Advancing Safe and Sustainable Water Reuse in Minnesota

2018 REPORT OF THE INTERAGENCY WORKGROUP ON WATER REUSE

MINNESOTA

Water Resources Center
UNIVERSITY OF MINNESOTA
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CLEAN WATER LAND & LEGACY AMENDMENT

Advancing Safe and Sustainable Water Reuse in Minnesota

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Acronyms

BMPs	Best Management Practices
BWSR	Board of Water and Soil Resources
CSW	Construction Stormwater
DLI	Department of Labor and Industry
DPR	Direct Potable Reuse
DNR	Minnesota Department of Natural Resources
FSMA	Food Safety Modernization Act
IPR	Indirect Potable Reuse
ISW	Industrial Stormwater
MDA	Minnesota Department of Agriculture
MDH	Minnesota Department of Health
MPCA	Minnesota Pollution Control Agency
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
O & M	Operation and Maintenance
RME	Responsible Management Entity
SDS	State Disposal System
SDWA	Safe Drinking Water Act
SWCD	Soil and Water Conservation District
UMN	University of Minnesota
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
WE&RF	Water Environment & Reuse Foundation[1]

The following names are used to reference certain reports in the text:

"Australian Guidelines" - *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks 2006 (Phase 1)* and *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 2) Stormwater Harvesting and Reuse, 2009* (Natural Resource Management Ministerial Council, Environment Protection and Heritage Council, & Australian Health Ministers Conference)

"National Academies Graywater/Stormwater Report" - *Using Graywater and Stormwater to Enhance Local Water Supplies: An Assessment of Risks, Costs, and Benefits* (National Academies of Sciences, Engineering, and Medicine)

"USEPA 2012 Guidelines" - *2012 Guidelines for Water Reuse (*U.S. Environmental Protection Agency)

"WE&RF Report" - *Final Report: Risk-Based Framework for the Development of Public Health Guidance for Decentralized Non-Potable Water Systems* (published by the Water Environment & Reuse Foundation)

[1] The Water Environment & Reuse Foundation is undergoing a merger and will be called "The Water Research Foundation" in the future.

Report Contributors

The Minnesota Legislature directed the Minnesota Department of Health to "prepare a comprehensive study of and recommendations for regulatory and non-regulatory approaches to water reuse for use in the development of state policy for water reuse in Minnesota," with funding through the Clean Water Fund of the Clean Water, Land and Legacy Amendment. The list below includes Water Reuse Interagency Workgroup representatives.

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Executive Summary

Water reuse will be an increasingly important part of managing Minnesota's water resources as demands on our water supplies continue to grow due to population increases, urbanization, climate change, increased irrigation and industry growth. Water reuse is happening across Minnesota. Despite increasing interest in water reuse, there is no comprehensive statewide guidance or policy on water reuse. In 2015, the Minnesota Legislature directed the Minnesota Department of Health to:

> *"Prepare a comprehensive study of and recommendations for regulatory and non-regulatory approaches to water reuse for use in the development of state policy for water reuse in Minnesota" (Session Law 2015, 1st special session, Chapter 2, Article 2, Section 8).*

The Clean Water, Land and Legacy Amendment provided funding for this project. In response to the Legislature's directive and funding, the Water Reuse Interagency Workgroup ("Workgroup") formed including representatives from the Departments of Agriculture, Health, Labor and Industry, and Natural Resources, the Minnesota Pollution Control Agency, Board of Water and Soil Resources, Metropolitan Council and the University of Minnesota Water Resources Center.

The Workgroup:

- Defined successful water reuse.
- Collected and assessed information on 1) water reuse in Minnesota, 2) water reuse in other states and nations and 3) ways to manage human health risks posed by water reuse.
- Sought stakeholder perspectives through surveys and meetings.

The Workgroup used the information to develop Minnesota-specific recommendations for state and local governments, non-governmental organizations, businesses and industries to consider in developing regulations and guidance for water reuse. The recommendations are:

a. **Create an expanded workgroup with practitioners, advisors and stakeholders** to continue development of standards and programs.
b. **Prioritize research needs and integrate ongoing research** to address questions about reuse.
c. **Define roles and responsibilities** to oversee and monitor water reuse.
d. **Establish an information and collaboration hub on the web** to share information and resources**.**
e. **Develop a risk-based management system** to determine if regulation or guidance is needed.
f. **Develop water quality criteria for a variety of reuse systems based on the log reduction target approach for pathogens** to manage human health risks.
g. **Resolve unique issues related to graywater reuse** to determine the feasibility of expanding graywater reuse**.**
h. **Provide education and training** to support water reuse.

This research, report and recommendations can help assist decision makers and stakeholders in setting a course of action to advance safe and sustainable water reuse in Minnesota.

Introduction

Why Consider Water Reuse in Minnesota?

Minnesota has historically been known as a water-rich state, with a substantial supply of groundwater, many lakes and rivers, and frequent rainfall. However, there are limits to those water supplies.

Three of four people in Minnesota get their drinking water from groundwater sources (1.1 million private well users and 2.9 million on public water supplies). Groundwater is not evenly distributed across the state, and some areas are beginning to feel stress from quality and/or quantity issues – such as the southwest and Twin Cities Metropolitan area. Minnesota increased its groundwater use by 35 percent over the past 25 years, and use continues to increase (Minnesota Environmental Quality Board, 2015). Changes in weather patterns, increased population, increased irrigation demands and growth in industries that require high water input have started to stress Minnesota's water resources. Depletion of groundwater reserves in some locations has focused attention on the need for more efficient use of water.

In addition to reducing groundwater use, water reuse offers multiple other benefits– such as managing stormwater–as discussed further below.

Definitions

There are many definitions of water reuse and the sources of water for reuse. The definitions below were selected by the Workgroup primarily because they are consistent with Minnesota's system of water management.

Reuse: The capture and use of stormwater, wastewater and subsurface water to meet water demands for intentional and beneficial uses.

<u>Categories of Source Water:</u>

Stormwater: Water generated by rainfall or snowmelt that causes runoff. [2]

Rainwater (subset of stormwater): *Water generated by rainfall or snowmelt that can be collected directly from roof surfaces.*

Wastewater: Used or discharged water from homes, institutional or public buildings, commercial establishments, farms or industries.

Domestic wastewater (subset of wastewater)*: Used water from bathing, laundry, toilet, kitchen or similar sources.*

Graywater (subset of wastewater): *Wastewater segregated from a domestic wastewater collection system, typically from laundry and bathing water*

Industrial process wastewater (subset of wastewater): *Wastewater generated by industrial processes, including backwash water and condensate.*

Subsurface water: Water collected from below the ground surface to maintain the structural integrity of a building, discharged through dewatering, or pumped for pollution containment.

<u>Categories of End Uses:</u>

Nonpotable uses: flushing, irrigation, cooling, washing, industrial processes

Potable uses: drinking, culinary and bathing

[2] Stormwater withdrawn from constructed management facilities is exempt from DNR water appropriation permitting.

Increasing Interest in Reuse

In the past decade, interest in water reuse has rapidly increased. Municipalities, watershed districts and watershed management organizations, businesses, industries and developers have installed projects or are considering doing so. A survey conducted by the Workgroup in summer of 2016 (Water Reuse Interagency Workgroup Survey) indicated that 22 out of 31 projects had been installed between 2010 and 2016.

Despite the increased interest in reuse, Minnesota, like many other states, lacks a comprehensive, statewide approach to guide municipalities, industries and other parties interested in implementing water reuse. Various Minnesota agencies, including the MPCA, DNR, DLI, BWSR and MDH, all play a role in water reuse. Agencies oversee and regulate management and discharge of wastewater and stormwater, water appropriations, water and wastewater infrastructure, protection of public health and safety, standards for contaminants in groundwater or surface water and standards for water used in food production and processing. However, for most types of reuse, clear guidance on best practices and an understandable regulatory path are lacking.

A number of reports and workshops have pointed to the need for better guidance.

The UMN Water Resources Center produced the Minnesota Water Sustainability Framework in 2011 to guide the work of the Clean Water Fund. The framework called on state agencies to plan for water reuse. Specifically, the recommendations were that the state agencies, in consultation with outside experts, should:

- Identify and evaluate all water reuse strategies and applications.
- Recommend applications relevant to Minnesota's seasons, geographical water use, soil types, and rainfall.
- Recommend an implementation strategy.

The framework also called for the MPCA and MDH to work together to set appropriate standards for water reuse applications identified in the recommendations.

The Environmental Quality Board's 2015 Water Policy Plan, "Beyond the Status Quo," recommends the following regulatory solution:

> *"Update plumbing codes and treatment standards to allow for safe and practical water reuse. Water withdrawn from Minnesota aquifers, streams and lakes is rarely reused, even though the water (or treated wastewater) remaining after use is clean enough to be reused for industrial and agricultural purposes. This single-use habit puts unnecessary pressure on water supplies." (EQB, 2015, p. 9)*

The Freshwater Society convened a workshop on reuse in May 2016. Attendees were asked to identify barriers to rainwater and wastewater reuse. A summary of the top five responses is below (Freshwater Society, 2016, p. 13).

Rainwater

1. Cost is high, and potable water is inexpensive.
2. Lack of state or national policies/guidelines for oversight and management of decentralized non-potable water systems.

3. Lack of water quality/performance standards for decentralized water systems.
4. Water appropriations permits and reporting processes are discouraging.
5. Not enough public health or risk data.

Wastewater

1. Cost is high, and potable water is inexpensive.
2. Treatment requirements are not in line with use.
3. High chlorides in treated wastewaters is a challenge for industrial reuse.
4. Lack of state or national polices/guidelines for oversight and management of decentralized non-potable water systems.
5. Lack of water quality data on alternate water sources.

The Metropolitan Council developed one of the first guidance documents specifically for stormwater reuse in Minnesota. The 2011 Stormwater Reuse Guide includes case studies, a "toolbox" of resources and worksheets and links to other resources.

In 2016, the MPCA worked with consultants and an advisory group to update the Minnesota Stormwater Manual and expand the section on stormwater harvest and reuse. The section expansion included a thorough review of benefits and other considerations, an overview of the four phases of project development (feasibility, pre-design, design and implementation) and guidance on water quality standards. The manual states that Minnesota-specific water quality guidelines for stormwater reuse for irrigation are to be "determined at a later date."

Groups working on stormwater management, such as the Minimal Impact Design Standards (MIDS) workgroup, asked MDH to recommend water quality standards for nonpotable applications. In addition, the Minnesota Plumbing Board (which was in the process of adopting the Uniform Plumbing Code for use in Minnesota) had an interest in adopting chapters on alternate sources of water, especially harvested rainwater and also asked MDH's opinion on water quality standards.

MDH was asked to participate in national groups to develop the Blueprint for Onsite Water Systems: A Step-by-Step Guide for Developing a Local Program to Manage Onsite Water Systems and the WE&RF report. Additionally, MDH, the Metropolitan Council and the City of Eagan are members of the National Blue Ribbon Commission for Onsite Non-potable Water Systems. Since 2016 the commission has been serving as a forum for collaboration and knowledge exchange. Projects have included:

- A model state guidance and policy framework for distributed non-potable water programs.
- Resources for water utilities based on best practices and lessons learned in the design, development, integration, and operation of Onsite Non-potable Water Systems (ONWS).
- Identification of additional research needs in the field.

To gain a better understanding about potential health risks from water reuse systems, MDH contracted with UMN to study the microbial water quality of two water reuse systems: a stormwater irrigation system and a rainwater collection system used for flushing toilets in a building. Air samples were also collected from the irrigation system while it was in operation. A MDH document Water Reuse System Sampling Results Summary summarizes initial results, and more detailed information will be available in 2018.

A UMN study funded by the Legislative-Citizen Commission on Minnesota Resources, Maximizing the Benefits of Water Reuse, is currently underway to assess the water quality of reuse systems. The goal of this project is to provide pathogen data needed to properly assess the risks of water reuse.

Figure 1. Some Factors to Consider in Exploring Reuse

Benefits, Costs and Risks of Water Reuse

The increasing interest in implementing water reuse projects has sparked discussions in the water reuse community about the benefits, costs and risks of water reuse. The following information provides a brief overview of some of the benefits, costs and risks discussed by the Workgroup and stakeholders.

Benefits

Water reuse can reduce demands on Minnesota's groundwater and surface water supplies. Reuse - along with other water conservation strategies - can save energy, improve water quality and reduce the impacts of land use and development on lakes, streams and groundwater. Reuse can also help meet some water demands locally, such as demands for irrigation, reducing the need to expand centralized water utilities.

Stormwater reuse for irrigation is one of the most common reuse scenarios currently being implemented in Minnesota. Examples of stormwater reuse projects developed in the past decade can be found in the Minnesota Stormwater Manual. The Minnesota Association of Watershed Districts Water Reuse Benefits Information Sheet (2017) cites the benefits of stormwater reuse for irrigation:

> *"Stormwater reuse irrigation projects reduce the amount of stormwater that flows out of a watershed by capturing and distributing it over a vegetated surface through irrigation. This reclaimed water evaporates during irrigation, evapotranspirates through plants, or percolates through the soil where it has the potential to replenish local groundwater supplies. Reuse irrigation projects benefit groundwater resources by reducing consumption of available groundwater supplies. Properly designed stormwater reuse systems can meet a significant portion of annual irrigation demand."*

Cities and watershed districts are generally required to reduce the volume of stormwater leaving a development site, as required by MS4 or CSW permits. Reuse of stormwater has been an effective strategy for managing stormwater discharges. In areas where infiltration of stormwater is impractical due to tight or waterlogged soils, reuse of stormwater is often the only practical option. Reuse also allows for shallow recharge of local groundwater through irrigation, or conservation of potable water supplies through indoor uses such as vehicle washing or toilet flushing.

Costs

The economic feasibility of reuse projects is often unclear, due to costs of energy, installation, O & M of infrastructure and equipment, and disposal of waste byproducts. Reuse systems can cost more to install than other conservation strategies, depending on the circumstances, because of the new infrastructure required. Planning for reuse in new developments and in tandem with infrastructure upgrades can help reduce costs. Stakeholders shared concerns in meetings, surveys and report comments about potential costs of additional treatment requirements. These costs need to be considered when recommending or requiring treatment. A better understanding of the costs of constructing and of maintaining existing reuse projects would help predict and assess future costs. The costs of reuse are examined in the USEPA 2012 Guidelines and the National Academies Graywater/Stormwater Report. These reports could be a good starting place for further study.

Risks

While there are many benefits to water reuse, water reuse also carries risks. Potential risks of water reuse include environmental, human health, system performance and impacts on other systems, and liability. Liability is discussed in the March 2017 Stakeholder Meeting Summary and Appendix C. Liability Risks.

Environmental Risks

Concentrating and/or redistributing pollution and water can cause environmental problems.

- Water quality: Recycling water multiple times or treating it for reuse applications can concentrate levels of pollution. Most municipal wastewater treatment systems are not designed to handle concentrated levels. The increased concentrations can lead to increased disposal and operating costs. Irrigating crops with water high in salt could pollute groundwater and surface water (NAS, 2016).
- Water quantity: Reusing water can impact the existing hydrologic conditions in the environment and the organisms that have adapted to these conditions. Irrigating or other land application of water can increase or decrease the volume of water into an ecosystem (USEPA, 2012).
- Soil and vegetation: Antimicrobials can impact the population of microbes in soil. Irrigating crops with water high in salt could cause damage to plants or turf (NAS, 2016).

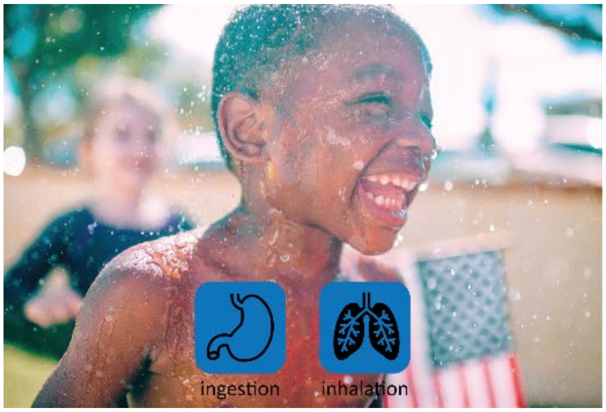
Human Health Risks

Exposing people to pathogens in water or physical hazards created by reuse systems can cause health problems. Human health risks related to water reuse are identified in public health research and case studies (NRMMC, 2006; NRMMC, 2009; WRF, 2007; Lim, 2015; Jiang, 2015). Some water reuse-related disease outbreaks have been identified (Ashbolt & Kirk, 2001; Greene et al., 2008; Schlech et al., 1985; Simmons et al., 2008).

- Gastrointestinal illness (from ingestion of water spray or hand-to-mouth contact): People can get sick from ingesting droplets of water from spray irrigation, vehicle washing or toilet flushing or after hand-to-mouth contact with something that has been sprayed with reused water.
- Gastrointestinal illness (from accidental cross-connections): Accidental cross-connections between reuse systems and the potable drinking water supply can allow pathogens to enter the drinking water.

- Legionnaires' disease (form of pneumonia): Mist with *Legionella* bacteria in it can cause Legionnaires' disease. Bacteria can grow if water treatment, disinfection, stagnation or temperature are not managed properly. A plastics processing facility in Minnesota that practices water recycling was the site of four sporadic Legionnaires' disease cases over a period of five years.
- Physical harm: Storage units for decentralized water reuse systems can create a physical drowning hazard or an insect/pest habitat if not managed properly.

Figure 2. Potential Exposure Pathways



System Performance and Impacts on other Systems Risks

- System performance: Reuse projects that do not have adequate planning and funding for ongoing O & M, monitoring and oversight can fail. The MPCA has procedures in place to oversee long-term O & M and monitoring for centralized wastewater reuse, but similar procedures do not currently exist for most other types of reuse.
- Impacts on other systems: Reduced customer usage can decrease revenue for water and wastewater utilities to manage their systems. Additionally, wastewater systems depend on graywater for dilution to keep sewer lines clear and maintain treatment processes.

Workgroup Establishment/Goal, Objectives, and Activities

Establishment/Goal

As a result of the increasing interest in and conversations about water reuse, the Minnesota Legislature recognized the need for a more comprehensive water reuse approach. In 2015, the Minnesota Legislature directed MDH, in collaboration with other state water management agencies, to:

> *"Prepare a comprehensive study of and recommendations for regulatory and non-regulatory approaches to water reuse for use in the development of state policy for water reuse in Minnesota" (Session Law 2015, 1st special session, Chapter 2, Article 2, Section 8).*

The study is funded through the Clean Water Fund of the Clean Water, Land and Legacy Amendment. In response to the Legislature's directive and funding, MDH organized the Water Reuse Interagency Workgroup. The Workgroup included representatives from MDA, MDH, DLI, DNR, the MPCA, BWSR, Metropolitan Council and the UMN Water Resources Center.

Objectives

The Workgroup established three main project objectives:

1. Define successful implementation of water reuse in Minnesota.
2. Identify current conditions that support successful water reuse, and identify barriers and solutions to barriers.
3. Develop recommendations for safe and sustainable water reuse practices and policies.

Activities

The Workgroup met monthly from January 2016 through August 2017, focusing its efforts in the areas described below.

Defining Successful Reuse

The Workgroup, with input from stakeholders, defined elements that would create successful implementation of water reuse in Minnesota. See Definition of Successful Water Reuse.

Collecting and Assessing Information

The Workgroup collected and assessed information on:

- Water reuse in Minnesota (examples of projects, current management, and challenges and opportunities).
- Examples of water reuse policies and management in other states and nations.
- Ways to manage human health risks posed by water reuse.

This report includes a list of Resources that may be of interest to readers. The Workgroup found the following resources to be particularly valuable for this project: the Australian Guidelines, the National Academies Graywater/Stormwater Report, the USEPA 2012 Guidelines and the WE&RF report.

Seeking Perspectives

The Workgroup reviewed information from surveys conducted by the Minnesota Technical Assistance Program and the MPCA, and built on the work of these surveys by conducting an in-depth survey of water reuse project owners. Appendix A. Surveys provides more information.

Workgroup members visited project sites in the east and southwest Twin Cities metropolitan area - visiting over 20 sites in Carver, Scott and Washington counties - to see how projects were working first-hand. Workgroup members also made numerous presentations at conferences and to interest groups, including the Minnesota Groundwater Association, the Water Resources Conference and the Minnesota Association of Watershed Districts.

The Workgroup convened four meetings with stakeholders to gather input on specific topics. Appendix B. Stakeholder Participation provides a list of stakeholders and summaries of the meetings. Full notes from the stakeholder meetings are available at the Water Reuse project website.

Developing Recommendations

The Workgroup used the definition of successful reuse, information gathered and stakeholder perspectives to develop Minnesota-specific recommendations. The recommendations are for state and local governments, non-governmental organizations, businesses and industries to consider in developing regulations and guidance for water reuse.

Definition of Successful Water Reuse

The Workgroup, with input from stakeholders, defined elements that would create successful implementation of water reuse in Minnesota.

- **Water reuse systems are safe, sustainable and sanitary.** Systems are maintained long-term. There is adequate oversight of the O & M of existing systems. Public health and environmental concerns are addressed. Acceptable risk is defined.
- **Water reuse is integrated into governance.** Reuse is integrated into the state's overall water management approach and investments in reuse are balanced with other opportunities to enhance water management. Water users account for reuse within the water appropriation permit system.
- **Water reuse has a clear regulatory pathway.** Unnecessary regulatory barriers are removed or minimized; the process is understandable. State and local agency requirements are synchronized.
- **Water reuse is integrated into water infrastructure and public services planning (e.g., water supply, wastewater).** Water and wastewater operations are considered (e.g., potential reduced revenue, changed solids loading in wastewater pipes).
- **Benefits to water resources are quantified.** Demands on groundwater and surface water are reduced. Stormwater management is improved. Systems are efficient and integrated, saving water, energy and money.
- **Water reuse is economically feasible.** Prices for source water and existing infrastructure and services reflect true costs. Programs exist to help owners fund reuse projects. Water reuse is integrated into water management to make best use of limited resources.
- **Continuing research and technical expertise for water reuse are available.** Findings and recommendations for best practices are communicated.
- **Water reuse is a common practice.** Reuse has moved past the pioneer phase and is now mainstream. Water reuse education and outreach programs are actively engaging stakeholders and the public. Public acceptance is achieved, along with understanding of what is and is not allowed.

State Agencies' Current Roles in Water Reuse

Many state, regional and local authorities play a role in managing Minnesota's water resources. Management includes aspects of outreach and education, research, standards and guidance, planning and funding, and regulations.

Table 1 provides summary information about the major state water management agencies' current roles in managing water reuse. Table 2 organizes these authorities by water sources and by stage of the reuse process, from capture and storage to treatment, distribution and end use.

These tables show that the current state regulatory system is complex, with overlapping responsibilities and some areas that are not clearly regulated. It is also important to note that a number of watershed districts, watershed management organizations, cities and SWCDs play important roles in managing stormwater. For example, local authorities usually enforce requirements for reducing the volume of stormwater runoff from developed properties set at the state level through CSW permits, ISW permits and MS4 permits (see discussion in the section on Water Reuse in Minnesota).

