Neglected Communities: A Rural Wastewater Crisis

A Report for Addressing Wastewater Systems Failures

Spring 2019 | Columbia University's MPA in Environmental Science and Policy

The Earth Institute
Columbia University

Columbia | SIPA
School of International and Public Affairs

Congresswoman Terri Sewell
Representing Alabama's 7th District

Neglected Communities

A Rural Wastewater Crisis

Columbia University | School of International and Public Affairs | The Earth Institute Workshop in Applied Earth Systems Management, Spring 2019

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The Workshop Team would like to thank U.S. Congresswoman Terri A. Sewell, Representative for Alabama's 7th District, for the opportunity to work on such an important issue facing rural communities. This has been an incredible learning experience for us, and we look forward to applying the skills that we have learned as we continue on our professional journeys. We would also like to thank Hillary Beard, Senior Policy Advisor to Representative Sewell, for all of her guidance and direction as we worked to develop recommendations that would best assist our client and the team in Washington D.C. Additionally we would like to thank our faculty advisor, Professor Nancy Degnan, for all of her support throughout the semester.

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Acronyms

ADEM = The Alabama Department of Environmental Management.
CDC = The Centers for Disease Control and Prevention.
CWA = The Clean Water Act.
USDA = the United State Department of Agriculture.
US EPA = The United States Environmental Protection Agency.

Workshop Graduate Course in Brief

The Master's of Public Administration Environmental Science and Policy (MPA-ESP) at Columbia University in the School of International and Public Affairs, is a one year accelerated master's program that focuses on an in-depth understanding of environmental sciences as the basis for creating effective environmental policies. Graduate students develop quantitative and qualitative skills required to address current and emerging environmental issues, including issues like climate change, global, regional and local water stress, environmental contamination, and renewable energy. The degree emphasizes applied science, project management, economics, and policy analysis both through real-world case studies and simulations. The program prepares its graduates to work in positions related to sustainability in the governmental, non-profit and business sectors (MPA in Environmental Science and Policy, n.d.).

The spring semester Workshop in Applied Policy Analysis is a culminating capstone course wherein a twelve-student team completes a pro bono consultancy assignment for a real-world public-sector client. As noted, our client for this project is Congresswoman Terri A. Sewell of Alabama's 7th District. Our Workshop Team researched the issue of rural wastewater infrastructure and the problems that inadequate systems can pose for poor, rural communities, across the U.S. We did so by focusing on a specific analysis of existing conditions found in three states: Alabama, California and Virginia. From this analysis, the Workshop Team then developed a set of recommendations intended to support our client, Congresswoman Sewell, in her efforts to solve this pressing problem for her constituents as well as for other citizens living in similarly impacted rural communities, nationwide.

Executive Summary

It is estimated that nearly one million Americans living in rural communities walk out of their homes and encounter human waste as a result of failing wastewater treatment systems. These failed systems have resulted in some homeowners resorting to piping untreated discharge out of the home. Decentralized systems, such as septic tanks, are designed to effectively service rural communities. Septic tanks, however, fail due to adverse soil conditions and or a lack of proper maintenance. Residents living in these rural communities are often unable to meet the costs of servicing and maintaining these systems. These system failures create environmental and biological hazards such as bacteria and viruses, contaminate groundwater, surface water and surrounding environs. Exposure to raw sewage also creates a multitude of public health issues with a direct impact on rural communities, including the resurgence of hookworm, a parasitic disease, thought to have been eradicated from the United States.

In an effort to provide a systematic framework to better understand causes, themes, and potential solutions to the wastewater systems failures experienced by people in rural communities, the Workshop Team employed a three-phase approach:

In Phase 1, we conducted background research to orient ourselves to the problem, including information on wastewater management failures in Lowndes County, Alabama, a county within the Seventh Congressional District. This part of our research helped us set out the parameters of the wastewater problem which the team used in our Phase 2 assessment of two other rural communities in the United States.

In Phase 2, we expanded our analysis to two additional U.S. case studies - Parklawn, California and Dawn, Virginia. The team did so for two reasons. First, our client requested that we look at other rural communities in support of her efforts to highlight failures in wastewater management at a national level. Second, the Workshop Team wanted to be certain that the themes identified through the Lowndes County focus, actually had applicability outside of Alabama. As such, any recommendations the Workshop Team would develop, could be used to assess and solve similar problems for people in other rural communities.

In Phase 3, we used the findings from our analysis to develop a set of comprehensive recommendations intended to address the factors that contribute to the rural wastewater crisis, on one hand; and, on the other, highlight steps that we see as critical to undertake, immediately.

The framework includes four pillars:

A.) Technical Considerations: Soil conditions that prevent proper drainage of wastewater, particularly for septic systems, are central to failure. Soil conditions define the prob-

lem from a technical and engineering perspective and must be understood from the point of view of what it is going to take to successfully manage wastewater as well as costs of initial capital investment, maintenance, and insurance.

B.) Data Considerations: poverty is clearly a socio-economic consideration and is connected to the third part of our framework, financial considerations. However, the Team was surprised to learn about the significant absence of available, specific data regarding the scope of wastewater failures experienced by people in rural, poor communities. Without available, accurate data, effective decisions about what to do, how and when to do it, are difficult.

C.) Financial Considerations: the installation and maintenance of wastewater treatment systems can vary widely. Meeting the costs of food, rent or home payments, and healthcare and medicine often come first making it difficult for individuals to meet these costs and also the costs of their wastewater systems. Finally, local governments often experience municipal debt, have a low tax base, and even lack the capacity, in some cases to effectively manage funds for wastewater management projects.

D.) Governance and Accountability Considerations: the final pillar of our framework is that of governance, specifically our finding that this issue is compounded by the mixed capacity of local and state government.

Governance and accountability also involves support to and interaction with the variety of stakeholders outside the public sector. Community based and advocacy organizations have been very active, particularly in Alabama, in their efforts to gain attention about, and solutions for, the wastewater management problems and their impacts. Members of these groups have much to contribute in terms of identifying the depth of the challenges, the ongoing issues faced by rural communities, and the importance of taking an holistic approach to data collection and accountability.

Given these themes, the Team delineated recommendations that address: 1.) Technical solutions for rural wastewater treatment systems including incentivizing effective wastewater solutions; 2.) Addressing Data gaps through more effective and expansive data collection and dissemination to increase capacity for effective assessment of wastewater problems unique to rural communities; 3.) Innovative financing and flexible funding mechanisms for low to middle-income families and rural localities with a specific focus on how to pay for the capital investment in wastewater treatment, its maintenance and repair; and, 4.) Identifying opportunities for federal

government, local and state levels to share expertise, advance effective oversight, and ensure greater accountability.

Introduction

Failing wastewater treatment systems are problematic for rural communities across the United States. Failing systems often occur where soil conditions prevent wastewater from draining properly, like in the case of clay soils, and are therefore not conducive to handling wastewater successfully (U. S. House of Representatives, Congresswoman Terri A. Sewell, 2018). As a result, homeowners resort to using makeshift methods of wastewater management such as straight pipes. These straight pipes can result in both environmental and public health problems.

Our client, U.S. Congresswoman Terri A. Sewell, 7th District, Alabama, has sought to alleviate the adverse impacts that come with a lack of access to adequate wastewater services, for her constituency as well as others in rural communities in America. Congresswoman Sewell has spearheaded bipartisan efforts to secure federal funding to address the wastewater problems for her constituency and for other rural communities throughout the United States, who also face similar circumstances. As a result, she successfully secured $1.8 billion in funding to address rural water and wastewater issues in the fiscal year 2018 United States Department of Agriculture (USDA) Appropriations Bill. Additionally, Congresswoman Sewell gained bipartisan support to successfully pass the Rural Septic Tank Access Act, which promises funding for wastewater management projects for the next four years, from 2019 to 2023.

Congresswoman Sewell asked the Workshop Team to develop an assessment of the wastewater crisis across the United States by (a) analyzing wastewater system failures in rural communities, (b) determining common themes from that assessment, and (c) offering a set of recommendations for Alabama and other communities in the United States. The Workshop Team's recommendations are meant to inform and enhance current efforts, undertaken by the Congresswoman, to address and provide solutions for wastewater failures faced by her constituency as well as by others in our nation's rural communities.

In this report, we outline our research approach and analyze the factors that have contributed to wastewater issues in rural America, by examining three different case study areas: Lowndes County, Alabama; Parklawn County, California and Dawn, Virginia. We conclude with

11 key recommendations that we hope can contribute to both community, and nationally, based solutions.

