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Wastewater Challenges in Small Minnesota Communities: Wastewater Treatment Operator Survey Results and Affordability Analysis

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WASTEWATER CHALLENGES IN SMALL MINNESOTA COMMUNITIES

WASTEWATER TREATMENT OPERATOR SURVEY RESULTS

AND

AFFORDABILITY ANALYSIS

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EXECUTIVE SUMMARY

INTRODUCTION

Well-maintained and properly functioning wastewater systems are critical infrastructure because they protect public health and make local economic development possible in small communities. Such systems, however, can also be expensive and difficult for small communities to keep up with. The purpose of this study was to assess regulatory, structural, operational, and affordability challenges associated with municipal wastewater infrastructure in small Minnesota communities. The findings of this study are based on data from three major sources: 1) a survey of wastewater treatment plant (WWTP) operators, 2) the Minnesota Pollution Control Agency's Water Infrastructure Needs Survey (MPCA WINS), and 3) the 2011-2015 American Community Survey (U.S. Census Bureau).

In our survey of WWTP operators, we included Minnesota communities with population up to 20,000 that were not located in economic development region 11. The sample of communities was stratified by several factors, including population size, economic development region, and type of wastewater treatment system. We obtained 76 complete responses via phone survey (conducted during late November through mid-December) from our initial sample of 200 communities. Although the responding communities (Figure 1, Tables 1 & 2) were reasonably representative of small Minnesota communities, economic development regions, and treatment technologies, communities with population of 500 or less were underrepresented by approximately 17%. This smallest community category still made up 30% of the completed surveys, however.

The affordability analysis included 681 Minnesota communities, and was conducted in order to gain a more thorough understanding of the impacts of wastewater treatment system costs on smaller communities (defined as population 5,000 or less). The most commonly used measure of affordability is a percentage (1.4%) of median household income (MHI), which, as explained in the main report below, is likely an inadequate way to gauge the affordability of sewer rates for populations such as 65 or older and low-income residents. The intent of the affordability analysis was to explore whether smaller communities, and specific populations within these communities, may be disproportionately burdened by wastewater system costs.

WWTP OPERATOR SURVEY FINDINGS

Smaller communities in Minnesota struggle to varying degrees to keep up with a changing regulatory environment and aging infrastructure due to lack of funding, lack of public awareness and support from leadership, and many other factors, some of which are unique to a handful of individual communities. Most of the communities in our sample reported at least some difficulty keeping up with training, mandatory reporting, or rules and regulations. Most communities also reported significant problems with infiltration and inflow (I&I) due to broken or cracked pipes, sump pump connections, extreme rain events, and lack of overflow capacity. At the same time, most communities have begun implementing a plan to alleviate I&I problems. However, many communities identified funding as a major difficulty in implementing these plans. Many wastewater treatment plant operators found the MPCA online reporting system challenging, and many also reported having to invest in expensive upgrades or facility replacement due to recent permit changes, with phosphorus noted as the most difficult and expensive limit to meet. Although biosolids handling and disposal was not at the time of the survey a major problem for most communities, some operators were concerned with the current cost and logistics (e.g. availability of land, timing of hauling, and finding people or companies to haul) of dealing with biosolids. Others noted past and potential future problems with cost and availability of hauling and disposal options.

AFFORDABILITY ANALYSIS FINDINGS

The types of infrastructure problems (e.g. leaking or broken pipes, ageing pumps and other equipment) faced by smaller communities (population 5,000 or less) are not unique to smaller communities. But in addition to reasons listed below, such problems may actually be more severe due to a history of less federal and state grant funding for small communities, and resulting deferred maintenance. There appear to be significant differences between smaller and larger communities in Minnesota when it comes to wastewater treatment system affordability in part because the economy of scale, or spreading costs among many household, businesses, and other organizations does not work in favor of small communities. On average, wastewater treatment system costs per household are higher in small communities, and there is often less capacity in smaller communities to absorb these higher costs.

- Median household income values in small communities are 26% lower than in larger communities
- The median value of the percentage of householders 65 and older in small communities is 6 percentage points higher, and the MHI for this group is almost 20% lower in small communities than in larger communities.
- There are 10 percentage points more lower income households in small communities. When comparing median values, 31% of small community households earn $30,000 or less; whereas 21% of households in larger communities fall into this earnings category.

We found that the median sewer rate for smaller communities is 21% higher in smaller communities than in communities with 5,000 or more residents. In a significant proportion of Minnesota communities, the population 65 and older is paying more than 1.4% of its MHI for sewer rates. But this problem is worse in smaller communities (in nearly 24% of small Minnesota communities, those 65 and older pay more than 1.4% of their MHI) than in larger communities (15%). All households earning less than $20,000 per year pay more than 1.4% of their income for sewer rates, but this problem is exacerbated in smaller communities as average sewer rates are higher.

ABBREVIATIONS

BOD: biochemical oxygen demand

DMR: discharge monitoring report

FOG: fat, oil, grease

Hg: mercury

I&I: infiltration and inflow

MHI: median household income

N: nitrogen

NH_3: ammonia

P: phosphorus

pH: potential hydrogen

SRMHI: sewer rate as a percentage of median household income

TSS: total suspended solids

WINS: wastewater infrastructure needs survey

GLOSSARY

Activated sludge: a biological sewage treatment process that uses bacteria and other microorganisms to consume organic matter in wastewater

Aerated pond: similar to stabilization ponds, but with the addition of artificial aeration to speed up the growth and activity of microorganisms in the ponds

Biochemical oxygen demand (BOD): the amount of oxygen required for organisms to break down organic materials in the wastewater stream

Biosolids: treated sewage sludge, mainly consisting of organic materials and other trace elements that are introduced into domestic wastewater

Community drainfield/mounds: an underground filtration system that receives effluent from large underground (septic) tanks to which multiple households are attached

Discharge monitoring report (DMR): MPCA-required form that must be submitted by all permitted wastewater facilities to inform the MPCA of flow and discharge in the wastewater system, as well as water quality sampling data

Effluent: liquid exiting a wastewater system at the outfall (end of the pipe)

Eutrophication: introduction of excessive nutrients into a water body, causing extreme plant and/or algae growth, which upon decay reduce the available oxygen in the water and degrade habitat for fish and other aquatic life

Infiltration and Inflow (I&I): consists mainly of stormwater and groundwater that enter sewer pipes through cracks and holes. Other sources of infiltration include improperly connected sump pumps and storm drains.

Influent: (expected) liquid and accompanying solids entering a wastewater system through sewer connections

Jetting: the use of (often warm or hot) high pressure water to clear obstructions, such as congealed fat

Lift station: also called pumping stations, move wastewater from lower to higher elevation, for example, when excavating to ensure sufficient gradient for gravity flow would be too expensive.

Median household income (MHI): the middle income value of all households in a community; one measure of a community's standard of living.

Oxidation ditch: a biological wastewater treatment system that retains wastewater longer (several days) than an activated sludge process (generally less than one day), but for much less time than pond systems (months)

Potential hydrogen (pH): the relative acidity or alkalinity. A value of 7.0 is neutral. Below 7.0 is acidic; above 7.0 is basic

PVC pipe: pipe made from polyvinyl chloride (a form of plastic), which is more flexible than iron or steel and does not corrode

Septage: contents pumped out of septic tanks, which in some cases are introduced into municipal sewage treatment systems for disposal

Septic tank: used to treat wastewater from single or small numbers of homes, generally in rural areas or small communities; effluent from septic tanks is usually filtered or drained through a mound or drainfield

Smoke testing: a method for testing pipes for leaks—smoke introduced to pipes will follow any leaks to the surface. These locations are then marked for repair.

Stabilization ponds: large manmade ponds in which sewage is treated by microorganisms, solar radiation, and wind

Sump pump: device used to remove water from basements and sump basins inside homes

Tertiary treatment: a (usually) final wastewater treatment stage that addresses particular water quality issues, such as nutrient removal

Total suspended solids (TSS): consist of particles floating in the water column; also often defined as the dry weight of suspended solids trapped in a filter

Trickling filter: a wastewater treatment technology that uses a bed of filter media (such as gravel or plastic) on which microorganisms grow and consume organic matter when wastewater is sprayed over the surface of the bed. Trickling filters are used after settling tanks remove the largest solid particles from the wastewater flow.

Wastewater Infrastructure Needs Survey (WINS): Annual survey of wastewater facilities in Minnesota that collects basic system data (e.g. daily flow, population served, type of treatment technology) as well as needs regarding repair, maintenance, and upgrades to wastewater treatment plants

Wastewater treatment plant (WWTP): one or more facilities where one or more treatment technologies are used to remove sediment, organic matter, and other components of wastewater prior to releasing effluent into a receiving water body.

