BUILDING PUBLIC CONFIDENCE IN CONSTRUCTED WETLANDS FOR WASTEWATER TREATMENT AND REUSE

by

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(Under the Direction of Laurie Fowler)

ABSTRACT

As population growth and climate change exacerbate water scarcity in many parts of the world, constructed wetlands have been proposed as a cost-effective wastewater treatment, storage, and reuse solution for small communities. Since public resistance remains a major barrier to potable water reuse in particular, this thesis attempts to identify strategies to build public confidence in the process of evaluating constructed wetlands' potential for wastewater treatment and reuse. For this work, a pilot project currently undertaken in Sewanee, Tennessee serves as a case study. Following introductory remarks, chapter 2 reviews the scientific literature on public perceptions of water reuse. Chapter 3 investigates through surveys and focus groups how to effectively communicate the pilot project to Sewanee residents. A strategic community engagement campaign is developed in chapter 4. Finally, chapter 5 proposes evaluation guidelines and tools to increase campaign effectiveness and efficiency, and to determine campaign success.

INDEX WORDS: constructed wetlands, wastewater treatment, water reuse, indirect potable reuse, public perception, community engagement, campaign evaluation, Sewanee Wetland Research Station

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DEDICATION

To Cornbread. I know she wouldn't mind toilet to tap.

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CHAPTER 1

INTRODUCTION

Whereas water on this planet may seem abundant, most is not immediately accessible for human use. In 1993, late Russian hydrologist Igor Shiklomanov estimated that of all water in the hydrosphere – representing a volume of circa 1.386 billion km^3 – merely 2.5% is freshwater. Approximately 69% of all freshwater is "locked away" in polar and mountainous regions; another 30.15% is groundwater. Freshwater lakes and rivers contain just 0.26% of global freshwater resources – or 0.007% of all water on earth.

These statistics might make it somewhat less surprising that the 2030 Water Resources Group projects global water requirements in 2030 to exceed reliably accessible resources by 40% (Addams, Boccaletti, Kerlin, & Stuchtey, 2009). Global demand is rising rapidly: The United Nations Department of Economic and Social Affairs (2015) predicts that the world population, which is currently at 7.4 billion (United States Census Bureau, 2017), will reach 8.5 billion by 2030 and 11.2 billion by 2100. Already, "two thirds of the world's population (…) live in areas that experience water scarcity for at least one month a year" (United Nations World Water Assessment Programme, 2017, p. 2). While population growth and increased demand may be the driving cause of a global water deficit, various additional factors can affect water availability on local and regional levels. Examples are unsustainable use, altered weather and climate patterns, and water pollution (United Nations World Water Assessment Programme, 2015).

Miscellaneous strategies have been proposed to address water scarcity on a community-level. Perhaps the simplest is water conservation, which has tremendous potential to prevent water

waste and overuse. However, in some cases, alternative water supply options are needed to meet essential demands. Recently, constructed wetlands have been proposed as a cost-effective wastewater treatment, storage, and reuse solution for small communities that seek to address current or expected water shortages (Ávila, Bayona, Martín, Salas, & García, 2015; Ávila, Garfí, & García, 2013; Greenway, 2005; United States Environmental Protection Agency, 2000b).

A major barrier to potable water reuse in particular, however, is public resistance, often based on the lack of information and misperception (Dishman, Sherrard, & Rebhun, 1989; Dolnicar, Hurlimann, & Nghiem, 2010; Ormerod & Scott, 2013). It appears that water reuse has an "image problem"; in 2015, New York Times reporter John Schwartz acknowledged, "a phrase like 'toilet to tap' can undercut earnest explanations" ("The Parched West", para. 5). Ironically, the title of the article itself was "Water Flowing from Toilet to Tap May be Hard to Swallow". Note that the author strongly supported the idea of potable reuse. For future water reuse projects to be successful, this issue needs to be addressed, especially if people are unfamiliar with the technology that is used in the wastewater treatment process (Marks, 2006).

This thesis therefore attempts to identify strategies to build public confidence in the process of evaluating constructed wetlands' potential for wastewater treatment and reuse. This is done in an experimental manner for a pilot project currently undertaken in Sewanee, Tennessee. To set the stage, the following two sections introduce the idea of using constructed wetlands for municipal wastewater treatment and reuse, and the pilot project.

1.1 Constructed wetlands for municipal wastewater treatment

Constructed wetlands (CWs) are carefully designed and engineered water treatment systems that mimic the same physical, microbial, biological, and chemical processes that occur in natural wetland ecosystems to improve water quality (Barth et al., 2012; United States Environmental

Protection Agency, 2000b). CWs have primarily been used for municipal treatment purposes, but also to treat agricultural and industrial wastewater, as well as mine drainage, landfill leachates, and stormwater runoff (Kadlec & Wallace, 2009).

Municipal wastewater treatment wetlands are most commonly used for secondary treatment (receiving effluent of primary treatment systems to degrade biological content) or as add-ons to existing secondary treatment plants for tertiary treatment (further and final polishing of the wastewater beyond regulatory discharge requirements) (Kadlec & Wallace, 2009). Many authors have pointed out the economic advantages of CWs to other wastewater polishing systems, especially due to their low operation and maintenance (O&M) costs[1] (Ávila et al., 2015; Dakua, Mahmood, Bhowmik, & Khaled, 2016; Deeptha, Sudarsan, & Baskar, 2015; Gkika, Gikas, & Tsihrintzis, 2014; Y. Li, Zhu, Ng, & Tan, 2014; Vymazal, 2010; Zhang, Gersberg, Ng, & Tan, 2014). Thus, CWs are often considered to augment existing wastewater treatment systems in relatively poor communities, not only in the Unites States but also in developing countries (Dakua et al., 2016; Ghrabi, Bousselmi, Masi, & Regelsberger, 2011; Kivaisi, 2001; Y. Li et al., 2014; Møller, Fryd, De Neergaard, & Magid, 2012; Murray & Hamilton, 2010; Mustafa, 2013).

As CWs store large volumes of water, they can also facilitate water reuse practices in regions that experienced prolonged drought and water shortages in the past and/or are likely to suffer from such in the future (Ávila et al., 2015; Ávila et al., 2013; Barbagallo, Barbera, Cirelli, Milani, & Toscano, 2014; Dakua et al., 2016; Ghermandi, Bixio, & Thoeye, 2007; Greenway, 2005; Kaushal, Wani, Patil, & Datta, 2016; Nelson et al., 1999). The E.L. Huie Jr. Constructed Treatment Wetlands in Clayton County, GA, for example, return 65.9 million liters per day back

[1] The capital costs of CWs depend on the costs of local construction materials and labor, as well as on a variety of other factors, including treatment goals, intended detention time, number of cells, and terrain (Interstate Technology & Regulatory Council, 2003; Kadlec & Wallace, 2009). Capital costs of CWs might therefore not necessarily be lower than those of alternative wastewater polishing systems.

to the county's drinking water reservoirs, a practice commonly known as indirect potable reuse[2] (Clayton County Water Authority, n.d.).

Another potential advantage of CWs (i.e. one that remains under investigation) is their ability to remove contaminants of emerging concern, including pharmaceuticals and personal care products (PPCPs), from the wastewater stream (Figure 1) (Ávila et al., 2015; Ávila et al., 2013; Y. Chen et al., 2016; Du et al., 2014; Lee, Lee, Park, Kim, & Cho, 2013; Y. Li et al., 2014; Zhang et al., 2014; Zhang, Ni, Gersberg, Ng, & Tan, 2015). However, as Verlicchi and Zambello (2014) point out, a CW's ability to effectively treat for these compounds may depend on the specific design parameters[3], again reflecting the urgent need for research in this area.

It should be noted that the effects of PPCPs in the environment are at present poorly understood. Numerous studies have found these compounds persist after conventional wastewater treatment and negatively impact aquatic organisms and other terrestrial wildlife that rely on water as a resource (Ávila et al., 2015; Y. Chen et al., 2016; Deo & Halden, 2013; Du et al., 2014; Hughes, Kay, & Brown, 2013; Kidd et al., 2007; Kolpin et al., 2002; Kolpin, Skopec, Meyer, Furlong, & Zaugg, 2004; Petrie, Barden, & Kasprzyk-Hordern, 2015; Touraud et al., 2011; Zhu & Chen, 2014). Currently, no consensus exists among scientists on what risks, if any, PPCPs pose on human health (Touraud, Roig, Sumpter, & Coetsier, 2011). Studies investigating PPCPs' potential to impact human health (see, for example, Houtman, Kroesbergen, Lekkerkerker-Teunissen, and van der Hoek, 2014) address concerns about the toxicity of individual contaminants, the risks of acute and chronic exposure, the interaction of multiple compounds, and

[2] Indirect potable reuse describes the process of blending treated wastewater with freshwater in an environmental buffer such as a reservoir or stream for future potable use (Ormerod & Scott, 2013; Rock, Solop, & Gerrity, 2012). Since treated wastewater is frequently discharged into streams, indirect potable reuse is a very common, yet often unplanned practice among downstream communities relying on surface freshwater supplies (Aitken, Bell, Hills, & Rees, 2014; Khan & Gerrard, 2006).