Research Approach

The goal for the first phase of our process was to identify what information was available and where there were information gaps. In this initial phase, the Workshop Team was guided by a congressional memorandum written by Congresswoman Sewell's staff entitled "Addressing the Gap in Reliable, Affordable Water and Wastewater Services in the United States." The memo is an overview of 9 states experiencing wastewater treatment system failures. It informed our Workshop Team's case study selection beyond Alabama to include California and Virginia.

The Workshop conducted a robust secondary literature review to deepen an understanding of the problem, its associated issues, and its potential solutions. Secondary research consisted of a systematic investigation of existing peer-reviewed journal articles, reports from media and news sources, and associated data and analysis. The Team identified and reviewed a total of 10 peer-reviewed journals, 12 reports from news sources, and 28 other data sources, including government reports, that are cited in the References.

In addition to secondary literature review, the Team initially identified a wide range of experts to interview, focusing on individuals with an expertise on issues related to clean water and wastewater management systems, and/or those who could provide insights into the needs of the people who experience wastewater infrastructure system failures and management problems. A total of 16 experts were interviewed from businesses; higher education and research institutions; government officials; non-profit, community groups and others from the advocacy sector. Interviewees provided deeper insights into the wastewater management challenges faced by people in rural communities and informed the case studies and the recommendations found in this report.

Interviews were conducted either in-person, by telephone, and/or via email correspondence. Appropriate questions were created by the Workshop Team to be used for each interview. Additional questions were added to each in-person and telephone interview when the interviewee provided new information. Following each interview, the Workshop Team shared their notes with the interviewees to ensure that information was accurately recorded. Direct quotes are only used in this report with the prior consent of the interviewee. Please see Appendix A for the listing of interview questions.

Name	Organization	Title
Azita Amiri, PhD, RN	The University of Alabama in Huntsville	Assistant Professor, College of Nursing
Nelson Brooke	Black Warrior Riverkeeper	Riverkeeper
Ed Clerico, P.E.	Natural Systems Utilities LLC.	CEO Emeritus
Mark Elliott, Ph.D.	University of Alabama	Associate Professor
Marianne Engelman Lado, JD	Yale University; Earthjustice	Visiting Clinical Professor; Senior Staff Attorney
Upmanu Lall, Ph.D.	Columbia University, Fu School of Engineering and Applied Science.	Director, Columbia Water Center; Chair, Department of Civil and Environmental Engineering.
Zach Lowenstein	U.S. Environmental Protection Agency	Environmental Scientist
James Maughan	California State Water Resources Control Board	Assistant Deputy Director of the Division of Financial Assistance
Jeffrey Potent	Columbia University, School of International and Public Affairs	Adjunct Professor of International and Public Affairs
Suzi Ruhl	U.S. Environmental Protection Agency Office of Environmental Justice	Senior Attorney Policy Advisor
Eileen Sobeck	California State Water Resources Control Board	Executive Director
Charles Scribner	Black Warrior Riverkeeper	Executive Director

Figure 1: This table contains a list of the expert interviewees consulted for this project excluding any community groups or individuals that asked not to be listed.

Finally, to ensure the the Workshop's research approach remained on track with our Client's requests, the Workshop Team conducted bi-weekly telephone discussions with Hillary Beard, Senior Policy Advisor to Congresswoman Sewell. These discussions ensured ongoing and dynamic communication as the project evolved.

PHASE I: PRELIMINARY ANALYSIS

Phase 1: Preliminary Analysis

The following section highlights our analysis from Phase 1 of our research approach. We focused our attention on Lowndes County, Alabama, which served as a baseline case study. From this analysis, we identified several key components that contribute to the problems in the County which include: Poor soil permeability, lack of reliable and accessible data, the financial constraints of poverty, and finally, a poor capacity at multiple levels of government to effectively respond to this issue.

Lowndes County, Alabama

Lowndes County is located in the Black Belt region of Alabama, within the 7th Congressional District, represented by Terri Sewell. Though the Black Belt was originally given that name due to the black fertile soil of the region, the term Black Belt today more commonly denotes areas in the South where black communities predominate. In Lowndes County, for example, approximately 73.5% of the county's 13,473 residents are Black or African-American (University of Alabama Institute for Rural Health Research, 2002). According to a 2017 study done in 2017, 50% of the 5,270 houses in Lowndes County as noted in the 2010 census do not have adequate sewage systems (McKenna et. al.). This ongoing wastewater management crisis has had severe public health effects. Hookworm, which was largely thought to have been eradicated in the United States since the 1980s, is resurgent in Lowndes County (Pilkington, 2017). The parasite is known to thrive in the stagnant, lagoon-like conditions that can be found in parts of Lowndes County. This section explores the challenges facing the county as it seeks to secure access to safe, modern, and well-maintained wastewater management systems.

In Lowndes County, extreme poverty and challenging natural soil conditions have resulted in a severe lack of adequate wastewater systems. Wastewater treatment systems fall into two categories decentralized and centralized. With decentralized systems, treatment takes place at the home. Preliminary treatment occurs in the tank. Secondary treatment occurs when the wastewater is discharged into the soil, with the soil further cleaning the wastewater. Examples of decentralized systems are septic tanks or cluster systems. In centralized systems, homes are connected to a network of pipes that transport the wastewater to one central treatment facility with multiple treatment stages. Examples of centralized systems are lagoons or municipal wastewater treatment plants.

Many residences in Lowndes County use decentralized systems like septic tanks, but these systems often fail for reasons such as poor soil conditions. Innovative decentralized systems have been designed but the longevity of these systems is unknown as they are still in the early stages of development. In Hayneville, a community within Lowndes County, citizens have access to a type of centralized system known as a lagoon system (Smith, 2017). The system consists of one or more ponds that contain the sewage. Wastewater treatment in the lagoon is passive and relies upon aerobic and anaerobic decomposition. While there are other types of centralized wastewater systems that have been used across the country, they are not ideal for rural areas as houses are dispersed across large areas making it difficult and expensive to connect the houses to a centralized treatment system.

In 2018, a graduate student at Duke University conducted a survey of 2,100 houses in Lowndes County and found that 22% of households were served by municipal lagoon systems, 67% used septic tanks, and 9% did not have wastewater treatment. Although the survey sample size was small, it provides a general sense of the availability of wastewater treatment methods. In comparison, 92% of the 2,100 households surveyed were served by a municipal drinking water utility (Meza, 2018).

Through its research, the Workshop Team also discovered a distinct lack of capacity on the part of local and state government to effectively address and solve wastewater management problems. That the crises has persisted for decades and has remained intractable, points to mismanagement on the part of government.

Technical Considerations

The Black Belt Region is overlaid by a layer of dark, rich, clay-like soil that is excellent for cultivating cotton, wheat, and rice (Winemiller, 2016). These soils have exceptionally high density and low infiltration capacity. Lowndes County, for example, is characterized by these dense clay soils as well as high water tables that do not allow discharged water to easily drain (He et al., 2011). Soil's ability to treat sewage can be evaluated in three dimensions: soil's texture (estimation of pore sizes in the soil), structure (aggregation of particles that affects porosity and water movement within the soil) and density (porosity of the soil that affect soil's permeability (Deighan, 2014). Ideal soil for wastewater treatment systems should have large quantities of pores and spaces in appropriate sizes that are interconnected. Due to the unique soil properties in Lowndes County, traditional onsite wastewater management technologies like septic tanks often are not successful, or cannot be used (He et al., 2011).

Data Considerations

In Lowndes County, the lack of data presents a challenge to policymakers and government officials. Information regarding wastewater infrastructure data, environmental data and public health data were assessed in Lowndes County, Alabama. Rural communities are often under surveyed and residents are often skeptical of government surveys.

In Lowndes County, the number of straight pipes currently in use, the quantity of untreated discharge, and the levels of resulting pollutants are unknown. The public health impacts of straight pipes or failing systems are not well understood (McKenna et. al, 2017). Recent research with a limited sample size has suggested the prevalence of hookworm is likely significant (McKenna et. al, 2017). The most robust data in Lowndes County demonstrates that 50% of homes either have failing sewage systems or no sewage systems at all. The environmental impact on groundwater contamination and nearby waterways is unknown. The low population density and lack of local government capacity presents challenges to comprehensively understand the scope and severity of the problem more precisely. The lack of data compounds the problem of improper wastewater management adding another factor that complicates the ability to provide proper wastewater systems.