The Workgroup identified the following issues related to the regulatory system:

- Although many statutes and rules govern water management, few rules are specific to water reuse, especially in the areas of water quality, system design and O & M.
- Agency expertise does not always align with agency authority. For example, DLI has authority to regulate indoor reuse, but the MPCA and MDH have the expertise in water and wastewater treatment.
- With the exception of rainwater catchment systems, now included in the Minnesota Plumbing Code, most in-building applications of wastewater, graywater and combined rainwater/stormwater reuse require variances through the Plumbing Board. Variances involve more in-depth scrutiny than a standard permit.
- Local plumbing authorities (delegated to administer building and plumbing codes) are not always consistent in how they consider variances or interpret the rules to allow for reuse.
- With the exception of centralized wastewater reclamation and food product manufacturing and marketing, there is currently no standardized system of oversight or monitoring for reuse systems.

Table 1. State Water Management Agencies' Roles, Statutory Authorities, and Guidance Pertaining to Water Reuse

Agency	Primary Role	Statutory Authority	Guidance
DLI	Focus on building safety, safe water use within buildings, cross-connection prevention, and drainage systems. Administer codes and licensing requirements, occupational safety and health.	▪ Administer Minnesota Plumbing Code (2015) including: ▪ Rainwater catchment systems ▪ Plumbing fixtures ▪ Building water supply systems ▪ Backflow prevention ▪ Storm drainage/sewer systems to point of disposal *Minnesota Rules, chapter 4714 – Plumbing Code*	▪ Review of variance applications for nonstandard practices (i.e., graywater and stormwater) by Plumbing Board.
DNR	Develop a water resources conservation program for the state. Administer the use, allocation and control of waters of the state.	▪ Permit water appropriations– most uses of more than 10,000 gallons per day or one million gallons per year require an appropriation permit. ▪ 2017 statute change eliminates appropriation permit requirement for stormwater reuse if the water is withdrawn from "constructed management facilities for storm water." ▪ Develop and manage water resources to assure an ongoing adequate supply for human, fish and wildlife needs. ▪ Provide oversight of public water supply plans *Minnesota Statutes, chapter 103G – Waters of the State*	▪ Water supply planning and conservation assistance.
MDA	Protect the safety of the state's food supply by overseeing its production, manufacturing, processing, selling, handling and storage. Protect groundwater from pesticide and fertilizer contamination.	▪ Regulate end use applications involving food crops or food processing. ▪ Implement federal food safety regulations within state. ▪ Regulate fertilizer and pesticide use. *Minnesota Statutes, chapters 31 – Food; 34A – Food Law (inspections); 32 – Dairy Products; 103H-Groundwater Protection; Minnesota Rules, chapter 4626 – Food Code; Federal Produce Safety Rule 21 CFR 112; Federal Sanitation Performance Standards 9 CFR 416.2(g)*	▪ Technical support to crop producers, food processers and food marketers in the safety of water supplies. ▪ Fertilizer and pesticide BMPs for crops and turf. ▪ Irrigation technical support with UMN. ▪ Educational nitrate testing for private wells. ▪ Technical support to MDH and the MPCA in establishing risk limits for contaminants.

Agency	Primary Role	Statutory Authority	Guidance
MDH	Focus on safe water use and drinking water protection; implement the federal Safe Drinking Water Act through a cooperative agreement with the USEPA.	▪ Implement Safe Drinking Water Act. ▪ Administer Minnesota Well Code including standards for wells and borings and well driller licensing and oversight. ▪ Determine wellhead protection areas and develop wellhead protection plans. ▪ Develop guidance on infiltration controls in drinking water supply management areas. ▪ Establish health risk limits for drinking water contaminants. *Minnesota Statutes, chapters 103H – Groundwater Protection, 103I – Wells, Borings, and Underground Uses; Minnesota Rules, chapter 4720 – Public Water Supplies and 4725 Wells and Borings*	▪ Source water assessments. ▪ Evaluation of safety of common rainwater and stormwater reuse installations.
MPCA	Protect water quality; implement the federal Clean Water Act through a cooperative agreement with the USEPA.	▪ Implement NPDES permitting program including permitting for stormwater (MS4, construction, and industrial) and wastewater discharge. ▪ Permit disposal systems for subsurface or land discharge of wastewater. ▪ Develop water quality standards. ▪ Conduct impaired waters assessments and develop total maximum daily load to address identified impairments. *Minnesota Statutes, chapter 115 –Water Pollution Control; Sanitary Districts; Minnesota Rules, chapters 7001 - NPDES, 7050 -Water Quality Standards, 7052 - Lake Superior Water Standards, 7080, 7081, 7082,7083 - Individual Subsurface Sewage Treatment Systems,7060 - Groundwater, 7090 – Storm Water*	▪ Minnesota Stormwater Manual including guidance for stormwater harvesting and use. ▪ Minimal Impact Design Standards: performance goals, standards, calculator and ordinance guidance for a higher level of stormwater management that mimics a site's natural hydrology. ▪ Municipal wastewater reuse guidance.
BWSR	Improve and protect water and soil resources by working with local organizations and landowners. Implement the state's soil and water conservation policy, comprehensive local water management and the Wetland Conservation Act.	▪ Direct soil and water conservation programs through actions of local governments, SWCDs, watershed districts, etc. ▪ Administer Wetland Conservation Act. ▪ Coordinate local water/watershed management plans. *Minnesota Statutes, chapters 103B – Water Planning and Project Implementation, 103C – Soil and Water Conservation Districts, 103D – Watershed Districts, 103F– Protection of Water Resources, 103G – Waters of the State*	▪ Technical assistance and grants to private landowners, local government units, SWCDs, watershed districts, etc.

Table 2. Reuse Regulation or Guidance by Water Source

Source	Capture/Storage	Treatment	Distribution	End Use
Rainwater	**DLI:** regulates collection from roofs and catchment systems **MPCA:** guidance through Stormwater Manual	**DLI:** regulates water quality treatment requirements	**DLI:** regulates use within buildings and drainage systems to discharge point **DNR:** regulates if volumes used more than 10,000 gallons per day or one million gallons per year, with some exceptions	*Irrigation: not specifically regulated* **DLI:** regulates use for toilet flushing **MDH:** guidance on infiltration in vulnerable groundwater areas **USEPA:** regulates injection **MDA:** regulates food processing, food crop irrigation, etc.
Stormwater	**MPCA:** guidance through Stormwater Manual **DLI:** regulates conveyance within piping	**MPCA:** guidance through Stormwater Manual	**DLI:** regulates use within buildings by variance **DNR:** regulates use except for water withdrawn from "constructed management facilities for storm water"	**MPCA**: guidance on irrigation through Stormwater Manual **DLI:** regulates toilet flushing by variance **MDH:** guidance on infiltration in vulnerable groundwater areas **USEPA:** regulates injection **MDA:** regulates food processing, food crop irrigation, etc.
Graywater	**DLI:** regulates diversion within buildings by variance **MPCA:** regulates, requirements similar to septic tank and disposal systems, with lower design flows and smaller tanks	**MPCA:** regulates through wastewater standards, no requirements specific to graywater **DLI:** regulates use within buildings by variance	**DLI:** regulates use within buildings by variance **MCPA:** regulates through wastewater standards **MDH:** regulates separation distances from wells	**MPCA:** irrigation – wastewater standards apply **DLI:** use in buildings – regulates by variance **MDA:** regulates food processing, food crop irrigation, etc.
Wastewater	**MPCA:** regulates disposal of wastewater, requirements for septic tanks, pumps, and dispersal in trenches, seepage beds, mounds or at-grade systems **DLI:** regulates use of public sewer/water	**MPCA:** regulates through NPDES and SDS permits, referencing California Titles 17 and 22 requirements; offers guidance on reuse; and regulates treatment and disposal of waste residuals	**MDH:** regulates separation distances from wells	**MPCA:** regulates irrigation as a discharge to land, guidance on reuse for nonpotable use **DLI:** regulates use in buildings by variance **MDA:** regulates food processing, food crop irrigation, etc.
Industrial Process Water	*Depends on process*	*Determined by end use or discharge permit* **MPCA:** regulates treatment and disposal of waste residuals	**DLI:** regulates up to water supply backflow preventer (prior to industrial use) or if industrial reuse is supplying plumbing fixture or plumbing system	**MPCA:** regulates discharges **MDA and MDH:** regulate food processing
Subsurface Water	**DLI:** regulates capture/storage by variance	**MDH:** regulates if treated for drinking water	**DLI:** regulates use within buildings by variance	**MPCA:** regulates pollution containment **MDH:** regulates supplementation of potable water supplies

I. Recommendations

The Workgroup developed Minnesota-specific recommendations for state and local governments, non-governmental organizations, cities, businesses and industries to consider in developing regulations and guidance for water reuse. The recommendations in this report are intended to move state policies toward safe and sustainable water reuse, as characterized in the Definition of Successful Water Reuse section, but should be viewed as only a first step in this direction.

Workgroup members and stakeholders offered important and diverse perspectives regarding potential water reuse recommendations and considerations related to implementation. For example, many stakeholders were opposed to any new regulations, while others saw the need for regulations to ensure safety and sustainability. The availability of resources and the feasibility of how best to integrate reuse within our broader system and priorities for water management were also an important part of the conversation.

The Workgroup's recommendations are made with the following in mind:

- The recommendations may not reflect all agency priorities and concerns. Furthermore, the Workgroup recognizes that there are many competing demands for water management resources, and resource availability may limit agencies' and others' ability to adopt and/or implement the recommendations.
- The recommendations do not address what reuse applications should be implemented in Minnesota or where. As with many newer practices, first projects are meant to be examples and help move the practice forward. However, long-term planning will require prioritizing reuse applications and integrating reuse into water infrastructure planning.
- Water reuse decisions should be science-based and carefully considered, with an appropriate balance of ensuring efficient resource allocation, supporting innovation, and managing risk and unintended consequences.
- Investment in water reuse should be weighed against the benefits that could be derived by directing those same resources to enhancing the effectiveness and efficiency of other aspects of our water management system.
- The recommendations do not the address the need to properly value water. The Workgroup felt this is critical for water management planning but is beyond the scope of this project. Minnesota is participating in national efforts such as the Value of Water Campaign and One Water for America Listening Sessions.
- The recommendations alone cannot define all policy decisions; rather, the recommendations identify areas for further assessment and study.
- Additional resources will be necessary to manage and support water reuse in Minnesota.

The Workgroup's recommendations, included in Table 3, are listed in probable chronological order relative to each other. The recommendations are closely linked, and some are dependent on others. The recommendations are discussed in detail on the following pages.

Table 3. Recommendation Time Frames and Dependencies

ID	Recommendation	Dependencies on other Recommendations (* indicates possible dependency)	Months	1-2 years	2-3 years	3-5 years
a	Create an expanded workgroup with practitioners, advisors and stakeholders	none	■	■	■	■
b	Prioritize research needs and integrate ongoing research	none	■	■	■	■
c	Define roles and responsibilities	a		■		
d	Establish an information and collaboration hub on the web	a, c*		■		
e	Develop a risk-based management system	a, c, f			■	
f	Develop water quality criteria for a variety of reuse systems based on the log reduction target approach for pathogens	a, b, c			■	
g	Resolve unique issues related to graywater reuse	a, b				■
h	Provide education and training	d*, e, f, g				■

Recommendation a. Create an expanded workgroup with practitioners, advisors and stakeholders

To continue development of standards and programs

This report can serve as a springboard to move state policies toward safe and sustainable water reuse. It will take a collaborative effort to further evaluate and implement the recommendations.

The Minnesota reuse community should establish a multidisciplinary group of practitioners (designers and operators), advisors (consultants, researchers, state and local government staff) and stakeholders (other interested individuals and groups). This group could evolve to include teams working on specific aspects of reuse, similar to the way the Workgroup operated. The goal is to continue to build a support system for water reuse in Minnesota. The group could take the lead or act as a participant on all of the following recommendations.

Next Steps for Consideration

- Pursue resources to support this group, including grants or other funding sources.
- Invite practitioners, advisors and stakeholders to participate.
- Develop objectives and timelines for the group.

Recommendation b. Prioritize research needs and integrate ongoing research

To address questions about reuse

The Workgroup's effort to collect and synthesize information revealed that there will be ongoing needs for research on water reuse in Minnesota.

The Minnesota reuse community should work together to prioritize research needs, as water reuse research is being conducted by a variety of entities in Minnesota on a range of topics. Research needs and new information could be shared through the information hub mentioned in Recommendation d. Establish an information and collaboration hub on the web.

The Workgroup and stakeholders identified the following major research needs and topics of interest:

- **Costs and benefits of reuse**: Topics of interest include valuing the benefits to infrastructure and ecological services (such as aquifer protection).
- **Water quality data for reuse**: Topics of interest include the presence and infectivity of microbial pathogens, certain chemicals and contaminants (e.g., pharmaceuticals and personal care products) and water quality issues specific to cold climates.
- **Safety and feasibility of potable reuse**: Topics of interest include indirect potable use through deep injection, subsurface injection or infiltration of treated wastewater or stormwater in Minnesota's geologic settings.

The Minnesota reuse community should continue to integrate new information from research into reuse management systems and education and training programs. Minnesota should collaborate with other entities on research efforts and share findings from our work.

Next Steps for Consideration

- Prioritize research needs and pursue funding to meet needs. Make sure to consider research efforts going on across the country and where we can collaborate.
- Integrate information from new research in Minnesota and from other states and countries into Minnesota practices and policies.

Recommendation c. Define roles and responsibilities

To oversee and monitor water reuse

The Workgroup established that current state agency roles in water reuse are often unclear, inconsistent and incomplete.

Minnesota should have clear agency roles for review, oversight and monitoring for each water reuse application. While some applications such as centralized wastewater reuse have established guidance and oversight, there is currently no comprehensive structure for overseeing and monitoring many other water reuse activities. As there are for drinking water and wastewater treatment, there are potentially shared authorities for reuse. New authorities may also be needed.

Criteria for review and oversight could be set at the state level but implemented by local authorities as appropriate. One potential scenario could involve the following shared authorities:

- **DLI** retains its authority to enforce the plumbing code and maintains responsibility for all piping, valves and other plumbing components of the reuse system for indoor reuse.
- **MPCA** provides guidance, review, oversight and monitoring of *outdoor* reuse systems and provides expertise on environmental water quality considerations.
- **MDH** takes the lead in establishing a system of oversight and monitoring of *indoor* reuse systems, while continuing to provide expertise on log reduction targets, national research and public health considerations.
- **DNR** continues to provide expertise in assessing potential environmental impacts of reuse systems on public waters, wetlands and groundwater resources.
- **MDA** retains its authority over food irrigation and facility inspection.

Agencies could coordinate on inspections and oversight to capitalize on existing responsibilities for inspections of pools and drinking water and wastewater systems. The scenario above would build on agencies' existing expertise and authority, although new authorities may also be needed. Implementing this recommendation would require additional resources.

This report is focused on agency roles, but other entities, including local authorities, consultants and research and advocacy organizations, will play a large role in gathering and sharing information and advancing reuse practice in Minnesota.

Next Steps for Consideration

- Continue to meet as agencies at least quarterly to continue discussions and review documents, proposed projects, research and options for implementing recommendations.

- Agree on a preferred management scenario and determine roles and responsibilities going forward.
- Assess the feasibility of the preferred management scenario, including the regulatory authorities, financial considerations, current fee structures, staffing needs and other resources needed to establish this type of system.
- Examine agency and local government fee structures currently in place for pool inspections, plumbing plan reviews and CSW permitting and drinking water supply.
- Define roles for other entities interested in reuse, such as participating in the practitioner, advisor and stakeholder group, creating and maintaining a database of reuse projects, writing up case studies or conducting pilot projects.

Recommendation d. Establish an information and collaboration hub on the web

To share information and resources

The Workgroup found that it was difficult for stakeholders to find information about water reuse on the web because of the lack of integration among state agencies and other parts of the water reuse community. Stakeholders indicated it would be useful to have one place to go for information.

Minnesota should have a single integrated website that includes:

- A list of contact people or positions within each state agency that deals with water reuse.
- Links to relevant statutes and rules.
- Links to state and national research.
- Examples of completed reuse projects.
- Lessons learned from those already managing reuse facilities.
- Additional guidance on various aspects of reuse, such as user-friendly fact sheets.

Integrated websites of this type are already in use for interagency and legislative initiatives such as Clean Water, Land and Legacy Amendment-funded projects[3], Minnesota Business First Stop[4], the Office of Enterprise Sustainability[5], and similar coordinated efforts. These websites are typically managed by one agency or office, while drawing on other agencies for information.

Next Steps for Consideration

- Assess the costs and time commitment involved in developing an integrated website.
- Evaluate existing and potential funding sources.
- Gather information for the website, making use of existing resources.

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[3]Clean Water, Land and Legacy Amendment-funded projects (http://www.legacy.leg.mn/)

[4]Minnesota Business First Stop (https://mn.gov/deed/business/help/first-stop/)

[5]Office of Enterprise Sustainability (https://mn.gov/admin/government/sustainability/)

Recommendation e. Develop a risk-based management system

To determine if regulation or guidance is needed

The Workgroup determined that there are potential risks for water reuse (see Introduction for overview of risk). The Workgroup wants reuse to be implemented safely, while being mindful of resources required to do so. Additionally, certain stakeholders indicated they would be more likely to implement reuse projects if guidance and regulation are available.

Minnesota could manage the risks of water reuse through a risk-based management system which uses a spectrum of strategies ranging from education and guidance to regulation. Risk-based management systems take into account factors such as contaminant concentrations at the source water, the number of people likely to be exposed to the contaminant and the complexity of the system. In general, the more people likely to be exposed to a contaminant, the higher the level of risk and the greater the need for regulation. Lower risk categories can rely on guidance more than regulation.

Table 4 and Table 5 include examples of how a risk-based management system could work in Minnesota. The tables divide reuse scenarios into three categories, and suggest a management approach for each:

- **Category 1 (low risk):** Primarily guidance
- **Category 2 (moderate risk)**: Mix of guidance and regulation
- **Category 3 (high risk):** Primarily regulation and licensing

Table 4 illustrates how each category has similarities to an existing water-related management approach in Minnesota, making it possible to estimate the resources required. Table 5 presents water reuse scenarios and management roles. A key component of ensuring long-term safety and sustainability of reuse systems is for someone to take responsibility of the system throughout its lifetime. The Workgroup uses the term Responsible Management Entity (RME) in the tables.

Next Steps for Consideration

- Determine where Minnesota reuse applications fit into the risk categories.
- Evaluate the risk-based management system using existing or new case studies. Case studies would be used to assess how these categories would be applied and any additional costs that would result, both to project developers and/or agencies and local government.
- Continue to evaluate resources required to implement a risk-based management system.

Table 4. Potential Risk Management Categories in Minnesota

Approach by Risk Category	Potential Agency Responsibilities	Similar Existing Approaches in Minnesota
1. Category 1 (low risk): Primarily guidance ▪ Lay out criteria at the state level. ▪ Make guidance and education materials available (e.g., in the Stormwater Manual). ▪ Expect systems to follow criteria. ▪ No regulation or enforcement of the criteria except in cases where a public health nuisance or environmental concern occurs.	▪ To develop, review, and maintain guidance and education materials. ▪ To register systems.	Recreational water quality criteria (i.e., swimming beaches)
2. Category 2 (moderate risk): Mix of guidance and regulation ▪ State reviews complex systems. ▪ Authorized local entities review less complex systems. ▪ RME monitors at pathogen control points, maintains records and provides records upon request.	▪ To review and permit systems. ▪ To maintain expertise for reviewing technologies. ▪ To develop and maintain design guidance and educational materials for designers and users. ▪ To periodically collect and review monitoring data for evaluation purposes. ▪ To take enforcement actions if criteria are not met.	Septic system management
3. Category 3 (high risk): Primarily regulation and licensing ▪ State or delegated local authority reviews and permits, manages performance reports and certifications, performs periodic inspections, and enforces permit compliance. ▪ RME must be qualified/certified, accept all performance responsibility, comply with permit requirements and reporting and provide financial security.	▪ To regulate, license, review and permit systems. ▪ To maintain expertise for reviewing technologies. ▪ To develop and maintain design guidance and educational materials for designers and users. ▪ To perform inspections (at most annually). ▪ To enforce permits.	Water supply facilities, wastewater treatment facilities, or public pools

Table 5. Potential Reuse Scenarios by Risk Category and Roles[6]

Example	# of Persons Exposed (pe/d)[7]	Likelihood of Malfunction	Management Category and Considerations	Agency Role
1) Single-owner occupied system using roof runoff for irrigation	Small user base (< ~20 pe/d)	Low: low pathogen content, simple process	Category 1: Building owner serves as RME with full responsibility	Provides educational information to building owners
2) Single-owner occupied system using graywater for toilet flushing and irrigation	Small user base (< ~20 pe/d)	Moderate: equipment maintenance required	Category 2: Independent registered service agent provides O&M	Requires manufacturer certification of equipment, O&M manual and issues permit
3) Single owner-occupied system using roof runoff and treated wastewater for toilet flushing, laundry and subsurface irrigation	Small user base (< ~20 pe/d)	Considerable: complex equipment requires routine O&M by trained staff	Category 2: Independent registered service agent provides O&M	Registers/licenses service agent, defines reporting of data and issues permit
4) Multi-user building with roof runoff system for irrigation	Moderate user base (20-100 pe/d)	Low: low pathogen content, simple process	Category 1: Building owner or homeowner association serves as RME with full responsibility	Registers/licenses service agent, defines performance reporting, issues permit
5) Multi-user building with stormwater system for irrigation	Moderate user base (20-100 pe/d)	Moderate: moderate pathogen content, system requires trained O&M staff oversight	Category 2: RME fully complies with regulatory authority's requirements	Registers/licenses service agent, defines reporting of data, issues permit
6) Golf course or athletic field with stormwater system for irrigation; restricted to nighttime use	Moderate user base (20-100 pe/d)	Moderate: moderate pathogen content, system requires trained O&M staff oversight	Category 1: Facility owner serves as RME with full responsibility	Provides educational information to building owners, registers system
7) District/multi-user building collecting roof runoff and treated wastewater for toilet flushing, laundry, cooling and irrigation	Large user base (100-5,000 pe/d)	Considerable: complex equipment requires routine O&M by skilled staff	Category 3: RME fully complies with regulatory authority's requirements with financial security and routine reporting	Registers/licenses service agent, defines reporting of data, issues permit, ensures financial guaranty

[6] (Adapted from Table 2-3, WE&RF Report) More details can be found in the WE&RF Report. Table adapted to include some systems currently in use or being developed in Minnesota, but is not comprehensive.

[7] pe/d = People exposed per day to the nonpotable water. The <~20 pe/d figure is a rough estimate of likely exposures in a single residence with consideration of visitors to the residence.

Recommendation f. Develop water quality criteria for a variety of reuse systems based on the log reduction target approach for pathogens

To manage human health risks

The Workgroup found that the log reduction target approach is used by a variety of entities to reduce risks from pathogens. The Workgroup identified the following benefits of this approach:

- Sets criteria specific to a variety of sources (not one size fits all) and end uses (fit-for-purpose) and can easily incorporate new data.
- Directly addresses human health concerns related to specific groups of pathogens.
- Offers a variety of options for meeting reduction targets.
- Makes use of existing, validated treatment technologies, and allows for new innovative technologies to be validated.
- Allows use of remote process monitoring rather than on-site monitoring.

The log reduction target approach uses the source water quality and end use exposure level to manage risks from specific pathogens of concern (pathogens include bacteria, viruses and protozoa). The log reduction target approach is consistent with fit-for-purpose concepts that suggest that drinking water quality is not needed for all end uses. Section V. Managing the Human Health Risks of Nonpotable Water Reuse of this report describes the log reduction approach in more detail.

