be able learn directly from peers about proven tactics.

The project goal is to aggregate advice from groups across the state who have successfully increased cover crop adoption in their region. Case study interviews will profile diverse, proven approaches with detailed, workable steps that can be taken to accelerate soil health practice adoption. Examples will include pooling multi-county resources for speaker tours, county soil health demonstration farms, self-guided tours, roadside interpretive signage, video profiles, and tips for supporting farmer-led networks. This advice will be summarized into short case studies and compiled into a booklet that will be available online. More detailed resources will also be included where available. This suite of diverse approaches to increase soil health practice adoption will be shared with other conservation partners, farmers and soil health leaders. The collective advice will be communicated broadly in order to improve information flow and share stories about successful approaches to increase cover crop and conservation tillage practice adoption. Research findings will be housed online in multiple locations including the emerging Watershed Engagement Programming (WEP) Hub.

Agricultural conservation practices and water quality: a perspective from the stream
Kade Flynn, John Baker, Brent Dalzell, Ryan Felton

The Conservation Reserve Program (CRP) offers incentives to take agricultural land out of production to help improve water quality. GIS-based toolkits like the Agricultural Conservation Planning Framework (ACPF) can support CRP efforts by targeting placement of conservation practices where they are most effective. To support wider adoption of these efforts, there is a need to measure the impact of CRP on water quality. These measurements are lacking, largely because it is difficult to take spatially resolved measurements of surface water quality in low-order agricultural streams.

In this study, we employ a novel sampling platform based on a light-weight kayak equipped with high-frequency sensors, an automated discrete sampling system, and a GPS unit to take spatially resolved measurements of surface water nitrate and phosphorus concentrations. In 2021, multiple sampling campaigns were performed in High Island Creek Watershed (HIC). Preliminary results indicate that the sampling platform identifies changes in stream water quality at a resolution sufficient to distinguish between subcatchment nutrient additions and inform on the role of wetlands at mediating in-stream nutrient concentrations. We have identified sections of HIC that contain adjacent subcatchments with contrasting amounts of CRP land. Ongoing field work will include these stream segments with the goal of determining whether field-based conservation practices can be linked to downstream trends in water quality. Additionally, we will complement watershed monitoring with ACPF-recommended practices to identify further opportunities for water quality improvement.

Wednesday October 19, 2022

Using Quorum Quenching Enzymes to Combat Aquatic Biofouling
Reed Jacobson

Aquatic biofouling is the attachment of unwanted organisms to a submerged surface. This causes many issues such as increased drag on vessels, biocorrosion, and the transmission of aquatic invasive species. Aquatic biofouling is largely dependent on bacterial communication in a process called quorum sensing, where the bacteria communicate with small molecules leading to biofilm formation. This creates a matrix for larger organism attachment and progresses the biofouling process. Current control methods often utilize toxic paint additives to prevent biofouling which can cause collateral damage to untargeted organisms and ecosystems. This project aims to incorporate enzymes that catalyze bacterial communication molecules into aquatic coatings and prevent bacterial communication in a process called quorum quenching. This will reduce bacterial biofilm buildup on the coatings leading to reduction in overall biofouling. The objectives of this project are to study the changes in overall biofouling and biomass accumulation with enzyme paint additive, observe changes in microbial community structure associated with enzyme paint additives, and search for potential links between shifts in microbial community structure and the attachment of larger fouling organisms. To accomplish these aims, small plastic sheets are painted with coatings of various additives and placed in diverse natural bodies of water for up to two years. The samples are then removed and the resulting biofouling is quantified via biomass attached, microbial community structure is assessed via DNA sequencing, and attached invertebrate organisms are identified and classified. Reduction in overall biofouling has been seen in submerged enzyme paint samples when compared to coatings without additives and coatings with added copper. The enzyme coating has also been shown to be effective in preventing the attachment of zebra mussels when compared to controls. The expected completion date of this project is 2023.

Effects of Soil Frost on Streamflow Generation Processes in Minnesota Headwater Catchments
Mariel Jones, Xue Feng

Across the Upper Midwest, the timing and magnitude of spring streamflow are changing due to decreases in snowfall and rapid spring warming caused by climate change. In the flat, peatland-dominated, headwater catchments of Minnesota, the complex flow paths within the watersheds help wetlands mediate the effects of climate change by creating storage components that control the flow of water through the watershed. In this project, we use extended hydrological records from the Marcell Experimental Forest near Grand Rapids, Minnesota, to analyze the feedback between precipitation, snow, water table elevation (WTE), and streamflow in a landscape with abundant peatlands. We use long-term trend analysis and statistical models to demonstrate the dynamic connectivity across different peatland landscapes. Results show that there have been decreases in both WTE and streamflow, caused by declines in spring recharge. By pulling out key water events during the transition between winter and spring (e.g. the date of snow disappearance or the date of the first streamflow peak), we demonstrate the flow path that precipitation takes from snowpack to water table to streamflow. Finally, using a statistical regression model we show that one storage mechanism, soil frost, is important in predicting the magnitude of total annual streamflow and likely influences the partitioning of precipitation and snowmelt into plant-available soil water and overland runoff. These findings demonstrate inherent complexity in headwater systems and show the need for increased study of the physical mechanisms of frost under long-term climate change scenarios.