Wastewater system: includes sewer pipes, lift stations, wastewater treatment plant and all associated infrastructure

A. INTRODUCTION

Wastewater systems are vital infrastructure for smaller communities, but can also be extremely expensive (these are multimillion-dollar investments) and, for a variety of reasons, challenging to maintain. These systems are invaluable because they serve an important public health protection role, and because without properly functioning wastewater systems, it will be difficult for smaller communities to retain or attract industry or other major employers. Wastewater systems (Figure A-1) include sewer connections to allow influent to enter the system, sewer main pipes that carry wastewater, pumps and lift stations to "boost" the wastewater stream where necessary, treatment plants that use various technologies to remove organic matter and other pollutants, and an outfall for returning treated effluent to a receiving water body. As indicated in Figure A-2, there are diverse wastewater treatment technologies in use in our sample of smaller communities (see the glossary for definitions of these technologies). Some treatment technologies such as stabilization ponds require very little hands-on day-to-day maintenance, while others, such as sequential batch reactors, require attention every few hours. Regardless of the treatment technologies in use, all of the wastewater systems require leak-free pipes for optimal operation, as well as wastewater users who do not introduce contraband (e.g. "flushable" wipes or rags) or copious amounts of fats, oil, and grease (FOG).

The University of Minnesota Morris Center for Small Towns (CST) was charged with addressing the question: What wastewater challenges do smaller communities face, and in addition to the information gathered annually by the Minnesota Pollution Control Agency's (MPCA) Wastewater Infrastructure Needs Survey (WINS) how can people "on the ground" help us answer this question? Following initial discussions, we decided to interview wastewater treatment plant (WWTP) operators, who, particularly in smaller communities, are the people most intimately familiar with how wastewater systems work and the needs and challenges associated with running wastewater systems. The WWTP operator survey aims to find out from the people who operate the systems what their opinions are about challenges they face in dealing with ageing infrastructure, increasing numbers of and changing regulations and rules, and decreasing (i.e. stricter) pollutant limits.

In addition to the WWTP operator survey, we also conducted an affordability analysis to see whether smaller communities, and subgroups within these communities, face additional challenges when it comes to paying for wastewater systems. Especially in larger communities, much of the initial cost of required water infrastructure upgrades or construction projects in the 1960s and 1970s was covered by federal grants. Since then, grant programs were replaced by revolving loan programs, and when revolving loan programs are short of funds, communities must tap their consumer base to cover maintenance, repair, and replacement costs. Based on an analysis of Minnesota communities with more than one mile of sewer pipe, it appears that there are only about half as many people per mile of pipe in smaller communities (median of 112) compared to larger communities (median of 217) (Figure A-1). And while the cost of the pipe itself (which may be of smaller diameter in smaller communities) and cost and complexity of pipe installation or repair/replacement may not be exactly equivalent, this still illustrates how economy of scale does not benefit smaller communities. Having to install and maintain comparable infrastructure with lower population density and meet increasingly strict wastewater regulations suggests that smaller communities may often bear higher per capita costs.

The US Environmental Protection Agency's[1] affordability criterion examines only one threshold value (of 1.4% of a community's median household income, or MHI) to determine whether a community's wastewater system is affordable. However, the EPA's use of the MHI as a single data point to measure community ability to afford infrastructure has several shortcomings, including:[2]

[1] And therefore also that of the MPCA and most if not all state agencies that implement the Clean Water Act

[2] United States Conference of Mayors, the American Water Works Association, and the Water Environment Federation 2013. Affordability Assessment Tool for Federal Water Mandates. Report Prepared by Stratus Consulting http://www.awwa.org/Portals/0/files/legreg/documents/affordability/AffordabilityAssessmentTool.pdf

- MHI does not capture impacts on sub-groups whose incomes tend to be clustered at the ends (especially the lower end) of the community's income distribution;
- MHI provides very little information about economic distress and is not an accepted measure of poverty or other means of indicating economic need in a community;
- MHI is only one data point taken at one point in time and gives no sense of how demographics or social and economic conditions may change over time in a community; and
- MHI is a household-level statistic and therefore does not capture impacts on non-household entities (e.g. businesses, non-profit organizations, schools, landlords and public housing agencies).

Our goal in this part of the report was to explore whether smaller communities and specific populations (e.g. age 65 and older, low-income) within these communities face unique challenges when it comes to paying for wastewater systems. We did not address the other three substantive critiques (listed above) of using MHI for affordability analyses.

The CST team that worked on this project brought a collective 15 years of experience studying wastewater and water systems, 10 years of experience with survey design, delivery, and analysis. Team members included Kelly Asche (Center for Small Towns), environmental studies faculty member Ed Brands, and two UMM student researchers, Zach Johnson and Tayler Vetsch. The project was funded by the Center for Rural Policy and Development (CRPD).

Population Per Mile of Pipe in Sewer Collection System*

Community size	Average	Median	Maximum	Minimum
5,000 or more	272	217	4593	73
<5,000	128	113	766	8