Financial Considerations

Many of these communities lack the financial means to build, operate and maintain effective water treatment systems (US EPA, n.d.). Extreme poverty has left some residents of Lowndes County with no other option except to resort to a makeshift method of using a PVC pipe, or a straight pipe, to remove wastewater from their homes (Smith, 2017). Straight pipes involve hazardous exposure to raw sewage which can lead to severe public health risks such as infectious diseases or parasites (Meza, 2018).

To provide more context, residents of Lowndes County have a per capita income of approximately $19,000 dollars (US Census Bureau, 2018). The costs for traditional wastewater systems can range from $4,000 to $12,000 per home in Lowndes County (The United States House of Representatives, Congresswoman Terri A. Sewell, 2018). Therefore due to the high cost per system for each household individual municipalities cannot afford to construct extensive sewer infrastructure (Tavernise, 2016). These trends have important implications for the welfare and the quality of life for the residents of this region.

Governance and Accountability Considerations

Wastewater infrastructure in the United States is governed by the Clean Water Act (CWA). The United States Environmental Protection Agency (USEPA) is responsible for promulgating regulations under CWA and enforcing compliance with CWA. It has, in many instances, delegated these responsibilities to state agencies in jurisdictions where analogous legislation has been adopted such as in Alabama where the Alabama Department of Environmental Management (ADEM) has been granted authority for enforcing compliance with CWA. Agencies in different states take different approaches to doing so. In Alabama, ADEM aggressively enforces compliance by levying fines against homeowners.

The United States Department of Agriculture (USDA) administers programs that provide federal aid in the form of grants and low-interest loans to state and local governments for the design and installation of wastewater infrastructure. Money is disbursed to qualified entities which are defined as a nonprofit or public agency, or a Native American tribe in accordance with an application and evaluation process established by USDA (United States Department of Agriculture Office of Rural Development, n.d.).

Local and state government and administration have been criticized for the persistence of sanitation issues in Lowndes County and other regions in Alabama. Sewage is generally managed at the local level, but counties in Alabama, like Lowndes, have not been successful in managing these issues (Chandler, 2019). The Alabama Department of Public Health is tasked with managing small-scale sewage overflows (ex: from a home not an entire municipality). However, the Alabama Department of Public Health is also tasked with regulating "everything from restaurants to tattoo parlors to septic tanks," resulting in a budget that is stretched thin, which limits which resources can be allocated to sanitation management (Brown, 2018).

The Workshop Team found that providing funding for impoverished rural communities has been a persistent challenge since applicant must be a qualified entity and sufficiently creditworthy to qualify for the loan. Since the funds may only be used for the design and installation of wastewater infrastructure and not for maintenance there are further challenges for impoverished communities.

PHASE II: CASE STUDIES

Phase 2: Case Studies

The Workshop Team expanded its efforts on case studies to gain a broader understanding of the nature, scope and extent of wastewater infrastructure problems beyond Alabama. The case studies focused on communities that face challenges most rural communities encounter with wastewater management issues and examined the means by which these communities have worked to resolve these issues. The two additional communities in this report are Parklawn, California and Dawn, Virginia. As with Alabama, the Workshop Team analyzed soil conditions, as well as the response by government and its effectiveness in addressing wastewater management issues. Thus, the same themes we developed through our Phase 1 analysis are used to make our recommendations, which, in turn, have potential applicability to other rural communities not covered in our report.

Parklawn, California

Parklawn is in Stanislaus County, California. Due to adverse soil conditions and high maintenance costs, many of their septic systems fail. Homeowners are legally responsible for complying with federal and state laws and regulations governing sewage discharge from their homes. The community's low median income compounds these difficulties. The State of California intervened to solve these problems by providing a grant from the Clean Water State Revolving Fund of nearly $5 million to connect Parklawn to nearby city Modesto's wastewater treatment system. Despite California's intervention and its investment in Parklawn, gaps remain in local capacity, and costs to homeowners are still prohibitive, as we will discuss in the following sections.

Technical Considerations

Like the residents of Alabama's Black Belt, residents of Parklawn struggle to maintain adequate septic tank systems in large part due to the impermeable clay soil in the area. Many Parklawn residents have to pump their tanks two to three times a year due to improper drainage as a result of dense, clay-like soils at a cost of up to $300 per occurrence (Yeung, 2012-b).

Data Considerations

As with Alabama, absence of data contributes to the problems faced by community members because there is no way to accurately measure the depth and breadth of impacts. Much of

what we understand about public health concerns in Parklawn, California stem from anecdotal evidence; thus, quantifying the problem becomes one of the greatest challenges in arriving at wastewater solutions (Yeung, 2012-a). Parklawn and many other communities like it remain invisible to policymakers because hard numbers are incredibly difficult to come by (Yeung, 2012-a).

In an effort to provide reliable estimates, an Oakland-based research and advocacy institute, PolicyLink, has created methodologies that can help identify these communities since U.S. Census Bureau data does not count every unincorporated area, which results in an undercount (Yeung,2012-a). PolicyLink identified 438 low-income unincorporated communities, like Parklawn, in California which do not possess proper infrastructure, as a result of using a new methodology to identify these communities (Yeung, 2012-a). PolicyLink also analyzed publicly available city and county maps and cross-referenced these with parcel density data and Census income data (to weed out wealthy and sparsely populated communities that are not likely to be affected by infrastructure problems); ultimately, this method helped identify an additional 525 communities struggling with wastewater issues in the San Joaquin Valley (Yeung, 2012-a).

Financial Considerations

Parklawn is relatively poor with a median income of roughly $19,000 per year. Modesto's median income is significantly higher, at $49,852 (US Census Bureau, 2018).

There are also disparities in the racial makeup of Parklawn relative to the nearby city of Modesto. Parklawn has a population of 1,337 residents, 50.3% of whom are white, compared to 65% of Modesto's population of approximately 200,000 people (US Census Bureau, 2010). Of Parklawn's residents, 94.4% identify as Hispanic or Latino, as compared with only 35.5% of Modesto's residents. Many are immigrants and migrant workers who come to the area to work in the agricultural industry, and nearly 85% of the population speak Spanish (Data USA, n.d.).

Financial considerations have compounded these problems and hindered their resolution. Residents of the City of Modesto had to approve a ballot measure to provide sewer service to Parklawn, and Stanislaus County had to draft an Out-Of-Boundary Service Agreement with the city to enable Parklawn to connect to Modesto's wastewater treatment system. However, the biggest challenge was the cost of renovation, which requires 50 year old subdivisions to be completely retrofitted to meet modern standards (Yeung, 2012-b).

Although the county worked for many years to upgrade the wastewater systems and annex Parklawn into the City of Modesto, no one was optimistic that the problems could be solved. The county spent $23.7 million since 1996 on improvements in 6 unincorporated areas in Mod-

esto, including $296,830 for Parklawn (Yeung, 2012-b). In 2013 Stanislaus County installed sewer lines, and was awarded a $4.5 million state grant from the Clean Water State Revolving Fund. The award allowed Parklawn to connect 326 residential properties to the City of Modesto's centralized municipal wastewater system, and construct a pump station to pump out the sewage from Parklawn into Modesto.

Governance and Accountability Considerations

Parklawn has been victimized by local and state government neglect, for years. However in 2016, Parklawn qualified under California law as a "severely disadvantaged community" the community received a state grant to construct 14,775 feet of sewer main lines to connect to Modesto's wastewater system (California State Water Resources Control Board, 2016).

Although the State grants paid for the sewer lines, residents of Parklawn still are responsible for installing their own service hookups, or hiring a contractor to do so. A failure to account for language barriers between the city and county governments, and the residents of Parklawn, and concerns about their legal status, made it difficult for residents to navigate the governmental process (Yeung, 2012-a).

The demographic and racial disparities were the subject of a 2005 federal lawsuit, *The Committee Concerning Community Improvement v. Modesto*. This lawsuit alleged that while Modesto has steadily grown over several decades by annexing surrounding areas it had deliberately passed over certain neighborhoods, resulting in unincorporated islands of distinctly different racial compositions. It also alleged that Stanislaus County had failed to provide the same services to Parklawn that it provides to predominantly white areas of the county (The Committee Concerning Community Improvement v. Modesto, 2005). The US Court of Appeals for the Ninth Circuit found that there was not sufficient statistical evidence of a factual disparity between the services provided to the City of Modesto and these "county islands" to hold either the city or county responsible (The Committee Concerning Community Improvement v. Modesto, 2009).

Parklawn residents joined with members of other unincorporated communities in the Modesto area to form the Committee Concerning Community Improvement (CCCI). The organization instituted a lawsuit against both the City of Modesto and Stanislaus County in the US District Court under the Fair Housing Law seeking to obtain sanitation services from those governments. The lawsuit was unsuccessful.