[3] See, for example, Y. Li et al. (2014) and Zhang et al. (2014) for studies that investigated how wetland design influences treatment efficacy for different pollutants.

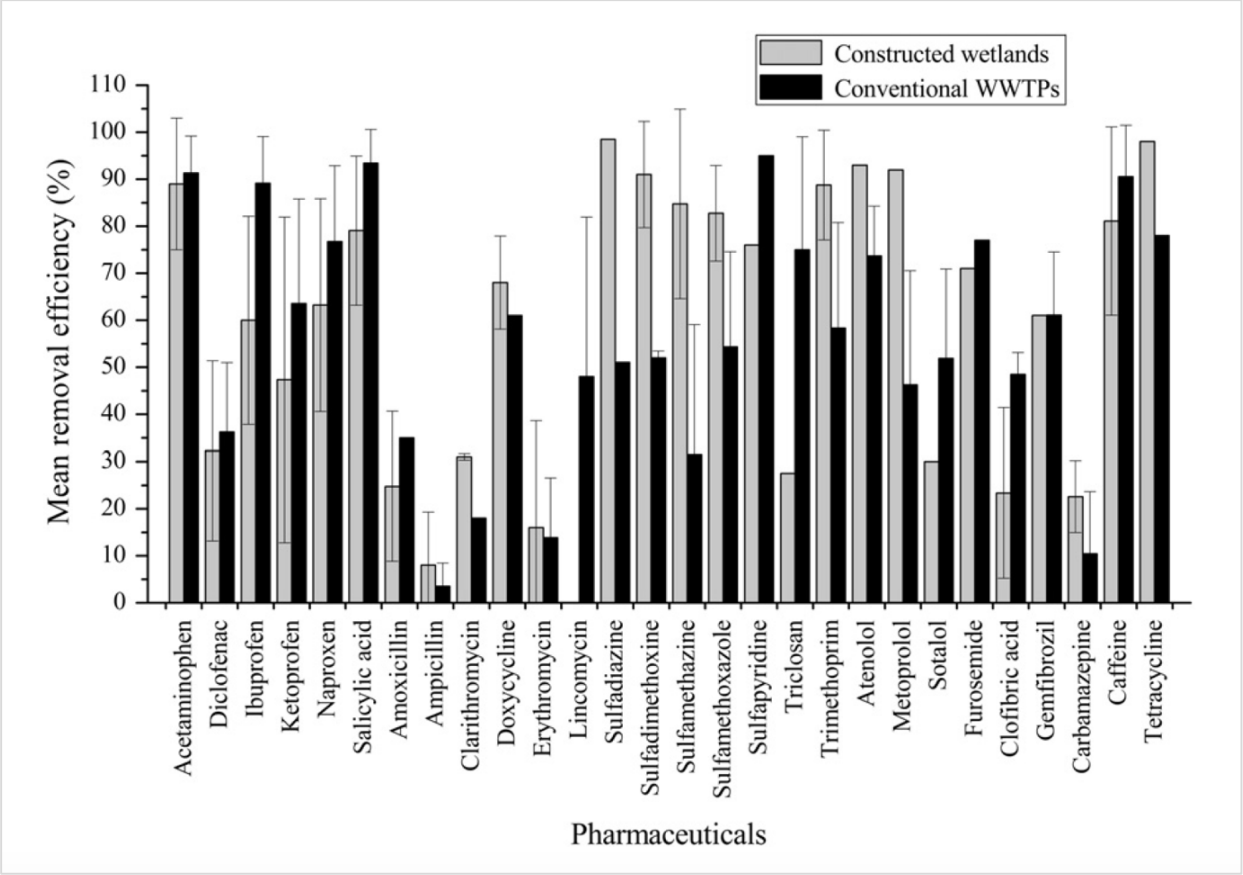


Figure 1: Mean removal efficiencies for selected pharmaceuticals in constructed wetlands and conventional wastewater treatment plants. Source: Y. Li et al. (2014).

the vulnerability of certain subpopulations such as children. Given the lack of knowledge about their impacts, much less threshold limits, emerging contaminants are currently not regulated by federal or state governments in the United States. In the event they are regulated in the future, CWs could provide small communities with a cost-effective way to comply with the new standards.

Altogether, CWs match all the criteria to be termed appropriate wastewater treatment technology for small, rural communities (United States Environmental Protection Agency, 2000b). They are affordable in the long term due to their low O&M costs, operable – meaning that CWs can easily be maintained with locally available labor, and reliable. Additionally, they may help assure adequate water supply to communities susceptible to drought.

1.2 Project description

Between 2007 and 2009, the Southern Cumberland Plateau region in Tennessee experienced one of the most severe droughts in recorded history. Many municipalities failed to satisfy their customers' essential water demands and had to purchase water from neighboring water districts (Stein & Hanson, 2009). Although the Sewanee Utility District of Franklin and Marion Counties (SUD) did not run out of water during the drought and in fact supplied water to neighboring communities during the crisis, the SUD resolved to investigate strategies to mitigate area-wide water shortages in the future. Over the course of the following years, conversations about collaborative research between faculty and staff at Sewanee: The University of the South (UoS), the University of Georgia (UGA), and the SUD began to center around CWs for wastewater treatment and water storage.

A CW was considered for the following reasons: First, a CW can store large volumes of water and thus could provide Sewanee with a stable and reliable water supply if effluent is reused. Second, Sewanee is a rural community – the most recent estimate indicates a total population of 2,642 (United States Census Bureau, 2015), and the average personal income per capita (PIPC) is relatively low: In 2016, the county's PIPC ($35,757) was 85 % of the state average ($42,094) and 74% of the national average ($ 48,112) (United States Bureau of Economic Analysis, 2016). Accordingly, financial resources for a high-cost wastewater treatment system in Sewanee are limited. CWs, however, can provide high treatment for low cost when land is available for natural processing systems. Third, several UoS studies (all unpublished[4]) have found trace levels of

[4]According to UoS Professor of Biology Deborah McGrath, these studies were not published because non-quantitative methods were used to test for these contaminants (personal communication, June 15, 2017). In other words, the authors determined that the contaminants listed above were present in the streams, however, they did not quantify the concentrations in which they were present. Further investigation is necessary to understand to what extent these contaminants survive current wastewater treatment processes in Sewanee.

pharmaceuticals and illicit drugs in some of the streams draining the watershed, indicating that Sewanee's current wastewater treatment system is not removing these types of contaminants. These include methamphetamine, N-formyl amphetamine, ephedrine (Teasley, Bennett, Crider, McGrath, & Smith, 2011), caffeine, acetaminophen, sulfamethoxazole, erythromycin, and carbamazepine (Hendon & White, 2015). However, these studies selected a limited number of target analytes. Many other PPCPs that were not part of the analyses performed might also be present in treated wastewater.

In the spring of 2012, faculty and graduate students at UGA, in collaboration with faculty and students at UoS, determined the feasibility, design considerations, and costs associated with a pilot CW for tertiary wastewater treatment and water storage. In 2014, UoS, with help from faculty at the Odum School of Ecology at UGA, applied for a grant from the Coca-Cola Foundation and the Coca-Cola Bottling Company United to realize the pilot project and eventually received funding in the amount of $590,000. After a nine-month design process, construction of a 0.16-hectare free water surface flow wetland began in February 2016 and was finished in June 2016; operation began that same month. The goals of the pilot project are to (1) determine whether CWs can cost-effectively remove pollutants, including contaminants of emerging concern, from municipal wastewater, and (2) use the facility as a means of engaging the public in water and wastewater issues, and in particular, reframing the community conversation about wastewater reuse.

1.2.1 Water usage in Sewanee

The location of Sewanee, TN, relative to Nashville to the northwest and Chattanooga to the southeast, is shown in Figure 2.