Wednesday October 19, 2022

Field-scale performance evaluation of Minnesota-sourced biochar and iron-enhanced sand for comprehensive contaminant removal from parking lot runoff

Karina Weelborg, Tadele Haile, Udai Singh, Joe Magner, Bridget Ulrich

Urban stormwater carries a myriad of pollutants that can degrade the quality of receiving waters. Biofiltration systems are often used in stormwater treatment to prevent such degradation. Using different types of adsorptive filter media has the potential to remove multiple contaminants from runoff but finding the correct media materials for comprehensive removal of said contaminates is still a challenge. Waste-derived biochar is a cost-effective media with great potential due to its large surface area and microporous structure. This study investigates the performance of MN-sourced and produced, waste-wood derived biochar as a biofiltration media amendment for comprehensive contaminant removal in the field. Three demonstration-scale filters at MWMO contain sand, biochar-amended sand, or iron-enhanced sand (IES) media. Filters are under evaluation for suspended solid, nutrient, E. coli, trace organic, and trace metal removal. Data from the first field season, a conditioning phase, has been collected. The biochar-amended media showed the greatest moisture content followed by IES and sand media at 0.150, 0.058, and 0.056 g/g respectively. Porosity values were highest in the IES media followed by biochar-amended and sand media at 0.500, 0.461, and 0.439 respectively. Infiltration tests show the highest Ksat in IES media followed by biochar-amended and sand media at 55.85, 39.95, and 35.4 in/hr respectively. Preliminary water quality data suggests a combination of biochar and iron-containing materials will likely be necessary for comprehensive contaminant removal. For example, biochar-amended media showed enhanced nitrogen removal but reduced phosphorus removal relative to sand-only filters, while IES filters showed enhanced phosphorus removal but did not impact nitrogen removal. To further understand removal processes with mixed filter media, a mesocosm study will be conducted to evaluate simultaneous nutrient removal in combined biochar and iron-oxide material media.

Watershed Engagement Programming (WEP) Hub: Building a virtual toolbox for water resource practitioners

Anne Sawyer, Anne Nelson

Successful conservation-oriented outreach and education requires practitioners to navigate complex topics in both one-on-one and public settings. Local entities that work with private landowners to voluntarily adopt conservation practices have incredible technical expertise, but often lack support and funding for communications training or for dedicated outreach staff. Furthermore, the pressure to complete projects on the ground makes it challenging to prioritize outreach program development. Therefore, as part of an Extension Foundation Fellowship project, we are building an online Watershed Engagement Programming (WEP) Hub to support these outreach and education needs in Minnesota and beyond. The WEP Hub will be a one-stop-shop for program and planning resources, including a clearinghouse for topical materials. To inform our process, we had conversations, convened focus groups, held a virtual chat, and designed a needs assessment and resource-gathering survey in Qualtrics. The survey, conducted from February through April, 2022, used a “network” approach, with personalized emails sent to those we knew, and then to others recommended by them, and so on. In preliminary results, 100% of respondents indicated that a virtual hub and clearinghouse would likely improve the efficiency and success of outreach efforts. The most useful resources identified by participants included templates for outreach materials, educational information for local and elected officials, program planning and evaluation resources, and tools for audience analysis. Several respondents also shared materials for the clearinghouse. Our poster will describe the needs assessment process, the survey results, and give a sneak peek of the WEP Hub.

Wednesday October 19, 2022

Quantifying urban canopy benefits using low-cost sensing systems
Xiating Chen, Xue Feng, Faith Breeden, Diana Karwan, Mirae Guenther, Lucy Rose

Urban trees are widely valued for their aesthetics and their functional benefits (e.g. regulating temperature and hydrology), gaining prominence as a climate adaptation strategy across the US. However, largely due to the costliness, accessibility, and instrumentation complexity of long-term monitoring, we know little to quantify either the horizontal or the vertical extents of urban tree canopies' diverse benefits.