In Minnesota this could look like:

- A flexible approach that determines what safeguard(s), such as treatment processes or management procedures, need to be in place to safely implement reuse.
- Tiered log reduction targets for pathogens based on the source and end use as appropriate. For example, wastewater requires greater reductions (more treatment and management safeguards) than rainwater, while vehicle washing has more exposure potential than toilet flushing and therefore requires greater reductions.
- Individual monitoring or verification of each treatment process or management procedure as appropriate to ensure effectiveness.

A log reduction target is already the basis for centralized reuse of municipal wastewater in Minnesota; therefore, the Workgroup is not recommending changes to the municipal wastewater reuse guidance at this time.

Next Steps for Consideration

- Work with the practitioner, advisor and stakeholder group (see Recommendation a. Create an expanded workgroup with practitioners, advisors and stakeholders) to develop Minnesota-specific criteria for log reduction targets, covering applications of current interest in Minnesota, and a process for adding applications in the future using the Australian Guidelines and WE&RF report as guides.
- Educate stakeholders about the log reduction target approach.

- Work with plumbing authorities to establish the log reduction target approach as a basis for the variance process until any regulatory changes are made.
- Determine recommended monitoring frequencies based on risk.
- Evaluate the log reduction approach using existing or new case studies. Continue assessing how this approach would be applied and any additional costs.
- Incorporate new information from current and future research projects as it becomes available.

Recommendation g. Resolve unique issues related to graywater reuse

To determine the feasibility of expanding graywater reuse

The Workgroup found that variances for graywater reuse are needed at this time, but there are potentially more efficient approaches if proper research and guidelines are available.

Graywater is currently regulated as wastewater, because graywater can contain pathogens and other contaminants of concern. Reusing graywater outdoors would require changes to Minnesota rules (for more information, see Graywater Reuse in Section III). For indoor use, graywater reuse is currently allowed only by variance to the plumbing code, primarily because of potential public health impacts. There are a number of potential issues that need to be examined before establishing a standard system for graywater reuse.

- Concentration of wastewater resulting from removal of graywater, which could require changes in design and maintenance of building plumbing, collection and treatment systems.
- Risks to groundwater quality if separation distances from dispersal to wells or the water table are not maintained.
- Potential public health impacts through increased exposure to pathogens from irrigation techniques other than drip or subsurface irrigation.
- Limitations to irrigation applications in Minnesota's cold climate.

Next Steps for Consideration

- Work with the practitioner, advisory and stakeholder group (see Recommendation a. Create an expanded workgroup with practitioners, advisors and stakeholders) to recommend potential solutions to address the issues listed above.

Recommendation h. Provide education and training

To support water reuse

The Workgroup found that surveys and comments from stakeholders identify a need for education and training for project designers and operators. Additionally, there is a growing interest for information sharing in the reuse community. Reuse has been a central topic at a number of conferences and roundtables convened by local governments, educational institutions and water and research organizations in Minnesota.

Various entities are already providing education and training on water and could expand their efforts to include water reuse:

- The UMN Water Resources Center provides training through its Onsite Sewage Treatment Program to installers, homeowners and small communities.
- The UMN Extension Stormwater Education Program provides training for managers, contractors, developers and engineers.
- A number of watershed districts provide training to member communities.
- The American Water Works Association and the Minnesota Wastewater Operators Association provide training to water and wastewater operators.

There are also national entities focused on educating and training about water reuse:

- WateReuse Association
- The Water Research Foundation

Next Steps for Consideration

- Make recommendations on education and training opportunities and requirements based on source water and reuse application**.**
- Review existing training materials and methods used by state and local governments for other water-related practices, such as stormwater, on-site sewage treatment, centralized wastewater and drinking water system management. Improve training or develop new training as needed for water reuse.
- Continue integrating the topic of reuse into conferences and events.
- Establish a Minnesota chapter of the WateReuse Association.
- Identify and pursue resources to support education and training activities.

II. Water Reuse in Minnesota

The Workgroup collected information on what types of reuse projects are happening in Minnesota and are gaining the most interest in the reuse community. The Workgroup wanted to evaluate needs for guidance and resources. Some types of systems are easy to track because they require permits, but most information comes from surveys or contact with people in the reuse community. This section provides a detailed summary of the most common types of reuse in Minnesota and a few emerging practices. It also covers variances for indoor applications of water reuse and funding sources for water reuse projects in Minnesota.

The types of reuse covered in this section are:

- Wastewater Reuse (nonpotable and potable - de facto, indirect and direct)
- Stormwater and Rainwater Reuse – Outdoor Use
- Stormwater and Rainwater Reuse – Indoor Use
- Graywater Reuse
- Additional Reuse Categories (industrial process, subsurface and superfund program)

For each type of reuse, you will find 1) an overview of projects being implemented and examples, 2) how it is currently managed and 3) the Workgroup's thoughts about some important challenges and opportunities.

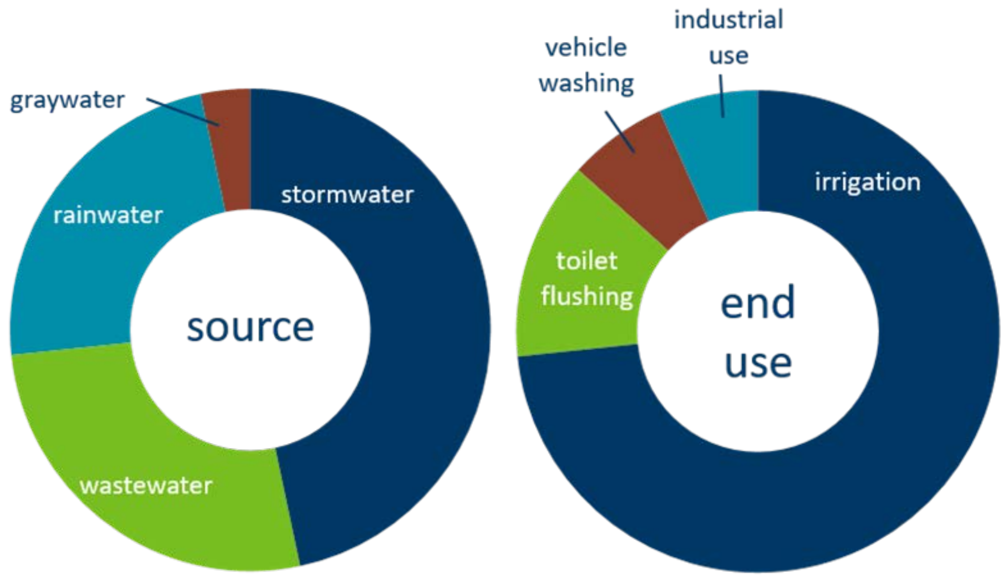
The Workgroup selected the content in this section and organized it based on what is most relevant to Minnesota and this report. It is not meant to cover all types of reuse or every aspect of reuse.[8]

The information gathered in this section informed the recommendations in the following ways:

- Centralized wastewater reuse already has a clear regulatory pathway and water quality requirements, so while ongoing review of practices and policies is recommended, the report recommendations do not focus on this type of reuse.
- Indoor reuse systems would potentially be best managed by MDH based on expertise regarding decentralized water systems including management and treatment.
- Variance processes are often a barrier for reuse projects, so the recommendations attempt to focus on research, guidance and oversight to allow more reuse applications to become standard practices.

[8] Several other practices are not categorized as "reuse" for the purpose of this study, including rapid infiltration for stormwater and wastewater disposal, and rain gardens or other bioretention basins.

Figure 3. Common types of water reuse projects in Minnesota by source and end use (estimations)



Wastewater Reuse

Wastewater reuse includes the reuse of treated municipal wastewater and is also known as recycled wastewater. Types of wastewater reuse include nonpotable and potable (de facto, indirect and direct).

Nonpotable Wastewater Reuse in Minnesota

Nonpotable wastewater reuse has been practiced in Minnesota for more than 40 years (MPCA, 2010). The primary driver of this practice is to limit discharge of pollutants to surface waters. This practice began as an effort to reduce the amount of pollutants being discharged to Minnesota lakes. Land treatment, rather than discharge to surface waters, provided a means for accomplishing this. The most common type of wastewater reuse, measured by number of permits, is irrigation of cropland, grassland or forests. Recently, more communities are recycling wastewater for golf course irrigation, industrial cooling and, in a few cases, toilet flushing. In 2017, over 40 Minnesota cities or private wastewater treatment facilities were reusing treated wastewater for some type of irrigation. Reuse of treated wastewater for cooling, while currently only practiced at the Mankato Energy Center, is currently the largest type of wastewater reuse by volume.

Figure 4. Treated wastewater used for golf course irrigation, Shakopee Mdewakanton Sioux Community

Current Regulation for Nonpotable Wastewater Reuse in Minnesota

Wastewater reuse for nonpotable uses is currently allowed under Minnesota rule. The regulatory path for wastewater reuse is essentially the same as that of all wastewater treatment and disposal, as illustrated in Figure 5. If wastewater reuse is added as a new type of treatment at an existing treatment facility, the existing permit may be modified or reissued, but the regulatory path would be essentially the same in either case.

Permit Requirements: The discharge of treated wastewater to surface waters, ground surface (e.g., spray or drip irrigation) or subsurface is regulated by the MPCA. The two types of water quality permits are the NPDES and the SDS.

The NPDES permit is a federal program, established under the Clean Water Act, regulating any treatment and disposal system that discharges to surface waters. For projects that discharge to both surface waters and ground surface/subsurface, an NPDES permit is issued jointly with an SDS permit. The SDS permit is a Minnesota program established under Minnesota Statutes, chapter 115, regulating discharges to ground surface (e.g., spray irrigation) or subsurface disposal.

Permits are issued on a case-by-case basis. Requirements vary based on the design flows of the facility, the type of treatment system, and where and how the treated wastewater will be discharged.

Wastewater Reuse Risk Levels and Treatment: The primary concern with reusing municipal wastewater is public health protection. Municipal wastewater is known to contain pathogens, therefore, reuse regulation is based on the potential for human exposure to the wastewater.

Since 1992, the MPCA has used the State of California Regulations as guidance for the permitting of wastewater reuse. California was one of the first states to develop detailed regulations to ensure that wastewater reuse would be protective of human health. Many other states have used California regulations as a template for their own requirements (USEPA, 2012). California bases the required level and method of treatment on the end use.

Typical wastewater treatment plants use conventional treatment components, including primary treatment (screening, settling) and secondary treatment (aeration), designed to meet standards for disposal of the treated wastewater into the environment. At a minimum, municipal wastewater must be treated by a secondary treatment process or its equivalent prior to nonpotable reuse. The highest level of treatment ("disinfected tertiary") also requires enhanced disinfection and filtration. The California Department of Public Health maintains a list of acceptable technologies. Other technologies may be allowed with additional justification. See California's Alternative Treatment Technology Report for Recycled Water for more information about the design and operation of filtration and disinfection processes.

Figure 5. Nonpotable Wastewater Reuse: Current Regulatory Path

Treatment Levels: Treatment levels and processes are established for three categories of nonpotable reuse:

- *Disinfected tertiary* treatment applies to uses with the highest degree of human contact, such as root crops, residential and public landscape irrigation, toilet flushing, snow making and cooling towers. Total coliform limit is 2.2 MPN (Most Probable Number)/100 ml (milliliters). A turbidity standard of 2 NTU (Nephelometric Turbidity Units) daily average and 10 NTU daily maximum also applies.
- *Disinfected secondary 23* treatment applies to uses with moderate risk of human contact, such as irrigating cemeteries, roadway landscaping, nursery stock and sod farms, pasture for livestock, industrial boiler feed water and similar uses. Total coliform limit is 23 MPN/100 ml.
- *Disinfected secondary 200* treatment applies to uses with little or no potential for human contact, such as spray or sprinkler irrigation of animal feed, fiber, and seed crops, Christmas trees and sod farms. Fecal coliform limit is 200 MPN/100 ml.

Disposal of Residuals: Additional treatment for reuse may involve various filtration components, such as granular media (e.g., greensand) filtration, microfiltration, ultrafiltration, nanofiltration and/or reverse osmosis. Lime softening and/or ion exchange softening steps also sometimes are used. Each of these treatment technologies makes the reused wastewater cleaner by removing additional pollutants – which then need to be disposed of in an environmentally sound manner. These residuals are typically highly concentrated, with much higher pollutant levels than the original treated wastewater before diversion for reuse.

Filters of various types remove concentrated particulates, salts, bacteria, viruses, metals and phosphorus, resulting in a residual brine or sludge. These residuals must be disposed of according to the applicable wastewater rules (NPDES and SDS) and solid and hazardous waste rules (Resource Conservation and Recovery Act), which can add substantial capital and O & M costs to the reuse project.

Storage Requirements: Irrigation using wastewater is prohibited during the winter in Minnesota. Irrigation facilities that cannot discharge elsewhere must provide a minimum of 210 days of storage to hold through the winter months. Facilities must also have a reuse contingency plan to ensure that insufficiently treated wastewater is not reused.

Other Restrictions: Additional restrictions include the following:

- Spray irrigation, other than disinfected tertiary water, is not allowed within 100 feet of a residence, playground, school or other area with similar public exposure.
- Runoff of recycled wastewater from the site is prohibited.
- Setback distances from wells must be in accordance with the Minnesota well code (Minnesota Rules, chapter 4725).
- Signs must be posted in all public use areas stating that the water is reused and nonpotable.

Monthly reporting and an annual report to the MPCA are required. The annual report must list locations and volumes of reused water used and a summary of monitoring results.

Note: In addition to the MPCA requirements, the quality of water used for irrigation of food crops will be regulated in the future by MDA, under the USDA's Food Safety Modernization Act (FSMA). The Produce Safety Rule is discussed below under Food Processing Water Reuse.

Considerations for Nonpotable Wastewater Reuse

Wastewater reuse offers the benefit of a consistent and high-volume source, and there is a good amount of research on quality and treatment technologies available. Implementation is currently limited in Minnesota primarily because other sources of water are relatively less expensive. Industries and other users typically choose municipal or groundwater sources. In addition, wastewater treatment plants are often not located near the end use. "Sewer mining" (tapping directly into sewer mains) and decentralized local treatment may be ways to increase wastewater reuse.

Reusing wastewater for irrigation can have the added benefit of applying nutrients such as nitrogen and phosphorus to grass or a cover crop. The nutrients can be used by the plants, reducing transport of nutrients to surface waters.

Decentralized (building to district/neighborhood scale) wastewater reuse is gaining interest in Minnesota, but does not currently have the same structure as centralized wastewater reuse. For example, if a building recycled wastewater, the MPCA would not get involved until the wastewater is discharged to the environment (typically through the municipal system). The MPCA would not offer oversight of the treatment system within the building.

Potable Wastewater Reuse in Minnesota

This report uses potable reuse definitions from the Framework for Direct Potable Reuse (WateReuse Research Foundation, 2015, p. xvi).

Definition of De Facto Potable Reuse:

> *The downstream use of surface water as a source of drinking water that is subject to upstream wastewater discharges (also referred to as "unplanned potable reuse").*

De Facto Potable Reuse in Minnesota: This situation is known to occur in locations in Minnesota where surface water comprises all or part of a municipal supply, such as the cities of Moorhead (downstream from Breckenridge) and Minneapolis and St. Paul (downstream from St. Cloud).

Considerations for De Facto Potable Reuse: Given the high level of wastewater treatment, dilution of the discharged wastewater, and drinking water treatment in all the areas where de facto reuse occurs, it is not considered a threat to water supplies in Minnesota, and is not the focus of this report.

Definition of Indirect Potable Reuse:

> *The introduction of advanced treated water into an environmental buffer such as a groundwater aquifer or surface water body before being withdrawn for potable purposes (see also "de facto potable reuse"). Indirect potable reuse can also be accomplished with tertiary effluent when applied by spreading (i.e., groundwater recharge) to take advantage of soil aquifer treatment.*

While septic systems could be considered IPR, there is not typically a direct intention to supplement drinking water supplies, although the treated wastewater could help replenish an aquifer.

Considerations for Indirect Potable Reuse: The Workgroup discussed IPR methods, including the deep injection of advanced treated (disinfected tertiary) wastewater directly into the aquifer, infiltration and subsurface injection. Several other states practice IPR and have detailed guidance available. Before IPR is practiced in Minnesota, we need to ensure safety and feasibility by considering and addressing any issues that may be unique to Minnesota's geology and groundwater quality.

Definition of Direct Potable Reuse:

> *There are two forms of direct potable reuse. In the first form, advanced treated water is introduced into the raw water supply upstream of a drinking water treatment facility. In the second form, finished drinking water from an advanced water treatment facility permitted as a drinking water treatment facility is introduced directly into a potable water supply distribution system.*

Considerations for Direct Potable Reuse: While DPR is technically possible, most Workgroup members felt that DPR should not be considered a high priority at present, given its high costs and limited applicability. Minnesota is not currently in a situation of water scarcity that necessitates DPR. However, Minnesota agencies, practitioners and implementers should monitor DPR efforts in other states. Texas and New Mexico have both established criteria for DPR, with projects requiring review by an expert panel. California initiated a feasibility study of DPR starting in 2012 and continues to move towards implementation. Other countries have also implemented DPR.

Stormwater and Rainwater – Outdoor Reuse

Outdoor reuse of stormwater is quickly becoming the most widespread type of water reuse in Minnesota. The most common use is for landscape irrigation. Other uses include cropland irrigation, street cleaning, dust control, vehicle washing, firefighting and decorative water features. Examples of stormwater reuse projects developed in the past decade can be found in the Minnesota Stormwater Manual. Some projects use only roof-collected rainwater, while most are using stormwater out of ponds.

Minnesota watershed districts, watershed management organizations, and a number of cities in the metropolitan area are pioneering stormwater reuse. These efforts are typically driven by NPDES permit requirements to reduce the quantity and improve the quality of the stormwater that leaves a site. Reducing the demand on groundwater and drinking water supplies are significant additional benefits, but are typically not the primary drivers of this practice.

Figure 6. Stormwater irrigation system for residential landscape irrigation in city of Carver, Carver County. Homeowners' association will manage system.

Current Regulations for Outdoor Reuse of Stormwater and Rainwater in Minnesota

For outdoor reuse, rainwater is generally managed identically to stormwater, although the volume of water collected from roof surfaces tends to be smaller.

Outdoor stormwater reuse is managed primarily by the MPCA and by local authorities such as cities, watershed districts and watershed management organizations that regulate the quantity of water discharged by a facility to protect water quality in receiving waters. The MPCA issues three types of stormwater related permits: Industrial, Municipal and Construction (the majority of permittees are covered under a general permit developed for each of these categories). All of these permits are mandated by federal regulations under the Clean Water Act. The DNR regulates stormwater use that exceeds withdrawals of 10,000 gallons per day or one million gallons per year unless the water is withdrawn from "constructed management facilities for storm water."

Industrial Stormwater (ISW) Permit: There are approximately 3,300 industries in Minnesota covered by the ISW Permit, with permit requirements for individual industries based on their Standard Industrial Classification (SIC) Code. There is currently no language within the ISW Permit related to or requiring stormwater reuse; however, the ISW program has developed guidance for reuse. Each ISW permittee must develop and implement a stormwater management program to reduce pollutant discharges from their facility. No additional MPCA permits would be required for a stormwater reuse project implemented at an ISW permitted facility at this time.

Construction Stormwater (CSW) Permit: There are generally about 2,000 construction projects each year that disturb more than one acre of land and therefore must obtain coverage under the CSW General Permit. While a major focus of the general permit is erosion and sediment control during construction, the permit also contains requirements for permanent stormwater treatment after a construction project has been completed. The permit focuses on stormwater volume reduction as the primary means of achieving the required stormwater treatment. The MPCA considers stormwater reuse as one of the potential BMPs for achieving the required stormwater volume reductions. As with the ISW permit, a CSW permittee would not need any additional MPCA permits to develop and implement a stormwater reuse project. The MPCA provides an overview of the CSW permit process at Construction Stormwater Permit Overview.

Municipal Separate Storm Sewer System (MS4) Permit: The MS4[9] General Permit gives owners or operators of MS4s approval to discharge stormwater to lakes, rivers, streams and wetlands in Minnesota.

There are currently 255 public entities[10] that are regulated under the MS4 Permit Program. These MS4 permittees are required to develop and implement a stormwater management program to reduce pollutant and sediment discharges from their stormwater conveyance system. One required element of the stormwater management program is the adoption of local controls and ordinances to reduce stormwater pollutant discharges from new development and redevelopment. Stormwater reuse is identified as one of the potential ways to meet these stormwater treatment standards.

CSW permits are also required in MS4 regulated communities, although there is some overlap between the CSW and MS4 permanent stormwater treatment requirements.

Projects that are driven purely by conservation - not undertaken in response to a water quality issue or as part of a new development or redevelopment - do not require a discharge permit.

Water Appropriation Permit – Stormwater Exemption: The DNR regulates the withdrawal and use of water; it does not regulate the collection of precipitation, snowmelt or other runoff water. A water appropriation permit from the DNR is required for withdrawal of more than 10,000 gallons of water per day or one million gallons per year with some exceptions. In 2017, a law was enacted that exempts some stormwater reuse facilities from this requirement (Laws 2017, Chapter 93, Sec. 116). No DNR permit is required for withdrawing water from a source that fits the definition of a “constructed management facilities for storm water.” This is defined in Minnesota Statutes, part 103G.005 as:

> *“Constructed management facilities for storm water” means ponds, basins, holding tanks, cisterns, infiltration trenches and swales, or other best management practices that have been designed, constructed, and operated to store or treat storm water in accordance with local, state, or federal requirements.*

Permits are required for withdrawal of stormwater from water features that do not meet this definition.

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[9] In general terms, MS4s are publicly owned or operated stormwater infrastructure, used solely for stormwater, and which are not part of a publicly owned wastewater treatment system. Examples of stormwater infrastructure include curbs, ditches, culverts, stormwater ponds and storm sewer pipes. Common owners or operators of MS4s include cities, townships and public institutions. See Municipal Stormwater Program (https://www.pca.state.mn.us/sites/default/files/wq-strm4-01.pdf) for details.

[10] This includes 253 permittees covered by the General Permit and two permittees covered by individual MS4 Permits (Minneapolis and St. Paul).

While outdoor stormwater reuse is subject to state permit requirements for discharge, the operation of the stormwater reuse facility itself is largely unregulated. Unlike a wastewater treatment facility, a stormwater treatment and conveyance system does not currently require individualized testing and monitoring unless required by the local entity (city) or watershed district. However, the Minnesota Stormwater Manual is intended to fill this gap by providing detailed guidance on the design, testing, operations and monitoring of stormwater reuse systems.

Note: In addition to MPCA and DNR requirements, the quality of water used for irrigation of food crops will be regulated in the future by MDA, under the USDA's Food Safety Modernization Act (FSMA). The Produce Safety Rule is discussed below under Food Processing Water Reuse.

Figure 7. Large stormwater pond in Waconia will serve new commercial lots along Highway 5 as part of a regional reuse system the city will manage. Water will also be used for street sweeping.

Considerations for Outdoor Reuse of Stormwater and Rainwater

Stormwater runoff is a leading source of water pollution. Runoff from buildings, city streets, driveways, parking lots and sidewalks can change the way water flows, impact aquatic habitats, and elevate pollutant concentrations in surface waters.