The State of California is uniquely positioned to address wastewater failures such as the one which occurred in Parklawn. The state has a robust system of voter initiative authorized

bond measures, which provide funding for the state's water management agency to address such problems (Sobeck, 2019). California also recently transferred responsibility for managing a large portion of its water resources from the Department of Public Health to a centralized water management agency, the State Water Resources Control Board. The consolidation of resources in a single agency gave the state greater ability to take direct action to respond to situations like those in Parklawn.

California Rural Legal Assistance, a non-profit which provides free legal services to low-income rural individuals, is also assisting Parklawn residents in their efforts to connect to the main lines. This is fairly expensive, costing homeowners between $2,000 to $4,000 for installation of the line, and an additional $200 for a county building permit fee (Carlson, 2015). To help finance these costs, low-interest loans with rates ranging between 0%-3% are being offered to homeowners by the Stanislaus County Housing Authority. Homeowners are required to pay the cost to destroy their existing septic systems once they are connected to the main sewer line, following approval by the county, and to establish a service account with Modesto's utility.

Dawn, Virginia

Located within Caroline County, Virginia, Dawn is an unincorporated, rural community with approximately 250 homes, 40 miles outside of Fredericksburg (Boorstein, 2004). Its residents rely on individual wells for drinking water and septic systems for waste management (County of Caroline, 2008). In December 2003, the region's top public health official declared a state of emergency after nearly a decade of struggling with water and wastewater issues (Boorstein, 2004). A combination of factors led to Dawn receiving a decentralized wastewater management system. Active community engagement combined with a willingness from the county government to intervene led to Dawn becoming a high enough priority to receive a wastewater management system.

Technical Considerations

While Lowndes County suffers from highly impermeable soils that prevent proper drainage, Dawn's highly permeable, sandy soils cause water to percolate much faster. This also prevents proper filtration of wastewater, which contaminates groundwater sources (Caroline County Virginia, n.d.). Additionally, Dawn experiences contaminated standing water because it is situated on wetlands, which are seasonally inundated or saturated by surface groundwater. During pe-

riods of heavy rainfall, septic systems fail, leading human waste to surface in standing water (County of Caroline, 2008).

Data Considerations

Dawn residents faced contamination of their groundwater because of untreated wastewater. Similar to Parklawn, residents of Dawn relied upon their own experiences with wastewater in their homes as evidence to engage county officials on addressing the issue when human waste began surfacing in their yards (Boorstein, 2004). One community volunteer stated that the Rappahannock Area Health District tested the water, but she claimed that they did not release the results (Boorstein, 2004). However, department officials contest that tests were never done, further saying that the state of the community's groundwater was evident by the condition of residents' yards (Boorstein, 2004). In the 1990s, the same community volunteer claimed that residents were privately testing their water, but community members were tight-lipped about the results so as not to alarm neighbors (Boorstein, 2004). No available data existed officially that could allow policymakers to comprehend the extent of the situation. Anecdotal evidence was the only data that community members could rely upon. This had been an issue that the community dealt with for many years, and it was not until the area became more developed, drawing more residents to the county, that this unincorporated community garnered attention.

In addition to lacking data that could quantify the extent of the damage, the district's environmental health department stopped issuing septic tank permits because of water contamination (Boorstein, 2004). Without these permits, new homes could not be built, which may have incentivized action by both the community and the county government in an effort to ease relocation and bring in new taxpayers (Boorstein, 2004). Nearly 68 percent of residents in Dawn are low to moderate income and cannot afford repairs or upgrades to existing septic tank systems (Boorstein, 2004). Some residents pump their own septic tanks or wait for the groundwater to go down so they can eventually flush their toilets (Boorstein, 2004). Few estimates exist that can estimate the number of homes without plumbing. In Caroline County, one estimate suggests that 2.52 percent of homes lack plumbing; another estimate suggests 6.04 percent of homes are without plumbing (Boorstein, 2004). The county public works director suggested a more accurate estimate would be that as many as 20 percents of homes in Dawn are without plumbing or possess plumbing that does not function (Boorstein, 2004). Dawn's wastewater issues may no longer be invisible to policymakers because of community action, yet their push to secure proper wastewater infrastructure might have been helped by quantifiable data that could have specifically identified the risks to public health and groundwater contamination.

Financial Considerations

Caroline County, Virginia has a population of 29,640 with population growth of 0.99% (Data USA, 2019). While its median household income is $57,294, median property value is estimated at $189,000 (Data USA, 2019). The poverty rate is at 13.1%, which is slightly above the national average 12.3% (Data USA, 2019; Fontenot et al., 2018). The demographics of the region are as follows: 65.3% White, 28.4% Black, 4.14% Hispanic, and 0.8% Asian (Data USA, 2019). Of the 29,640 residents of the county, 98.9% of them are citizens of the United States. Unlike Lowndes County, the communities within Caroline County, are predominantly white and have higher property values and median household incomes. However, no specific data for Dawn county exists that can help differentiate it from its incorporated municipal counterparts. Nearly 68% of the community comprise low to middle income families, which makes septic tank repairs and upgrades difficult for these residents to achieve (Boorstein, 2004). Even while the county may be at a higher socioeconomic level than Lowndes County, the residents of Dawn have struggled in similar ways as the residents of Lowndes County. Both communities have experienced the absence of effectively managed wastewater management systems and properly functioning infrastructure.

Governance and Accountability Considerations

In the late 1990s, the Virginia Department of Health noted that there were public health issues in Dawn, Virginia related to exposure to raw sewage (EPA, 2012). The Caroline County Department of Public Health identified a number of malfunctioning septic systems, many of which were over 30 years old (Caroline County Virginia, n.d.).

In 1997, the County undertook a feasibility study for construction of a public water and sewer system before applying for grants the following year (Caroline County Virginia, n.d.). By the early 2000s, community volunteers in Dawn organized and canvassed residents of the community when the possibility arose of grants being available to deal with the wastewater problem (Boorstein, 2004). Things escalated when a Caroline County public health official called for a state of emergency in 2003 due to the raw sewage seeping into people's yards (Boorstein, 2004). Even though this had been an issue that residents had dealt with for years, county government seemed willing to engage on this issue now for several reasons. People, who wanted to relocate, were unable to build houses because of new, tougher septic standards (Boorstein, 2004). Northern Caroline County had gradually become a suburb of nearby Fredericksburg, leading the county to invest in a new wastewater treatment facility for gas stations, restaurants, and some homes

(Boorstein, 2004). Also, the Virginia State Fair had relocated to a farm just down the road from Dawn (Boorstein, 2004). All of these factors contributed to Caroline County officials being more willing to engage with the community on the wastewater issues that the community was facing.

Thus, in 2003, the county hired Arcadis Engineering to construct a decentralized wastewater treatment facility that would be both cheap and efficient in managing wastewater (Bio-Microbics, 2009). The county committed $1.8 million in local funds while non-local funding, such as Community Development Block Grant Funds and U.S. EPA State and Territorial Assistance Grants, provided additional financial support (EPA, 2012). This decentralized system could be expanded in the future to serve more residents, in an effort to reduce upfront capital expenses related to construction and operation. These lower costs meant that fees for debt services and users would be theoretically lower (Schiebel, 2011).

In 2004, the Department of Housing and Community Development announced $1.5 million in grants that would cover rebuilding systems for only the worst 160 homes in Dawn (Boorstein, 2004). By the summer of 2007, the first homes were fully connected to the decentralized system with 182 homes and businesses connected in the first year and a half; more than half of the homes connected to the system were owned by low-to-moderate income homeowners (EPA, 2012). The system proved to be such a success in its first years of operation that Dawn won a national award in 2009 for outstanding civic accomplishment (Bio-Microbics, 2009).

While seemingly a success, as of 2015, rising taxes on water and sewage have made it more difficult to live in Caroline County since fees have been raised to assist in recovering money spent on water and wastewater improvements in Dawn. According to local residents in Caroline County, monthly water and sewer fees increased by 3 to 7.3%, resulting in families of four to five paying an additional $150 to $300 per month in taxes as opposed to the $24 per month they were originally paying (Uphaus-Conner, 2017). Aqua Virginia, the water utility that services most of Virginia, also wanted to implement a water and wastewater infrastructure service charge that would allow it to make capital improvements to its water system and address water quality issues without raising base rates (Uphaus-Conner, 2017). However, many fear that there is no way to guarantee that Caroline County will be the beneficiary of the money collected from the surcharge. Plus, issues pertaining to water quality are rampant through Virginia's 1st and 4th Districts, represented by Robert J. Wittmann (R-VA) and Donald McEachin, (D-VA) respectively. In northern Chesapeake, residents spar frequently with Aqua Virginia about discolored, rusty, foul-smelling water that regularly poors from their tap -- an issue that residents of Caroline County and others also share (Hafner, 2017).