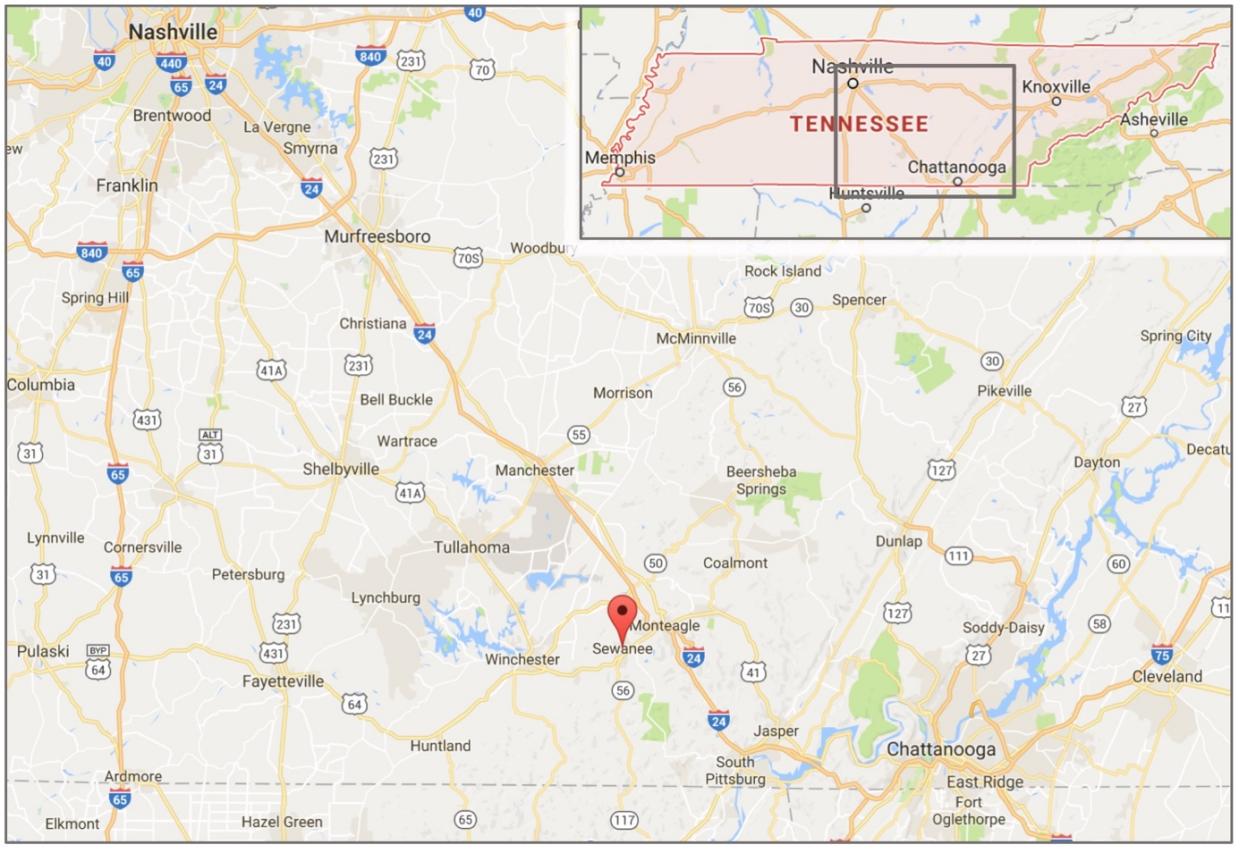


Figure 2: General location of Sewanee, Tennessee. Modified from Google (n.d.).

Drinking water treatment – As Sewanee is located on top of the Cumberland Plateau, it obtains all of its freshwater from rainwater-fed reservoirs – Lake O'Donnell and Lake Jackson (Garden, 2011). The two reservoirs impound approximately 300 and 490 million liters of water, respectively (Knoll, Potter, & Van De Ven, 2015). During severe droughts, Lakes O'Donnell and Jackson are augmented with water from nearby Lake Dimmick. Since the 1970s, the SUD has owned and operated the drinking water treatment plant and distribution system, and today serves approximately 1,200 customers, including the university. In the Spring 2017 semester, UoS had, according to Director of Residential Life Kate Reed, 1424 undergraduate students living in 19 traditional residence halls and 199 students living in 23 special interest houses (personal communication, April 24, 2017). In 2011, the SUD switched from a conventional sand filtration

drinking water system to membrane systems, which resulted in a higher degree of filtration and a 30% reduction in disinfection by-products (Garden, 2011). The SUD conducts tests for over 80 contaminants that may be present in drinking water. Only eleven of these have been detected, all of them at safe levels. Overall, Sewanee's drinking water meets all EPA health standards[5] (Sewanee Utility District of Franklin and Marion Counties, 2015).

Wastewater treatment – Raw wastewater is screened to remove large solids. Afterwards, it is pumped into two facultative lagoons (A or B), which operate in parallel to feed into a third stabilization pond (lagoon C) (Figure 3). The three lagoons each are 2.5 meters deep and consist of an aerobic layer at the top and an anaerobic layer at the bottom. Aerobic bacteria break down organic carbon which is released as carbon dioxide (CO_2), whereas anaerobic bacteria convert nitrate (NO_3^-) to nitrogen gas (N_2) that exits the lagoon via denitrification. Phosphate is adsorbed to solids, which settle on the bottom of the lagoons as sediment. After 45 days, water from lagoon C enters a chlorine contact chamber for disinfection (Hopson, Williams, McGrath, & White, 2016). Afterwards, the water (which now meets EPA and state regulations) is sprayed onto 27.52 hectares of upland hardwood forest divided into 19 spray fields (Devakaram, 2007). Although the main purpose of the land application system (LAS) is discharge, plants take up remaining nutrients from the treated water as it percolates through the soil, providing an additional treatment step[6]. The water eventually resurfaces in three ephemeral streams draining the site[7]. Overall, the SUD's

[5] The Sewanee Utility District of Franklin and Marion Counties (2015) does not specify whether the water meets secondary drinking water standards.

[6] On June 4, 2004, the Tennessee Department of Environment & Conservation received information about possible violations of the SUD's State Operating Permit, which dictates that effluent is applied to land. During a compliance evaluation inspection on July 6, 2004, it was found that the LAS had not been maintained properly, and consequently, that treated wastewater was entering "Waters of the United States" via overland flow (Agreed Order, 2005). Due to this violation, TDEC mandated changes to the spraying regime, as well as improved maintenance and oversight (S. Torreano, personal communication, June 16, 2017). Since correction, no violations have been found.

[7] These streams owe their existence to the land application system. Therefore, they have no official names (D. McGrath, personal communication, June 15, 2017).

wastewater treatment system has a design capacity to treat 2.233 million liters of wastewater per day (Devakaram, 2007).

1.2.2 Design of the pilot constructed wetland

The 0.16-hectare pilot wetland was incorporated into the SUD's existing wastewater treatment system (Figure 3). The pilot CW employs a free water surface flow (FWSF) system and consists of three wetland basins, each designed to provide specific treatment functions. Accordingly, each wetland is characterized by a different shape, water depth, and plant group. Overall, vegetation resembles a native wetland vegetation assemblage in the Cumberland Plateau region.

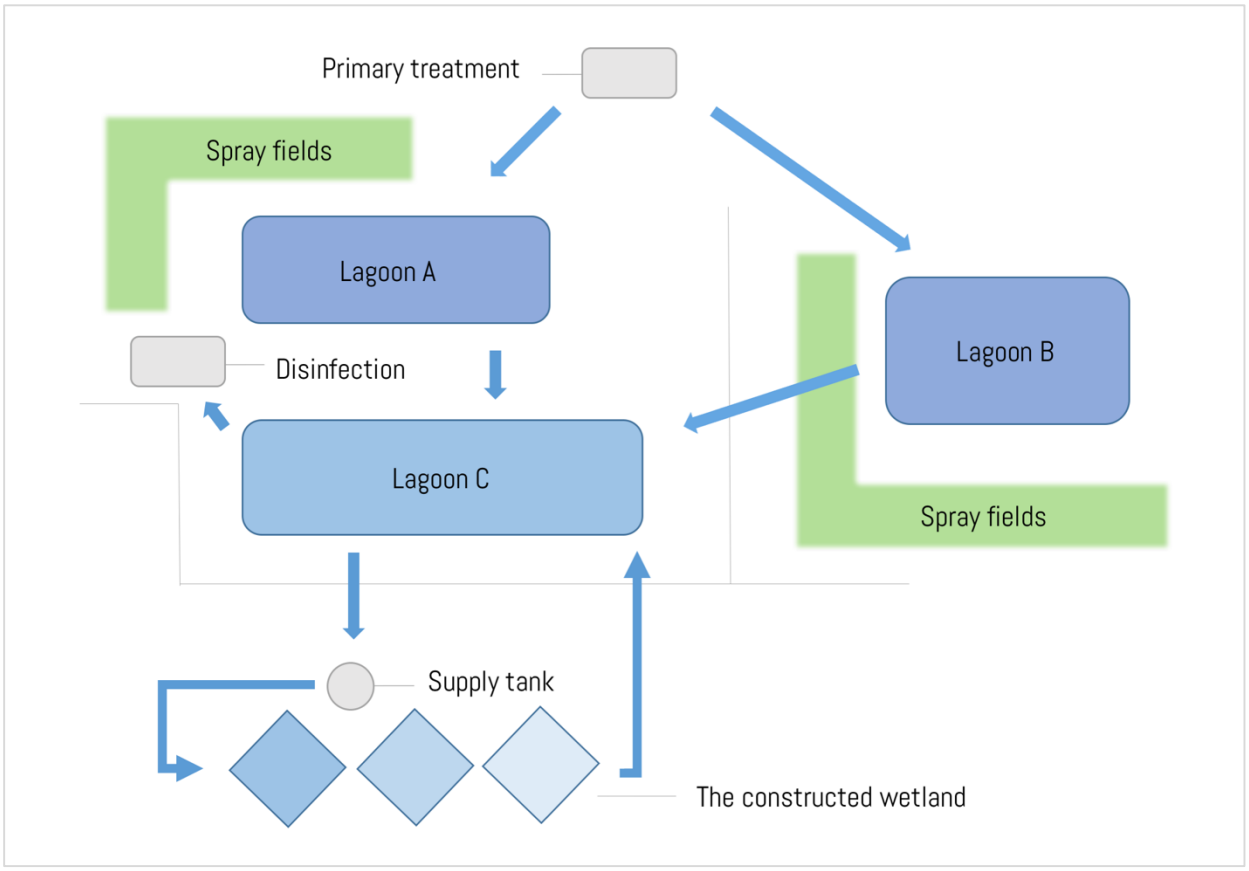


Figure 3: Overview of the pilot constructed wetland's position in the Sewanee's Utility District's overall wastewater treatment system.