While stormwater reuse is an important BMP for stormwater management, it is only one of many, and is best used in conjunction with other practices such as rain gardens, green roofs, and other green infrastructure practices, where feasible. In some cases stormwater reuse can help replicate pre-settlement hydrology by encouraging water to soak into the ground instead of flowing directly to surface waters. In other cases, stormwater runoff is part of the hydrologic cycle and may be an important source of water for streams and wetlands. Overuse of stormwater for irrigation can reduce or disrupt needed flows to these waters. However, in areas where infiltration is not feasible due to heavy clay soils and other constraints, reuse can be the best option.

The available volume of stormwater is usually less than wastewater, and is more intermittent in nature. Therefore storage capacity is a key factor in system design. In some cases stormwater storage needs to be emptied quickly in order to be available for the next rain event, making irrigation a less desirable use for this water (since landscape may not need to be irrigated soon after rainfall).

Stormwater and Rainwater – Indoor Reuse

Indoor reuse of stormwater is less common than outdoor use. Some projects, such as CHS Field in St. Paul, where rainwater is used to irrigate the ballfield and flush toilets, involve both indoor and outdoor uses. The regulatory path for indoor reuse of rainwater recently became clearer with changes to the plumbing code described below.

Current Regulation for Indoor Nonpotable Reuse of Stormwater and Rainwater in Minnesota

Capture and harvesting of rainwater from roofs for indoor nonpotable use is specifically allowed under the Minnesota Plumbing Code, Minnesota Rules, chapter 4714. The 2015 revision of the code took effect on January 23, 2016**.** The code incorporates the 2012 edition of the Uniform Plumbing Code with Minnesota-specific amendments and replaces the old Minnesota Rules, chapter 4715.

The following discussion applies to indoor "nonpotable rainwater catchment systems" (the terminology used in the plumbing code). If rainwater captured from a roof is used outdoors, it would be regulated just like stormwater, as discussed in the previous section. Indoor use of stormwater currently requires a variance from the Plumbing Board.

These requirements currently apply to indoor nonpotable rainwater catchment systems[11]:

- When designed, installed, treated and maintained to meet code requirements, nonpotable rainwater catchment systems are acceptable for use to supply water to toilets, urinals, trap primers for floor drains, industrial processes (but not food industries), water features, vehicle washing facilities and cooling tower makeup water.
- Required O & M, monitoring, testing and inspection of rainwater catchment systems are the responsibility of the property owner.
- Filtration and disinfection of rainwater catchment systems must be provided to maintain minimum water quality for use.
- Rainwater catchment systems must be designed by a Minnesota-registered professional engineer.
- Cross-connection inspection and testing are required after the initial installation in the presence of the administrative authority. After this initial inspection, a cross-connection inspection is required annually and a cross-connection test is required every five years.

[11] According to the Minnesota Plumbing Code A rainwater catchment system is defined in the plumbing codes as "a system that utilizes the principle of collecting, storing and using rainwater from a rooftop or other aboveground, manmade collection surface."

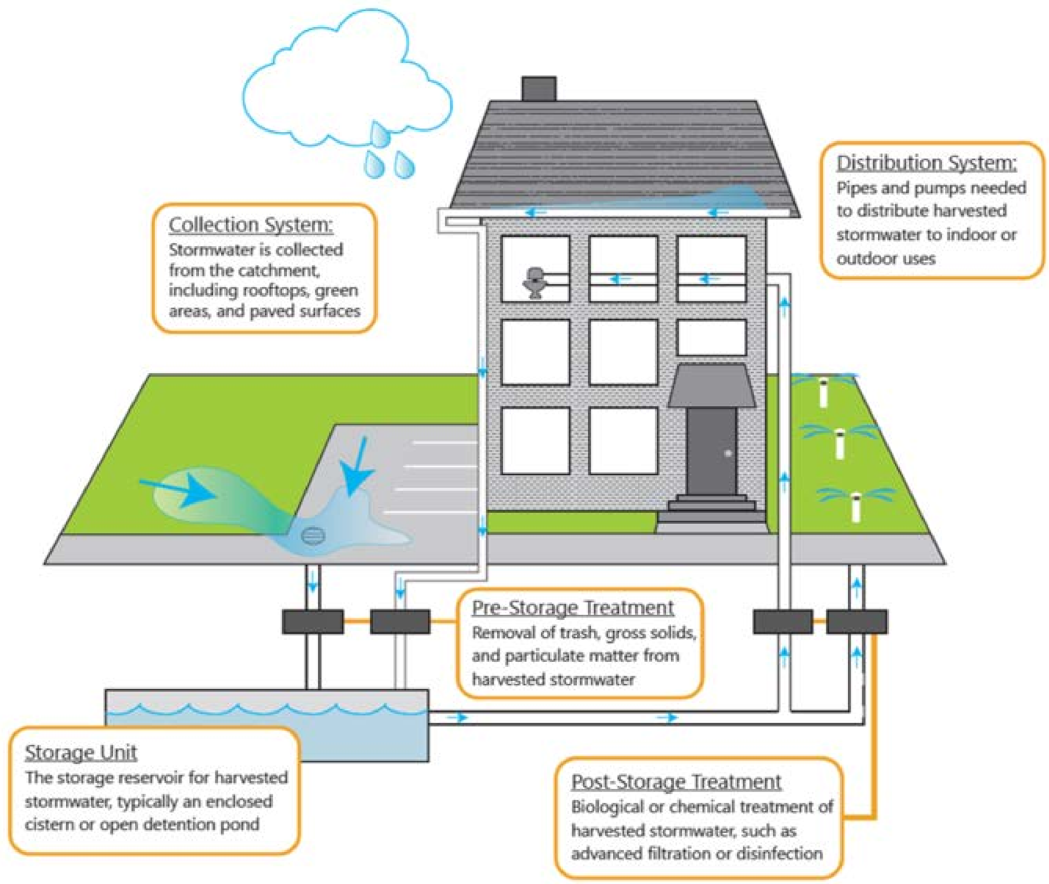

Figure 8. Schematic of rainwater/stormwater harvesting system from Minnesota Stormwater Manual

DLI administers the plumbing code and requires plan submittal, licensing of plumbers, and inspection and testing of new or altered systems.

- Plans for installations of plumbing in public, multifamily, commercial and industrial facilities must be reviewed and approved by DLI or the administrative authority prior to installation.
- DLI conducts inspections in areas of the state where there is no adopted building code or where plan review agencies and licensed plumbers are not available to perform inspections.
- In communities that have adopted the state building and plumbing codes, local building officials are authorized to perform inspections, except for state projects.

Considerations for Indoor Reuse of Stormwater and Rainwater

Indoor reuse of stormwater and rainwater offers benefits when irrigation is not needed for a site. It can be available for year-round use, even if not a consistently available source. It is important to note that the plumbing code allows indoor reuse of rainwater, but not of stormwater. Indoor use of stormwater, with the exception of cooling water used by industries, typically requires a variance from the Plumbing Board. The Uniform Plumbing Code contains a chapter on “alternate water sources for nonpotable applications.” This chapter was not adopted in Minnesota, in part because without amendments it would create conflicts with other Minnesota rules, and in part because it references the "health authority having jurisdiction" in relation to water quality requirements. In Minnesota, there is no specific authority for an agency to set water quality standards for nonpotable uses.

In general, the Workgroup thought that incorporating indoor reuse standards in the plumbing code seemed problematic on a few levels:

- Water treatment requires a different skill set than plumbing.
- Plumbing authorities are typically not set up for ongoing oversight.
- The Uniform Plumbing Code requires additional input from other agencies, but without prior authority granted to those agencies.

Potable Reuse of Stormwater and Rainwater

Under the SDWA, harvested rainwater is an allowable source of drinking water under certain conditions, and must meet treatment requirements described in the Surface Water Treatment Rule. There are currently no public water supplies in Minnesota using harvested rainwater as their drinking water source. Direct stormwater reuse for potable uses is also not practiced in Minnesota, although stormwater is a component of many natural surface waters. Using any source of surface water (including harvested rainwater) for drinking is not currently recommended at the homeowner level because of the treatment and monitoring required to ensure safe drinking water.

Graywater Reuse

Graywater reuse is not widely practiced in Minnesota for several reasons:

- There are concerns regarding health risks and potential for human exposure (special considerations needed for at-risk populations like children and the elderly).
- Irrigation is only feasible for part of the year, while graywater is produced year-round.
- Current regulations are restrictive (see below).

Current Regulation for Graywater Reuse in Minnesota

Minnesota rules for graywater systems (Minnesota Rules, part 7080.2240) treat systems as essentially equivalent to a septic system for wastewater. A separate tank is required, and the system is assumed to discharge to a subsurface drainfield. However, the flow values used in sizing the system are 60 percent of conventional septic systems and the minimum tank capacity is also reduced. The rule is used largely for remote sites without conventional septic systems because they use a composting toilet or outhouse.

The plumbing code (Minnesota Rules, part 4714.0311) requires that if a public sewer or another method approved by the MPCA is available for a building, it must be used for any type of liquid waste from any plumbing system in that building. Additionally, if a public water supply is accessible, it must be connected, unless otherwise permitted by the administrative authority (typically a city).

Because of these provisions and the potential public health impacts, graywater use within a building requires a variance from the Plumbing Board. As discussed below, several systems have been approved in recent years for purposes of water conservation or where adequate public water supplies are unavailable. These systems provide treatment as appropriate for the end use.

Figure 9. Shower building at Lake Vermilion State Park. Photo: SRF Consulting

Considerations for Graywater Reuse

Graywater provides a steady source of reuse, regardless of rainfall, as compared with stormwater. It has been shown to more effectively meet toilet flushing demand compared with stormwater in several cities. Reuse of graywater is typically more beneficial for residential and multi-residential applications than most commercial buildings which are not likely to generate enough graywater to meet end use demands (NAS, 2016). Some commercial applications where graywater reuse makes sense include hotels and laundromats. However there are issues that need to be resolved before making graywater reuse common practice:

- If graywater is removed from wastewater, the wastewater could become more concentrated. This could require increased frequency of flushing for sewer mains or changes in the design of on-site sewage treatment systems to address the increased concentration of solids and pollutants. Reduced flow could also impact plumbing and drainage systems.
- There are currently regulations regarding wastewater dispersal (e.g., separation distances) to make sure it is properly treated and does not impact water quality.
- Drip or subsurface irrigation would be needed to construct a “laundry to landscape” system, and would need to be designed to meet standards in existing state rules. Irrigation techniques, other than drip or subsurface irrigation, could have a negative impact on public health through increased exposure to pathogens. Furthermore, all irrigation applications have limitations in Minnesota’s cold climate and may not result in significant water savings.

- Graywater reuse, even in conjunction with composting toilets, does not always avoid the need for a septic system because kitchen sinks can still add contaminants to the graywater that prohibit or complicate reuse. In addition, composting toilets require a variance to the plumbing code.

Additional Reuse Categories

The following types of reuse are unique enough that they lack common regulatory paths, but rather are regulated based on their specific site conditions and exposure risks.

Industrial Process Water Reuse

Industries are prime candidates for water reuse as they are often high-volume users of water and/or producers of wastewater. Reuse for industrial processes is typically not regulated by the Minnesota Plumbing Code, unless the reused water is supplying plumbing fixtures. Typically an industry is responsible for the safety of the process and the workers. Regulation of industrial water use generally occurs at the "front end" (the amount of water the plant can use under its appropriation permit, if it has one) and the "back end" (the standards for the quality of the water the plant discharges). However, many industrial operations purchase water from public supplies and do not need a separate appropriation permit.

Granite Falls Energy, an ethanol plant in southwest Minnesota is an example of industrial process water reuse in Minnesota. The plant uses stormwater and agricultural drainage water to reduce the amount of groundwater it pumps[12]. Refineries in the metro area have also reduced their water consumption through recycling. Another relatively common and generally accepted type of industrial reuse is recycling of water in commercial car washes.

Many reuse efforts are motivated by the need to ensure consistent product quality while reducing inputs and associated costs. Water appropriation permit requirements may also limit the amount of water that can be withdrawn from groundwater or surface water.

One source of assistance in identifying reuse opportunities is the Minnesota Technical Assistance Program. The Minnesota Technical Assistance Program provides technical assistance for industrial water efficiency and reuse through engineering assistance by experienced staff and places students with companies to work on energy and waste reduction projects. Many of these projects have resulted in water reuse efforts at the host companies.

Food Processing Water Reuse

Water use by food processors is more closely regulated than that of other industries. Source water must come from a "suitable water supply" (Minnesota Statutes, section 31.175). This means it must meet Minnesota rules as a water supply, and the water must meet drinking water standards at the point where it enters the plant. Water used in food marketing (grocery stores) is also regulated.

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[12] Producer spotlight: Granite Falls Energy (www.mnbiofuels.org/newsletter/item/489)

The food processing industry has been reusing water within its facilities for some time. In general, water reused within a facility must be monitored to ensure that the water does not become a source of contamination to the final product. Generally, the water is monitored for bacteriological qualities, but could also be monitored for physical factors (such as pH), or chemical factors, depending on the use.

Current examples of water reuse in food processing facilities include the following:

- Some plants use evaporators to condense products for shipping and/or drying, such as whey from cheese manufacturing. The water removed during condensing is known as “cow water” (Condensate of Whey). The cow water is stored for reuse then used for multiple purposes, including clean-in-place (CIP) pre-rinse and cleaning make-up water (not final rinse), boiler feed water and other limited uses. If the cow water meets some enhanced criteria, it can be used for other purposes, such as at hose stations, for CIP final rinse, and for sanitizing and process water. The criteria for these purposes are listed in the Pasteurized Milk Ordinance (a federal regulation applied by MDA) as plant reclaimed water, Categories 1, 2 and 3. Most cheese plants use Category 2 reclaimed water for limited purposes. Some plants have used chemical treatment or UV treatment of the reclaimed water to allow use as Category 1 reclaimed water (potable water uses).
- One plant operates high temperature processing equipment and routes the non-contact hot water from plate heat exchangers to a storage tank for use in CIP systems and hose stations. This project was undertaken to eliminate most of the hot water discharge into a lake, but the benefit is water reuse and reduced heating input to CIP systems.
- Some whey processing facilities use filtration permeate from their processes to feed a reverse osmosis (RO) system. The RO permeate water is then used for further processes such as micro or nanofiltration. The RO water is considered Category 1 (as stated above), and is used in the enhanced filtration processes to suspend the solids to aid further filtration. These facilities also use the RO water for CIP purposes.
- Raw peas (for processing into canned or frozen product) come into a plant and go through a series of flumes to wash off field dirt, drop out stones or mud balls, float off other plant debris, etc. The flume water recycles through the system; approved chemicals are used to enhance the process, fresh water is added periodically, and water quality is monitored (pH factors, bacteriological qualities) to ensure that the reused water does not become a source of adulteration to the product.

One pilot project in Minnesota involved Gold’n Plump, which worked with MDH, the MPCA and other stakeholders in 2016 to test two ultrafiltration systems to determine whether reused water could meet drinking water quality standards and be used in product rinsing. While several uses of reconditioned water are allowed under USDA regulations, federal standards (USDA – 9 CFR 416.2(g)) currently do not allow for this type of reuse. This potential reuse system promises considerable potable water savings; however, it is challenging for MDH to evaluate the safety of the process when very little is known about the quality of this type of wastewater. It is not clear whether criteria for treatment of municipal wastewater should apply.

Produce is becoming more tightly regulated under the new Food Safety Modernization Act (FSMA). The Produce Safety Rule (21 CFR 112) became effective January 26, 2016, with varied implementation dates based on the size of the farm. The earliest implementation date is January 26, 2018. The rule establishes water quality standards and testing requirements for water applied to growing produce. There are important exemptions from the rule (type of produce, size of farm). Information on the rule can be found at FSMA Final Rule on Produce Safety.

There are additional standards in the produce rule for other uses of water, including water used for handwashing during and after harvest, water used on food-contact surfaces, water used to directly contact produce (including to make ice) during or after harvest, and water used for sprout irrigation.

It is also possible that industrial or food processing waters could be used for other public purposes. For example, a few cities have expressed interest in using once-through cooling water to augment their municipal supply of drinking water. There are other existing facilities that produce highly treated wastewater that could meet current Minnesota guidance for reclaimed wastewater. These applications will likely need to be reviewed on a case-by-case basis due to the uniqueness of each water source, but should be considered as potential reuse applications.

Subsurface Water Reuse

This category is diverse, ranging from water drawn from former mine pits and quarries to subsurface water removed from around building foundations, or groundwater pumped to remove and treat pollutants. This diversity makes it difficult to generalize or to identify common regulations or treatment protocols.

Figure 10. Dewatering mine pit in Hibbing

Subsurface Water Reuse in Minnesota: Examples of subsurface water reuse include the following, as well as water reuse in the Superfund Program, below:

- The drinking water supply for the cities of Burnsville and Savage is augmented by water from a privately owned limestone quarry, previously discharged into the Minnesota River. The quarry water, which is treated along with groundwater from the cities' wells, makes up about one-third of the water supply. Its use has relieved a decline in groundwater levels that was threatening the nearby Savage Fen, a rare type of wetland[13].

- A number of cities on the Iron Range draw drinking water supplies from former mine pits, which in turn are fed by groundwater, rainwater and runoff.

Water Reuse in the Superfund Program

Water reuse in the Superfund Program is managed by the MPCA. Reuse is often evaluated in the context of an overall cleanup effort. Initially after a water contamination issue is identified, the Superfund Program works to identify what the contaminants are and how widespread the problem is. Once the extent of contamination is known, the Superfund Program works through the remediation process to identify alternatives to restore the aquifer to acceptable concentration levels. Treatment options are identified, and the pros and cons of each alternative are assessed.

If the chosen alternative includes pumping water from the ground for treatment, the alternative may incorporate options for reusing the contaminated water after it is treated. For example, one alternative may be to pump groundwater to prevent the contamination from traveling further down gradient. Once the water is pumped, it may be feasible to treat the water to drinking water or industrial standards so that it can be reused for domestic or industrial use, respectively.

The following Superfund sites and applications are among those that include water reuse as a component of the overall remedy:

- 3M Woodbury Site – industrial reuse
- 3M Cottage Grove Facility – industrial reuse

There are other sites where drinking water wells are impacted by the Superfund site contaminants, and the use of those wells serves to help control contaminant plumes, but these sites are not considered reuse.

Current Regulation for Water Reuse in the Superfund Program: For drinking water reuse, MDH has regulatory authority for water quality standards and system design and monitoring. For industrial reuse, there is no specific oversight other than NPDES permit requirements for the ultimate discharge of the reused water.

Variances for Indoor Stormwater, Wastewater and Graywater Reuse

The Minnesota Plumbing Code does not currently provide a formal regulatory process for indoor stormwater, wastewater or graywater reuse. Such practices are allowed by a variance to the plumbing code approved by the Plumbing Board, or in some cases do not need plumbing review (e.g., many industrial processes). Minnesota Statutes, chapter 14.055 allows a person or

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[13] Burnsville-Savage water-sharing arrangement brings environmental benefits. Retrieved from www.startribune.com/burnsville-savage-water-sharing-arrangement-brings-environmental-benefits/253418301/

entity to petition an agency for a variance from a rule. There are several general standards that apply to variances:

- An agency may attach any conditions to a variance that it determines are needed to protect public health, safety or the environment.
- The variance is only applicable going forward, not retroactively.
- The conditions attached to a variance are enforceable.

An agency must grant a variance, known as a mandatory variance, if it finds that applying a rule in a particular instance would not serve any of the purposes of the rule. An agency has the option of granting a variance, known as a discretionary variance, if it determines that:

- Application of the rule would result in hardship or injustice.
- The variance would be consistent with the public interest.
- The variance would not prejudice (negatively impact) the legal or economic rights of any person or entity.

Minnesota Statutes, chapter 14.056 establishes procedures for variances. Agencies may charge a variance fee and apply specific standards and requirements. Applicants must show the following:

- Why the applicant believes that a variance is justified, under the three criteria above.
- The type of system proposed.
- The discharge water quality of the proposed system.
- Other information needed to assess the proposed system.

A variance application often involves a substantial amount of paperwork, and the outcome is uncertain. However, several variance applications submitted for graywater reuse in recent years have been approved by the Plumbing Board. Once a variance is approved, either DLI or the local authority conducts plan review and construction inspections. Variances approved in 2015 and 2016 included:

- Graywater system for washing golf carts at Manitou Ridge Golf Course in the city of White Bear Lake, with the goal of minimizing groundwater use in the vicinity of White Bear Lake.
- Graywater system at Lake Vermilion-Soudan Underground Mine State Park campground. There are limited groundwater and public water supplies in that area. Graywater from sinks and showers is used for flushing toilets in two shower buildings before being discharged to the septic system.
- Graywater drip irrigation system at the Margaret A. Cargill Philanthropies headquarters in Eden Prairie, with the goals of water conservation, a LEED Platinum rating for the site and promotion of sustainable practices.

Funding Sources for Reuse

Going into the future, both ongoing funding along with smart planning will be necessary to support successful reuse. Many Minnesota reuse projects have received funding through grants and other sources, including watershed districts and local governments. The following funding sources are available through state agencies, and through partnerships with federal agencies in some cases.

Clean Water, Land and Legacy Amendment: Funds are available for stormwater projects through the Clean Water Fund, administered by BWSR. These projects are awarded to county SWCDs, watershed districts, water management organizations and other entities. Projects often include reuse as one component of multiple conservation practices intended to reduce sediment and nutrient loading to water bodies, reduce runoff volumes, and curb erosion. Projects can be viewed under "Projects and Practices" at Minnesota Clean Water Fund.

Clean Water Revolving Fund (also known as the Clean Water State Revolving Fund or simply SRF): The fund provides financial assistance for wastewater and stormwater reuse. The SRF is established under the federal Clean Water Act and state law to make loans to for both point source (wastewater and stormwater) and nonpoint source water pollution control projects. The Public Facilities Authority prepares an annual Intended Use Plan (IUP) based on a Project Priority List developed by the MPCA. The IUP describes the projects and activities eligible for funding during the state fiscal year. This fund includes an allocation for green projects. For more information, see Wastewater and stormwater financial assistance.

State of Minnesota Watershed Project Funding: Funding opportunities for nonpoint sources of pollution are available through federal and state funds. Nonpoint sources of pollution include paved surfaces, storm sewers, construction sites, agricultural fields and over-fertilized lawns. These funds are awarded through either competitive watershed grants (such as Federal Section 319 and State Clean Water Partnership) or non-competitive (for Clean Water Fund dollars) processes. Funds have been awarded to several projects that reuse stormwater for golf course and ball field irrigation.

III. Water Reuse in other Jurisdictions

The Workgroup wanted to understand what methods of communicating and educating about water reuse were effective in other jurisdictions, since this will be an essential part of moving reuse forward in the future. The Workgroup did not focus on summarizing the regulatory structure for reuse in other jurisdictions, given that the USEPA 2012 Guidelines and National Academies Graywater/Stormwater Report already include useful summaries of state and international rules and practices. However, the report does review and discuss the risk basis for regulations in Section V. Managing the Human Health Risks of Nonpotable Water Reuse.

The Workgroup reviewed websites and interviewed staff via phone or email. The Workgroup found that jurisdictions are:

- Using websites to provide information, brochures, information sheets and other outreach materials.
- Providing digital access to technical guidance documents.
- Delivering training and certification programs for reuse system designers and operators.
- Providing technical assistance to businesses implementing reuse.
- Developing online permitting tools with checklists.