*Data Source: MPCA Water Infrastructure Needs Survey

**Note: data from communities with collection systems less than one mile in length are not included

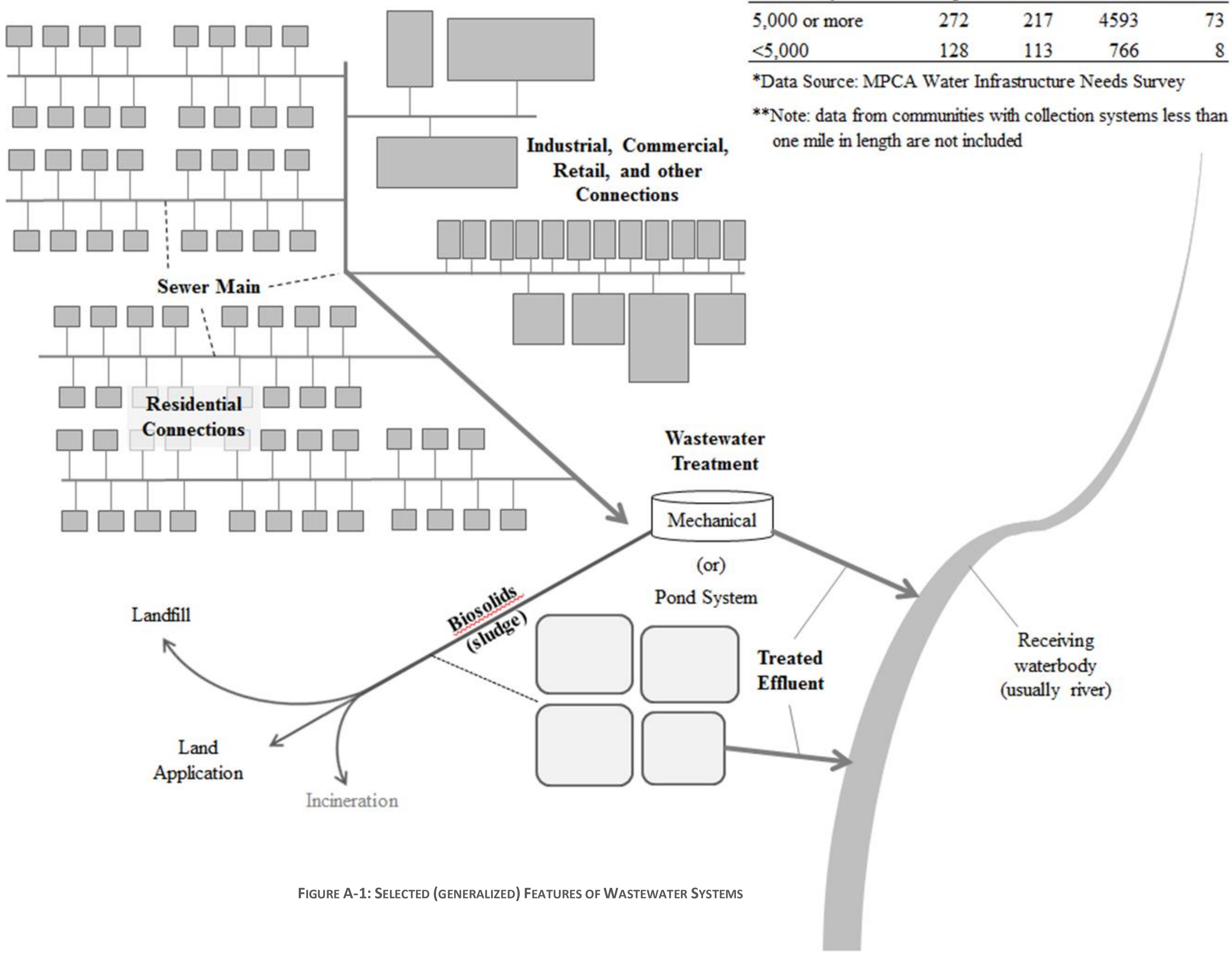

FIGURE A-1: SELECTED (GENERALIZED) FEATURES OF WASTEWATER SYSTEMS

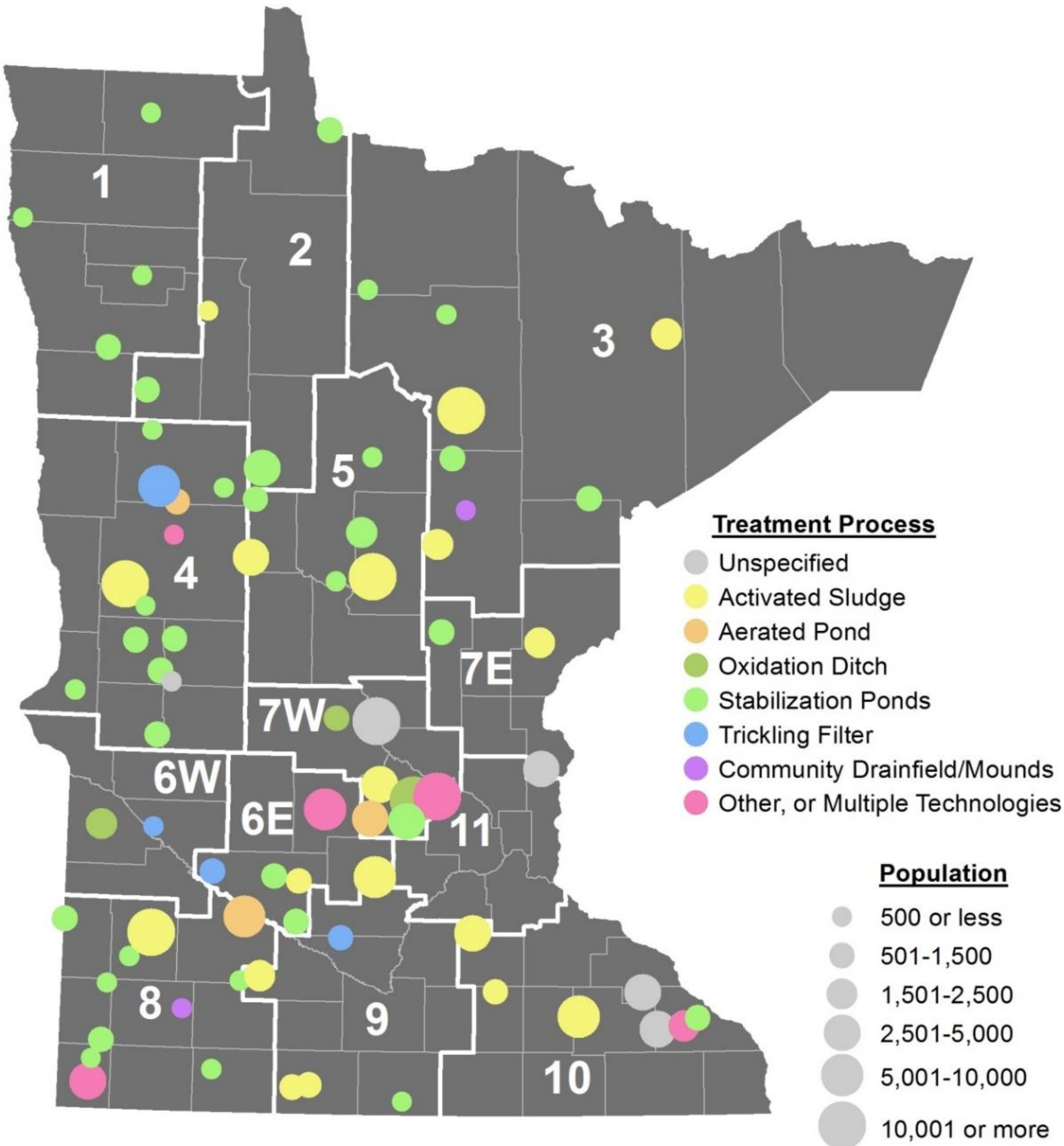

Figure A-2: Community Size, Treatment Technology, and Distribution by Economic Development Region (Communities that Responded to the WWTP Operator Survey)

B. METHODOLOGY

A. WWTP OPERATOR SURVEY

a. Survey Design, Administration, and Analysis

Topics (e.g. inflow & infiltration, training, reporting) covered in the survey as well as survey questions were developed by the team based on major issues raised in the MPCA WINS Report and other wastewater-related literature, and in consultation with Bill Dunn, MPCA, and Marnie Werner, CRPD. Feedback from Ryan Mogard, our local (Morris, MN) wastewater treatment plant operator was also important in shaping the survey and determining that it should be designed to be completed in 15 minutes or less. The survey includes questions on training requirements, monitoring and reporting, rules and regulations, system operations, water quality parameters, general challenges, and demographics. A complete copy of the survey is provided in Appendix A.

Several different modes for delivering the survey were evaluated, including in-person, via mail, online, or via phone. The in-person mode was deemed too expensive and time-consuming for this project. Again, feedback from Ryan Mogard was helpful in determining that phone would probably be the best way to reach most of the operators, since there is a significant age range (which would likely cause online survey delivery to skew towards younger operators). Mail surveys often suffer from low completion and return rates, and we believed a higher completion rate could be achieved via phone.

Phone calls were conducted from mid-November to mid-December resulting in 3 contact attempts through our sample list. Survey responses were recorded in Qualtrics (online survey management tool) in real-time, and all team members participated in quality controlling the responses in Qualtrics (i.e. checking for accuracy in spelling and terminology). Once response collection ceased, we then coded the qualitative responses to aid in summarizing the data in tables and graphs. Two different team members coded the responses and compared results to ensure consistency.

b. Sample of Minnesota Communities

We constructed an initial sample of 200 smaller communities that was proportionally representative of 1) the number of Minnesota communities in each population size category, 2) the number of such communities in economic development regions (excluding EDR 11) within the state, and 3) the prevalence of various forms of wastewater treatment technologies utilized at wastewater treatment plants across the state.

Surveys were administered via phone between late November and mid-December 2016. Names and contact information of the WWTP operators were gathered from the MPCA's WINS records. Approximately two weeks prior to initiating phone calls, these WWTP operators were all sent postcards indicating that they would be contacted for a survey about challenges associated with their wastewater systems (see Appendix B). WWTP operators were then contacted via phone, at which point survey appointments were made or messages were left. WWTP operators in all 200 communities in the sample were contacted and 76 surveys were actually completed.

The 76 completed surveys retained most of the representative characteristics of our initial sample of 200 communities, but did under represent (by 17%) the smallest communities (and thus slightly over-represented the other size categories) (Tables B-1 and B-2). These communities still comprise approximately 30% of the completed surveys and thus challenges unique to this community size category should still be reflected in the survey results.

Population Range	# Communities in MPCA WINS	% of total	Responses	% of total responses	Difference
0-500	308	47%	23	30%	-17%
501-1500	183	28%	24	32%	4%
1501-2500	54	8%	7	9%	1%
2501-5000	60	9%	10	13%	4%
5001-10000	28	4%	5	7%	3%
10001-20000	24	4%	7	9%	5%
Total			**76**		

TABLE B-1: POPULATION CHARACTERISTICS OF SAMPLE (MINNESOTA COMMUNITIES THAT COMPLETED THE SURVEY)

Economic Development Region	Number of Communities	Economic Development Region	Number of Communities
1	4	7E	3
2	4	7W	7
3	8	8	11
4	13	9	5
5	6	10	7
6E	6	11	0
6W	2	**Total**	**76**

TABLE B-2: DISTRIBUTION OF SAMPLE COMMUNITIES BY ECONOMIC DEVELOPMENT REGION

B. AFFORDABILITY ANALYSIS

The analysis utilized data from the 2011-2015 American Community Survey and the MPCA WINS survey. The data from the American Community Survey include the median household income of households 65 and older, the total number of households, and the number of households by income categories[3] for each community in Minnesota. The data used from the MPCA WINS survey includes the 2015 sewer rates for each community in Minnesota. MPCA data on household level sewer rates is based on an assumed consumption of 60,000 gallons of water per annum[4].

The analysis focuses on comparing smaller (population less than 5,000) and larger (population 5,000 or more) communities, and sub-populations within the communities (age 65 or over, lower income).