To understand how urban canopies function with respect to water, we proposed a paired natural experiment using a low-cost, Arduino-based sensing system. Through multi-year monitoring before and after the ash removal at a tree and plot-level, we want to gain insights into plant-soil-water dynamics, urban canopy's interception capacity, and the interaction between hydrological and climate processes. We will measure evapotranspiration rate (via lab-assembled Granier-type sap flux probes) and canopy interception in trees (via throughfall, the precipitation passes directly through a canopy), root-infiltration-runoff dynamics in soil (via soil moisture at multiple depths below and away from the canopy), and ambient air temperature and relative humidity.

Here, we will demonstrate our proposed experimental set-up, discuss the advantages and limitations of our urban tree sensing network, and present preliminary data from monitoring campus trees on University of Minnesota's Twin Cities campus and park trees in St Paul. We also discuss the importance of municipal partnership in urban hydrology research. We anticipate that the results from this study will quantify urban trees' ability to reduce stormwater runoff and to mitigate urban heat island effects, and inform multi-component regional natural resource planning by integrating urban forestry planning and water resources planning.

Throughfall Fluxes Below Urban Canopies
Faith Breeden, Xiating Chen, Mirae Guenther, Diana Karwan, Lucy Rose, Xue Feng

Due to the rapid growth of large and densely populated cities, urban municipalities are increasingly searching for green solutions to manage pollution. Expansion of urban tree cover has been popular among cities in an effort to mitigate air pollution and manage stormwater. While this growth of urban forests has had positive environmental impacts, little is known regarding the interactions between precipitation and canopy cover and tree canopy influence on nutrient fluxes. Previous studies have shown variability in atmospheric deposition between urban and forested areas, which has been attributed to wind direction and speed, as well as distance from pollution sources. In addition, throughfall composition has also been shown to differ by tree species as well as canopy structure. In order to address research gaps centered around the interactions between precipitation and urban canopies, we collected throughfall under multiple Fraxinus sp.(ash) trees after each rain event for one growing season and analyzed for nutrients to determine rates of wet deposition under tree canopies. We designed collections around trees as part of the Minneapolis-St. Paul Long Term Ecological Research Program (MSP LTER) with the goal of better understanding the role of urban forests on nutrient pathways to stormwater and surface water. This presentation will outline our collection strategies and present data results of throughfall water and nutrient fluxes.

Wednesday October 19, 2022

A Closer Look at Innovative Datasets Used to Evaluate Waters in the Metropolitan Council's Priority Waters List

Henry McCarthy, Emily Resseger, Erik Herberg

Description: In early 2022, the Metropolitan Council adopted a Priority Waters List. This new list builds on the Met Council's Priority Lakes List that was last updated in 2015. In addition to the inclusion of rivers and streams in this iteration of the list, new categories, datasets, and methods were used to evaluate the more than 950 lakes and hundreds of miles of rivers and streams in the region.

Waterbodies were scored in seven quantifiable categories: Drinking Water Protection, Recreation and Tourism, Healthy Habitat, Tranquil Connection, Equity, Industry and Utility, and Science and Education. A waterbody qualifies for the list if it is a drinking water source, has a high Recreation and Tourism Score, a high Healthy Habitat score, or a high "well-rounded" score, which is an average score of all seven categories.

Over 70 datasets were used (and in some cases developed) to score waterbodies in the seven quantifiable categories. Many of those datasets are publicly available regional or state datasets, including local, regional, and state parks; public water access sites; biological indicators; regional, state, and national monitoring locations; and drinking water management areas.

This poster will highlight three datasets used in the draft Priority Waters List to evaluate a waterbody's accessibility by public transportation, its regional visitation, and its proximity to historically disinvested or discriminated against communities. These datasets were used to calculate waterbody scores in the Recreation and Tourism and Equity categories. The use of these datasets contributes to a more holistic and inclusive evaluation of waterbodies in the region.

Wednesday October 19, 2022

Nitrogen Rates Effect on Nitrate Leaching and Nitrous Oxide and Ammonia Emissions in Southwestern Minnesota Corn Fields