Reviewing the examples presented below helped the Workgroup reach the following recommendations for communication and education:

- Establish a web-based information and collaboration hub for water reuse in Minnesota. The hub could consolidate existing and new information and resources and provide guidance on how to get water reuse projects implemented.
- Educate and train practitioners about water reuse.
- Provide a starting place for developing education and training programs in Minnesota.

States

Arizona Department of Environmental Quality (DEQ)

Arizona DEQ has authority for drinking water, NPDES permitting, stormwater and groundwater, essentially functioning as a "one-stop shop." Arizona has a long history of wastewater reclamation for irrigation, industrial use, groundwater recharge and indirect potable use. Private residential use of graywater is allowed for drip or flood irrigation under a general permit. Arizona DEQ is currently revising its rules for reuse of reclaimed water and graywater, last updated in 2001. The first installment of changes will revise the permitting framework and administrative requirements for permitting, and provide interim criteria for permitting an "Advanced Reclaimed Water Treatment Facility" to provide purified water for potable use. The next installment will involve revising the reclaimed water quality standards, adding some allowed uses, and providing more substantial detail on DPR permitting. The Water Recycling FAQs from University of Arizona Cooperative Extension provides a helpful summary.

California State Water Resources Control Board

In California, water quality criteria for centralized wastewater reuse are established in Title 22 of the California Code of Regulations. The State Water Board has adopted a Recycled Water Policy, intended to provide direction to Regional Water Boards and project developers. In 2009 the board issued a statewide general permit for landscape irrigation of public open space and common facilities with municipal recycled water. However, most regulation of water reuse (termed “recycling”) is occurring at the local level. A prime example of this is the efforts of the San Francisco Public Utilities Commission, discussed below under Counties and Municipalities.

The California Department of Water Resources is the main state organization providing outreach materials on water conservation in general at Save Our Water.

Florida Department of Environmental Protection (DEP)

DEP programs are focused in two topic areas: domestic wastewater reuse (reclaimed water) and industrial wastewater reuse. The Florida Department of Health deals with graywater reuse systems.

The program and rules were first developed in the late 1980s. Today, the DEP’s primary outreach and communication tool is their website Water Reuse Program. Brochures and guidance documents highlight the reasons for and benefits of reusing water.

When a wastewater utility initiates a water reuse project, a revised wastewater permit is required, and the DEP permitting staff use this opportunity to communicate with the applicant about design and O & M requirements of the system.

Florida DEP does not conduct training nor require certification for designers, builders or operators of either domestic or industrial wastewater reuse systems. Rather, the state rules for wastewater reuse require certain licensures for designers and operators. Trainings and/or certifications for designers and operators of water reuse systems are performed by a Florida utility council.

Oregon Department of Environmental Quality (DEQ)

Oregon DEQ has a website dedicated to water reuse: Water Reuse Program. Oregon DEQ provides regulatory oversight of graywater, recycled water (treated municipal wastewater) and industrial wastewater. A water reuse fact sheet briefly introduces the types of reuse and the benefits of reusing the water.

A Governor’s Executive Order in 2005 directed the state of Oregon to promote water reuse as a method to meet the state’s water needs and ordered state agencies to work together to overcome barriers to reuse. In 2006, a Memorandum of Understanding was developed by six state agencies to define their respective roles and responsibilities pertaining to the approval of water reuse projects and other actions to be taken to promote water reuse, including contributing to a Water Reuse Guide and examination of national reuse standards for inclusion in the state plumbing code.

Texas Water Development Board and Commission on Environmental Quality

Water reuse in Texas is managed by the Texas Commission on Environmental Quality (TCEQ) and the Texas Water Development Board (TWDB). The TCEQ handles the regulatory programs for groundwater, wastewater, stormwater and drinking water. TWDB manages all aspects of water planning and water quality monitoring, and provides project funding for planning, acquisition, design and construction of water related infrastructure and other water quality improvements, similar to BWSR, MPCA and PFA in Minnesota. TWDB also does research and sampling for new systems.

Both agency websites are the primary tool for outreach and information on any water reuse topic. TCEQ discusses graywater reuse at Beneficial Re-Use of Graywater and Alternative Onsite Water and municipal and industrial reclaimed water at Requirements for Reclaimed Water.

Neither agency has a formal training program, although TCEQ does offer a few technical trainings. TCEQ staff assist small business and local governments in meeting environmental regulations, including water permits.

Texas has developed several indirect and direct potable treated wastewater reuse projects. A list of those systems is available at Water Reuse Projects. Most systems use advanced treatment of wastewater and then blend the water with other supplies. Potable reuse systems often have public perception issues; however, Texas reported that customers in water scarce areas were generally comfortable and supported reuse when there was proper outreach.

Virginia Department of Environmental Quality (DEQ)

The primary outreach tool for the Virginia DEQ is their Water Reclamation and Reuse website. They also communicate water reuse information in a Frequently Asked Questions about Water Reclamation and Reuse fact sheet. The fact sheet outlines the roles and responsibilities of various state agencies related to water reuse projects and sources of water.

Virginia DEQ regulates the reclamation and reuse of treated wastewater and stormwater. The Department of Health provides guidance for the recycling and use of graywater and harvested rainwater. The Department of Housing and Community Development regulates nonpotable water systems that reuse rainwater, graywater and reclaimed water inside of buildings according to the state building code.

Washington State Departments of Ecology and Health

The Department of Ecology provides limited information regarding reclaimed wastewater at Reclaimed Water. The state's reclaimed water rule is currently being updated to establish procedures and technical requirements for using reclaimed water. The rule update addresses the impact of reclaimed water projects on western water rights, particularly when wastewater facilities reduce the discharge of treated wastewater to a stream.

The Department of Health uses the following websites:

- Greywater Reuse communicates information about graywater use and the regulations for using graywater for subsurface irrigation. It discusses how local health jurisdictions can adopt the regulations at a local level to implement graywater use for subsurface irrigation.

The website includes a list of benefits of graywater use under the heading, "Did You Know…?"

- Water Conservation and Water Recycling describes the various types of water reuse and the state agencies with responsibility for project permitting and guidance.

Wisconsin

The Wisconsin state plumbing code allows for reuse of stormwater, graywater and treated wastewater, using a performance standard-based system. Stormwater reuse is regulated by the Division of Industry Services. The General Plumbing Program reviews plans for graywater reuse. The following information sheet from the Wisconsin Department of Safety and Professional Services identifies over 65 stormwater and wastewater reuse projects in the state as of 2016: Wisconsin Groundwater Coordinating Council Report to the Legislature

Homeowners and building managers are responsible for O & M. There is no local or state oversight after construction is complete.

Counties and Municipalities

King County, Washington

This county, encompassing the Seattle metro area, uses the Recycled Water website to communicate the benefits of treated wastewater. The website communicates the safety of recycled water and the research and technology that goes into treating wastewater effluent to a quality suitable for various nonpotable uses. It highlights:

- A survey of residents that demonstrates support for using recycled water.
- A project using recycled water for irrigating athletic fields.
- A golf course using recycled water for irrigation.
- Three geographically dispersed wastewater treatment plants providing recycled water for various uses.

The Program Overview website provides information on recycled water for industrial purposes, irrigation and wetland enhancements. A video series highlights successful recycled water partnerships such as soccer field irrigation.

Chicago, Illinois

The Public Building Commission of Chicago published the Water Reuse Handbook in 2011. The Handbook is for public buildings and includes a summary of regulations in Illinois and Chicago, specifically for rainwater harvesting and graywater systems.

The Metropolitan Water Reclamation District of Greater Chicago is not currently engaged in water reuse, but has a contract with Illinois American Water, a private water provider, to use 350 million gallons per day of treated effluent from one of their reclamation plants. A potential customer is a Ford Assembly Plant approximately two miles away.

San Francisco, California

The San Francisco Public Utilities Commission (SFPUC) manages power, water and sewer for the San Francisco area. SFPUC is committed to diversifying water supplies as drought becomes more prevalent and climate change continues to impact water and sewer services. Their website describes methods to recycle water (treated wastewater), use graywater, harvest rainwater and conserve primary drinking water supplies. A primary focus is the nonpotable use of recycled water, including irrigation, toilet flushing, industrial processes, decorative fountains, soil compaction and dust control and street cleaning. San Francisco's Recycled Water Ordinance brochure was developed for property owners and developers to understand how the recycled water ordinance may impact their project. In addition, Recycled Water includes case studies of a number of recycled water projects in the area.

SFPUC has also led other efforts to make water reuse more successful in their city, state and the nation. SFPUC initiated the groups that developed both the Blueprint for Onsite Water Systems: A Step-by-Step Guide for Developing a Local Program to Manage Onsite Water Systems and the WE&RF Report.

Tucson, Arizona

The city website discusses the use of reclaimed water as a strategy to reduce the need for using the Colorado River and groundwater for non-drinking water uses. Tucson Water was one of the first water utilities in the country to begin recycling water. Reclaimed water is typically used for irrigation, dust control, firefighting and other industrial uses. The What is Reclaimed Water? website includes a variety of information on availability of reclaimed water, code requirements, water quality, water rates, signage, guidance for working in areas that apply reclaimed water and related topics.

International

Australia

New South Wales developed an online permitting tool (BASIX) that requires applicants looking for residential or commercial building permits to select from a menu of water conservation options to achieve at least a 40 percent reduction in water consumption. It provides a checklist and a schematic of both a single residential dwelling and a multi-unit dwelling, identifying areas of the buildings where water can be conserved. In addition, there are several case studies that outline the water efficiency improvements incorporated into each design and build. The website is directed at the general public and those needing a permit.

Canada

Health Canada is the federal department responsible for helping Canadian residents maintain and improve their health. In 2010, the agency developed a technical guidance document Canadian Guidelines for Domestic Reclaimed Water for Use in Toilet and Urinal Flushing. Some Canadian provinces (including Alberta, British Columbia and Saskatchewan) have developed their own guidelines for reusing treated wastewater.

Germany

Germany has developed market-oriented standards and specifications with experts from industry, research, consumer protection and the public sector for water reuse systems. Although the outreach on water reuse in general may not be very substantial, the German Institute for Standardization develops technical documents with valuable information for the advancement of water reuse projects in Germany. More information can be found at DIN; search ‘water reuse’.

IV. Managing the Human Health Risks of Nonpotable Water Reuse

Exposing people to pathogens in water or physical hazards created by reuse systems can cause health problems. Some of the risks mentioned in the Benefits, Costs and Risks of Water Reuse section of this report are gastrointestinal illness (from ingestion of water spray or hand-to-mouth contact or from accidental cross-connections), Legionnaires' disease (form of pneumonia), or physical harm.

In this section you will find information about:

- Reasons to consider human health.
- An approach for addressing human health risk.
- Applications of the log reduction approach.
- What the log reduction approach looks like to end users.
- Protecting health through proper storage and distribution.

The information in this section informed the recommendations in the following ways:

- The information showed that the risk posed by some types of reuse may be unacceptable to the public and there is a need to address risk.
- A log reduction approach provides a meaningful and proven way to set water quality criteria.
- A risk-based framework determines whether criteria are implemented through regulation or guidance and focuses resources where risk is highest.

Reasons to Consider Human Health

In terms of human health and water, the state of Minnesota has primarily focused on drinking water and water for recreational uses. Many of the same principles used in evaluating the human health impacts of drinking water and recreational water also apply to reuse.

In the past, MDH would get an occasional call from a golf course, city or other entity that was irrigating from a stormwater pond or other alternate water source, asking if they should treat the water they were using for irrigation. Staff would typically recommend either treating the water to drinking water quality standards or watering at night to limit human exposure to the irrigation water. This response reflected the absence of any formal standards or recommendations for nonpotable water applications like irrigation. In recent years, these calls have increased in frequency. MDH has also received questions about indoor use of harvested rainwater, stormwater and graywater from both practitioners and regulatory authorities. MDH wanted to provide better-informed recommendations to Minnesotans and began researching the issue. MDH staff:

- **Reviewed literature on illnesses associated with water reuse.** The literature review showed that human health risks related to water reuse are identified in public health research and case studies (NRMMC, 2006; NRMMC, 2009; WRF, 2007; Lim, 2015; Jiang, 2015). Some water reuse-related disease outbreaks have also been identified (Ashbolt & Kirk, 2001; Greene et al., 2008; Schlech et al., 1985; Simmons et al., 2008).

- **Initiated a research partnership with UMN.** The goal of the partnership was to start to address water quality data gaps and develop expertise in microbial risk assessment. The Water Reuse System Sampling Results Summary from the UMN partnership provides data and describes human health concerns.
- **Joined a group of professionals across the nation working to develop consistent water quality criteria for decentralized reuse.** The expert panel convened by the national workgroup recommended a risk-based framework for decentralized reuse (more information in the Increasing Interest in Reuse section of this report).
- **Reviewed approaches to water quality standards for reuse in other cities, states and countries.** The preferred approach will be discussed in detail in the following pages.

It is important to note that this section focuses on microbial contaminants rather than chemical contaminants. Chemical contaminants will generally not be present at high enough concentrations to cause human harm from small, infrequent nonpotable exposures. However, certain end uses that were not considered as part of the Workgroup effort – like irrigation of edible crops – could require additional consideration because of greater exposure to chemical contaminants.

An Approach for Addressing Human Health Risk

Existing risk-based water reuse guidance uses a pathogen log reduction target approach to set water quality standards. Log reduction targets are one way to describe how much management or treatment is needed to reduce microbes or exposure to a safe level. The log reduction target approach offers the following advantages:

- Sets criteria specific to a variety of sources (not one size fits all) and end uses (fit-for-purpose) and can easily incorporate new data.
- Directly addresses human health concerns related to specific groups of pathogens.
- Offers options for meeting reduction targets.
- Makes use of existing, validated treatment technologies, and allows for new innovative technologies to be validated.
- Allows use of remote process monitoring rather than all on-site monitoring.

Applications of the Log Reduction Approach

The following examples help illustrate the log reduction approach. The Safe Drinking Water Act (SDWA) is used as the first example. It offers a good description of the approach, has been around for a long time and is established in Minnesota and the U.S. The SDWA example is followed by other examples related to water reuse:

- MPCA guidance: centralized municipal wastewater reuse
- Minnesota Plumbing Code: indoor use of rainwater
- Australian Guidelines and the WE&RF Report: reuse of wastewater, graywater stormwater and rainwater

Drinking Water

The SDWA uses two different approaches to controlling water contaminants. Most chemical contaminants are regulated through a Maximum Contaminant Level, or MCL. Sampling is conducted at a set frequency for a given contaminant and results must be below the MCL.

When there is no economically and technically feasible method to routinely measure a contaminant's concentration, USEPA sets a "treatment technique" rather than an MCL. A treatment technique is an enforceable procedure or level of treatment performance which public water systems must follow to ensure control of a contaminant.

USEPA applies treatment techniques to most microbial contaminants. This involves:

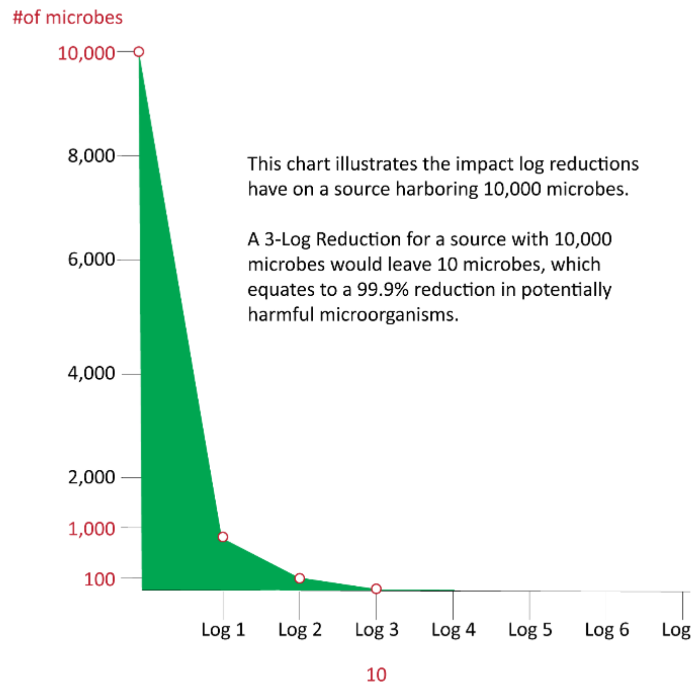

Figure 11. Log Reduction

- Identifying an acceptable concentration for finished water (water that comes out of the tap).
- Determining or estimating the concentration of microbes in each source type.
- Setting a target for log reduction (percent reduction) of the microbe.

Example: The treatment technique for a public drinking water supply using a surface water source requires a minimum 2-log (99%) removal of *Cryptosporidium*, 3-log (99.9%) removal or inactivation of *Giardia*, and 4-log (99.99%) removal or inactivation of viruses.

The example above illustrates that there may be several different pathogens of concern. The three major groups of pathogens are viruses, protozoa (including *Giardia* and *Cryptosporidium*) and bacteria. Log reduction targets may be set for individual microbes or for pathogen groups as appropriate.

All surface water systems must meet these minimum requirements, unless they meet certain specific criteria to allow an exemption. Variability in source water quality is taken into account largely through statistical techniques. More recently, surface water systems have also been required to monitor the source water at specified time periods. If source water monitoring indicates a high level of contamination, additional treatment is required.

Other treatment techniques involve enforceable procedures. For example, if the presence of total coliform bacteria is confirmed in a water distribution system, the system must conduct an assessment to determine the cause of contamination. In this case, the assessment is the treatment technique.

Centralized Municipal Wastewater Reuse

The MPCA uses the log reduction approach in guidance on centralized municipal wastewater reuse. The guidance is informed by the California Title 22 Recycling Criteria for reuse of municipal wastewater. For disinfected tertiary treatment, the California Code of Regulations states that filtration coupled with disinfection should provide a 5-log reduction of viruses from secondary treated wastewater (California State Water Resources Control Board, 2014). The virus removal is achieved through treatment processes and verified through water quality testing including indicator bacteria (total coliform) and turbidity.

Indoor Reuse of Rainwater

Recent changes to the Minnesota Plumbing Code were discussed in the Stormwater and Rainwater – Indoor Reuse section, and it was mentioned that filtration and disinfection are required to maintain minimum water quality for use. Specifically, the code requires a minimum five micron or smaller absolute filter and 0.5-log inactivation (reduction) of viruses.

Reuse of Wastewater, Graywater, Stormwater and Rainwater

Both the Australian Guidelines and the WE&RF Report have tables of log reduction targets for bacteria, virus and protozoa for a variety of reuse sources and end uses. These two resources also contain many details and useful information related to implementing log reduction targets. The Australian Guidelines allow management options to be used to meet the log reduction requirements, while the WE&RF Report does not.

What the Log Reduction Approach Looks Like to End Users

To the end user, this approach would appear as a list of management and treatment options for a given source and end use, along with associated monitoring and/or recordkeeping to verify proper implementation of each option. Management options are often less costly than treatment options. Examples of common management options include using subsurface irrigation, controlling irrigation spray drift, restricting public access, irrigating non-contact landscapes, and providing waiting periods after irrigation and before access to irrigated areas. Examples of common treatment options include filtration, chlorination, ultraviolet disinfection and detention time.

After a system becomes operational, these log reduction requirements typically function “behind the scenes” for operators. It is the operation requirements set by guidance, regulation and/or the design engineer that the operators use on a day-to-day basis. For example, the operator might need to maintain a minimum required chlorine residual to verify virus log reduction requirements are met, or to measure turbidity following filtration to verify *Giardia* log reduction requirements are met. For restricted access, maintenance records for signage and fences might be used as verification. The frequency of any required monitoring is set based on a variety of factors such as exposure levels and system size.

Other Approaches Considered

Several stakeholders recommended using performance based standards or outcomes to guide reuse. There are many understandings of the term "performance based standards" (Coglianes et al., 2002). One common definition is an approach that focuses on desired, measurable outcomes, rather than prescriptive processes, techniques or procedures[14]. The log reduction approach meets this definition in that it defines the desired outcomes (log reduction targets that need to be met to protect human health for each source and end use), but allows choice in the treatment or management options used to meet those targets.

For practitioners accustomed to BMPs for stormwater management, water quality criteria for wastewater discharge, or certification standards for graywater, the log reduction approach may seem new. However, as illustrated below, while the terminology may not include log reduction, the concepts for the approaches are fundamentally the same in that they focus on pollutant removal and provide options to achieve a certain water quality.

Stormwater

Stormwater management typically uses BMPs to meet water quality performance goals. BMPs include maintenance procedures and prohibition of certain practices, as well as treatment requirements, operating procedures and practices that prevent pollution. The Minnesota Stormwater Manual lists median pollutant removal percentages for several stormwater BMPs.

Example: The Minnesota Stormwater Manual lists constructed wet ponds as achieving 60% bacteria removal (equivalent to 0.4 log reduction).

Wastewater

As mentioned in the on Water Reuse in Minnesota section, the NPDES is a federal program, established under the Clean Water Act, regulating any treatment and disposal system that discharges to surface waters. USEPA guidance states that "effluent limitations serve as the primary mechanism in NPDES permits for controlling discharges of pollutants to receiving waters".

When developing wastewater limitations for an NPDES permit, a permit writer must consider limits based on both technology available to control the pollutants (i.e., technology-based effluent limits) and what is protective of the water quality standards of the receiving water (i.e., water quality-based effluent limits).

Example: Minnesota applies the federal-based Clean Water Act municipal wastewater secondary treatment technology-based effluent limits. The limits are for an indicator organism fecal coliform as 200 organisms/100 mL (as a monthly geometric mean). The municipal NPDES

[14] U.S. Nuclear Regulatory Commission: Performance-based regulation (https://www.nrc.gov/reading-rm/basic-ref/glossary/performance-based-regulation.html)

permit requires sampling and analysis to show that the treatment facility is performing consistently and the treated effluent is in compliance with the limit.

Graywater

For indoor reuse of graywater, a standard that is often cited in codes or guidance is NSF International/American National Standards Institute (ANSI) Standard 350 for Onsite Residential and Commercial Water Reuse Treatment Systems. The scope of this standard includes on-site treated wastewater and other commercial treatment systems, but it is most commonly referenced for graywater. The standard was developed to establish minimum material, design, construction and performance requirements for on-site residential and commercial water reuse treatment systems. While this standard represents a significant effort to enable reuse projects to move forward, it also has the potential to require additional certification (at additional cost) for technologies that have already been validated elsewhere, is not based on current risk assessments, and does not include guidance for long-term monitoring.

Protecting Health through Proper Storage and Distribution

Proper storage and distribution of reuse water are also important to maintaining water quality and protecting public health and the environment. Some pathogens like *Legionella* can grow in distribution systems and are the largest recognized cause of waterborne risk from drinking water in the U.S. Meeting the log reduction requirements suggested above would be the first step to maintaining appropriate water quality all the way to the end use. But just as when distributing drinking water, the distribution system also needs to be managed to prevent deterioration of water quality due to stagnation, high temperature and other factors. Some BMPs for storage and distribution can be found in the WE&RF Report or in other standards such as ANSI/ASHRAE (The American Society of Heating, Refrigerating and Air-Conditioning Engineers) Standard 188 Legionellosis: Risk Management for Building Water Systems.