While Dawn no longer struggles with wastewater management in the way that it did, rates and fees are still rising to pay for the infrastructure despite the local and non-local funding that was procured and promises from the engineering firm that these systems would be low-cost. Additionally, no data or studies measuring public health or environmental impacts exist that can demonstrate whether or not these systems are functioning in the way that they should. While one community benefited from new wastewater infrastructure, the entire county has now subsumed the fiscal responsibility. This added pressure is exacerbated by the fact that many in the county struggle with their own water quality issues, relying on bottled water for their consumption, since many doubt the quality of the water coming out of their pipes (Hafner, 2017).

PHASE III: POLICY RECOMMENDATIONS

Phase 3: Policy Recommendations

This section follows the four pillars of our thematic framework presented through three case analyses. Additionally, on May 07, 2019, the Workshop Team briefed Congresswoman Sewell and her staff on our findings. The Workshop Team determined their strongest recommendations fell in the data and funding categories. The two priority recommendations are: 1.) Creating an open-access data sharing portal for sanitation research to improve access and facilitate collaboration; and, 2.) investigating long-term funding options such as bonds or revolving funds for system maintenance operations.

A: Technical Considerations

1. Ensure that wastewater treatment technologies are deployed in accordance with local circumstances.

Goal: Avoid costly system failures.
Summary:

- Examine and fully assess local context before proceeding with development of proposed solutions.
- Involve local community in siting wastewater treatment facilities and or solutions.
- Make community members part of key decision-making leadership and processes.

When it comes to the actual technologies installed to mitigate a community's wastewater issues, all soil is not the same, nor are all the affected rural communities. A technical solution that works well in one locale could be wasteful or ineffectual in another. Thus, we recommend maintaining flexibility with respect to the treatment systems employed at different sites. Although this seems like a straightforward recommendation, we identified several scenarios in our analysis where the selected technical option was not fully compatible with site-specific conditions. A balance must be struck between short-term cost-effectiveness and long-term system viability, particularly in consideration of maintenance. Our analysis of wastewater infrastructure failures demonstrates that the one-size-fits-all approach is rarely a good idea, especially when it comes to environmental engineering. Site-responsive technical solutions will allow for better outcomes for the citizens and the agencies involved.

Variegated, site-specific technologies also help keep program costs low, as multiple vendors will be eligible to perform the work. Instead of awarding a no-bid contract to a firm with proprietary technology, technical flexibility will create a market for contractors eager to submit bids to perform this work.

2. Incentivize the development of innovative decentralized solutions.

Goal: Bring emerging technologies to market at scale.

Summary:

- Support and fund design challenges.
- Fully fund demonstration projects.
- Fund research grants to advance research in onsite wastewater systems.
- Expand partnerships with universities and community organizations.

The Alabama Center for Rural Enterprise (ACRE) hosted a Water/Wastewater Design Challenge November 4-6th, 2016. The main goal of the event was to collect data about existing wastewater treatment problems and potential technical solutions. The challenge brought together professionals with a variety of expertise: Civil engineers; local, state, and federal environmental agency representatives; community leaders; residents; and the press. The goal of the Challenge was to identify the most feasible solutions and then implement them in a demonstration project over two to three years. The system that is deemed the most successful at the end of the demonstration period is implemented on a broader basis with the support of federal funding (Unitarian Universalist Service Committee, 2016). Design challenges, such as the one just described, are a potential model that can be used to generate innovative ideas and "out-of-the-box thinking". Design challenges also create a potential opportunity to increase engagement with local universities and students, as well as raise awareness of the issue.

B. Data Considerations

1. Investigate pathways to allocate government funds to support the research, data collection, and development required to address the rural wastewater crisis.

Goal: Include provisions in legislation to allocate funds to data collection and reporting to quantify the extent of the problem and track progress.

Summary:

- Rural, low income communities, like Lowndes County, do not have the financial or technical capacity to dedicate resources for data collection.
- Wastewater treatment and sanitation issues span the purview of many federal agencies.
- This recommendation overlaps with others concerning data collection because the lack of funds allocated for this purpose is a limitation.

One of our key findings is that data necessary to quantify and address the wastewater crisis is often limited, nonexistent, or difficult to find. These data gaps exist is because often rural, low income communities, like Lowndes County, have neither the technical capacity nor financial resources to dedicate to data identification, collection, storage and dynamic use for problem solving and decision-making.

According to data collected by the American Association for the Advancement of Science (AAAS), federal money spent on research and development accounts for 40% of the total US GDP (AAAS, n.d.). For instance, The Department of Defense and National Institutes of Health spent more of their Fiscal Year 2018 budget on research and development than the USDA (AAAS, n.d.).

At the USDA, critical research is undertaken by the Agriculture Research Service which reports to the Undersecretary for Research, Education and Economics. When it comes to wastewater management for rural communities, however, research on wastewater conditions and failures is conducted through the Assistant to the Secretary for Rural Development (USDA, n.d.). Additionally, wastewater was not prioritized by the Interagency Task Force on Agriculture and Rural Prosperity. It was only merited a brief mention on one line of the report in relation to access to clean water infrastructure (USDA, 2017).

Several rural data sources are provided by USDA Economic Research Service (ERS). These data sources do not focus on wastewater issues. While the USDA does not currently collect data on wastewater issues, there is the opportunity to address these issues using resources available to the Assistant to the Secretary for Rural Development.

Other federal agencies such as the National Institutes of Health (NIH) currently allocate greater amounts of funding to research, development and data collection and storage. Given the health implications of the wastewater crisis, it could be beneficial to collaborate with NIH or another government or nonprofit health organization to collect the data needed to ascertain the scope of the problem in rural communities in Alabama and other parts of the United States .

The USEPA has a number of resources related to rural wastewater that are focused on helping provide information about training and available fiscal resources that communities can use to help make better decisions about their wastewater problems. Examples of USEPA resources include:

- Tools, Training, and Technical Assistance for Small and Rural Wastewater Systems https://www.epa.gov/small-and-rural-wastewater-systems/tools-training-and-technical-assistance-small-and-rura
- Water Infrastructure and Resiliency Finance Center https://www.epa.gov/waterfinancecenter
- Webcasts About Onsite Wastewater Treatment https://www.epa.gov/septic/webcasts-about-onsite-wastewater-treatment

Since wastewater treatment and sanitation issues span the purview of many federal agencies, and that research and development money is allocated by these agencies to other areas, there may be an opportunity to investigate how to allocate funds for federal agencies to work together to support the collection of the data needed for the establishment of baseline information on the scope of the national wastewater crisis. Provisions could be included in future legislation that specifically allocates funds to the appropriate data collection agencies to ensure that the need to collect data is not overlooked.

This recommendation overlaps with others in this report concerning data collection because the lack of funds allocated for this purpose is a potential limitation on the work being performed to quantify the extent of this problem and the progress being made in addressing it.

2. Gather data to quantify the number of homes without adequate wastewater treatment systems.

Goal: Establish a baseline to track progress**.**

Summary:

- The full scope of the problem at the national scale must be understood.
- Questions regarding household plumbing have not been included on the U.S. Census since 1990.

The full scope of this problem, at a national scale, must be understood in order to begin to fully address and solve the problem. The Rural Community Assistance Partnership reports that

many international health and development organizations, like the World Health Organization, state that 100% of people in the U.S. have access to clean water and sanitation services, but because the number of people that lack these services is less than one percent of the total population, the number is rounded up (Rural Community Assistance Partnership, 2017). Although the number of people in the United States without access to adequate sanitation services is small in comparison with the total population, it is a significant problem for the individuals and communities that lack adequate wastewater services (Rural Community Assistance Partnership, 2017; Wescoat et al., 2007).

A 2017 report entitled, "An Overview of Clean Water Access Challenges in the United States" by the University of North Carolina Environmental Finance Center called for the establishment of a framework to address the national gap in data on water and sanitation access:

"To effectively address the broad water access challenges, managers, policy makers, advocates, and others need to understand the extent and location of different water access challenges. Nationwide census data on household sanitation has not been gathered since 1990, and there is insufficient data on other aspects of the nation's water infrastructure, as well. Detailed data and information gathering should be included in all strategies to address water access challenges" (Riggs et al., 2017).