Zachary Aanerud, Fabian Fernandes

Nitrogen (N) fertilizer is one of the most important inputs for crop production worldwide. Nitrogen fertilizer usage is also linked to major forms of contaminants to the environment including nitrate leaching, nitrous oxide, and ammonia emissions. While many nitrogen studies in the past have focused on the economic optimum N rate (EONR) for corn production, relatively few studies have focused on understanding the linkage between N rate and these contaminants. Of those relatively small number of studies devoted to linking N rate to environmental N losses, most are only focused on one contaminant at the time. Studies that evaluate crop response to N rate concomitantly with the various environmental N loss mechanisms are almost non-existent. Understanding the effect of N rate on both crop production and environmental impact at, above, and below the EONR is needed to truly come to understand the total cost-benefit of crop production and a healthy environment. The objective of this study was to evaluate the effect of N rate on corn grain yield and profitability, soil and plant N removal, N balance, and N losses [nitrate (NO_3^-), nitrous oxide (N_2O), and ammonia (NH_3)]. This field experiment was conducted at the University of Minnesota Southwest Research and Outreach Center in Lamberton, MN during the 2021 growing season. The EONR calculated at a nitrogen to corn price ratio of 0.1 ($0.80 per lb of N and $8 per bushel of corn) was only 79 lbs acre-1 and the grain yield at the EONR was only 100 bu acre-1. The 2021 growing season was unusually dry. The EONR and grain yield reflect that moisture, not N, was the limiting factor. Because of the drought there were only two flow events in the fall and both flow events produced minimal drainage. This limited the amount of data on nitrate in addition to nitrous oxide and ammonia measurements are currently being analyzed and will be presented. This study will be repeated over two additional growing seasons.

Stormwater Infiltration Siting for the City of Edina

Jessica Wilson, Martha Burket, Noah Gallagher, Owen Turner, Karina Anderson

The City of Edina is experiencing rapid redevelopment, and infiltration is a key strategy for managing the associated stormwater. There are many technical reasons (e.g. high water table, low hydraulic conductivity) why infiltration may fail. There are also other reasons (e.g. protection of drinking water sources, policies, environmental justice) why infiltration in some areas is not responsible. The goal of this project is to identify areas where stormwater infiltration is both responsible and technically feasible within the City of Edina. A GIS-based model developed by University of Minnesota researchers (Tecca et al. 2021) was implemented for the area. The original model from Tecca et al. used publicly available data from the MnTOPO elevation dataset and the Web Soil Survey. The Web Soil Survey data had insufficient information for portions of Edina, so local data supplied by the City of Edina was used as well. Several manuals, plans, and datasets were reviewed to determine where infiltration practices would not be responsible. These sources were developed by groups including the Minnesota Pollution Control Agency, the City of Edina, and the Metropolitan Council. Based on the results of the project thus far, it is possible to perform a citywide analysis of infiltration feasibility. However, this analysis must be tailored to a specific city because of the variability in data availability and local policies/plans. The process of performing the analysis, along with the results for the City of Edina, will be discussed.

Wednesday October 19, 2022

Contaminants of Emergent Concern Quantification and Movement in Septage applied to Crop Fields
Elizabeth Boor, Jack Distel, Sondra Larson, Sara Heger

This study will examine how Contaminants of Emerging Concern (CEC) in septage move through and interact with soil, groundwater, and plant tissue. Crop field conditions will be replicated in a soil column model and CEC will be quantified with triple quadrupole mass spectrometry. The results of this study will show how CEC from septic tank septage mobilize and break down in crop field application.

Making Progress One Courageous Conversation at a Time
Adrian Potter, Delaney Moberly

A few years before George Floyd was murdered, SRF created its DEI (Diversity, Equity, and Inclusion) Committee. The committee is devoted to ensuring SRF's workplace culture reflects our desire to minimize barriers, fosters a deeper understanding of each other, and promotes inclusive values. During the summer of 2020, SRF realized we also needed to provide a safe environment for staff to discuss challenging topics; and so the Courageous Conversation program began. Courageous Conversations are hour-long, companywide discussions focusing on important, relevant topics, using videos, articles, or other resources as starting points for dialogue. Prompted by George Floyd's death and the anguish and unrest that followed, this program sparked discussions of topics within our industry that were built on a history of systemic injustice. Adrian and Delaney will share how SRF utilizes these Courageous Conversations to form a foundation of awareness amongst employees and the positive impact these discussions have had on our company.

The Mississippi River Green Team: Impacts of an environmental workforce program
Michaela Neu, Gretchen Engstrom

The Mississippi River Green Team, created in 2008 by the Minneapolis Park and Recreation Board and the Mississippi Watershed Management Organization, is an employment and conservation program for teens from North and Northeast Minneapolis. Program goals include diversifying the environmental workforce, inspiring environmental stewards, and improving community capacity for environmental protection. The program provides an opportunity for participants to have a mentored job experience, learn about environmental careers and acquire new skills. As part of their two-year, year-round commitment, participants work to complete projects like removing invasive weeds, installing raingardens, and planting trees and prairie plants. Participants also receive professional development trainings and after completing the program, are connected to an alumni network that offers support in pursuing internships, educational programs and career goals. Survey results have illustrated that this program has influenced participants overall environmental knowledge and behavior, and in some cases, results in environmentally-focused career choices.