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Resources

This resource list provides links to documents and websites that are linked to or referenced in this report.

Minnesota Resources

Guidance and Regulation

Construction Stormwater Permit Overview *(https://www.pca.state.mn.us/sites/default/files/wq-strm2-05.pdf):* Minnesota Pollution Control Agency document about Minnesota's NPDES permit

Minnesota Stormwater Manual *(https://stormwater.pca.state.mn.us/index.php?title=Stormwater_and_rainwater_harvest_and_use/reuse)*: Minnesota Pollution Control Agency website including a wiki-based guidance manual with a section on stormwater reuse

Minnesota Plumbing Code *(http://www.dli.mn.gov/ccld/PlumbingCode.asp)*: Minnesota Department of Labor and Industry website including information about the Minnesota Plumbing Code

Municipal Wastewater Reuse *(www.pca.state.mn.us/sites/default/files/wq-wwr1-01.pdf)*: Minnesota Pollution Control Agency guidance document about wastewater reuse

Stormwater Reuse Guide *(https://metrocouncil.org/Wastewater-Water/Planning/Water-Supply-Planning/Studies-Projects-Workgroups-(1)/Completed-Studies-Projects/Stormwater-Reuse-Guide.aspx)*: Metropolitan Council guidance document about stormwater reuse

Studies and Assessment

Beyond the Status Quo: 2015 EQB Water Policy Report *(https://www.eqb.state.mn.us/sites/default/files/documents/WaterReport_091715_FINAL_R.pdf)*: Minnesota Environmental Quality Board document about options to move beyond the status quo on water challenges Minnesota faces

Maximizing the Benefits of Water Reuse *(https://www.lccmr.leg.mn/proposals/2017/original/055-b.pdf)*: Environment and Natural Resources Trust Fund 2017 Request for Proposal document about a University of Minnesota study on pathogens and design for Minnesota reuse systems

Minnesota Water Sustainability Framework *(https://www.wrc.umn.edu/sites/wrc.umn.edu/files/minnesota_water_framework.pdf)***:** Minnesota Water Resource Center document about how to create a sustainable water future in Minnesota

Water Reuse (*http://www.health.state.mn.us/waterreuse*): Water Reuse Interagency Workgroup website including information about workgroup and stakeholder meetings, presentations and other resources

Water Reuse Benefits Information Sheet *(https://static1.squarespace.com/static/5963dafa4c8b03a819ee618d/t/5a8c836571c10bd7c92e0cc6/1519158118317/WD+Water+Reuse+Benefits+Sheet.pdf)*: Minnesota Association of Watershed Districts document about water reuse benefits

Water Reuse System Sampling Results Summary *(http://www.health.state.mn.us/divs/eh/risk/guidance/dwec/qmra/umresults.pdf)*: Minnesota Department of Health document about a collaborative study on microbial populations in a stormwater irrigation system in a city park and a toilet flushing system in a building

Water Reuse Workshop *(http://freshwater.org/wp-content/uploads/2016/07/Water-Reuse-Workshop-Proceedings-Report-1.pdf)*: Freshwater Society document about proceedings from a July 2016 water reuse workshop

Funding Opportunities and Projects Funded

Minnesota Clean Water Fund *(http://www.bwsr.state.mn.us/cleanwaterfund/index.html)*: Minnesota Board of Water and Soil Resources website including a list of projects (some include reuse as a component)

Wastewater and Stormwater Financial Assistance *(https://www.pca.state.mn.us/water/wastewater-and-stormwater-financial-assistance)*: Minnesota Pollution Control Agency website including information about funding for green projects under the Clean Water Revolving Fund

US Resources

Guidance and Regulation

2012 Guidelines for Water Reuse *(https://nepis.epa.gov/Exe/ZyPDF.cgi/P100FS7K.PDF?Dockey=P100FS7K.PDF)*: referred to in this document as the "USEPA 2012 Guidelines" - U.S. Environmental Protection Agency and U.S. Agency for International Development document about the different aspects of water reuse (primarily wastewater) and case studies from the U.S. and the world

2016 On-site non-potable water reuse funding agreement *(www.nyc.gov/html/dep/pdf/conservation/onsite-water-reuse-funding-agreement.pdf)*: New York City document about grant program to support on-site non-potable water reuse, including an example of insurance requirements for water reuse projects

Blueprint for Onsite Water Systems: A Step-by-Step Guide for Developing a Local Program to Manage Onsite Water Systems *(http://sfwater.org/modules/showdocument.aspx?documentid=6057)*: San Francisco Public Utilities Commission document about how communities can implement on-site water treatment (document is product of collaborative effort from water agencies, public health departments - including the Minnesota Department of Health, and research institutions from across North America)

Comparative survey of liability and indemnification concepts for reclaimed water: *(www.eli.org/sites/default/files/docs/elis_comparative_survey_of_liability_and_indemnification_concepts_for_reclaimed_water.pdf)*: Environmental Law Institute document on state laws and regulations that make specific reference to reclaimed water

Final Report: Risk-Based Framework for the Development of Public Health Guidance for Decentralized Non-Potable Water Systems *(http://sfwater.org/Modules/ShowDocument.aspx?documentID=10493)*: referred to in this document as the "WE&RF report" – Water Environment and Reuse Foundation document about a framework to establish scale-appropriate water quality criteria and monitoring for state and local health departments (document is product of a collaborative effort from a National Water Research Institute Panel and Stakeholder Advisory Committee)

FSMA Final Rule on Produce Safety *(https://www.fda.gov/Food/GuidanceRegulation/FSMA/ucm334114.htm*): U.S. Food and Drug Administration website about produce safety rule (includes criteria for microbial water quality for agricultural water)

Studies and Assessment

Application of Microbial Risk Assessment Techniques to Estimate Risk Due to Exposure to Reclaimed Waters *(https://watereuse.org/watereuse-research/04-11-application-of-microbial-risk-assessment-techniques-to-estimate-risk-due-to-exposure-to-reclaimed-waters/)*: WateReuse Foundation document about microbial risk and the relative risks to human health associated with nonpotable water reuse applications

Assessment of Public Health Risk Associated with Viral Contamination in Harvested Urban Stormwater for Domestic Applications *(https://www.sciencedirect.com/science/article/pii/S0048969715003526?via%3Dihub)*: *Science of The Total Environment* document about the health risk associated with urban stormwater reuse and non-potable uses: 1) toilet flushing, 2) showering, and 3) food-crop irrigation

Framework for Direct Potable Reuse *(https://watereuse.org/wp-content/uploads/2015/09/14-20.pdf)*: National Water Research Institute document about direct potable reuse and issues that need to be addressed in developing guidelines and regulations

Human and Environmental Health Risks and Benefits associated with use of Urban Stormwater *(http://wires.wiley.com/WileyCDA/WiresArticle/articles.html?doi=10.1002%2Fwat2.1107)*: A *WIREs Water* document about quantitative microbial risk assessment for use of urban stormwater

National Blue Ribbon Commission for Onsite Non-potable Water Systems *(http://uswateralliance.org/initiatives/commission)*: US Water Alliance website about a commission of representatives from municipalities, public health agencies, water utilities, and national organizations working on onsite non-potable water systems

Performance-based Regulation: Prospects and Limitations in Health, Safety, and Environmental Protection *(https://sites.hks.harvard.edu/m-rcbg/Events/Papers/RPPREPORT3.pdf)***:** John F. Kennedy School of Government at Harvard University document about performance-based regulation and regulatory agencies' experiences using it

Recurrent Multistate Outbreak of *Salmonella* Newport associated with Tomatoes from Contaminated Fields, 2005 *(https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2870807/)*: *Epidemiology and Infection* document about a *Salmonella* outbreak associated with pond water used to irrigate tomato fields

Using Graywater and Stormwater to Enhance Local Water Supplies: An Assessment of Risks, Costs, and Benefits *(https://www.nap.edu/catalog/21866/using-graywater-and-stormwater-to-enhance-local-water-supplies-an)*: National Academies of Science, Engineering and Medicine document about the risks, costs, and benefits of various beneficial uses of stormwater and graywater and approaches needed for its safe use

International Resources

Guidance and Regulation

Australian Guidelines for Water Recycling: Managing Health and Environmental Risks 2006 (Phase 1): *(http://www.nepc.gov.au/system/files/resources/5fe5174a-bdec-a194-79ad-86586fd19601/files/wq-agwr-gl-managing-health-environmental-risks-phase1-final-200611.pdf)*: Australia governmental document about guidelines for addressing the health and environmental risks of wastewater reuse

Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 2) Stormwater Harvesting and Reuse, 2009 *(https://www.clearwater.asn.au/user-data/resource-files/WQ_AGWR_GL__Stormwater_Harvesting_and_Reuse_Final_200907[1].pdf)*: Australia governmental document about guidelines for addressing the health and environmental risks of stormwater reuse

BASIX *(https://www.planningportal.nsw.gov.au/planning-tools/basix)*: New South Wales of Australia website including an online permitting tool and case studies

Canadian Guidelines for Domestic Reclaimed Water for Use in Toilet and Urinal Flushing *(https://www.canada.ca/en/health-canada/services/publications/healthy-living/canadian-guidelines-domestic-reclaimed-water-use-toilet-urinal-flushing.html)*: Canadian website including information about reusing treated wastewater

DIN *(https://www.din.de/en)*: search ‘water reuse’ – Germany website including information about market-oriented standards and specifications for water reuse systems

Studies and Assessment

A Legionnaires’ Disease Outbreak: A Water Blaster and Roof-Collected Rainwater System *(https://www.sciencedirect.com/science/article/pii/S0043135407006513?via%3Dihub)*: *Water Research* document about a Legionnaires’ outbreak linked to roof-collected rainwater supplies

Legionnaires' Disease in the Caribbean: An Outbreak associated with a Resort Hotel *(https://www.ncbi.nlm.nih.gov/pubmed/4062461)*: *Archives of Internal Medicine* document about an outbreak of Legionnaires’ disease associated with a rainwater sourced potable water system

Salmonella **Mississippi Infections in Tasmania: The Role of Native Australian Animals and Untreated Drinking Water** *(https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2870509/)*: *Epidemiology and Infection* document about *Salmonella* illnesses associated with private rainwater collection systems

Other Jurisdictions in the US (States, Counties, and Municipalities)

Guidance and Regulation

Alternative Treatment Technology Report for Recycled Water *(www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/dwdocuments/Alternative%20Treatment%20Technology%20Report%20for%20RW%2009_2014.pdf)*: California document about technologies conditionally acceptable for compliance with treatment requirements of the California Water Recycling Criteria (Title 22)

Water Reuse Program *(https://floridadep.gov/water/domestic-wastewater/content/water-reuse-program)*: Florida outreach materials and guidance documents on water reuse

Water Reuse Program *(http://www.oregon.gov/deq/wq/programs/Pages/Water-Reuse.aspx)*: Oregon water reuse website, includes guidance

Beneficial Re-Use of Graywater and Alternative Onsite Water *(https://www.tceq.texas.gov/permitting/wastewater/graywater/)*: Texas website including guidance on graywater reuse

Frequently Asked Questions About Water Reclamation and Reuse *(http://www.deq.virginia.gov/Portals/0/DEQ/Water/VirginiaPollutionAbatement/Water_Recl_and_Reuse_FA Q Sheet _5-2014.pdf)*: Virginia document about water reuse guidance and regulations

Greywater Reuse *(http://www.doh.wa.gov/CommunityandEnvironment/WastewaterManagement/GreywaterReuse)*: Washington website including information about water reuse guidance and regulation

Reclaimed Water (*https://ecology.wa.gov/Water-Shorelines/Water-quality/Reclaimed-water)*: Washington website including information about water reuse guidance and regulations

Requirements for Reclaimed Water *(https://www.tceq.texas.gov/assistance/water/reclaimed _water.html/)*: Texas website including guidance on municipal and industrial reuse

San Francisco's Recycled Water Ordinance *(http://www.sfwater.org/modules/showdocument.aspx?documentid=1293)*: San Francisco Water Power Sewer document about recycled water ordinances

Seacoast Utility Authority Reclaimed Water Policy *(http://www.sua.com/Reclaimed-Water-Policy)*: Florida utility website including information about water reuse guidance and regulation

Water Conservation and Water Recycling *(http://www.doh.wa.gov/CommunityandEnvironment/WastewaterManagement/WaterConservation)*: Washington website including information about water reuse guidance and regulations

Water Reclamation and Reuse *(http://www.deq.virginia.gov/Programs/Water/LandApplicationBeneficialReuse/WaterReclamationReuse.aspx)*: Virginia website including information about water reuse guidance and regulations

Water Reclamation and Reuse Standards *(https://fortress.wa.gov/ecy/publications/documents/97023.pdf)*: Washington document about water reclamation and reuse standards

Water Reuse Handbook *(http://www.pbcchicago.com/wpcontent/uploads/2017/07/PBCWaterReuseHandbook_August2011.pdf):* Public Building Commission of Chicago document about water reuse regulations for public buildings in Illinois and Chicago

Studies and Assessment

Program Overview *(http://www.kingcounty.gov/services/environment/wastewater/resource-recovery/recycled-water/program-overview.aspx)*: King County, Washington website including information on reuse

Recycled Water *(http://www.sfwater.org/index.aspx?page=141)*: San Francisco Water Power Sewer website including information about recycled water project case studies

Save Our Water *(http://saveourwater.com)*: California Department of Water Resources website including outreach materials on water conservation

Water Recycling FAQs *(https://extension.arizona.edu/sites/extension.arizona.edu/files/pubs/az1568.pdf)*: University of Arizona Cooperative Extension document about water reuse approaches in the US

Water Reuse Projects *(http://www.twdb.texas.gov/innovativewater/reuse/projects.asp)*: Texas website including a list of indirect and direct potable treated wastewater reuse projects

What is Reclaimed Water? *(https://www.tucsonaz.gov/water/what-is-reclaimed-water)*: Tuscon, Arizona website including information about reclaimed water

Wisconsin Groundwater Coordinating Council Report to the Legislature (*http://dnr.wi.gov/topic/groundwater/documents/gcc/agencyactivities/dspsactivities.pdf*): Wisconsin document including a list of stormwater and wastewater reuse projects as of 2016

Appendix A. Surveys

The Workgroup reviewed information from surveys conducted by the Minnesota Technical Assistance Program and the MPCA, and built on the work of these surveys by conducting an in-depth survey of water reuse project owners. The goal was to better understand current water reuse practices and perceptions in Minnesota and help inform the recommendations made in this report.

Minnesota Technical Assistance Program Survey

In early 2015, the University of Minnesota Technical Assistance Program ("MnTAP") conducted a survey on water reuse in Minnesota to get an estimate of the number of reuse applications taking place in Minnesota, gauge the level of interest in future applications, identify barriers or gaps that currently limit or prevent water reuse, and identify concerns related to water reuse. The survey had 588 respondents. Respondents included golf course managers, watershed district staff, SWCDs, K-12 schools, corporations, wastewater utilities and consultants. Key findings from the survey include:

- The primary barrier to water reuse for most respondents is cost, but other responses focused on the lack of technical information or design standards, code/regulatory issues and public health concerns.
- The lack of examples and state-specific guidance in Minnesota also discourages reuse.
- Desired resources include financial resources/incentives, design standards, case studies, applicable water quality standards and information on treatment options.

Municipal Separate Storm Sewer System (MS4) Survey

In 2015 and early 2016, the MPCA conducted a phone survey with 177 Municipal Separate Storm Sewer System (MS4) permittees on stormwater reuse. Key findings from the survey include:

- Existing projects were implemented primarily for purposes of water conservation, to meet stormwater regulatory requirements and to achieve cost savings.
- There were challenges in designing systems that could operate year-round and a lack of building and plumbing code guidance for determining treatment and filtration requirements.
- Water appropriation permit requirements were seen as a barrier by some respondents.

Water Reuse Interagency Workgroup Survey

In the summer of 2016, the Workgroup conducted a more detailed survey of existing water reuse projects. There were 43 respondents. Respondents shared information about when, where, why and how they implemented their reuse project. They also shared who their project partners are; what their project is; the types of permits they had to get; the project's costs, outcomes, and savings; difficulties of implementing the project; and what resources would have been helpful in completing the project. Key findings from the survey include:

- Water conservation was the main reason behind most of the reuse projects.
- Many of the projects monitor for some aspect of water quality in the system, but what they monitor varies.
- There was a wide variation in the described outcomes of the project. The annual amount of drinking water saved ranged from 75,000 to 4 million gallons per year.
- The main difficulties respondents identified were design challenges and regulations/permitting difficulties.

Summary of Responses

The following are written summaries of survey responses, paired in many instances with a figure displaying more detailed results.

1. Respondents:

There were 43 responses to the survey. However, some respondents replied to the survey multiple times representing different projects, and a few respondents were not representing projects but had an interest in reuse.

2. County project is located in:

The majority of projects (31) were located in the seven-county Twin Cities metropolitan area (Anoka, Carver, Dakota, Hennepin, Ramsey, Scott and Washington counties). The largest number of projects (9) was reported in Hennepin County. See Figure 12.

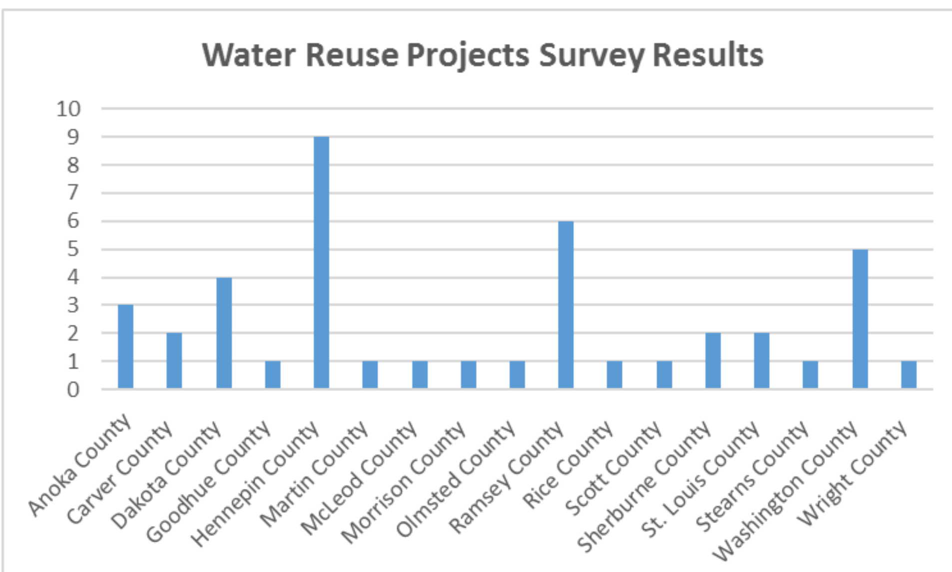

Figure 12. County project is located in

3. Year project was implemented:

More than 50 percent of the projects (22) have been installed within the last three years. Four projects have been installed for more than 10 years. See Figure 13.

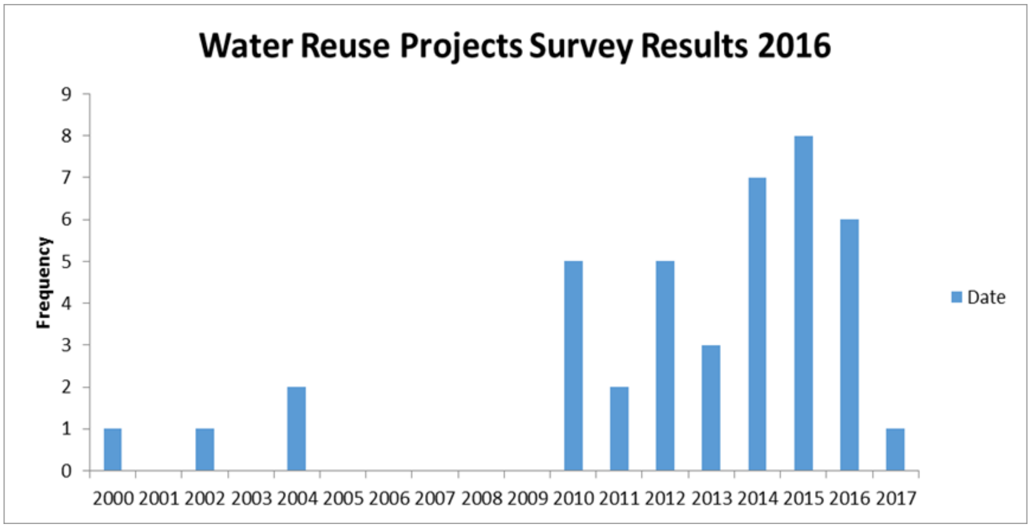

Figure 13. Year project was implemented

4. Who are the project partners (owners, designers, users)?

There was wide variation of responses to this question. Some projects had only one partner while others had up to four. Partners included private entities (golf courses, professional baseball leagues, and private developers) and a variety of local, state and federal governments.

5. Please provide a brief description of the project:

Responses to this question can be grouped into four main categories.

- *Stormwater collection to be reused for the irrigation of green spaces*: This category was the most predominant in the responses received. In several cases, the projects described capturing stormwater in either a stormwater retention pond or cistern to be used to irrigate recreational fields (baseball and soccer fields) or green spaces.
- *Rainwater harvesting from rooftops for irrigation of green space:* This category is similar to stormwater collection, except in this category roof water only was captured into rain barrels or cisterns for irrigation purposes.
- *Reuse of stormwater for residential homes/private developments:* Systems in this category are used for private developments rather than public spaces for toilet flushing, fountains and irrigation purposes.
- *Reuse of water for industrial purposes*: Uses in this category included industrial cooling and process water.

6a. Collection (for example, gutters, roof drains, plumbing fixtures, catch basins, storm sewer, public sanitary sewer):

Storm sewers, and gutter and roof drains were identified in more than 50 percent of the responses. Stormwater collection mechanisms, including drainage ditches, ponds, swales, and raingardens, were also identified.

6b. Storage (for example, storage tank size and material):

Roughly 40 percent of the respondents identified using ponds for storage, and roughly 60 percent identified storage tanks. The size and material of the storage tanks ranged widely from a 55 gallon plastic rain barrel to a 142,000 gallon corrugated metal tank.

6c. Treatment (for example, treatment goals, treatment processes):

Six respondents identified that no treatment took place. In some cases, existing stormwater treatment trains provide the only treatment. Other projects indicated settling or screens were in place. For some projects, ultraviolet light was used for disinfection.

6d. Distribution (for example, how is treated water distributed to the end use, backflow prevention, pipe labeling):

For projects that identified reusing stormwater for irrigation purposes, most respondents cited using a pump to distribute water to the irrigation system (irrigation systems were identified either as sprinkler heads or drip irrigation). In a few cases, respondents noted that backflow prevention was used.

For projects reusing water for toilets or for industrial uses, backflow prevention and pipe labeling were identified as part of distributing water to end source.

7. What was the main reason(s) for the project?

Many respondents had multiple responses to this question. Water conservation was clearly the main reason behind the reuse projects. Ten who chose water conservation as a main reason also responded that the projects served as demonstrations of reuse. The demonstrations were primarily used as an educational tool on water reuse for the community or local government entities. One survey respondent listed diversion of storm runoff containing phosphorus from an area lake as a primary reason.

The other two significant responses were cost savings and environmental regulations, receiving 13 and 14 responses, respectively. Both projects that have industrial/process water as a source cited cost savings as the main reason. Examples of projects with environmental regulations as the driving factor include graywater as a source, golf course irrigation, and two maintenance garage projects. The other two areas that received replies are stormwater management and adaptation to climate change.