SEWER RATE COMPARISON BY COMMUNITY SIZE

Summary statistics (mean, median, maximum, minimum) of sewer rates were calculated for each community group. Comparing the median sewer rates for each community group was used as the basis for analysis. However, mean values were provided as well and were calculated in the following manner:

$(\text{sewer rate}_{\text{smaller community 1}} + \text{sewer rate}_{\text{smaller community 2}} .... + \text{sewer rate}_{\text{smaller community n}}) / n_{\text{smaller community}}$

and

$(\text{sewer rate}_{\text{larger community 1}} + \text{sewer rate}_{\text{larger community 2}} .... + \text{sewer rate}_{\text{larger community n}}) / n_{\text{larger community}}$.

[3] American Community Survey; 16 income category table

[4] This is the assumed volume for a typical household as noted in the MPCA's WINS survey https://www.pca.state.mn.us/sites/default/files/lrwq-wwtp-1sy16.pdf

Householders 65 years or older

Sewer rates as a % of MHI 65+

To compare affordability of sewer rates for householders 65 and older, sewer rates were divided by the median household income of householders 65 and older in each type of community, which gives us the sewer rate as a percentage of the median household income (SRMHI) for those 65 and older in each community:

SRMHI = (sewer rate) / (median household income 65+).

Summary statistics (mean, median, maximum, minimum) are provided and the means were calculated in the following manner:

(SRMHI $65+_{\text{smaller community 1}}$ + SRMHI $65+_{\text{smaller community 2}}$....+ SRMHI $65+_{\text{smaller community n}}$) / n;

and,

(SRMHI $65+_{\text{larger community 1}}$ + SRMHI $65+_{\text{larger community 2}}$....+ SRMHI $65+_{\text{larger community n}}$) / n.

In addition to comparing the summary statistics, the SRMHI 65+ value for each community was compared to the 1.4% affordability threshold used by the MPCA to assess water infrastructure affordability. Percentages of the communities in which the SRMHI 65+ was above the threshold were calculated for each community group for comparison:

(# of communities with SRMHI $65+_{\text{smaller communities}}$ > 1.4%) / $n_{\text{smaller communities}}$

(# of communities with SRMHI $65+_{\text{larger communities}}$ > 1.4%) / $n_{\text{larger communities}}$

Comparison of Median Household Incomes 65+

Summary statistics (mean, median, maximum, minimum) of the MHI for householders 65 and older were calculated for each community group. Medians are used as the basis of our analysis, but mean values are provided as well and were calculated in the following manner:

(MHI $65+_{\text{smaller community 1}}$ + MHI $65+_{\text{smaller community 2}}$... + MHI $65+_{\text{smaller community n}}$) / n

and,

(MHI $65+_{\text{larger community 1}}$ + MHI $65+_{\text{larger community 2}}$... + MHI $65+_{\text{larger community n}}$) / n.

Comparison of Householders 65 and Older as a Percentage of Total Households

The number of households with householders 65 and over was divided by the total number of households in each community.

% of households 65+ = (# of households 65 and older) / (total households)

Summary statistics (mean, median, maximum, minimum) were provided for each community group for comparison. Medians are used as the basis of our analysis, however mean values are provided as well and were calculated by;

(% of households $65+_{\text{smaller community 1}}$ + % of households $65+_{\text{smaller community 2}}$... + % of households $65+_{\text{smaller community n}}$) / n;

and

(% of households $65+_{\text{larger community 1}}$ + % of households $65+_{\text{larger community 2}}$... + % of households $65+_{\text{larger community n}}$) / n.

Lower-Income Populations

To explore differences in impacts sewer rates have on lower income households, each community's sewer rate was divided by the mid-point of each American Community Survey income category below $35,000.

SRMHI lower-income = (sewer rate)/(income category mid-point)

The median for the smaller community group was provided for each income category, as was the comparison of medians in smaller vs. larger communities.

Lower-income Households as a Percentage of Total Households

To compare proportions of lower-income groups in smaller and larger communities, the number of households earning $35,000 or less annually were divided by the total number of households in each community.

% lower-income households = (households < $35,000) / (total households)

Summary statistics (mean, median, maximum, minimum) were calculated for each community group. The median was used as the basis for the analysis; however, mean values were provided as well and were calculated in the following manner:

(% households $(<\$35k)_{\text{smaller community 1}}$ + % households $(<\$35k)_{\text{smaller community 2}}$... + % households $(<\$35k)_{\text{smaller community n}}$) / n;

and

(% households $(<\$35k)_{\text{larger community 1}}$ + % households $(<\$35k)_{\text{larger community 2}}$... + % households $(<\$35k)_{\text{larger community n}}$) / n.

C. WWTP OPERATOR SURVEY RESULTS

Over half of respondents reported it was at least somewhat challenging to satisfy training requirements, stay informed of any changes to state rule and regulations, or complete the MPCA DMR reports (Figure C-1). Nearly half of respondents indicated that completing the MPCA DMR reports were at least somewhat challenging (Figure C-2). Most respondents who provided additional details as to why they found completing MPCA DMR reports challenging expressed frustration with the process of entering information into the online reporting system or with changes in the way the online system works (Table C-3).

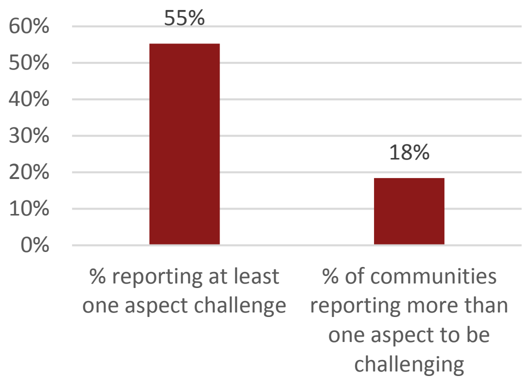

FIGURE C-1: ARE SATISFYING TRAINING REQUIREMENTS, STAYING INFORMED OF ANY CHANGES TO STATE RULES AND REGULATIONS, OR COMPLETING THE DMR REPORTS CHALLENGING? (N=76)

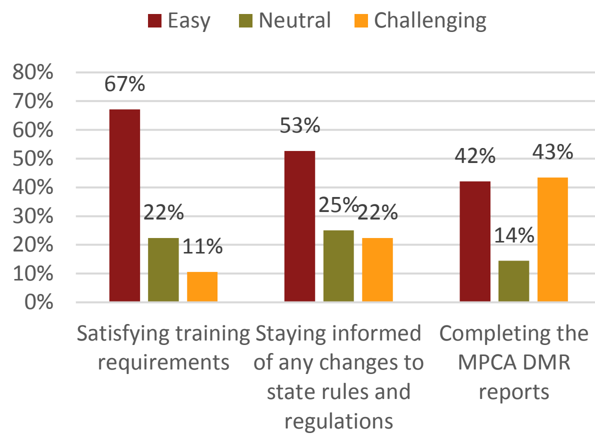

FIGURE C-2: % OF RESPONDENTS BY LEVEL OF EASE OR CHALLENGE FOR ASPECTS OF JOB (N=76)

Response	#
Relevance	4
Time	3
Location	2
Experience	1
N	**8**

TABLE C-1: SUMMARIZED RESPONSES TO: "WHAT ASPECTS OF SATISFYING TRAINING REQUIREMENTS ARE MOST CHALLENGING?"

Response	#
Communication	10
Process	8
Permit Changes	6
New Standards	5
N	**17**

TABLE C-2: SUMMARIZED RESPONSES TO: "WHAT ASPECTS OF STAYING INFORMED OF ANY CHANGES TO STATE RULES AND REGULATIONS ARE MOST CHALLENGING?"

Response	#
Process	31
Guidelines	5
Regulatory Issues	5
Funding	1
N	**32**

TABLE C-3: SUMMARIZED RESPONSES TO: "WHAT ASPECTS OF COMPLETING THE MPCA DMR REPORTS ARE MOST CHALLENGING?"

Three-quarters of respondents reported challenges with influent sources (Figure C-3). Of those reporting challenges, infiltration and in-flow (I&I) was most frequently mentioned (Figure C-4). Many respondents (N=45) noted at least one specific factor related to infiltration and inflow in their system or situation. Those most frequently noted included significant rain events, aging infrastructure, pond system capacity, and lack of funds (Table C-4).