Treated wastewater is pumped from lagoon C into a 24,600-liter supply tank that allows discharge via valve controls and gravity into the first wetland basin. Approximately 87,000 liters of water enter the pilot CW per day (D. McGrath, personal communication, January 10, 2017). From there, the water moves through the system down a slight elevational gradient. Each basin's water level can be controlled manually through flashboard risers at the outflow. After passing through the three basins, the water discharges back into lagoon C to comply with the SUD's NPDES permit (Hopson et al., 2016). An aerial view of the pilot CW is provided in Figure 4; major components of the facility are labeled.

Figure 4: Aerial view of the pilot constructed wetland. Photo taken by Dr. Brandon Moore, Assistant Professor of Biology at Sewanee: The University of the South.

As water enters the first wetland, it moves through a small, deep photolysis zone (Hopson et al., 2016), which is particularly important for the removal of many PPCPs (Ávila et al., 2015;

Challis, Hanson, Friesenc, & Wong, 2014; W. C. Li, 2014; Petrie et al., 2015; Verlicchi & Zambello, 2014; Zhang et al., 2014). Effluent flow continues through a field of soft stem bulrush (*Schoenoplectus tabernaemontani*), which take up nutrients, such as nitrogen and phosphorus, through their root systems. Presumably, bacteria in the oxygen zone around the plant roots transform and remove nutrients from the wetland as well (Kadlec & Wallace, 2009). Adsorption to organic matter in plants and sediments may also remove phosphorus over time. The same nutrient removal processes – plant uptake, microbial transformation, and adsorption to organic matter – occur in the second and third wetland.

The second wetland contains nine mounds, which provide a larger area for sediment to adsorb nutrients and other compounds. The irregular topography adds turbulence and facilitates mixing of the water. To prevent erosion, the mounds are planted with boneset (*Eupatorium perfoliatum*), blue flag iris (*Iris versicolor*), rose mallow (*Hibiscus moscheutos*), and swamp milkweed (*Asclepias incarnate*). This native wetland plant mixture is visually appealing and attracts a great variety of pollinators. The open areas provide additional opportunities for sunlight to break down contaminants (Hopson et al., 2016).

The first half of the third wetland is planted with pickerelweed (*Pontederia cordata*), which has been extensively studied for its importance in phytoremediation of nutrient pollution (see, for example, Wang & Sample, 2014). Additionally, as a flowering plant, pickerelweed attracts pollinators and is visually pleasing. The second half is left vegetation-free, serving as an additional photolysis zone. The water leaves the wetland through a flume where the flow rate is measured and is returned to lagoon C (Hopson et al., 2016).

Periodic effluent sampling began in June 2016 immediately following the establishment of the wetland vegetation. Seasonal samples are taken at five locations: in lagoon C (close to where

the treated wastewater effluent is pumped into the supply tank), at the first wetland basin's inflow, and at each basin's outflow (Hopson et al., 2016). Water sampling and analysis procedures, as well as first monitoring results are documented in Hopson et al. (2016) for common water quality indicators[8], as well as in Smith (2017) for pharmaceuticals and hormones[9].

1.2.3 Possible configuration of a full-scale water reuse system in Sewanee

If the pilot project demonstrates that a CW can consistently remove contaminants, including PPCPs, from Sewanee's wastewater, a full-scale wetland may replace the SUD's current land application system and instead introduce treated wastewater into the municipal water supply. Note that this full-scale wetland would operate in conjunction with the existing facultative lagoons, which are essential for the settling of solids and denitrification processes. A possible configuration of a full-scale water reuse system in Sewanee is shown in Figure 5.

According to Ben Beavers, general manager of the SUD, a full-scale wetland could provide a stable and reliable water supply (maximal 1.5 million liters per day incorporating expected population growth) to the Sewanee community (personal communication, March 2, 2017). Beavers expects a full-scale CW would be the most cost-effective option to mitigate future water shortages and anticipates that a CW would polish treated wastewater to a higher quality than the current LAS at the same cost.

The full-scale CW would be built in the watershed of Lake Jackson, an area that consists of 95% of forested area which is owned by UoS. In terms of additional infrastructure needs, this system would require pipelines and pumps that transport treated wastewater from the facultative

[8] Common water quality indicators that are tested for include: total nitrogen (organic, nitrite, nitrate, and ammonia), total phosphorus (organic, reactive, and acid-hydrolyzable), bacteria (*E. coli* and total coliform), pH, temperature, conductivity, biochemical oxygen demand, total suspended solids, turbidity, and dissolved oxygen.

[9] Pharmaceuticals and hormones that are sampled for include: atenolol, acetaminophen, caffeine, methylphenidate, propranolol, diphenhydramine, carbamazepine, fluoxetine, sertraline, naproxen, norethindrone, valsartan, norgestrel, medroxyprogesterone, and gemfibrozil.

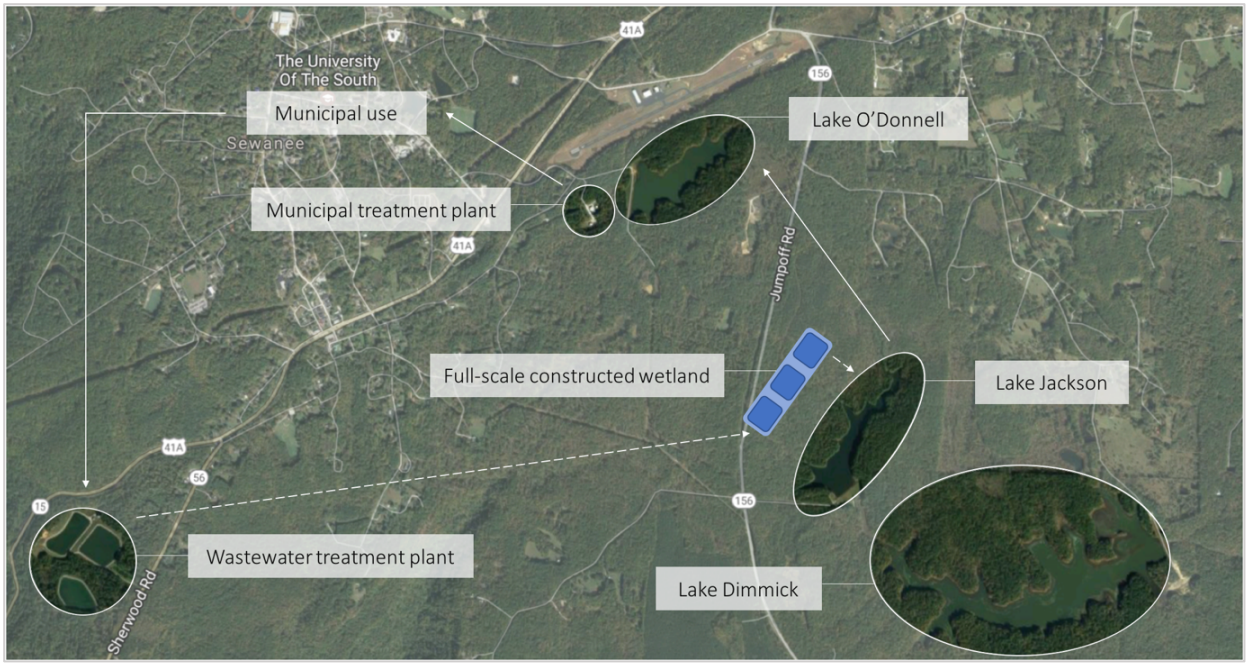


Figure 5: Possible configuration of a full-scale constructed wetland-based water reuse system in Sewanee, Tennessee. Background: Google (n.d.).

lagoons to the inflow of the CW, as well as from its outflow to Lake Jackson. Potentially, an additional employee would need to be hired for wetland maintenance (B. Beavers, personal communication, March 2, 2017). Finally, permitting requirements would need to be discussed with the Tennessee Department of Environment & Conservation (TDEC). For example, a National Pollutant Discharge Elimination System (NPDES) permit would have to be obtained since treated wastewater would be discharged into Waters of the United States. Water reuse is regulated on a state level in the United States, however, there currently exist no regulations or guidelines governing indirect potable reuse in Tennessee (United States Environmental Protection Agency, 2012). According to George Garden, Chief Engineer at TDEC's Division of Water Resources, the state government is "a couple of years away (…) [from] indirect or direct potable reuse regulations, but it is on the horizon" (personal communication, April 23, 2017).