8. Which permits did you need to obtain for the project or for other aspects on installation?

Thirty respondents answered this question, some with multiple responses. Building/plumbing permits were required for 22 of the projects. Most golf courses and ballparks required both NPDES and DNR Water Appropriation permits. Other permits required by agencies not on the chart below were grading/land disturbance (two respondents) and the Army Corps of Engineers. See Figure 14.

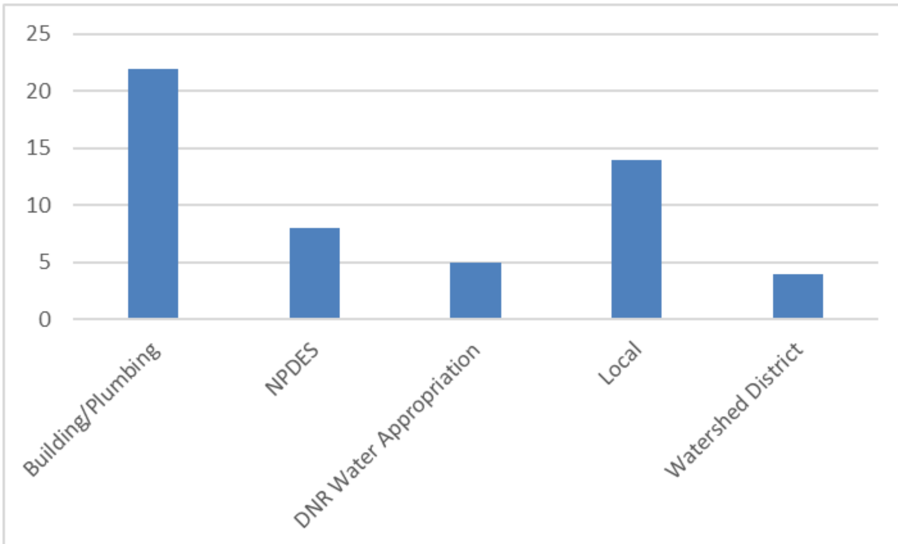

Figure 14. Which permits were obtained for the project?

9. What is the source of the water you're reusing?

Over 84 percent of the projects reported in the survey results involved rainwater or stormwater as the source of water. There were 26 responses for rainwater and 23 for stormwater, with many selecting both reuse options. The remaining responses were as follows: industrial/process (3), reclaimed wastewater (2), graywater (2), subsurface (1), backwash from water treatment (1). See Figure 15.

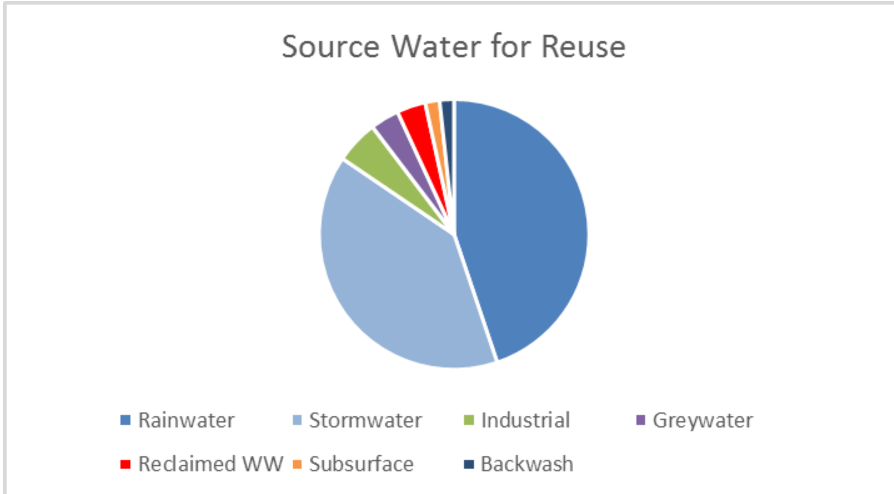

Figure 15. Source of water reused

10. Is there a backup water source in the event your primary water source isn't available or isn't sufficient to meet your needs?

Figure 16 shows that most water reuse projects have a backup water supply. The only two backup options reported were municipal water supplies or a private well/groundwater supply. Of the 30 "yes" responses, 15 stated a municipal backup supply and eight stated a well/groundwater supply (Figure 17). The rest were either unknown or left blank.

Of the nine respondents who answered "no" to having a backup water source, seven projects are primarily used for irrigation, one for water features and another is unknown. Of these nine submissions, only one respondent listed permit requirements (Building/plumbing, NPDES, and DNR Water Appropriation) under Question 8.

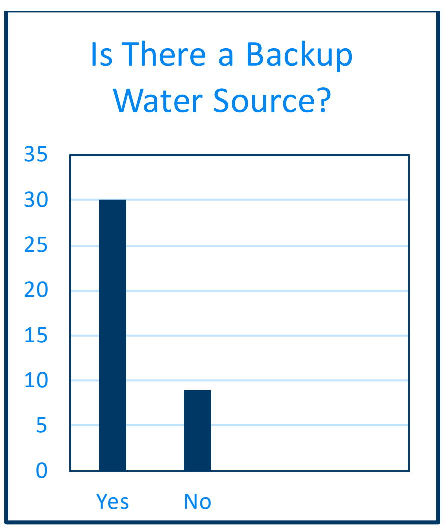

Figure 16. Is there a backup water source?

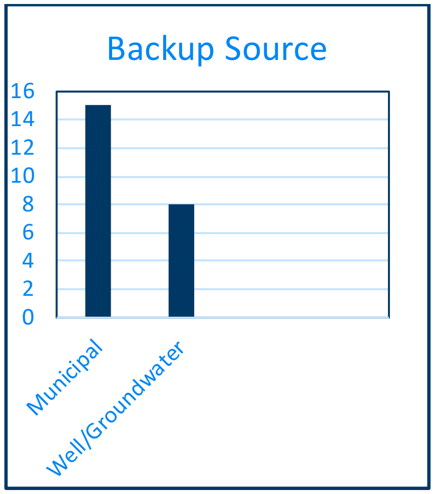

Figure 17. What is the backup water source?

11. What is the primary use(s) of the reused water?

Irrigation is the most common use of reused water (Figure 18), with irrigation of parks, open space and sports fields being the types of irrigation projects most reported (Figure 19). Golf courses are considered a separate use from sports fields in this report, and two golf course projects were reported compared to eight sports field projects.

Industrial reuse of water was reported in eight projects. Water is reused in industry in a number of ways including material processing and cooling. Although water reuse in the food processing industry is long-established, only one food processing water reuse project was reported, and that is in the demonstration stage. Reuse of water for toilet flushing was reported by five projects.

Two reported projects, one established and one planned, process reused water to drinking water standards, allowing its use for practically all purposes. The Stark Rain H_2Ouse is a single family home in St. Louis County that has been operating since 2004. The city of Glencoe, population 5,600, is considering processing wastewater so it can be reused in its municipal water supply system.

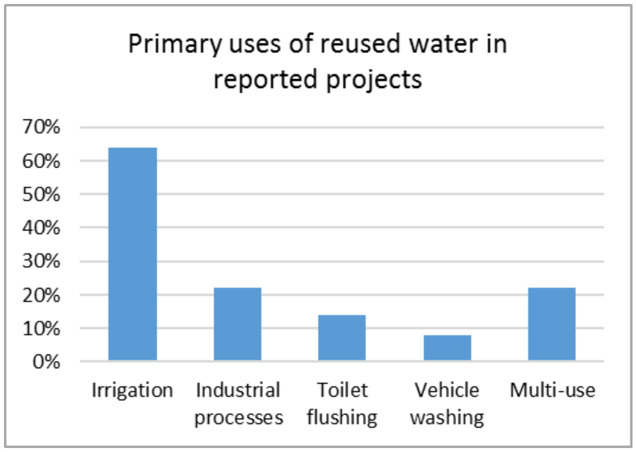

Figure 18. Primary uses of reused water in reported projects

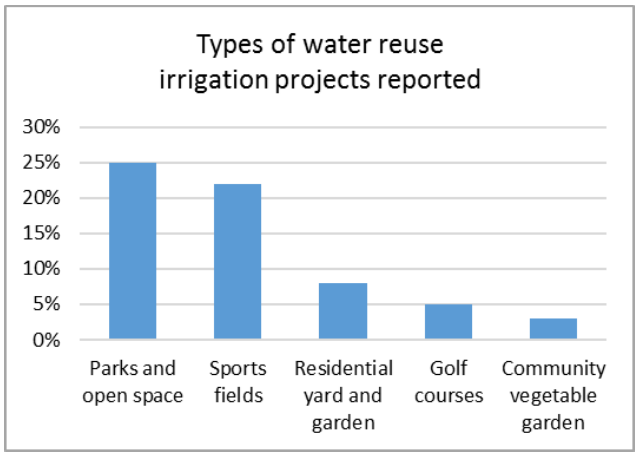

Figure 19. Types of water reuse irrigation projects reported

12. Please describe the ongoing operations and maintenance work the project requires:

Since the majority of reported water reuse projects involve irrigation, typical irrigation system maintenance was most often cited, including pump installation and maintenance, filter and sediment basin cleanout, storage tank inspection, irrigation nozzle inspection and replacement, and system winterization.

Frequency of filter cleaning and replacement varies – including intervals of annually, biannually, quarterly, monthly, and daily (one project monitored filters daily). Five projects use ultraviolet (UV) light for bacteria control, which requires annual replacement of UV light bulbs.

13 and 14. What were the capital costs for the project (in dollars)? What are the annual operations and maintenance costs for the project (in dollars)?

Six projects reported capital costs under $50,000; whereas the remaining 18 projects had capital costs fairly evenly distributed between $50,000 and $2,500,000.

Annual project operations and maintenance costs reported for the majority of projects are below $2,000. However, a significant number of projects report having annual operations and maintenance costs from $10,000 to $35,000. Further discussion of project costs is limited by not having adequate detail in survey results to be able to relate costs back to project size and scope.

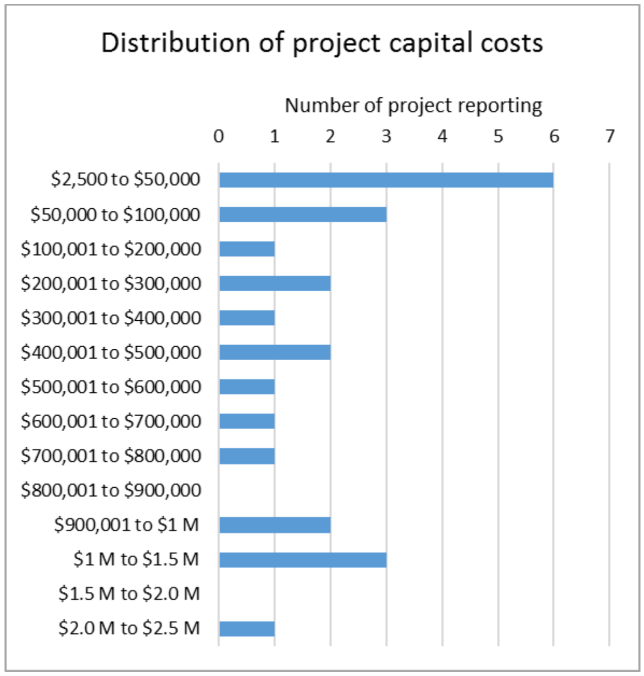

Figure 20. Distribution of project capital costs

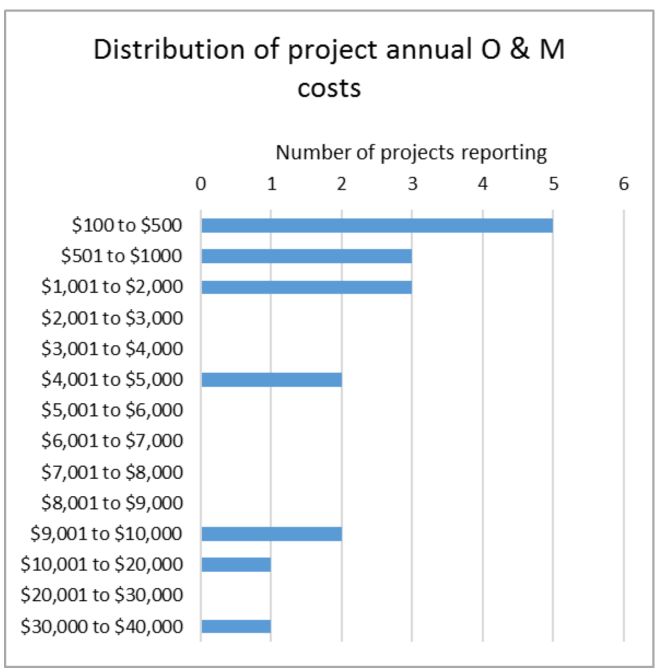

Figure 21. Distribution of project annual operating and maintenance costs

15. Do you monitor the water quality of this reuse system?

Twelve respondents reported monitoring as either being implemented or in the planning stage. Nine reported monitoring for chemical parameters, the most common being suspended solids, followed by chloride, phosphorus and nitrogen. One project monitors for heavy metals and one for pH.

Seven projects reported monitoring for fecal coliform or other microorganisms, including *Legionella* and viruses. Projects which monitor for microorganisms include those with direct human contact with reused water, including sports fields, toilets, a garden, food processing and domestic potable water use.

Two respondents reported monitoring for physical parameters, one monitors flow rate and one monitors temperature. One project reported continuous monitoring, but most reported periodic sampling varying from quarterly to annual.

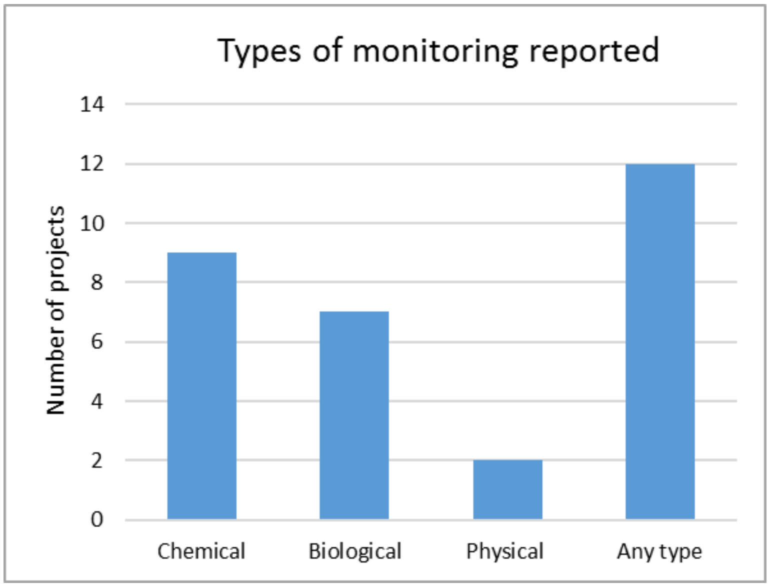

Figure 22. Types of monitoring reported

16. What have been the outcomes of the project (for example, estimated annual water reuse volume and cost savings; estimated stormwater pollutant load reduction)?

There was a wide variation of responses to this question. The annual amount of drinking water saved ranged from 75,000 gallons per year to four million gallons per year. One respondent reported saving 141,000 gallons between August 2015 and October 2015, while another reported saving 725,000 gallons of municipal water per year.

Financial savings often correlated with water savings. Examples include:

- A savings of 450,000 gallons per year was correlated to $1,600 per year.
- A savings of 320,600 gallons per year was correlated with $500 per year.
- A savings of 449,000 gallons per year was correlated with $2,000 per year.
- One respondent reported a 30 percent reduction in peak pumping.

Respondents also reported pollutant loading reductions. One respondent reported reducing total phosphorous loading 1.2 pounds per year and reducing total suspended solids loading 328 pounds per year. Other reported values included a 95 percent total suspended solids removal and a 50 percent phosphorus removal. In some cases, the pollutant loading reductions were not calculated. One respondent stated that the system had not run long enough, consistently, to quantify loading reductions.

In one case, mechanical issues limited the operation of the system over the first 2 1/2 years of operation. Another respondent stated that water use is not recorded so there is no way to estimate water savings. One respondent was waiting for an MPCA permit to conduct a feasibility study.

17a. Did you do any public outreach and/or education for the project?

Of the 37 responses to this question, 22 replied "yes" (Figure 23).

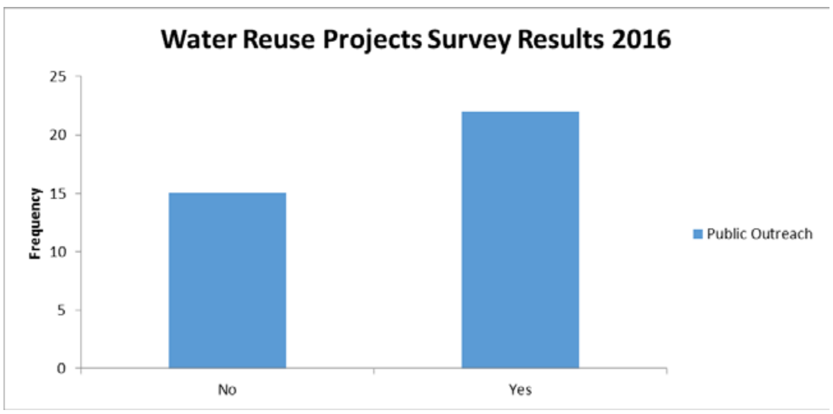

Figure 23. Conducting public outreach for water reuse project

17b. Describe your outreach and/or education efforts:

Six of the respondents stated that tours are provided of their respective facilities. Some of the organizations benefiting from these tours include the American Society of Landscape Architects, Green Building Council members, American Council of Engineering Companies, Minnesota Freshwater Society, and Design Builders International Association. Public speaking engagements, such as city council meetings and conferences and fact sheets were also commonly reported by the respondents.

Detailed signage, interactive kiosks and interpretive concrete etching were also reported at one of the water reuse facilities. One of the respondents reported that the water reuse project is being incorporated into the curriculum of a nearby school in which students will be involved with monitoring the system. Students have also assisted in designing interpretive signage.

Other reported activities include creation of websites and education boards and neighborhood meetings.

18a. What difficulties did you experience while implementing your reuse project?

As shown in Figure 24, design challenges and regulatory/permitting difficulties were the most commonly stated difficulties in implementing reuse projects.

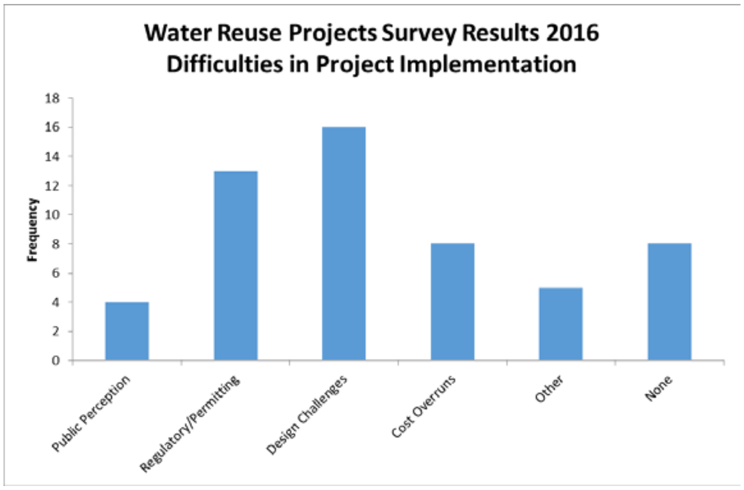

Figure 24. Difficulties in project implementation

Public perception was a challenge on some projects. At one project site, the residents do not like the natural vegetation being irrigated during rainfall events. Another project has residents that are concerned about the impact of water withdrawals on lake levels.

Respondents commonly mentioned permitting as a difficulty in project implementation. The stated challenges included: lack of end use standards, no defined review process, and challenges in correlating event-based watershed rules to annual treatment volumes. One project required three years from initial proposal to implementation (this was prior to the adoption of the rainwater harvesting chapter of the Uniform Plumbing Code). Some respondents described the DNR permitting process as long and complex and in conflict with the watershed district's requirements. One respondent stated that a clear range of standards that vary treatment based on end use is needed.

Respondents also described design challenges. Multiple respondents recommended having a mechanical engineer being involved with a project from the beginning. It is important to have the mechanical/civil engineer work closely with the rainwater harvesting and controls supplier. One project came in $50,000 over budget due to construction bids coming in higher than expected. Another respondent stated that their pond size should have been larger.

When asked to describe the difficulties encountered, responses included:

- Mowers hitting sprinkler heads.
- The need to operate year-round.
- Need the bag filters to run at high flow rates and have hold-down devices installed in order to function properly.
- Pond for water storage would not hold water and needed addition of a clay liner.

- Difficulties finding a contractor to set up and work on their unique system.

19. Please describe any concerns you have regarding public exposure to the reused water, and what if anything you do to minimize public exposure.

Seventeen respondents stated that they have no concerns regarding public exposure to reused water. Of those respondents who expressed concerns, different exposure pathways were described. Three separate respondents expressed concerns about:

- Ingestion of pond water, although the likelihood of this occurrence was not defined.
- Algae growth presenting problems for intake and discharge components in the system.
- Airborne bacteriological exposure from sprinklers, and that additional research into this subject was needed.

Respondents reported a number of different tactics for minimizing public exposure to reuse water. Three respondents used time of day restrictions to minimize exposure (e.g., early morning or nighttime irrigation). Six respondents made statements to the effect that the treatment system would prevent public exposure. Two respondents stated that state water quality requirements would be protective of the public. Some respondents mentioned using signage and fencing to prevent public exposure.

20. Looking back, what resources or information would have helped you complete the project?

Numerous respondents stated that regulations and codes would have helped them complete their projects. A number of respondents stated that state standards, plumbing codes, MDH requirements for direct potable reuse, and guidance and treatment standards for stormwater reuse for irrigation would be helpful. One respondent stated that standardized regulation of reuse water quality would have been helpful.

One respondent stated that algae control and screening would have helped their project. Another respondent thought that collaboration of the engineers with the electricians, plumbers and excavators would have been helpful in completing the project. Two respondents stated that examples of reuse systems were desired. In one case the response was quite specific: examples of graywater recycling systems to achieve zero water discharge, codes for potable use of captured rainwater, and codes for graywater and blackwater use including composting systems. Another response was more general: provide examples of system design, treatment methods and costs.

One respondent expressed concern for a lack of governmental response to a concern about the ability of a pond to hold water. Other respondents stated that it would have been helpful if people would be willing to at least try to do a reuse project.

21. What specific things could state government do to create a clearer and more efficient process for water reuse project implementation?

Nine respondents focused on regulations in answering this question. Some examples include:

- Have a clear set of requirements for reuse, right now it's all up in the air as to what will be allowed.
- Guidance/regulations on using stormwater for irrigation. Does it need to be treated? (I would hope the answer is no).
- Clear definition of when and what these facilities can be used for and any water quality standards to be met for each potential usage.
- Adopt codes for potable rainwater use.
- Update the plumbing code to allow for graywater use inside buildings.
- Need a clear range of standards which vary levels of treatment based on the end use; need to be able to use all sources of stormwater for residential, commercial, industrial, indoor and outdoor water reuse.