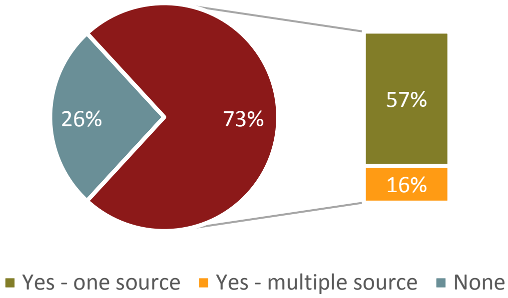

FIGURE C-3: DO ONE OR MORE INFLUENT SOURCES POSE A CHALLENGE? (N=76)

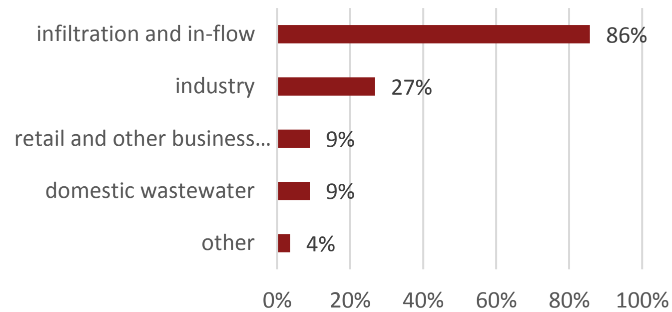

FIGURE C-4: CHALLENGING INFLUENT SOURCES REPORTED BY RESPONDENTS (N=56)

Response	#
Rain	26
Aging infrastructure	20
Pond system	10
Funding	9
Maintenance	6
Sump Pumps	3
Septic tanks in town	1
N	**45**

TABLE C-4: SUMMARIZED RESPONSES TO: "WHAT CHALLENGES DO YOU FACE WITH I&I?"

Sixty-one percent of respondents identified at least one type of problematic parameter, while 25% reported multiple problematic parameters (Figure C-5). Of the problematic parameters, phosphorus was identified most frequently (57%), while fats, oils, and grease (FOG) was identified by approximately a third of respondents, and total suspended solids (TSS) by 17%, and BOD by 9% (Figure C-6). A rather long list of other problematic parameters was identified by multiple respondents, and includes: non-flushable items such as sanitary wipes, disinfecting wipes, and rags; high concentrations of E. coli, mercury, nitrate/ammonia , salt, copper, and chlorides; and, high pH levels.

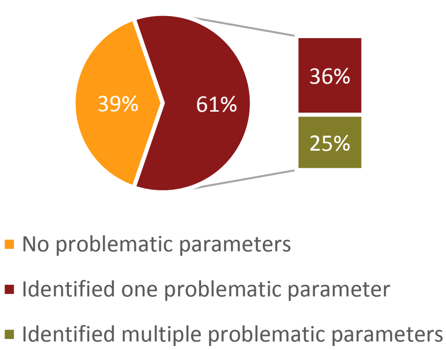

FIGURE C-5: ARE THERE ANY PARAMETERS THAT ARE PROBLEMATIC IN THE OPERATION OF YOUR WASTEWATER SYSTEM? (N=76)

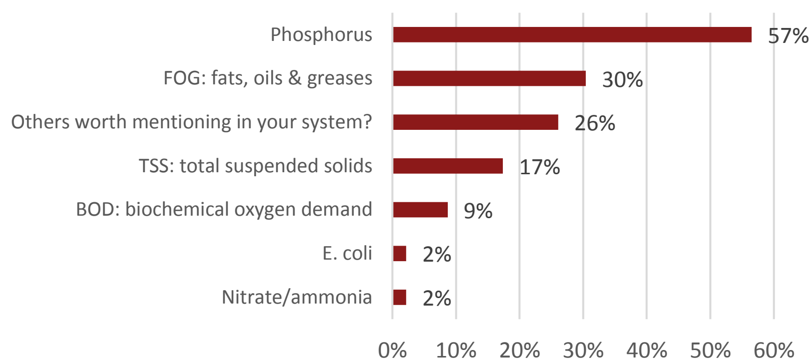

FIGURE C-6: PROBLEMATIC PARAMETERS REPORTED (N=46)

Over half of respondents rated their communities' maintenance and monitoring of the wastewater system either moderately/slightly well or not well at all (Figure C-7). However, eighty-three percent of these respondents believe that maintenance and monitoring has improved recently (Figure C-8).

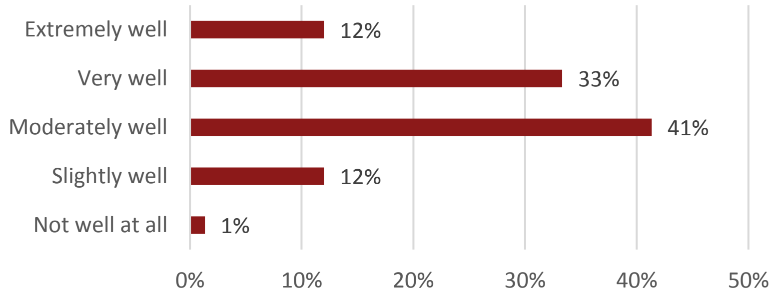

FIGURE C-7: HOW WELL HAS YOUR COMMUNITY PERFORMED MAINTENANCE AND MONITORING? (N=76)

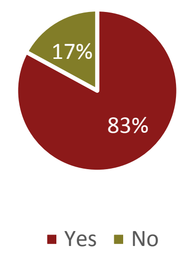

FIGURE C-8: HAS MONITORING AND MAINTENANCE HAS IMPROVED RECENTLY? (N=41)

There are two main ways in which respondents indicated their communities deal with biosolids: land application (45%) and leaving it in the pond (43%). Some communities that leave biosolids in their pond systems often add "super bugs" or sludge eating bacteria to reduce the amount of sludge in ponds and avoid dredging sludge from the ponds. Six respondents reported using multiple strategies with reed beds being the 'other' strategy. Four respondents reported hauling septage (untreated wastewater) to other nearby communities for treatment (Figure C-9).

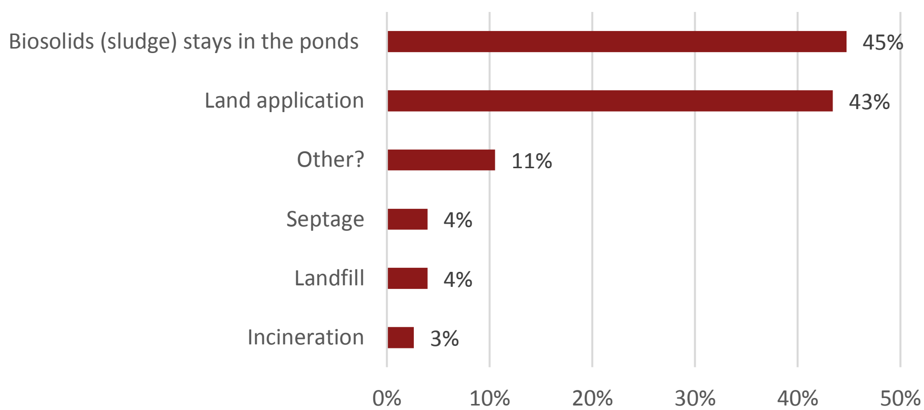

FIGURE C-9: HOW DOES YOUR COMMUNITY DEAL WITH BIOSOLIDS (SLUDGE)? (N=76)

Over half of the respondents reported no problems with biosolids, but other respondents reported various problems relating to cost of land application, the timing (related to agricultural schedules or inclement weather) of hauling/application, finding land to apply on (now or in the future), and the cost of purchasing sludge eating bacteria (Table C-5).

Response	#
No problems	41
Cost of hauling or applying to land	11
Timing of hauling	8
Finding land to apply on	5
Finding land in the future	2
Cost of 'bugs'	2
Finding people or company to haul	1
N	**71**

TABLE C-5: SUMMARIZED RESPONSES TO: "WHAT CHALLENGES DO YOU FACE WITH BIOSOLIDS?"

Over three quarters of respondents reported that their community has developed and implemented an I&I reduction program (Figure C-10). Respondents reported a variety of approaches to detecting (e.g. remote controlled camera, smoke testing) and remedying (e.g. replacing clay pipes with PVC, disconnecting sump pumps, jetting) broken pipes or other locations where infiltration can occur (Table C-6). Of the respondents who described challenges implementing the I&I program, funding was identified as the most important factor, followed by time, public support, and public awareness (Table C-7).

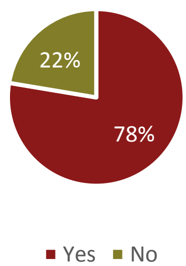

FIGURE C-10: DOES YOUR COMMUNITY HAVE AN I&I REDUCTION PROGRAM? (N=76)

Response	#
Sump pump	18
Multiple responses	18
Old infrastructure	17
Camera	16
Clay-pipe-PVC replacement	12
funding	7
Smoke Testing	6
Community size	4
Jetting	3
N	**57**

TABLE C-6: SUMMARIZED RESPONSES TO: "PLEASE DESCRIBE THE (I&I) PROGRAM"

Response	#
$	25
time	8
public support	6
public awareness	6
sump-gutter connections	5
septage	4
state government	2
City government	1
N	**39**

TABLE C-7: SUMMARIZED RESPONSES TO: "ARE THERE ANY CHALLENGES ASSOCIATED WITH IMPLEMENTING THIS (I&I) PROGRAM?"