If the pilot project does indeed prove successful[10], all five SUD board members would need to be in favor of an indirect potable reuse project before it would be realized (B. Beavers, personal communication, March 2, 2017). According to Beavers, this in turn requires the support of the Sewanee community. Therefore, the second major goal of the pilot project is to develop a comprehensive community engagement campaign to build public confidence in the process of evaluating the potential for an indirect potable reuse project. Additional funding to develop and begin implementing the engagement campaign was provided by the Riverview Foundation and through the Odum School of Ecology Butler Fellowship.

Community engagement is important because the primary barrier to potable water is public resistance; even where public benefits are outstanding, opposition may ultimately lead to the failure of a water reuse project (Dishman et al., 1989; Dolnicar et al., 2010; Ormerod & Scott, 2013). In Sewanee, for example, some community members have expressed discomfort with the idea of recirculating treated wastewater effluent into a relatively "pure" rain-fed municipal water source. This thesis will therefore attempt to investigate how community engagement can build the basis for public acceptance of water reuse in Sewanee, assuming a successful outcome of the pilot project. The answer to this question will be important for communities throughout the southeastern United States seeking to address current or expected water shortages, as well as for any water-dependent industry such as Coca-Cola.

1.3 Thesis outline

The remainder of this thesis is structured as follows: Chapter 2 reviews the scientific literature to describe how social, cultural, and psychological factors can influence public acceptance of water

[10] It is recommended that the research team and the Sewanee Utility District delineate a set of measurable target criteria to define what constitutes "success", as well as commits to a timeframe in which to conclude the pilot project. Criteria should include chemical, biological, ecological, economic, and social parameters.

reuse. Chapter 3 explains the research that has been conducted both before and as part of this thesis to understand how to effectively communicate with Sewanee community members about the pilot project. A strategic community engagement campaign, based on insights gained from previous chapters, is developed in chapter 4. Finally, chapter 5 proposes evaluation guidelines and tools for future use to increase campaign effectiveness and efficiency, and to determine campaign success.

CHAPTER 2

PUBLIC PERCEPTION OF WATER REUSE – A LITERATURE REVIEW

Engineers and water planners generally agree that modern technology can treat water, including wastewater, to such high quality that it once again meets current drinking water standards. Treated wastewater is therefore often considered suitable and safe for indirect and even direct potable reuse (Carr & Potter, 2013; Ormerod & Scott, 2013). In fact, there exist no known cases of human illness related to intentional water reuse practices (Rock et al., 2012)[11]. However, public resistance has long been an obstacle to the successful implementation of water reuse projects, and researchers have been investigating what factors can increase people's willingness to reuse treated wastewater since the early 1970s (Dolnicar & Hurlimann, 2009; Khan & Gerrard, 2006; Nancarrow, Leviston, Po, Porter, & Tucker, 2008). Understanding this social dynamic is becoming increasingly important as population growth and climate change are expected to exacerbate water scarcity in many parts of the world (Schewe et al., 2014).

2.1 The case of Toowoomba, Australia

The failure to address public concerns with planned water reuse projects may ultimately result in the failure of the project. An often-cited example is the case of Toowoomba, Australia, where, in a 2006 referendum, residents voted against an indirect potable reuse project to augment dam supplies, despite experiencing frequent restrictions to water use (Z. Chen et al., 2013; Ching, 2010; Dolnicar & Hurlimann, 2009; Hurlimann & Dolnicar, 2010; Ross, Fielding, & Louis, 2014). Residents were concerned about adverse health effects that might result from drinking reclaimed

[11] As discussed in section X, the impacts of PPCPs on human health are not well understood; human exposure to these contaminants are of a concern to *any* public water supplier, not only those engaged in water reuse.

water, although many admitted to know nothing or not much about water reuse (Dolnicar & Hurlimann, 2009). In addition, according to Hurlimann and Dolnicar (2010) and Ross et al. (2014), residents thought the project might have negative impacts on Toowoomba's image and feared that their city might become less attractive to businesses or tourism. Another contributing factor was the confusing use of negative terminology such as "toilet to tap", even by politicians supporting the project (Ching, 2010). Overall, this case supports the idea that the lack of early community involvement and miscommunication can result in the failure of a water reuse project.

2.2 Factors influencing public perceptions of water reuse

Many authors have addressed the concerns people may have about reusing treated wastewater. The general concept of a negative emotional response, i.e. the psychological barrier created by knowing its origin, has in the literature been termed the "yuck factor" (Aitken et al., 2014; Ching, 2010; Dolnicar & Hurlimann, 2009; Garcia & Pargament, 2015; Hartley, 2006; Nancarrow et al., 2008; Ormerod & Scott, 2013; Po, Kaercher, & Nancarrow, 2003; Rock et al., 2012; Russell & Hampton, 2006; Wester et al., 2015). Wester et al. (2015) argue that the "yuck factor" can be broken down to perceived health concerns over pathogens that may remain in reclaimed water, which creates a feeling of disgust, as well as a fear of illness and disease. Eliminating the "yuck factor" may thus require a water quality monitoring program that objectively demonstrates that no pathogens remain in reclaimed water, so that the level of association between water reuse and pathogens can be reduced (Ross et al., 2014; Wester et al., 2015). Aitken et al. (2014) and Russell and Hampton (2006) also point out that negative water reuse terminology such as "toilet to tap" triggers or reinforces pathogen disgust and should therefore be avoided. The media, having according to Ching (2010) "the power to create knowledge and shape social norms for water reuse" (p. 115), should be considered a key institutional partner in fighting the "yuck factor", however, a genuine

partnership between project leaders and the media requires close and careful cooperation. Additionally, increasing "exposure" to water reuse, for example by providing information about successful reuse projects that generate water equal in quality to that of drinking water, and by emphasizing that all water constantly undergoes natural recycling through the hydrologic cycle, may remove uncertainties and perceived risks from water reuse and lower disgust reactions (Khan & Gerrard, 2006; Po et al., 2003; Wester et al., 2015).

However, the "yuck factor" should not be relied on to exclusively explain any negative response the public may have towards water reuse, and neither should project managers solely focus their efforts on building public support by trying to eliminate "yuck" (Russell & Hampton, 2006). According to the literature, public perceptions of water reuse can be affected by numerous factors. Each is described in detail below. Note that many of these factors are closely linked; therefore, a clear distinction cannot always be made.

2.2.1 Perceived safety of using reclaimed water

In a survey on water reuse in metropolitan Kuwait, 69% of respondents indicated they would not use reclaimed water for domestic consumption purposes for health reasons (Alhumoud & Madzikanda, 2010). Similarly, when survey participants in Australia were asked their opinion on water reuse, many indicated health concerns, particularly about not yet scientifically-detectable contaminants (Dolnicar & Hurlimann, 2009; Dolnicar & Schäfer, 2009). People therefore require guarantees that reclaimed water is safe and approved for its intended use(s), so that there are no health risks associated with using it for them or their children (Bruvold, 1988; Dishman et al., 1989; Hartley, 2006; Khan & Gerrard, 2006; Nancarrow et al., 2008; Ormerod & Scott, 2013; Po et al., 2003). This in turn requires proof that the wastewater treatment system can effectively remove substances that can cause damage to human beings, such as pathogens and heavy metals,

before the water is introduced into the municipal water supply (Garcia & Pargament, 2015). Thus, authorities should demonstrate that reclaimed water meets public health and safety standards (such as by the EPA or World Health Organization (WHO)), and that treatment technology is reliable and effective in producing water of this quality (Khan & Gerrard, 2006).

2.2.2 Perceived quality of reclaimed water

Related to perceived health concerns associated with reclaimed water is how people perceive its quality. For example, Z. Chen et al. (2013) found that fear of odor was a major factor preventing study participants from using reclaimed water for household laundry in Australia. Other factors that often are perceived as indicators for low water quality and accordingly may decrease public acceptance include color or bad taste (Dolnicar & Hurlimann, 2009). Since many studies have shown that people often consider reclaimed water to be of insufficient quality; eliminating odor, color, and bad taste should intuitively lead to wider societal acceptance (Carr & Potter, 2013; Hartley, 2006; Ormerod & Scott, 2013). Associated with this is, as previously mentioned, the necessity of monitoring a water reuse system and implementing a public data sharing program (Carr & Potter, 2013; Dishman et al., 1989).

2.2.3 Environmental risks associated with water reuse

Some people find it important that reclaimed water does not harm the environment (Bruvold, 1988; Khan & Gerrard, 2006). Of course, this may be true for environmentalists or in fact anybody who appreciates nature for its intrinsic value, but it might also be due to economic reasons. From a farmer's viewpoint, for example, it would be unacceptable if some contaminants are not effectively reduced, if the presence of such compounds could have a negative impact on crops or livestock. This may in turn lead to economic disadvantages and losses for the farmer (Carr, Potter, & Nortcliff, 2011; Franklin, Williams, Andrews, Woodward, & Watson, 2016).