A comprehensive data set that documents how many people are affected by these problems in the U.S. would provide a baseline for measuring the extent of the problem and the progress being made in addressing it. Likewise, more accurate data would support the decision-making about federal funding and its most effective allocation to areas that are the neediest.

Data regarding household plumbing can be used to identify areas at-risk for waterborne disease and groundwater contamination (Cohn, 2014). Census Bureau officials acknowledge that the question, "does this house, apartment or mobile home have a flush toilet?" was more beneficial when it was included in 1940s when wastewater infrastructure was not as widespread, but it is still useful in rural populations and on American Indian lands (Cohn, 2014).

It is important to note, however, that some respondents may take offense at such inquiry. A 2014 article by the PEW Research Center Fact Tank, entitled "Census may change some questions after pushback from public," reported that some Americans complained to Congress that these questions are a violation of privacy, or are "nosy." These complaints contributed to their removal (Cohn, 2014).

Despite challenges to the inclusion of questions on household plumbing and sanitation as part of the 2020 census as a recommendation, the Team believes that this information needs to be

gathered to establish a baseline that allows for clearly articulated and measurable goals, which in turn lead to frameworks that are designed to solve the problems and ensure ongoing operations.

3. Gather data on the public health impacts of episodic and ongoing exposure to raw sewage.

Goal: Facilitate data collection, provide health services, and build community trust.

Summary:

- Scale and scope of adverse health effects are not well understood.
- Emulate public health forum hosted by Congresswoman Terri Sewell, Alabama, and Senator Doug Jones, Alabama.
- Better public health data can help move organizations and public health agencies to action.
- Residents in rural communities have limited access to medical services.
- Residents may fear penalty for bringing wastewater issues forward.

One of the most significant barriers to solving the wastewater crisis in Lowndes County is the lack of data. Data is essential for assessing and quantifying the scope of the problem, and for driving the relevant stakeholders to act to solve it. Data on on the public health impacts of the wastewater crisis are especially important because they describe how community members are directly affected by the problem. However, limited resources and stigmatization over wastewater treatment noncompliance limit the scope of the data available.

Free community public health events could have multiple benefits, including:

- Provide free and confidential health screenings to underserved communities
- Create an opportunity to collect data about the health impacts of the wastewater crisis
- Provide a platform to disseminate information to community members regarding how to get help with a failing wastewater system
- Facilitate relationship building and trust between the medical community and members of the local community
- Reduce stigmatization of those who cannot afford to improve their wastewater systems on their own, and provide resources for them to get help

A study entitled *The Human Intestinal Parasite Burden and Poor Sanitation in Lowndes County* was published in November 2017 by McKenna et al., 2017 in *The American Journal of*

Tropical Medicine and Hygiene. Stool samples were submitted by the individuals from the community, after they received verbal and written instructions. Additionally, soil samples were gathered near areas of sewage collections or run-off by.

The researchers faced challenges with the study for two main reason. First, participants did not fully trust the medical community; and second, use of straight pipes by homeowners is illegal in Lowndes so participation rates were lower than anticipated (66 out of a goal of 100).

By working with the Alabama Center for Rural Enterprise (ACRE), which worked with members of the community on a regular basis and built and reinforced trust, the research team was able to include more participants than they would have been able to otherwise.

However, data challenges remained because questionnaires were incomplete. The experience of this study demonstrates the importance of building trust and rapport to collect meaningful data.

This public health data collection effort seems to be the most significant in terms of assessing the health effects of exposure to raw sewage. Despite the small subset that it relies upon for its conclusions, the study emphasizes the importance of public health events. These events could help bridge the gaps created by lack of trust as well as lack of knowledge regarding how to adequately report on health information. This will enable government officials, researchers and community members to gain further insights into how wastewater and sanitation issues affect their community and other communities throughout the United States.

4. Investigate how environmental data can be used to assess the impact of failing wastewater systems and incentivize federal action.

Goal: Increase environmental data.

Summary:

- Water contamination is transboundary.
- Additional environmental data is needed to understand how the wastewater crisis impacts water quality.
- Environmental data may provide traction to address the issue.

The public health and social impacts of the wastewater crisis in rural Alabama and elsewhere tends to overshadow the environmental impacts of the associated pollution. Due to the urgent nature of the problem and its impact on human lives, this makes sense. The environmental impact of this crisis should not be overlooked and likely contributes to the public health problem, longer-term. Environmental regulation, focused on how failing wastewater systems contaminate

national waterways and groundwater, can serve as a driving force for action that mandates state-level involvement. Establishing state-level responsibility to address the issue would ultimately improve the lives of the people affected by the crisis. However, if the environmental data reveal a larger problem, it is important to establish innovative partnerships and strategies to address the problem, rather than relying on punitive measures that push the problem down on people that do not have the means to handle it.

Environmental issues, especially water contamination, are transboundary. Additional environmental data is needed to understand how the wastewater crisis impacts water systems. Data should be collected across the entire state of Alabama, to assess how these issues affect the north and southernmost parts of the state, and not only the Black Belt. Data also needs to be collected in other parts of the country to assess the full extent of the crisis.

5. Create an open-access data sharing portal for sanitation research to improve access to resources and facilitate collaboration.

Goal: Enable collaboration and sharing of data and resources to eliminate duplication of efforts.

Summary:

- At least three groups are working on this issue at Columbia University alone, alongside many other universities throughout the country.
- Research overlaps, but researchers are not working together. New projects always start at "square one" instead of building on each other.
- The portal could potentially be established and hosted by an Alabama university.
- Data portal examples include: www.hydroshare.org, https://www.waterqualitydata.us/, https://www.researchwithnj.com/.

Over the course of our analysis, we came across the work of many university research groups and organizations that have analyzed rural wastewater and sanitation issues. Many are also focusing on Lowndes County. At Columbia University alone, we are aware of two other research groups, one out of the Law School and one from the Columbia Water Center, working on this problem in addition to our own. We also are aware of and reviewed the work of researchers at Duke University, University of North Carolina, University of Alabama, Auburn University, Drexel University, the Alabama Center for Rural Enterprise (ACRE), and the Rural Community Assistance Partnership (RCAP), to name a few of the others working on this problem.

As we progressed through our analysis, we identified many areas of overlap as well as areas where knowledge gaps exist. An online national repository and collaborative data space for wastewater and sanitation issues would enable data and resources to be shared more easily and help eliminate duplication of efforts.

This type of portal would allow wastewater and sanitation related data and resources to be accessed through a single interface. Data and resources could be published to the portal by the authors, and would then be accessible by the public and other researchers. This would increase efficiency by enabling more resources to be found in one location, rather than having research groups go on a "scavenger hunt" of sorts to find information, as our group felt that we did at times. Even at this stage of our process, we are uncovering new information and previously published reports and articles that it would have been helpful to have accessed at the beginning of our analysis.

Examples of these types of collaborative data portals already exist. Portals geared towards water data also exist. The USGS, USEPA, and National Water Quality Monitoring Council (NWQMC) co-sponsor the Water Quality Portal Data Discovery Tool (https://www.waterqualitydata.us/) which hosts data collected by over 400 state, federal, tribal, and local agencies (National Water Quality Monitoring Council, n.d.). The Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) hosts a portal called HydroShare (https://www.hydroshare.org/) for water scientists to publish and share water data in citable, shareable, and searchable format. "The goal of HydroShare is to advance hydrologic science by enabling the water-resources community to more easily and freely share products resulting from their research and/or data collection" (HydroShare, n.d.).

While not environmentally focused, the State of New Jersey has a portal called "Research with New Jersey" (https://www.researchwithnj.com/) which "helps businesses and entrepreneurs identify and collaborate with our top universities and experts. This free database [helps users] discover thousands of experts in science, technology, engineering and mathematics (STEM) as well as their professional backgrounds, publications, and achievements" (Research with New Jersey, n.d.) Users can search the portal to find resources and publications by person, university affiliation, publication name, activity type, or press and media articles. While the goal of this portal is different, the underlying framework is similar to what is needed for a wastewater and sanitation portal. The Research with New Jersey portal is powered by PURE, an enterprise research management solution that aggregates many information and media sources and makes them searchable and available through a single platform.

Similar models could be replicated to facilitate sharing wastewater and sanitation related data, and collaborations between research groups and organizations.

C. Financial Considerations

1. Investigate long-term funding options for system maintenance and operations.

Goal: Avoid new systems failing or falling into disrepair.