Nearly 40% of respondents reported their community has made expensive upgrades due to lack of scheduled maintenance or stricter and/or new permit limits (Figure C-11). Of these, 89% of respondents indicated these upgrades were due to new and/or increased permit limits (Figure C-12).

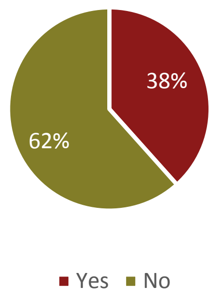

FIGURE C-11: HAS YOUR COMMUNITY MADE EXPENSIVE UPGRADES DUE TO LACK OF MAINTENANCE OR, STRICTER AND/OR NEW PERMIT LIMITS? (N=76)

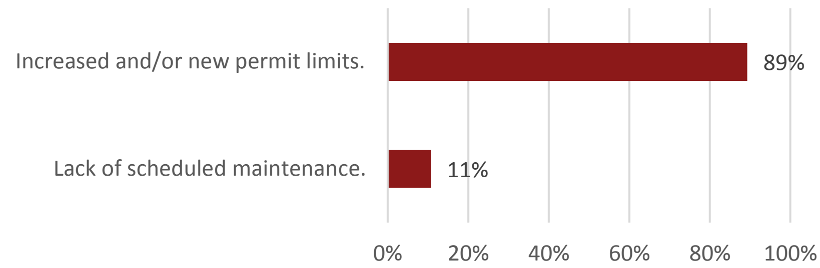

FIGURE C-12: REASONS FOR RECENT SYSTEM UPGRADES (N=28)

When identifying which parameter limit changes were the driving factors for recent upgrades, phosphorus was mentioned most frequently, followed by chlorides, nitrogen/ammonia, and mercury (Table C-8). Other driving factors for upgrades were lack of proper maintenance, eutrophication standards, and biosolids handling. A diversity of specific upgrades and replacements were noted by respondents, including entirely new treatment plants, new lift stations, new biosolids handling equipment, disinfection, new filters, and tertiary treatment (for nutrient removal) (Table C-9).

Response	#
P	13
Chlorides	8
N	3
NH3	2
Hg	1
N	**26**

TABLE C-8: SUMMARIZED RESPONSES TO: "WHAT PARAMETER LIMIT CHANGES WERE THE REASON FOR RECENT UPGRADES?"

Response	#
New plant	7
Multiple responses	7
New lift station(s)	5
Disinfection	5
Sludge handling equipment	4
New filters	2
Tertiary treatment	2
Pumps	2
Pipes replaced	2
Storage added	2
Chlorides	1
Pretreatment	1
N	**24**

TABLE C-9: SUMMARIZED RESPONSES TO: "WHAT UPGRADES AND/OR REPLACEMENTS WERE MADE TO THE SYSTEM?"

Maintenance of ageing systems along with cost of operations and maintenance were the most frequently identified main challenges with operating a wastewater treatment system in a smaller Minnesota community (Table C-10). Many other specific problems were noted, several of which also fall under these same broad categories. These included I&I, staffing levels, and poor initial construction, and other mechanical issues such as pond gate deterioration. There were several respondents who noted lack of support or public awareness as being problematic; some noted water sampling and testing logistics as being troublesome, and others noted problems with wildlife (e.g. snapping turtles at the treatment plant outfall) or a lack of good effluent discharge options.

Response	#	Response	#
Maintenance	25	Keeping system clean	2
Cost	21	Contraband	2
New regulations or limits	13	FOG	2
Multiple Responses	13	Rags	1
Old infrastructure	11	Biosolids	1
I&I	11	Pond gates	1
staffing	9	Poor initial construction	1
Pond levels	4	Lack of good discharge options	1
Lack of support from leaders	3	Snapping turtles	1
sampling logistics	2	TSS	1
Lack of public understanding	2	Online Reporting	1
		N	**67**

TABLE C-10: RESPONSES TO QUESTION, "FROM YOUR PERSPECTIVE, WHAT ARE THE MAIN CHALLENGES WITH OPERATING AND MAINTAINING YOUR WASTEWATER SYSTEM OR THE WATER BODY YOUR SYSTEM DISCHARGES INTO?"

ABOUT THE RESPONDENTS

Almost all of the respondents reported being public employees of the community (Figure C-13). Over half of those reporting age and experience were older than 50 (Figure C-14) with more than 20 years of experience (Figure C-15).

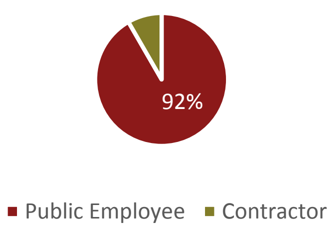

FIGURE C-13: RESPONDENTS WHETHER PUBLIC EMPLOYEE OR CONTRACTOR FOR COMMUNITY (N=36)

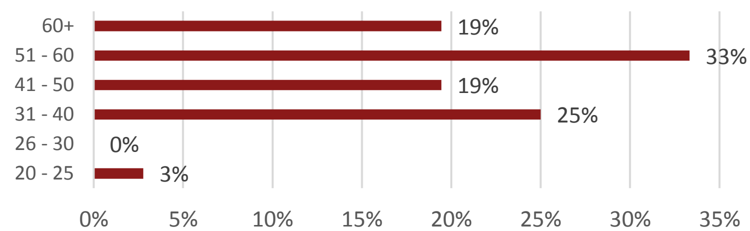

FIGURE C-94: RESPONDENTS' REPORTED AGE (N=36)

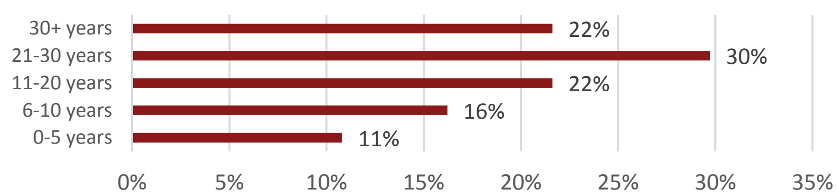

FIGURE C-15: RESPONDENTS' REPORTED YEARS OF EXPERIENCE (N=37)

D. AFFORDABILITY ANALYSIS RESULTS

1. SEWER RATE BY COMMUNITY SIZE

Costs to upgrade, replace, and maintain wastewater infrastructure are usually spread across all households in a community. It may be intuitive to think that smaller communities pay less for infrastructure since there are fewer households to serve. However, the number of households served is often inversely proportional to per household cost of maintaining or replacing infrastructure. In other words, smaller communities generally pay more per household than is the case in larger communities. For example, the cost of rehabilitating a lift station in Bellingham (112 households)[5] is listed as $100,000 while a similar project cost $300,000 in Burnsville (26,108 households)[6]. Although the estimated project cost in the smaller community is only a third of that in the larger community, the cost per household in Bellingham ($892.86) is approximately 75 times as much as the cost per household in Burnsville ($11.49).

Community	Project Type	Cost Estimate	Population	Households	Cost/Household
Bellingham	Lift Station Rehab	$100,000	229	112	$892.86
Burnsville	Lift Station Rehab	$300,000	60,699	26,108	$11.49

TABLE D-1: COMPARING SIMILAR WASTEWATER PROJECT COSTS

The higher cost of infrastructure per household is reflected in generally higher sewer rates in smaller communities compared to larger communities. In smaller[7] communities, the median sewer rate of a typical household that used approximately 60,000 gallons of water annually was 21% higher than larger communities (Table D-2). Each community's population and annual average household sewer rate are shown in Figure D-1, with red dots representing smaller communities and green dots representing larger communities. Although there is more variability in sewer rates in smaller communities, in general, annual sewer rates decrease with increasing community population. This finding is not surprising because larger communities are able to spread infrastructure costs out over many more households than is the case in smaller communities.