2.2.4 Environmental benefits associated with water reuse

Public acceptance may increase if the environmental benefits of water reuse are clear (Bruvold, 1988; Hartley, 2006; Khan & Gerrard, 2006). More specifically, explaining the importance of conserving water through reuse for in-stream uses, such as protecting aquatic biota and recreational opportunities, may help to gain community support, especially among environmental enthusiasts (Po et al., 2003). In fact, it has been shown that high levels of environmental awareness correlate with increased public acceptance of water reuse (Menegaki, Hanley, & Tsagarakis, 2007; Po et al., 2003). Equally important to building community confidence would be to demonstrate a reduction or removal of PPCPs that can otherwise adversely impact aquatic organisms and terrestrial wildlife that rely on water as a resource (see section 1.1).

2.2.5 Potential of water reuse to avoid scarcity

People tend to be more accepting of water reuse if such a practice can help mitigate water scarcity and shortages (Bruvold, 1988; Hartley, 2006). Experiencing previous water restrictions usually correlates with a higher willingness to use reclaimed water (Dishman et al., 1989; Menegaki et al., 2007). The same might even be true for people who are aware of water use restrictions suffered by neighboring communities. Public perception of water reuse can thus also take on a geographical dimension, with initial acceptance usually being higher in arid regions (Dishman et al., 1989; Ormerod & Scott, 2013). Accepting reclaimed water is also a matter of whether there actually exists a choice about using it; in other words, water reuse may, compared to other natural and alternative water supply sources, be the only feasible option to overcome water shortages (Dolnicar & Hurlimann, 2009; Po et al., 2003). Water scarcity accompanied by a sense of crisis could therefore facilitate the introduction of a reuse project, as communities generally become more "water aware" and more supportive of innovative water management strategies during prolonged

periods of droughts (Ching, 2010; Khan & Gerrard, 2006). In contrast, a reuse project is more difficult to introduce when it is currently not necessary, either due to abundant fresh water availability or other, more feasible options for alternative water supplies (Dolnicar & Hurlimann, 2009; Khan & Gerrard, 2006; Po et al., 2003).

2.2.6 Costs associated with water reuse

It should be demonstrated that the costs of water treatment and distribution systems, as well as costs for operation and maintenance, are reasonable, and that water reuse is the most cost-effective among all alternative water supply options (Bruvold, 1988; Hartley, 2006; Khan & Gerrard, 2006; Rock et al., 2012). The cost of reclaimed water itself can also influence people's opinion on water reuse; people generally expect to pay less for reclaimed water as it usually is thought to be of lower quality (Menegaki et al., 2007; Po et al., 2003). Therefore, high costs may lower public support, whereas a price that is lower than that of traditional water supply could increase support, especially among poorer parts of the population, as the overall expenses for water decrease (Z. Chen et al., 2013; Khan & Gerrard, 2006). Accordingly, suppliers should offer reclaimed water at a reduced price if infrastructural investments allow it. This may also increase agricultural revenues, which could be a strong financial incentive for farmers (Hijazi, Parameswar, Pasch, McCornick, & Haddadin, 2006).

2.2.7 Use of terminology

The public's attention should not explicitly be drawn to wastewater as the source of reclaimed water (Hartley, 2006). Negative terminology (such as "toilet to tap" or "sewage beverage") can create disgust on a semantic level and should be avoided when communicating with the public (Ching, 2010; Po et al., 2003; Wester et al., 2015). In fact, negative terminology is a reoccurring factor in reuse schemes that failed due to public opposition (see section 2.1) (Aitken et al., 2014;

Ching, 2010; Hartley, 2006). Inconsistent use of terminology may confuse the public and should therefore be avoided as well (Ching, 2010). In contrast, neutral or positive terminology is often associated with successful reuse projects (the example of NEWater is discussed in section 2.6) (Ching, 2010; Po et al., 2003). Additionally, some terms have been found to be preferred over others; according to Rock et al. (2012), terms such as "water recycling" or "repurified water" could potentially help to increase public acceptance.

2.2.8 Familiarity with and knowledge about water reuse

Familiarity with other wastewater reclamation schemes could raise local support for a specific reuse project (Russell & Hampton, 2006). In fact, increased knowledge about water reuse in general usually correlates with higher levels of public acceptance (Alhumoud & Madzikanda, 2010; Z. Chen et al., 2013; Dishman et al., 1989; Dolnicar et al., 2010). Findings by Dolnicar and Hurlimann (2009) support this relationship; in a survey conducted in Australia, some respondents indicated they were concerned about using reclaimed water due to a lack of information and knowledge about water reuse, which, they said, prevents them from making an informed decision on the safety of using reclaimed water. The provision of information as a strategy to increase public acceptance will be discussed as part of the next section and in section 2.5.

2.2.9 Trust in authorities and treatment technology

Trust and confidence in local decision-makers, water utilities, and treatment technology are usually associated with lower risk perception, which in turn may increase public acceptance of water reuse (Dishman et al., 1989; Hartley, 2006; Marks, 2006; Po et al., 2003; Rock et al., 2012; Ross et al., 2014). Accordingly, negative past experiences with local officials can create a lack of trust and credibility (Ormerod & Scott, 2013). Distrust may then result in a feeling of fear, uncertainty, and insecurity associated with the introduction of alternative water supply options (Carr & Potter,

2013). Additionally, disagreement in support of reuse among professionals and experts may also lead to difficulties in gaining public support (Marks, 2006).

An effective way of building and maintaining trust is the consultation and engagement of the public in decision-making and planning processes, along with the provision of accurate, unbiased, and comprehensive information (Dolnicar et al., 2010; Hijazi et al., 2006; Menegaki et al., 2007; Nancarrow et al., 2008; Ross et al., 2014; Russell & Hampton, 2006). Other trust-building strategies include demonstrating accountability, ensuring fairness in the way a project is implemented, maintaining transparency in the project's process, and promoting public dialogue, including open discussions of potential problems and concerns (Hartley, 2006; Hijazi et al., 2006; Hurlimann & Dolnicar, 2010; Khan & Gerrard, 2006; Russell & Hampton, 2006). Finally, trust is built up over time, and so a good reputation based on past decisions and actions is likely to motivate a community to trust authorities with implementing a reuse project (Khan & Gerrard, 2006).

2.2.10 Environmental justice issues associated with water reuse

Reuse projects that target low or medium-income water users or minorities are likely to fail (for examples, see Po et al., 2003). In addition, siting water reclamation plants near poor communities could be considered environmentally unjust as well (Po et al., 2003; Rock et al., 2012). In general, a reuse project is less likely to gain public support if it is perceived unfair in any way or to any part of the population (Nancarrow et al., 2008; Po et al., 2003; Ross et al., 2014).

2.2.11 Location of the reclamation plant

Water reuse projects may also meet opposition if the proposed reclamation plant is located next to a major residential area (due to fear of odors, mosquitos, accessibility by children, or other safety issues), has negative impacts on the "attractiveness" of a landscape, or conflicts with other potential land uses (United States Environmental Protection Agency, 2000a).

2.3 Differences in willingness to adopt reclaimed water for specific uses

Numerous studies have looked at people's willingness to adopt reclaimed water for different types of usage (Dolnicar & Saunders, 2006). In a 1988 literature review, Bruvold (1988) lists 27 uses of reclaimed water and indicates the average percentages of people who were opposed to each form of usage in seven different studies. He shows that people are more likely to oppose water reuse as the degree of intimacy and human contact increases. Interestingly, the same seems to be true for desalinated water, although for close-to-body uses such as showering, cooking, or drinking, public acceptance generally tends to be higher for desalinated water than for reclaimed water (Dolnicar & Schäfer, 2009). The idea that the proposed end-use of reclaimed water and the associated degree of human contact can greatly influence the level of public acceptance has been supported by most authors (Aitken et al., 2014; Alhumoud & Madzikanda, 2010; Dolnicar & Saunders, 2006; Dolnicar & Schäfer, 2009; Garcia & Pargament, 2015; Khan & Gerrard, 2006; Marks, 2006; Menegaki et al., 2007; Murray & Hamilton, 2010; Nancarrow et al., 2008; Olson & Bruvold, 1982; Ormerod & Scott, 2013; Po et al., 2003; Rock et al., 2012).

Dolnicar and Saunders (2006) come to the same conclusion in reviewing and summarizing eight studies on public opposition towards different uses of reclaimed water. As shown in Figure 6, people generally oppose drinking reclaimed water and using it for purposes that involve ingestion (such as food preparation) or skin contact (bathing). As the level of potential contact decreases, opposition also decreases. Accordingly, very few people oppose using reclaimed water for most outdoor recreational purposes (golf course irrigation), industrial purposes (cooling), or firefighting, i.e. in emergency situations.