Summary:

- New systems are often accompanied by unaffordable rate increases.
- Most available funding can only be allocated to upfront capital and construction costs, leaving operation and maintenance costs to local communities.
- States have low borrowing rates for infrastructure bonds.
- Clean Water and Drinking Water State Revolving Funds could be used as a model and adapted at the state or regional level.

A key finding of our case study analysis is that financing rural wastewater treatment systems is often a major challenge. These systems not only have high upfront capital costs, but also have long-term maintenance and operation costs. This is a challenge for rural, low-income communities because they generate low tax revenues and lack the financial means to support large scale wastewater infrastructure projects.

A finding from the analysis of Parklawn, California is that California has a robust system of voter initiative-authorized bond measures that provides substantial funding for the state's water management agency to address various local wastewater treatment problems. USEPA has awarded more than $187.3 million to California's Clean Water and Drinking Water State Revolving Fund (SRF) program for drinking water and wastewater infrastructure improvements. These federal funds are supplemented by state funding sources, and used to provide low-interest loans for wastewater and drinking water infrastructure projects. As money is repaid to the revolving loan fund, California funds new infrastructure projects (Mogharabi, 2018).

D. Governance and Accountability Considerations

1. Assemble an interagency task force or working group to address rural wastewater challenges.

Goal: Establish authority over and responsibility for wastewater issues by centralizing oversight and expertise.

Summary:

- Designate clear lines of responsibility and authority over addressing wastewater issues.
- Potential models include the federal Environmental Justice Interagency Working Group, which includes the EPA, USDA, and other agencies.

Oversight and responsibility for wastewater infrastructure and sanitation issues span the purview of many federal agencies. Our analysis showed that it was difficult to coordinate collaborative efforts between agencies. The creation of an interagency task force would ensure that the resources of different agencies are focused on addressing the national problem of failing wastewater systems and the resulting public health risks. An interagency task force would:

- Facilitate an interdisciplinary assessment of wastewater challenges;
- Bridge the silos and limitations that exist within any one agency;
- Provide a venue to share knowledge and expertise; and,
- Formalize coordination of responsibilities between agencies.

Several interagency tasks forces currently exist. For example, The Federal Environmental Justice Interagency Working Group (EJ IWG) consists of 17 federal agencies and White House offices charged with identifying and address environmental justice issues (EPA, n.d.). In October of 2017, EJ IWG Rural Committee met to discuss the wastewater infrastructure challenges and needs in Lowndes County (McMullan, Zotto, and Sieloff, 2017).

Another example is the Interagency Working Group created by the Harmful Algal Bloom and Hypoxia Research and Control Act (HABHRCA). The working group is charged with convening federal agencies to assess harmful algal blooms on a national scale and develop action plans to address the problem. It includes representatives from the Food and Drug Administration, United States Department of Agriculture, Centers for Disease Control, United States Army Corps of Engineers, National Aeronautics and Space Administration, National Oceanic and Atmospher-

ic Administration, United States Geological Survey, and the National Science Foundation (National Centers for Coastal Ocean Science, n.d.).

2. Leverage the expertise and breadth of national organizations to establish a comprehensive approach to the wastewater crisis.

Goal: Facilitate greater communication between private and non-profit organizations and government agencies to address the problem.

Summary:

- Engaging multiple stakeholders and experts can facilitate a comprehensive understanding of the scope of the problem and potential responses.
- Stakeholder examples include professional associations like: The Rural Community Assistance Partnership (RCAP), Water Environment Foundation (WEF), the National Rural Water Association (NRWA), the National Onsite Wastewater Recycling Association (NOWRA), and the American Academy of Water Resource Engineers (AAWRE); Environmentally-focused non-profit organizations such as Waterkeeper Alliance.

In order to overcome the many challenges that stand in the way of fully functional rural wastewater treatment, the expertise housed in nationwide professional associations like the Water Environment Foundation (WEF), the National Rural Water Association (NRWA), the National Onsite Wastewater Recycling Association (NOWRA), and the American Academy of Water Resource Engineers (AAWRE) can and ought to be leveraged, along with the expertise of environmentally-focused non-profit organizations such as Waterkeeper Alliance.

With the help of members and leaders from these organizations and other experts engaged in professional and academic research into wastewater solutions, a more comprehensive understanding of the scope of the problem and the strategies that have proven most useful to address them on a case-by-case basis can be developed. Working with trade and environmental organizations can also help to vet and ensure the caliber of any work performed by contractors using funding from the Farm Bill and other federal and state grant and loan programs.

CONCLUSION AND REFERENCES

Conclusion

Wastewater management issues are still prevalent throughout rural America. The issues that have led to this problem including poor soil, financial constraints, and limited government capacity are inextricably linked. In order to work towards ensuring that every person has adequate wastewater treatment systems the problem needs to be viewed holistically to address all of the facets of the issue and to ensure that all key stakeholder groups are involved. As such, the recommendations described above present a number of options for Congresswoman Sewell and her team that could potentially be used to help remediate this problem. The main two recommendations emphasize two areas that are of particular importance in order to insure that this problem can eventually be resolved.

After meeting with Congresswoman Sewell and her staff, the Workshop Team determined their strongest recommendations for immediate implementation are under the themes of: Data Considerations which involved creating an open-access data sharing portal for sanitation research to improve access and facilitate collaboration solutions and ongoing monitoring; and, Governance and Accountability Considerations with a particular focus on innovative funding and finance mechanisms, including investigating long-term funding options such as bonds or revolving funds for system maintenance operations.

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APPENDICES

Appendix A

Interview Questions

Questions about technology

1. In your view, what is the biggest barrier to increasing affordable wastewater systems in rural communities in the United States / Alabama?

2. What technologies have you seen work best in situations of decentralized management or rural settings and poverty? What unintended consequences have they seen or experienced?

Alabama's Black Belt region, which is one focus of our project, is characterized by dense clay soil and high groundwater tables that do not allow discharged water to easily drain. Because of the unique soil properties, traditional onsite wastewater management technologies, like septic tanks, often are not successful or cannot be used in this region.

3. What has been from your experience, or based on your knowledge, the most reliable and effective technology that could be used in Alabama's black belt (or in another rural community with similar or divergent soil conditions [depending on what the expert's research is in])?

4. What would you say, in your experience, is the average investment cost of these effective wastewater systems?

5. How difficult is it to maintain the system and keep it operational?
    - Does it require periodic maintenance and repair?
    - How often?
    - What is the cost of such maintenance and repairs?
    - Do they require technological know-how or can a person with average skills undertake such maintenance and repair work?
    - If it requires technological know-how, what type of training expertise is required?

6. Have government or academic experts been helpful in addressing this problem? If so who?

Questions about funding and grants

1. Does your organization receive funding from the local, state and/or federal levels? Do the funds mostly come from a specific agency at this/these levels? Are these in the form of

loans? Do you need to repay them? At what interest and over what period of time? What about the structure of capital investment?

2. Does your organization receive grants from other nonprofits or from foundations?

3. We have come across different USDA grant programs and wanted to get your thoughts on them (e.g. *Water, waste disposal, and wastewater facility grants, Rural water and wastewater technical assistance and training programs, Rural water and wastewater circuit rider program).*

4. Does your organization use these grants? If yes, which of these programs has been most effective? Have you been able to find funds to match the grants? Who, within your organization, manages the grants.

5. Is the funding project specific? If so, would you be able to share information with us about the project?

6. Are maintenance costs a significant issue in the community? If yes, can the community obtain grants and/or low-cost loans to cover maintenance [operating] costs?

7. What is the type and scope of work required to manage the grants, oversee their usage and track relevant data?

8. How difficult is the grant application process?

9. What about property values and taxes? In your experience, have these gone up after wastewater treatment infrastructure has been provided? Can people pay the tax increases? How has this impacted their lives?

Appendix B

The United States Department of Agriculture (NSDA) classifies soil based upon its characteristics. According to NSDA, soils can, generally, be classified into 12 "orders" (Natural Resource Conservation Service Soil, n.d.). The soil order is often defined by a single dominant characteristic affecting soils in that location. The chart below examines each of these 12 soil orders: Entisols, Inceptisols, Andisols, Mollisols, Alfisols, Spodosols, Ultisols, Oxisols, Gelisols, Histosols, Aridisols, and Vertisols.