Sewer rate		
	Less than 5,000	**5,000 or more**
N	543	138
Mean	$402.12	$348.32
Median	$387.00	$319.29
Min	$20.00	$122.98
Max	$2,220.00	$1,060.00

TABLE D-2: SUMMARY STATISTICS - ANNUAL SEWER RATE, SMALLER VS. LARGER COMMUNITIES

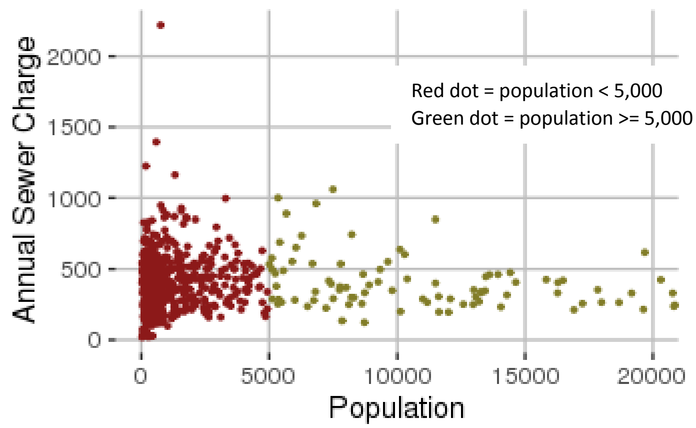

FIGURE D-1: COMMUNITY SIZE AND ANNUAL SEWER RATE BY COMMUNITY POPULATION TYPE

2. POPULATION 65 OR OLDER

In addition to looking at communities as a whole, we can also "zoom in" on particular groups, such as householders aged 65 and over. When comparing the medians, householders 65 or older in smaller communities pay 0.49 percentage

[5] 2011 – 2015 American Community Survey

[6] Future wastewater infrastructure needs and capital costs – Appendix 1 - 7; https://www.pca.state.mn.us/sites/default/files/Appendix%201-7.pdf

[7] Smaller communities are defined as having less than 5,000 inhabitants.

points more of their MHI towards sewer rates than is the case with the same age group in larger communities (Table D-3). Sewer rates as a percent of MHI (SRMHI) for those 65 and older decreases with increasing population (Figure D-2).

(Sewer rate) / (MHI 65+)		
	Less than 5,000	**5,000 or more**
N	396	126
Mean	1.37%	.97%
Median	1.28%	.79%
Min	.07%	.29%
Max	7.4%	4.28%

TABLE D-3: SUMMARY STATISTICS OF ANNUAL SEWER RATES AS A PERCENTAGE OF MHI FOR HOUSEHOLDS 65 OR OLDER, SMALLER VS. LARGER COMMUNITIES

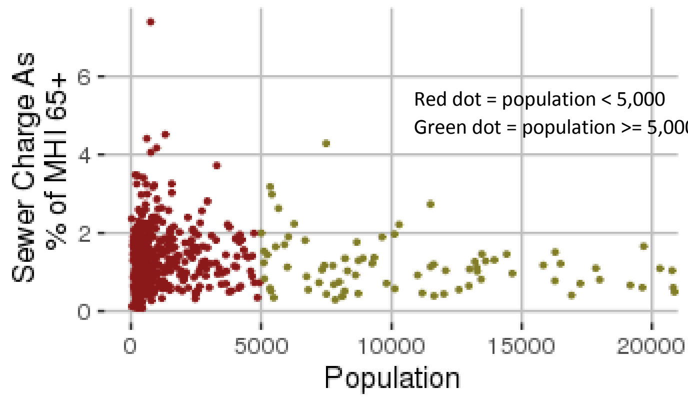

FIGURE D-2: POPULATION AND ANNUAL SEWER RATE AS % OF MHI 65, SMALLER VS. LARGER COMMUNITIES

For each community, we calculated SRMHI for householders 65 and older and compared these values to the EPA's sewer rate affordability threshold of 1.4% of MHI. We found that, for the 65 and older group SRMHI was above the EPA's threshold in 23.9% of smaller communities, compared with 15.4% of larger communities. The median and mean SRMHI (1.28% and 1.37% respectively) paid by the 65 and older group in smaller communities were in fact very close to the EPA's affordability threshold of 1.4% of MHI.

That sewer rates were unaffordable (by EPA's definition) for the 65 and older group in nearly ¼ of smaller communities is perhaps not surprising given that smaller communities have higher sewer rates and the median MHI of householders 65 and older in smaller communities was 19% lower compared to their counterparts in larger communities (Table D-4).

MHI 65+		
	Less than 5,000	**5,000 or more**
N	486	131
Mean	$33,578.17	$40,302.98
Median	$31,847.92	$39,332.94
Min	$11,000	$21,341.00
Max	$107,500.00	$78,713.00

TABLE D-4: MHI OF HOUSEHOLDERS 65+, SMALLER VS. LARGER COMMUNITIES

It is also important to consider that older householders are much more likely to struggle with high or increasing wastewater rates due to fixed retirement or pension incomes. When planning for future wastewater infrastructure investments or other actions that may result in increasing sewer rates it is important to keep in mind that householders 65 and older comprise 6 percentage points more of the total households in smaller communities than is the case in larger communities (Table D-5). In addition, the variability of householders 65 and older as a percentage of total households is much greater in smaller communities than is the case in larger communities (Figure D-3). In other words, the red dots (representing smaller communities) are much more spread out along the y axis (householders 65+ as % of total households) than are the green dots (larger communities)[8]. Whereas householders 65 and older make up between 10 and 40% of larger communities, householders 65 and older comprise between zero and 100% of smaller communities.

Householders 65+/Total Households		
	Less than 5,000	5,000 or more
N	707	143
Mean	28%	22%
Median	28%	22%
Min	0%	10%
Max	100%	35%

TABLE D-5: SUMMARY STATISTICS OF HOUSEHOLDERS 65 OR OLDER AS A PERCENT OF TOTAL HOUSEHOLDS, SMALLER VS. LARGER COMMUNITIES

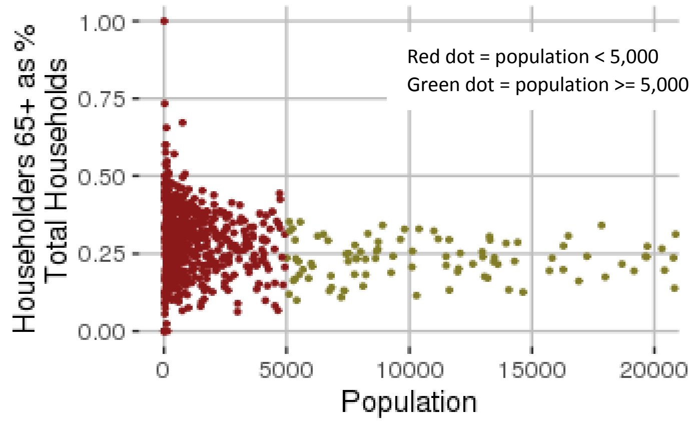

FIGURE D-3: POPULATION AND HOUSEHOLDERS 65+ AS % OF TOTAL HOUSEHOLDS, SMALLER VS. LARGER COMMUNITIES

3. LOWER-INCOME POPULATIONS

We also explored the affordability of sewer rates for lower-income populations in smaller communities. Since the median household income for each income category[9] is not published, we substituted the mid-point of each income category for the MHI. The SRMHI for each income category was calculated by dividing the average smaller community sewer rate by the income category mid-point (Table D-5). Regardless of community size, sewer rates (unless subsidized by local utilities) are generally unaffordable for any household earning less than $20,000. As indicated in Table D-6, the median values of smaller community households earning less than $30,000 are higher than 1.4% of their MHI for sewer rates. In addition, when comparing the medians smaller community households earning less than $35,000 are paying more of their MHI for sewer rates than their counterparts in larger communities (right-hand column of Table D-6).

Income Range	Mid-point	Median sewer rate as % of mid-point	% points higher than communities with pop 5,000 or greater
$10,000 - $14,999	$12,500	3.10%	.74
$15,000 - $19,999	$17,500	2.21%	.52
$20,000 - $24,999	$22,500	1.72%	.41
$25,000 - $29,999	$27,500	1.41%	.34
$30,000 - $34,999	$32,500	1.19%	.28

TABLE D-6: AVERAGE SEWER RATE AS % OF MID-POINT FOR EACH INCOME CATEGORY IN SMALLER COMMUNITIES

Compared to larger communities, smaller communities have a higher proportion of lower-income households, and a lower proportion of higher-income households (Table D-7 and D-8). In smaller communities, households earning less

[8] It should also be noted that there is also greater variability in average annual sewer rates in smaller vs. larger communities
[9] ACS 16 income categories

than $30,000 are 10 percentage points more common than in larger communities, whereas households earning $99,999 or more are nearly 15 percentage points less common in smaller communities than they are in larger communities. Figure D-4 and D-5 highlight these differences. Figure D-4 shows a larger share of smaller communities (red dots) with a higher percentage (above 25%) of their total households earning less than $30,000 compared to larger communities. And figure D-5 shows a larger share of smaller communities with a lower percentage (below 20%) of their total households earning more than $99,999.