Menegaki et al. (2007) even show that the public's willingness to consume agricultural products that had been irrigated with reclaimed water may vary depending on the perceived level

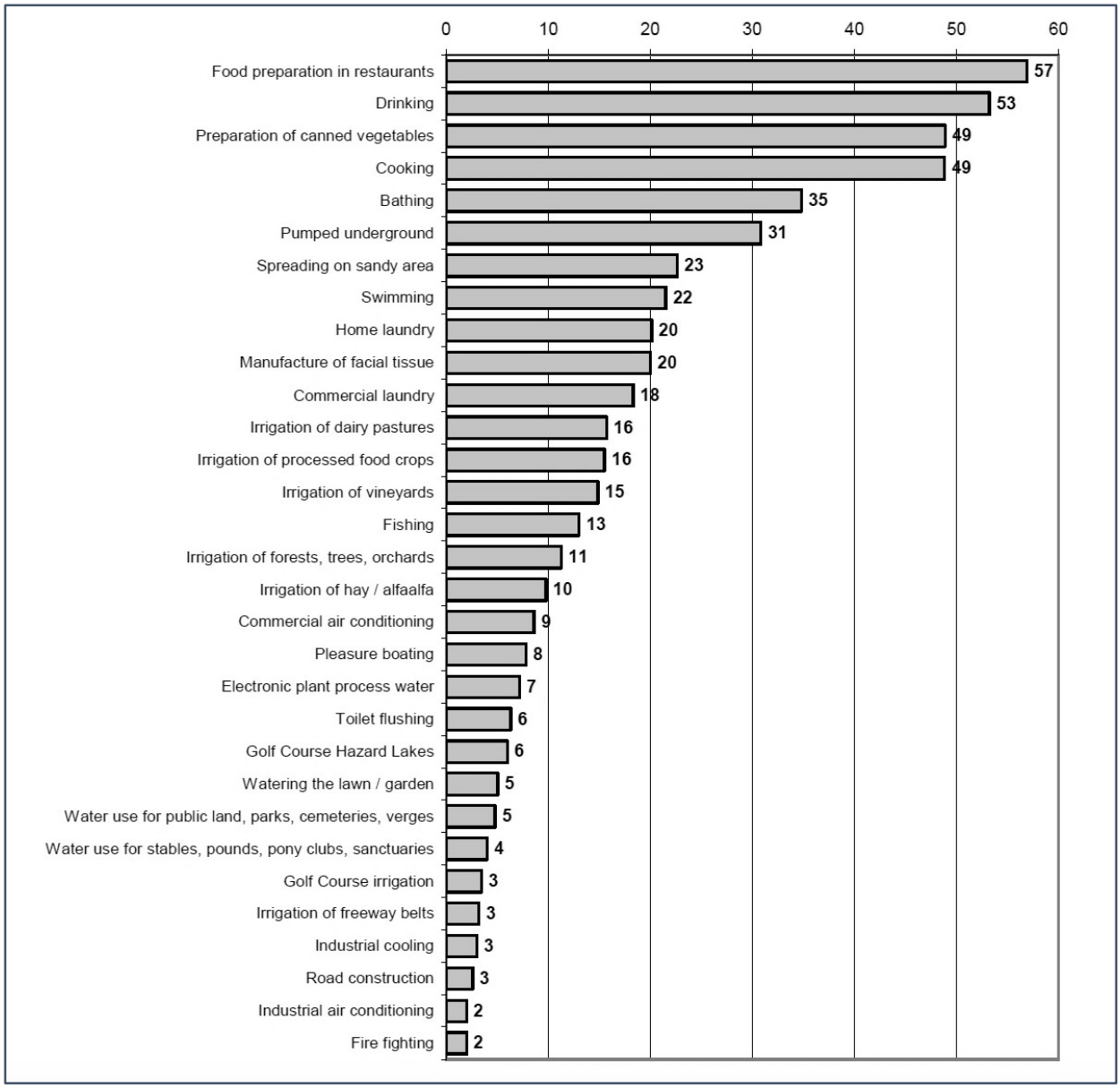


Figure 6: Average percentages of people opposed to particular uses of reclaimed water. Source: Dolnicar and Saunders (2006).

of contact with potential residues from the water. For example, people were shown to be more supportive of the use of reclaimed water in olive oil production than in tomato production. Additionally, acceptance tends to be higher for products that are not directly consumed by humans or that have to be peeled or washed before consumption (Po et al., 2003).

Based on this literature, it could be argued that beginning with low-contact uses for reclaimed water and, as public acceptance grows, moving towards more intimate forms of usage is a strategy that should be considered by policymakers who discuss implementing water reuse projects in their communities (Bruvold, 1988). Dishman et al. (1989) and Marks (2006) agree that positive experiences with low-contact water reuse can build public confidence and trust for higher-contact uses.

It should be noted, however, that not all studies found a significant relationship between the degree of human contact and the level of public acceptance of water reuse. When Bruvold (1988) studied public perception of particular reuse options in California, specifically describing to survey participants how reclaimed water in the respondent's community would be used, he found little to no relationship between the degree of human contact and how supportive people were towards different uses of reclaimed water. He concludes that residents who are faced with specific water reuse options are more amenable towards these if they are water conserving, environmentally friendly, cheap – both in terms of water treatment and distribution – and protect human health. Bruvold proposes that the degree of human contact has a greater impact on public acceptance when people are asked about general reuse options, while the factors he identifies in his study have more influence on public perception when people are asked about particular reuse options in their communities. No empirical research has yet tested this hypothesis (Po et al., 2003).

2.4 Socio-demographic characteristics and water reuse acceptance

Many studies have tried to empirically determine the socio-demographic characteristics held by people who tend to be more accepting and open towards reclaimed water than others (Aitken et al., 2014; Alhumoud & Madzikanda, 2010; Carr et al., 2011; Dolnicar & Schäfer, 2009; Lohman & Milliken, 1985; Menegaki et al., 2007; Nancarrow et al., 2008; Rock et al., 2012; Wester et al.,

2015). In a 2006 literature review, Dolnicar and Saunders show that the factor most frequently found to have a significant impact on the level of water reuse acceptance is education – six out of ten studies found a significant relationship between the two factors (Figure 7). Education is followed by age (four out of ten studies), followed by knowledge, income, and gender (all three out of ten studies).

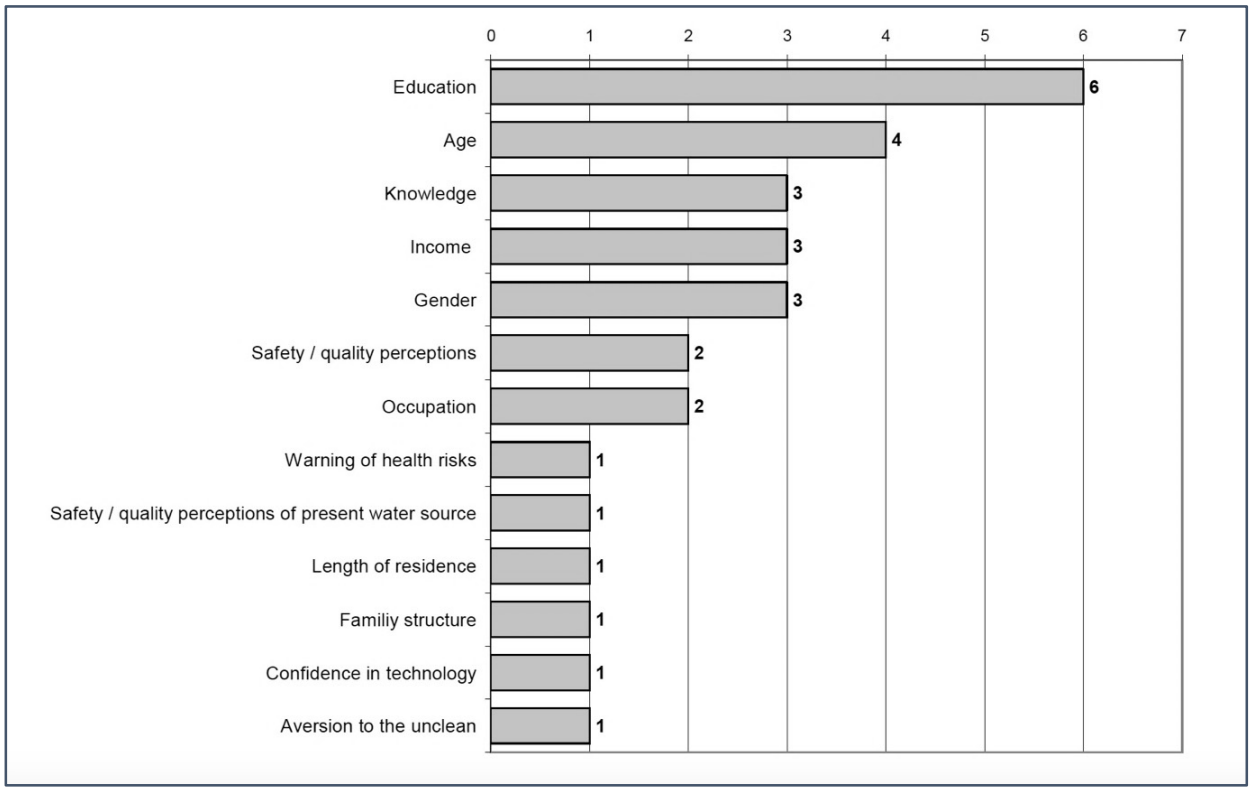


Figure 7: Number of studies that found a significant relationship between socio-demographic characteristics and acceptance levels of reclaimed water. Source: Dolnicar and Saunders (2006).