Soil Order	Key Characteristics
Entisols	• Soils with little profile development • Many different parent materials contribute to varied soil properties of this order. • Often found in very dry or cool locations • Geographically extensive, commonly found with aridisols. • Widely varied productivity potential • Extent of world ice-free land area: 16%
Inceptisols	• The beginnings of soil profile development • Color differences between horizons starting to show • Prominent in mountainous areas, but occur almost everywhere • Widely variable productivity potential • Extent of world ice-free land area: 10%
Aridisols	• Soils of arid, desert climates • Varied parent materials • Often have accumulations of lime ($CaCO_3$), sodium, or salts. • Can be made productive if irrigation water is available. • Found extensively in tropical latitudes, rainshadows, and arid climates. • Extent of world ice-free land area: 12%
Mollisols	• Mineral soils developed under grassland vegetation • Thick, dark-colored 'A' horizon, rich in organic matter • Dominant soil order of the North American Great Plains region. • Large areas of Mollisols are also found in Eastern Europe, Russia, China, and South America. • Generally very fertile for plant growth due to clay and organic matter content. • Considered to be among the most fertile soils on Earth. • Extent of world ice-free land area: 7%
Alfisols	• Found under forest and savanna vegetation • Clay accumulations in subsoil horizons • Often are leached below topsoil (E horizon) • Generally fertile, with high base saturation%. • Comparable in productivity to Mollisols and Ultisols. • Extensive in humid mid-latitudes • Extent of world ice-free land area: 10%

Andisols	• Form in regions of recent volcanism • Volcanic parent materials • Generally high in natural fertility • 'Light' soils that are easily cultivated. • Potentially very productive soils • Limited geographic distribution • Extent of world ice-free land area: 1%
Spodosols	• Form in sandy materials under coniferous forest vegetation • Usually associated with a wet, cool climate • Coarse texture, high leaching potential • Have a Spodic horizon, composed of organic matter, Fe and Al oxides • Acidic, with low natural fertility • Require inputs of lime and fertilizers to be agriculturally productive. • Commonly formed in northern Europe, Russia, and northeastern North America • Extent of world ice-free land area: 4%
Ultisols	• Intensely weathered soils of humid areas • Form on older geologic locations in weathered parent materials • Contain subsurface clay accumulations (claypans). • Low in natural fertility (Ca^{2+}, Mg^{2+}, and K^{+}) and high in soil acidity (H^{+}, Al^{3+}) • Can be agriculturally productive with inputs of lime and fertilizers • Extent of world ice-free land area: 8%
Oxisols	• The most highly-weathered soils • Form in hot, humid climates with high annual rainfall. • Commonly occur in equatorial latitudes. • Highly weathered and leached, dominated by iron and aluminum oxides. • Low in natural fertility (basic cations, Ca^{2+}, Mg^{2+}, K^{+}) and high in soil acidity (H^{+}, Al^{3+}) • Physically stable soils, with low shrink-swell properties.

Gelisols	• Soils with frozen subsoils (permafrost) • Limited profile development • Surface accumulations of soil organic matter • Productivity limited by short growing season • Extensive in high latitudes • Extent of world ice-free land area: 9%
Histosols	• Organic Peat Lands, or Boggy soils • Consist of layered organic materials (more than 20% organic materials by mass) • Form in cool, wetland environments • Do not contain permafrost. • Found mainly in geographically high latitude areas or other marshy wetlands. • Extent of world ice-free land area: 1%
Vertisols	• Soils with high content of shrinking/swelling clay minerals. • Self-mixing due to shrink-swell of clay minerals • Dark colored with variable organic matter content (1 – 6%) • Typically form in limestone or basalt, or in topographic depressions. • Most commonly formed in warm, subhumid or semi-arid climates. • Large areas are found in Northeastern Africa, India, and Australia, with smaller areas scattered worldwide.

Source: USDA Natural Resources Conservation Service. (1999). *Soil Taxonomy: A Basic System of Soil Classification for Making and Interpreting Soil Surveys* (No. 436; p. 886). Retrieved from https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_051232.pdf

Appendix C

Select national organizations working on wastewater issues across the United States

National Rural Water Association

The National Rural Water Association is a robust and active national organization that works closely with the US Environmental Protection Agency (EPA) and Department of Agriculture (USDA) to secure funding for rural water systems around the country. In particular, they collaborate with the administration of the USDA Water and Waste Disposal Program to secure loans and grants to build new wastewater disposal infrastructure and improve existing systems. 85% of the projects funded through this program serve populations of under 5,000 people, and 41% serve populations of under 1,000 people (National Rural Water Association, 2018). Through this program, Lowndes County, Alabama received approximately $10.5 million in the period of 2009-2016, of which $5.9 million was in grants and the remainder in loans (National Association of Counties, n.d.).

Besides work with the USDA to secure funding, the National Rural Water Association has a "cooperative agreement" with the EPA to help smaller public water systems comply with EPA regulations. Through funding from the USDA's Rural Development program, the National Rural Water Association provides training and technical assistance to communities in the process of developing small rural systems (National Rural Water Association, 2018). This NRWA program, which provides both technical training and assistance in securing funding sources, could be an invaluable tool for rural communities such as Alabama's Black Belt that are struggling to provide adequate wastewater services.

Plumbers Without Borders

Plumbers Without Borders is a non-profit organization whose mission is to connect skilled plumbers and mechanical tradespersons with organizations that need them to help increase access to safe water and sanitation services. Almost all of their work since their founding in 2010, however, has focused on developing water infrastructure in developing countries and areas outside of the United States. Nonetheless, their mission does not explicitly state that they are focused on work abroad, and instead emphasizes that they seek primarily to combat "water and sanitation poverty" (Plumbers Without Borders, 2015). As such, it is conceivable that they may be interested in connecting their volunteers with organizations in Alabama and the rest of the United States working on providing access to wastewater services. Such work would not be in keeping with their existing operations, however, and would likely require some type of outreach or publicity to attract their attention and investment.

Engineers Without Borders (EWB) USA

Engineers Without Borders USA is the United States affiliate of the larger Engineers Without Borders international organization. Much like Plumbers Without Borders, a large proportion of their services is dedicated to projects outside the United States. EWB-USA also runs a Community Engineering Corps, however, that is specifically intended to provide "engineering design and related technical services for infrastructure projects for underserved communities in the United States" (Engineers Without Borders, n.d.). This Community Engineering Corps has assisted in the development or upgrade of wastewater systems in Ohio and California, and claims that their broad definition of communities with which they will work–which includes municipalities, private organizations, and community groups–makes them flexible in terms of projects they can approach (Community Engineering Corps, 2017).

Though EWB-USA has not worked in Alabama before, they have participated in projects in one of our case study locales, California's Salinas Valley, and have expertise in projects around the world re-

lating to designing both centralized and decentralized wastewater systems (Engineers Without Borders, 2019). For these reasons, Engineers Without Borders and particularly the Community Engineering Corps may be a worthwhile organization to consider for their expertise in designing wastewater systems in underserved communities like Uniontown.

National Onsite Wastewater Recycling Association

The National Onsite Wastewater Recycling Association is the largest national organization in the US to focus on onsite and decentralized wastewater treatment services. One of their primary operations is to provide information on decentralized services, including information from the EPA, Water Environment Research Foundation, National Environmental Services Center and others on the design, implementation, and operation of decentralized wastewater systems (National Onsite Wastewater Recycling Association, n.d.-c).

Besides providing technical information on decentralized systems, it seems that the major focus of the National Onsite Wastewater Recycling Association is to provide lobbying efforts at the federal level. The Association claims to work closely with Congress and the EPA to create legislation and policies that favor or facilitate onsite/decentralized systems (National Onsite Wastewater Recycling Association, n.d.-b). Perhaps most relevant to our study, they provide advocacy for, training on, and information about a number of different types of decentralized wastewater systems, including cluster systems, individual (septic) systems, collection systems, and onsite systems that rely on natural processes to treat water (National Onsite Wastewater Recycling Association, n.d.-a). This resource should be useful for our group as we evaluate specific design options in later stages, and for community organizations and local governments in Alabama and elsewhere as they consider what technologies are most appropriate for their communities.

National Association of Wastewater Technicians

The National Association of Wastewater Technicians is a trade and professional organization designed to support those who work in the wastewater industry. Like the National Onsite Wastewater Recycling Association, one of its principle engagements is lobbying Congress to pass legislation favorable to wastewater technicians. The National Association of Wastewater Technicians also provides training, but this training is of a much more technical nature, in alignment with the association's role as a trade organizations, providing certifications for wastewater system servicers rather than higher-level information about the design and implementation of wastewater systems overall (National Association of Wastewater Technicians, 2019). The Alabama Onsite Wastewater Association is an Alabama affiliate of the National Association of Wastewater Technicians, and similarly provides technical training and other information through trade shows and conferences as well as education and licensing programs (Alabama Onsite Water Association, 2019).