Households Earning Less Than $30,000 as % of Total Households		
	Less than 5,000	5,000 or more
N	707	143
Mean	31.70%	22.44%
Median	31.27%	21.00%
Min	0%	5.55%
Max	100%	48.47%

TABLE D-7: SUMMARY STATISTICS - HOUSEHOLDS EARNING LESS THAN $30,000 AS A PERCENTAGE OF TOTAL HOUSEHOLDS, SMALLER VS. LARGER COMMUNITIES

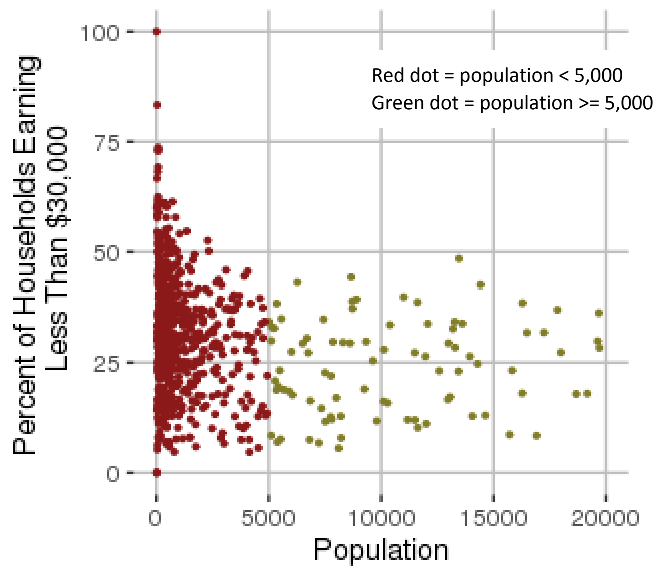

FIGURE D-4: POPULATION AND HOUSEHOLDS EARNING LESS THAN $30,000 AS A % OF TOTAL HOUSEHOLDS

Households Earning More Than $99,999 as % of Total Households		
	Less than 5,000	5,000 or more
N	707	143
Mean	13.26%	27.68%
Median	10.26%	24.87%
Min	0.00%	4.83%
Max	72.22%	62.35%

TABLE D-8: SUMMARY STATISTICS- HOUSEHOLDS EARNING MORE THAN $99,999 AS A PERCENTAGE OF TOTAL HOUSEHOLDS, SMALLER VS. LARGER COMMUNITIES

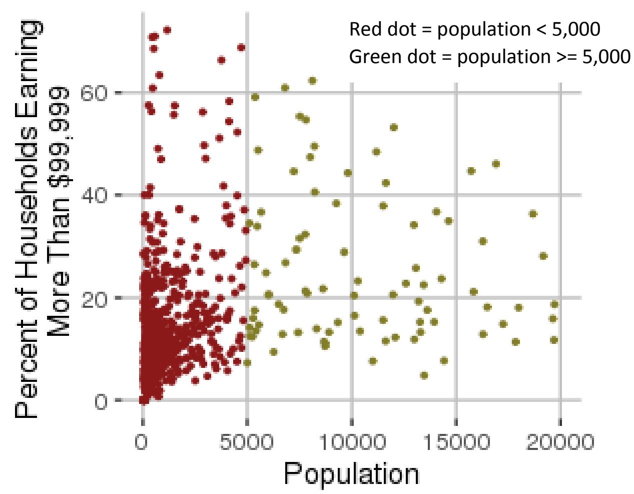

FIGURE D-5: POPULATION AND HOUSEHOLDS EARNING MORE THAN $99,999 AS A % OF TOTAL HOUSEHOLDS

APPENDIX A. WWTP OPERATOR SURVEY QUESTIONS

"This first section is going to ask you a series of questions about any challenges you face relating to the regulatory reporting and training requirements when working for [insert community]'s wastewater treatment plan."

Question 1: Please tell us whether any of the following activities and requirements are easy, somewhat easy, neutral, somewhat challenging, or challenging in your work with [insert community]'s wastewater treatment plant.

	Easy	Somewhat easy	Neutral	Somewhat challenging	Challenging
satisfying training requirements	❍	❍	❍	❍	❍
staying informed of any changes to state rules and regulations	❍	❍	❍	❍	❍
completing the MPCA DMR reports	❍	❍	❍	❍	❍

Question 1a – c: Follow up logic -> if "somewhat challenging" or "challenging" is chosen for any of the questions, then

"What aspects are most challenging".

Question 2: Are there any changes you think should be made to existing permit or training requirements?

"This next section is going to ask you a series of questions about any challenges you face relating to maintaining and increasing water quality when working for [insert community]'s wastewater treatment plan."

Question 3: Do any of the following influent sources pose challenges in the operations or infrastructure of your treatment system? (select all that apply)

- ❑ industry
- ❑ infiltration and in-flow
- ❑ domestic wastewater
- ❑ retail and other business wastewater
- ❑ other _____________________
- ❑ none

Question 3a – e: Follow up logic -> if any of the choices above are chosen, then ask for each one

"What challenges do you face with…"

Question 4: Are any of the following types of parameters problematic in the operations or infrastructure of this community's wastewater treatment system? (select all that apply)

- ❑ FOG: fats, oils & greases
- ❑ TSS: total suspended solids
- ❑ BOD: biochemical oxygen demand
- ❑ nitrate/ammonia
- ❑ phosphorus
- ❑ E. coli
- ❑ others worth mentioning in your system? ____________________

Question 4a – g: Follow up logic -> if any of the choices above are chosen, then ask for each one

"What challenges do you face with…"

Question 5: Does this community voluntarily monitor unregulated contaminants in the wastewater treatment system?

- ❍ Yes
- ❍ No

Question 5a: Follow up logic -> if "yes" is chosen, then

"Which contaminants does the community monitor and why?"

Question 6: How does this community deal with biosolids (sludge)? (select all that apply)

- ❑ Land application
- ❑ Landfill
- ❑ Incineration
- ❑ Biosolids (sludge) stays in the ponds (only if it is a pond system)
- ❑ Septage
- ❑ Other? ____________________

Question 7: Are there any challenges associated with this process?

Question 8: Does this community have an I&I reduction program?

- ❍ Yes
- ❍ No

Question 8a: Follow up logic -> if "yes" is chosen, then

"Please describe the program."

Question 8b: Follow up logic -> if "yes" is chosen, then

"Are there any challenges associated with implementing this program?"

Question 9: In your opinion, how well has the community done in performing maintenance and monitoring on the entire wastewater system over its lifetime?

- ❍ Extremely well
- ❍ Very well
- ❍ Moderately well
- ❍ Slightly well
- ❍ Not well at all

Question 9a: Follow up logic -> if "not well at all" or "slightly well" or "moderately well" is chosen, then

"Has this trend improved recently?"

a. Yes
b. No

Question 10: Has the community had to make expensive upgrades or part replacement due to any of the following? (select all that apply)

- ❑ Lack of scheduled maintenance.
- ❑ Decreased and/or new permit limits.
- ❑ None

Question 10a: Follow up logic -> if "increased and/or new permit limits" is chosen, then

"Which permit changes contributed to the need to upgrade or replace parts in the system?"

Question 10b: Follow up logic -> if "increased and/or new permit limits" and/or "lack of scheduled maintenance" are chosen, then

"What upgrades and/or replacements were made to the system?"

Question 11: From your perspective, what are the main challenges with operating and maintaining your wastewater system or the water body your system discharges into?

Question 12: Which of the following best represents your experience as a wastewater treatment plant operator?

- ❍ 0-5 years
- ❍ 6-10 years
- ❍ 11-20 years
- ❍ 21-30 years
- ❍ 30+ years

Question 13: Which of the following best represents your age?

- ❍ 20 - 25
- ❍ 26 - 30
- ❍ 31 - 40
- ❍ 41 - 50
- ❍ 51 - 60
- ❍ 60+

Question 14: Are you a public employee or contractor?

- ❍ Public Employee
- ❍ Contractor

APPENDIX B. COPY OF POSTCARD TEXT

Dear Wastewater Treatment Plant Operator,

I am writing to tell you about a survey that will be happening in the coming weeks. The goal of this survey is to give you an opportunity **to express the regulatory, structural, and managerial challenges related to municipal wastewater infrastructure in your community**. This information will illuminate the on-the-ground issues communities and their residents face when it comes to operating and maintaining their systems and will **be used to inform legislators** about your situation and on possible strategies to help with funding and related issues.

This survey is being conducted as a partnership between the Center for Rural Policy and Development (RCPD) and the University of Minnesota Morris, Center for Small Towns.

Over a three week period beginning Monday, November 28th, we will be calling with a ten to fifteen minute survey. Your participation in this survey is crucial in providing evidence to legislators about the **need to support our wastewater facilities**.

Confidentiality:

Responses to this survey will be kept anonymous. We will publish only summary results in reports and no identifying information will be included. All responses will be stored securely and only the lead researcher will have access to these records.

Contact and Questions:

If you have any questions about the survey, the overall project, or its sponsors; please **feel free** to contact the project leader listed below.

Thank you in advance for your time and participation,

Sincerely,

Kelly Asche

Center for Small Towns

(320) 589-6453

Email: kasche@morris.umn.edu