Three respondents focused on guidance:

- Provide guidance for local building officials that review/approve projects.
- Clear guidance on requirements for using stormwater to offset industrial water demand.
- Provide guiding document to help with code compliance and plan review.

Two respondents stated that grant funding would be helpful, because "these systems are not cheap to design and construct".

Two respondents focused on permitting issues:

- The state could lessen the burden of the permitting process and allow for cities to have a general permit, or something similar, for all stormwater reuse projects. With an easier and shorter process, many other projects would be encouraged and implemented. There is little incentive for a city or developer to go through the complex process as it stands now. Creating an easy process with matching requirements to other state agencies would allow all relevant parties to do "what's right".
- Eliminate the surface water appropriation fee associated with the DNR permit. It is not a burdensome cost, but is somewhat of a hassle, given the public benefits of these types of projects. It is important for the permit itself to still be required so that DNR can track the projects and maintain some level of oversight. The perpetual annual collection of fees seems to be an overreach, however.

Three additional comments are included below:

- It went well - DNR were supportive and MDH worked with us on plumbing issues involved in partial use of existing well also used for potable water for City Hall.
- MDH has been very collaborative, but there doesn't seem to be and effective inter-departmental strategy to manage water resources. For example, if we implement a reuse system and the DNR appropriates additional water withdrawals to another local business, then we may not have achieved the highest level of ground water protection benefits. Additionally the price of water is low so it is hard justify the operating and capital costs for these systems.
- State government should identify recommended training programs for all disciplines.

22. May we contact you for further information about your water reuse project?

Thirty of 35 respondents said the Workgroup could contact them regarding their water reuse project (Figure 25).

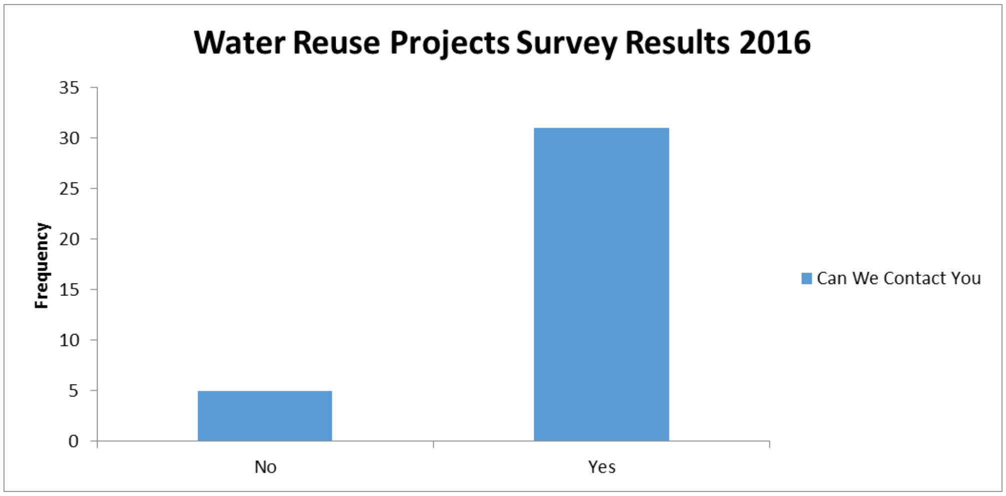

Figure 25. May we contact you?

23. Do you have any other comments or concerns you would like to share with the Water Reuse Interagency Workgroup?

Sixteen respondents supplied comments or concerns. Four of the comments focused on regulatory issues. One respondent commented that appropriation permits should not be mandated for the water reuse, while another stated "Don't over-regulate or you will price these systems out of existence." Another respondent would like the MPCA's Minimal Impact Design Standards (MIDS) calculator refined to include indoor and outdoor uses. Finally, one respondent stated that "USDA inspectors are often unwilling to allow the adoption of water saving practices."

Other comments addressed a number of different topics. One respondent said that no funding is available for water reuse projects, and another respondent commented that the tremendous volume of tap water being used for lawn irrigation is unsustainable from the standpoint of groundwater resources. On a different topic, one respondent would like industry representatives involved in workgroups; furthermore, WebEx access for those outside of the Twin Cities metropolitan area should be provided and mileage compensation provided for small businesses to attend meetings.

Appendix B. Stakeholder Participation

STAKEHOLDER LIST AND MEETING SUMMARIES

Stakeholder List

This list includes organizations represented at stakeholder meetings and that submitted comments on draft reports. The list does not include individual names for confidentiality purposes.

American Public Works Association Minnesota Chapter
Anoka County Conservation District
Barr Engineering
Bois de Sioux Watershed District
Bolton & Menk
Builders' Association of the Twin Cities
Building Owners and Managers Association
Calpine Energy
Capitol Region Watershed District
Cartwright Consulting
Carver County
Central States Water Environment Association
City of Blaine
City of Eagan
City of Hastings
City of Hugo
City of Mankato
City of Minneapolis
City of Rosemount
City of Woodbury
Coon Creek Watershed District
Ecolab
Emmons & Olivier Resources, Inc.
Freshwater Society
Gold’n Plump Company
Granite Falls Energy
H. R. Green
Housing First Minnesota
Houston Engineering
IDEXX Water
JMS Custom Homes
Larry Walker Associates
League of MN Cities
Legislative Water Commission
Metro Cities
Minnesota State
Mississippi Watershed Management Organization
MN Agricultural Water Resource Center
MN Association of Watershed Districts
MN Bio-Fuels Association
MN Chamber of Commerce
MN Cities Stormwater Coalition
MN Department of Transportation
MN Golf Course Superintendents’ Association
MN Nursery & Landscape Association
MN Public Facilities Authority
MN Rural Water Association
MN Technical Assistance Program
MN Turf and Grounds Foundation
Natural Systems Utilities
Plumbing-Heating-Cooling Contractors Association
Plumbers Local #15
Plumbing Board Minnesota
Rice Creek Watershed District
Sambatek, Inc.
SEH, Inc.
Seneca Foods
Shakopee Mdewakanton Sioux Community
Superior Mechanical
SRF Consulting
St. Paul Plumbers #34
Stark Environmental
Stinson Leonard Street
Vermillion River Watershed Joint Powers Organization
Water Control Corporation
Water in Motion
WSB & Associates

Stakeholder Meeting Summaries

The Workgroup convened four meetings with stakeholders in 2016 and 2017. The Workgroup invited certain organizations to participate because of their involvement with water reuse, but anyone could participate in stakeholder meetings. The stakeholder meetings were a unique opportunity for organizations and individuals to provide valuable input on water reuse options being considered. Meeting summaries are below. Full meeting notes and materials can be found at Water Reuse.

September 2016

The first of four planned stakeholder meetings occurred September 26, 2016. Approximately 60 stakeholders attended. The Workgroup presented about the Workgroup's purpose and the state of water reuse and regulation in Minnesota.

Stakeholders reviewed the Workgroup's definition of water reuse, definition of success and list of existing issues in water reuse. Stakeholders then filled out individual worksheets, which asked:

- What general impressions or questions arose in your mind as you heard us talk about the water reuse project?
- Was there anything you expected to read or hear today, but did not?
- What successes and/or issues are most critical/important to you or your organization?
- Do you have any advice to the Workgroup as we start to develop our recommendations on water reuse in Minnesota?

The stakeholders discussed their answers in small groups. Each group was asked to submit suggested changes or critical items to highlight from the successes and issues lists. They also provided advice to the Workgroup. The full group reviewed small group responses and organized them by theme.

November 2016

Approximately 60 individuals and organizations were invited to the second meeting, held on November 17, 2016. About 45 stakeholders attended. At the meeting, Anne Gelbmann (MPCA) presented the results of a survey of agencies in MS4 areas. The survey asked about any water reuse projects respondents had and any problems they had encountered in developing or maintaining the projects.

The Workgroup developed recommendation options that the stakeholders reviewed. Stakeholders then filled out individual worksheets, which asked:

- What were your initial impressions? What stands out?
- What recommendation options do you like and should have priority in moving forward?
- What recommendation options are concerning to you? Why?
- What can we do to improve the recommendation options? What needs to be added? What needs to be changed? What needs to be removed?

The stakeholders discussed their answers in small groups. Following are response highlights.

Information, Resources and Outreach Issues

There is strong interest among stakeholders in creating a central source for reuse information and resources, including funding. Some stakeholders also recommend identifying a lead agency that could manage all reuse programs in Minnesota. Comments included:

- Create one-stop shop for data, wiki-type resource, or another type of database/resource.
- Also outline permit process – the regulatory pathway.
- Design guidelines/standards, good design practice, level of treatment – based on use.

Regulatory and Guidance Issues

In general, participants in stakeholder meetings (many of whom represent local governments or other regulated entities) do not support new regulations or any expansion of the scope of existing regulations. However, there is a recognition that some level of regulation is important for public health and safety. The most acceptable regulations involve "fast, cheap, and straightforward" processes. However, most stakeholders strongly agree on the need for better guidance and design standards for the most common or desired reuse applications. Comments included:

- Incentives preferred over regulation.
- Delegate authority to city, county, organized entity.
- Create new framework for regulating water as a resource.
- More equitable distribution of regulatory pathways; streamline nonpotable industrial uses.
- Adopt Uniform Plumbing Code for stormwater reuse.
- Streamline and continue work on general permitting.

Operation and Maintenance Issues

Currently, some existing rainwater catchment systems in Minnesota are not functioning properly or are failing. Overall, there is a lack of state/national guidelines for O & M, monitoring, and oversight of water reuse systems. Comments included:

- Leave operations and maintenance requirements for stormwater to local governments.
- Certification of system operation is a good idea – but systems are quite diverse, so not sure how this would work.
- Who would house O &M reporting data?

Research Issues

Research is needed in many areas. A few specific areas that were mentioned include: monitoring of existing systems and long term examples of system operation, groundwater injection, and detailed cost breakdowns. As a group, stakeholders do not want to limit sources and end uses. Utilities need to know how to replace or balance loss of revenue if they still need to provide water or wastewater services but customers use fewer services.

Risk Assessment Issues

Stakeholders need more information on risk assessment. There was a call to address all scales and uses (although some are wary of potable reuse and groundwater injection) but not let more complex systems hold up easier projects. Low risk uses need to be defined. There seems to be general agreement on "fit-for-purpose" concepts for contaminant reduction and the need to establish water quality standards. However, some wastewater permittees are concerned about potential changes in their monitoring practices or permit conditions. Some expressed concern about the concentration of chemicals when recycling. The need for risk/benefit analysis falls under both research and risk assessment recommendations. Issues that cause "catastrophic" failure should be identified.

March 2017

The Workgroup invited over 75 individuals or organizations to participate in the third stakeholder meeting.

This stakeholder meeting took place on Monday, March 13, 2017. Around 45 people attended. Anita Anderson (Workgroup Chair, MDH) presented on risk management and water reuse. The presentation outlined the concept of risk for water reuse and identified a "log pathogen reduction target" approach to manage water reuse risk.

Stakeholders then self-selected into four small groups focusing on key topics where the Workgroup was interested in obtaining feedback: plumbing, liability, wastewater/graywater and risk management. Each small group held two sessions so stakeholders could rotate between them and provide detailed information. Each small group was moderated by a Workgroup member who asked a series of questions regarding the topic.

Stakeholder Feedback

Each small group had rich, thoughtful discussions. The following is a summary of the common themes from the discussions on each topic.

Liability

- There were different takes on liability from people with different risk perceptions. Some didn't worry about liability. Others wanted more standards in place from the state so they have something to work towards to reduce their liability.
- There is interest in a "permit shield" approach – the permit requires you to build to a set of standards; if you demonstrate you met the standards, it then shields you from liability to some extent.
- O & M are critical in ensuring that systems function properly. Some people think we should set up standards to be clear about how to meet standards. Others said that requiring O & M will raise costs and make reuse cost-ineffective.
- The group still hasn't heard from the general public, who might be affected by some of these projects.
- The group didn't talk about different sources. They discussed reuse as a whole, so some may have been thinking about graywater while others were thinking about stormwater.

Risk Management

- People on the wastewater side understand regulations, and are used to doing water quality monitoring. They saw a need for that.
- People on the stormwater side had questions about the levels of risks, and about the information available about the quality of stormwater. They were less ready to do

monitoring or treatment, and asked if education can suffice instead of requirements. They wondered whether the group had considered the risk-benefit equation carefully.

- There was a question of what will happen with projects that have already been installed. If the state is going to do regulation, they would want it done sooner rather than later so they can adjust new projects now and not have to redo them later.
- Some stakeholders wanted to ensure the systems will not pose a public health threat. Overall, there was interest in doing more research on water reuse systems in Minnesota, but also concern that research findings could result in requirements intended to protect public health that will be considered too burdensome. There was acknowledgement that the source of the water being reused will be an important factor in gauging the amount of risk for each system.

Wastewater/Graywater

- The concept of resilience was discussed – systems with reuse options can be more resilient in the face of future water shortages.
- The group, like others, did not agree about the need for regulation.
- Options discussed included direct potable use (considered a long-term option in Mankato) and reuse of splash pad water, which can be very wasteful if discharged but expensive to retrofit for reuse.
- People who work on decentralized systems in other states have a different perspective that is more favorable toward graywater reuse.
- Home water softeners are a barrier to graywater reuse.
- Much of what is built in today’s market is developer-driven. Home builders are not promoting dual piping that would allow reuse. However, contractors are saying they can put in graywater systems through permitting at the city level; this might be happening in Minneapolis.
- For wastewater reuse, the key problem is that moving water is expensive, so proximity of source to end use is important.
- Different certifications like LEED, Living Building Challenge, Envision, and Sustainable Sites might drive reuse.

Plumbing Code

- Most stakeholders agreed the state should be more proactive. They all agreed that the state doesn’t have a water quantity issue now, but they wanted to be ready for when we do have one.
- There were concerns about homeowner ability to maintain reuse systems.
- Stakeholders were concerned about O & M, and were not opposed to training and certification of operators, especially for graywater.
- They discussed the need for oversight and who would do oversight, and how it will scale up over time for safe systems. For example, St. Paul already inspects systems twice a year. How do they adjust oversight when the number of projects increases? Will they charge fees?
- They discussed having reuse stay in the plumbing code.
- They discussed guidance for design review and meeting water quality standards.

October 2017

About 35 participants convened for the fourth stakeholder meeting, with eight more participating via WebEx. This stakeholder meeting took place on October 2, 2017.

The goals of this meeting were to discover ways to clarify parts of the report, find areas of support and listen to stakeholder concerns. Anita Anderson (MDH) presented on why the group began meeting, what the group accomplished and recommended, and the next steps for the group.

Participants filled out individual worksheets, which asked:

- In the Workgroup's report, what aspects did you like? What works for you? Do you support any of the recommendations?
- Where does the report need more clarity? What is confusing or could be worded more clearly?
- What concerns do you have with the report? What needs to be changed or edited?

The stakeholders discussed their answers in small groups and shared two to three answers for each set of questions with the full group. Then the full group discussed the following questions:

- How they could help in moving forward with the recommendations?
- Where else should the Workgroup look to collect final information or data?
- How can they share information with their constituents?

Worksheet responses and notes from the full-group discussions are grouped by general theme below.

Worksheet Responses

In the Workgroup's report, what aspects did you like? What works for you? Do you support any of the recommendations?

- The report's discussion and clarification of the roles and jurisdictions of state agencies.
  - Maintains protections inside buildings (DLI role).
  - Excellent summary of the issues.
  - Definition of successful implementation of water reuse.
- The report indicates state support of reuse and will act as an incentive for cities to implement.
- Information about possible risk associated with collected stormwater.
- Stormwater reuse singled out as being the most common reuse practice and having multiple benefits, mention of economic feasibility of reuse.
  - The acknowledgement that many landscape irrigation reuse systems are being successfully designed, installed and maintained today.
- Assessment of best practices in other states.
- Opportunities for education provided through UMN stormwater education program and watershed district organizations.
- The flexibility described in pathogen reduction target recommendation.

Where does the report need more clarity? What is confusing or could be worded more clearly?

- Organization and contents of the report:

  - Better definition of terms needed.
  - More guidance on "how to read" report for stakeholders, public.
  - Case studies of installation and ongoing maintenance/utility/labor/reporting.

- Uncertainty over next steps – by state agencies and/or others?
  - Funding doesn't need to be used until 2019, rushed report has led to many concerns and lack of research/evidence based recommendations.

- Uncertainty over log reduction approach – amount of sampling needed. Tables not yet complete.
  - Fear of unintended consequences by publishing exact numbers without confidence in the reduction targets, especially for stormwater reuse.
  - Potential impact on industries and practitioners.
  - Intended use of the technical materials prescribed, including the referenced report from California.
  - Any work in this area should first focus on performance-based outcomes, not prescriptive requirements.

- Purpose of report: Is it background/information sharing or guidance or is it a regulatory document – or will it be used in rulemaking? Clarify that rulemaking is not yet recommended.
- Concern regarding oversight of systems; who is going to follow up?

What concerns do you have with the report? What needs to be changed or edited?

- Does this report simplify the reuse regulatory paths (still complicated)? How will the recommendation be implemented on a practical level?
- Don't assume all types of reuse creates a health risk: acknowledge that little to no treatment is an option depending on end use.
- The risk assessment approach espoused in the report puts into doubt the thousands of surface-water-based landscape irrigation systems in use today and over time.
  - Why can't ISW, CSW, and MS4 permits function as the regulatory tool for stormwater reuse?
  - What level of contact is assumed for stormwater ponds? Clarify exposure potential.
  - The focus on nighttime or fenced-off access seems too restrictive and expensive. Irrigate during periods of non-use. Use signage.
  - Has irrigation from existing ponds lowered water levels unacceptably?

- Technical questions:
  - What about unknown chemicals?
  - Why did the report not address *Legionella*?
  - How do you measure or assess log reduction with a highly variable source (e.g., stormwater)?
  - How do you prove log reductions if you don't have a quantity to remove? Must make assumptions on quality of water before you treat it.
  - Suggest the use of a single bacterial target (total coliform) for each of the three disinfected levels of recycled water – this is common practice among states with recycled water programs.

  - What source should laboratories use for methods of testing recycled water?
  - Cost implications, do educational signs put irrigation into the restricted category/remove treatment requirement?
  - Is any area truly restricted?
  - If the pathogen reduction approach were implemented, would it replace standards outlined in Uniform Plumbing Code?
  - Additional analysis by MDH: Is this focused only on the two study reuse systems?
- Communication of risks moving forward to stakeholders and the public.
- Grouping many sources under one regulatory framework causes concern. Comparing apples to apples – don't apply standards for one source water to another.
- If public health concerns dominate and monitoring/treatment are required, reuse projects will not be cost-effective to implement.
  - Report seems to be tilted toward public health. Environmental and ecological risks should be taken into account more, more like a three-way balance. Focus only on public health could cause more harm to the environment.
  - Stormwater use out in the natural environment shouldn't be more restrictive than recreational use.

How to assist in moving recommendations forward?

- Next steps need to be laid out – who, what, when? Is there funding and political will? More monitoring is needed. A lot of watershed districts run monitoring programs. The state could request a clear picture of the data needed. Watershed management organizations and SWCDs could do to help fill in the gaps. We need a clear picture of what's needed to move this forward.
- If the state can't fund/push something forward (e.g., specific data need to help with risk assessment) report should identify other agencies such as watershed districts and watershed management organizations that can assist, for example, by collecting specific data on viruses/protozoa etc.

Appendix C. Liability Risks

There are concerns about liability risks associated with water reuse: the potential to be held responsible for adverse outcomes related to the reuse of water sources. The Workgroup attempted to get some perspective on issues of liability by contacting insurance companies, including those that underwrite activities of municipalities in Minnesota (League of Minnesota Cities, personal communication, June 2016), a state attorney with knowledge of liability issues, and staff in other states already implementing water reuse. Workgroup members also held small group discussions with stakeholders to explore liability concerns.

Insurance Companies

Insurance companies, including those serving states where water reuse is common, did not seem to be very familiar with the water reuse topic or the potential risks that could be related to water reuse. One underwriter identified concern for pollution of the groundwater from irrigation systems using stormwater contaminated with petroleum products from vehicles. Additional concerns related mostly to infrastructure damage from storms, vandalism or other physical hazards.

Attorney Perspective

From the attorney perspective (MDH attorney, personal communication, April 13, 2017), liability will depend on circumstances of each case. There are currently no specific legislative requirements or specifications related to water reuse in Minnesota. Because water reuse systems could vary greatly in purpose, and the quality of source water and end use can also vary, each water reuse system might require a unique assessment, with specific contracts or policies created to define or protect against liability.

In general, governmental agencies are immune to lawsuits in the course of ministerial duties based on tort claims law, unless there are specific legislative instructions for a course of action that are not appropriately implemented. If a governmental or private organization reuses water, such as for irrigation of a public area, indemnity could be specified in public policy or law, although there is always a possibility of a challenge to the policy or law.

In situations where reclaimed or harvested water will be supplied to an end user by a producer, a contract that describes expectations or assigns liability under certain scenarios may be needed. A contract could clearly define the need for the water end user to test the water quality parameters and/or use the water at their own risk. Reuse systems that bring water inside buildings will need to comply with plumbing codes.

States and Local Governments

In state and local governments where liability issues have already been considered, the focus to date has been mostly on wastewater reuse systems. Where state guidelines for reuse are in place, one of the primary approaches to control risk and assign liability is through state or local permits for installation and operation of water reuse systems.

In some states, indemnity clauses are used to control liability issues and possible resulting litigation if the water delivered does not meet a specified quality. At times, insurance policies to protect against water quality that fails to meet specific parameters are recommended or required (Seacoast Utility Authority, 2015; New York Department of Environmental Quality, 2016).

In other states, such as Washington and Florida, liability is assigned to the distributor of the water. In Washington under 1997 rules, the producer of the reclaimed water is responsible for maintaining appropriate water quality (Washington State Department of Health and Washington State Department of Ecology, 1997). In Florida, a person practicing spray irrigation is not liable for civil damages resulting from the irrigation, as long as the irrigation system complied with appropriate rules and permits, per Florida Statutes, section 403.135. On the other hand, the wastewater treatment facility providing the water is not excused from the liability). For a town in Arizona (Town of Gilbert, AZ, 2014), the town as producer of the reclaimed water takes responsibility for quality until it is delivered to the user, then passes the liability to the user.

Some states, like Texas and Oregon, also require users of reclaimed water to follow specific regulations (Environmental Law Institute, 2007).

Even with these contractual provisions, it appears common law provisions of liability might still apply, leaving reused water suppliers, distributors, and users somewhat vulnerable to lawsuits under other regulations for wastewater treatment, distribution and reuse. In fact, Washington's provisions for water reuse explicitly state that common liability still applies, regardless of the contract specifications. However, there are still some practices or specific water reuse projects covered by "safe harbor" laws that create immunity to most liability laws.

Use of the water as a product that could result in damage, injury or loss if it does not meet specifications is another potential area of liability. As noted by the Environmental Law Institute (2017) in reference to an article by an attorney on water reuse, the concept of water as a product might mean that laws governing the manufacturing of a good, rather than of supplying a service, might apply. Laws governing breach of warranty might also come into play.

Overall, as examples from other states seem to indicate, it appears that liability and indemnification concerning expected quantity and quality of reused water and any potential damages that could occur if a product fails to meet these parameters should be set out in contractual agreements if not addressed in law or rule. Designers and implementers need to consider available information related to risks.