Further investigating these relationships, discomfort towards using reclaimed water tends to be higher among those with lower levels of education (Alhumoud & Madzikanda, 2010; Dolnicar & Schäfer, 2009; Lohman & Milliken, 1985; Olson & Bruvold, 1982; Rock et al., 2012; Wester et al., 2015), those with less knowledge about water reuse in general (Alhumoud &

Madzikanda, 2010; Z. Chen et al., 2013; Dolnicar et al., 2010), and women (Dolnicar & Schäfer, 2009; Lohman & Milliken, 1985; Nancarrow et al., 2008; Olson & Bruvold, 1982; Wester et al., 2015). Wester et al. (2015) found that higher discomfort towards using reclaimed water among women is caused by a statistically higher pathogen disgust sensitivity (see also Nancarrow et al., 2008). Wester et al. (2015) suggest that this could be explained by the fact that women often hold key household positions and thus have to make food and health decisions. Considering age and income, results are inconclusive: Olson and Bruvold (1982) and Menegaki et al. (2007) found that older people tend to be more opposed to reclaimed water than younger ones, which contradicts survey results by Dolnicar and Schäfer (2009). Menegaki et al. (2007) discovered that a higher income is associated with greater opposition towards water reuse, whereas Lohman and Milliken (1985) found the opposite.

Acceptance of reclaimed water may also be influenced by cultural and religious beliefs (Alhumoud & Madzikanda, 2010; Garcia & Pargament, 2015). Pauling and Ataria (2010), for example, emphasize that Māori – the indigenous Polynesian people of New Zealand – commonly find the direct discharge of treated wastewater into a water body unacceptable, as they believe that this practice harms and possibly destroys the waterway's life essence. A water reuse project may therefore result in opposition unless this perception is addressed. Regarding the influence of religious beliefs, research results have been inconclusive: Carr et al. (2011) found little evidence for a relationship between religious beliefs and acceptance of reclaimed water in Jordan. In contrast, Aitken et al. (2014) conducted a survey in London and found that Muslims were significantly less supportive of potable water reuse than people of different religions. The authors cite the central role water plays in Islamic ritual ablutions and suggest that future public engagement strategies should especially target Muslim populations. Interestingly, a legal ruling by

Kuwait's Ministry of Awqaf and Islamic Affairs declared that reclaimed water is considered clean for human use, including all religious rituals, if it meets general health standards (Alhumoud & Madzikanda, 2010).

Altogether, the relationships between socio-demographic factors and the level of public acceptance towards water reuse identified in the literature are highly inconclusive. In fact, many studies found no significant relationships at all, which confirms that public acceptance may be associated with a very different socio-demographic profile in one community than in another (Aitken et al., 2014; Khan & Gerrard, 2006; Ormerod & Scott, 2013). Additionally, demographic factors alone are not reliable to exclusively explain individual differences in the acceptance of water reuse (Ormerod & Scott, 2013; Po et al., 2003).

Nevertheless, investigating the socio-demographic factors which correlate with acceptance or opposition towards reclaimed water *among prospective users* can help project managers to tailor a more successful communication and engagement program (Aitken et al., 2014; Khan & Gerrard, 2006; Wester et al., 2015). For example, knowing that a certain age group in a community tends to be more opposed to water reuse than others will make public engagement more effective and resource-efficient, as educational messages can specifically be targeted at those most discomforted by using reclaimed water (Wester et al., 2015). Similarly, identifying "strong accepters" in a community can be helpful in the early stages of a reuse project, as these individuals or groups might agree to champion reclaimed water before it is introduced on a wider scale. Community members that were originally opposed to reclaimed water may then recognize its value and safety, based on the experience of these early adopters (Dolnicar & Schäfer, 2009).

2.5 Building acceptance of water reuse through community engagement

A variety of strategies can be used to increase knowledge about water reuse, help populations understand and address potential misperceptions and concerns, and establish a genuine and legitimate partnership with the community when considering a reuse project (Po et al., 2003). Alternatively, some strategies have been shown to be ineffective and even counterproductive in communicating about water reuse projects. These include the "decide, announce, and defense" approach or implementing a community engagement campaign after a project's conception (Dolnicar et al., 2010; Po et al., 2003). It is also generally accepted that social marketing, i.e. persuading people to use reclaimed water, is ineffective (Dolnicar et al., 2010; Marks, 2006; Menegaki et al., 2007; Nancarrow et al., 2008; Po et al., 2003). Instead, many authors argue that long-term community support can only be achieved through early public involvement in broader resource planning efforts, even before a specific plan for a reuse project exists or is introduced to the public (Khan & Gerrard, 2006; Po et al., 2003; Russell & Hampton, 2006). This creates a neutral environment, outside the context of an immediate, potentially controversial reuse plan (Khan & Gerrard, 2006). Key to this involvement process is the early and continuous encouragement and empowerment of community members, which enables them to make an informed, reasoned decision about water supply options in their community.

When a water reuse project is proposed as a water supply option, project managers should focus on the provision of accurate, unbiased, complete, and comprehensive information to the public, community educators, and media (Po et al., 2003). Overall, a successful community engagement campaign provides sufficient information and consultation to enable community members to compare all benefits and costs (or risks) associated with a reuse project, so that they can draw their own conclusions of whether to adopt it or not (Khan & Gerrard, 2006; Russell &

Hampton, 2006). Involving the public in the planning as well as in the decision-making process is important as people will likely expect some level of control, however, the level of influence the public has should be defined early, or limitations at later stages might result in dissatisfaction (Russell & Hampton, 2006).

Multiple information sources and various communication channels are needed to fully inform the public about water reuse in general and proposed projects specifically (Marks, 2006). These include, for example, information offices; informational tours or other events at the water reclamation plant; education in local schools; public forums; presentations by water utility representatives, technical practitioners, researchers, or scientists; consultation hotlines; informative leaflets; and online media (Dolnicar & Schäfer, 2009; Hijazi et al., 2006; Khan & Gerrard, 2006; Marks, 2006; Russell & Hampton, 2006). Additionally, it can be helpful to coordinate and work with local media, as positive media coverage can support public outreach efforts (Ching, 2010; Hijazi et al., 2006). It should be noted, however, that some information sources are more trusted than others. For example, Carr and Potter (2013) found that in Jordan, information on water reuse from scientists and water utilities was generally more trusted than information coming from local officials or the media. Dolnicar and Hurlimann (2009) agree that scientists play a key role in the provision of information on alternative water sources based on their research in Australia.

It is difficult to determine the amount of information one should provide to the public. People do not want to be "drowned" in information, on the other hand, too little might result in suspicion and distrust. Overall, the greater the perceived risks with the reuse project, the greater the levels of communication will be required. Furthermore, project managers should never hold back information. Delays in passing on information may lead to rumors, concerns, suspicion, or

distrust. Most importantly, the communication process should be considered an ongoing activity throughout the lifetime of the reuse project, since the community's demographics, size, and/or attitudes towards water reuse may change over time (Khan & Gerrard, 2006).

The information provided should be simple, fully understandable, and practical to a layperson unfamiliar with the details of the wastewater treatment process (Dolnicar et al., 2010). Accordingly, all technical information should be synthesized into a format that is completely jargon-free (Hijazi et al., 2006; Khan & Gerrard, 2006). Visualization of information can be effective as well (Dolnicar et al., 2010). Most information should be verifiable through independent third parties that are not linked to the utility district or other sponsoring agencies (Khan & Gerrard, 2006). Furthermore, the provision of information should take place in a fair manner, which means that every individual has to be equally able to access information, and that everyone's opinion, views, and concerns matter and are listened to (Khan & Gerrard, 2006).

As important as the provision of information is, community engagement should be a sustained dialogue between the organization and the community. Monitoring public concerns and opinions, listening and, if necessary, seeking clarification through consultation hotlines or public forums, for example, are crucial (Khan & Gerrard, 2006). Based on the community's input, the campaign manager should also evaluate and update the information provided to the public, so that the engagement campaign always remains tailored to the specific information demands of the community (Russell & Hampton, 2006).

While people's views on water reuse may change as their level of knowledge increases, not everybody may eventually share the same views as practitioners, experts, or decision-makers. Some individuals may even become less supportive as they receive more information. It should therefore not be assumed that community engagement and dialogue guarantee public acceptance,

especially by groups that have been opposed to the project all along (Khan & Gerrard, 2006; Russell & Hampton, 2006). Thus, although community engagement is crucial, it should never be seen as the one, simple solution to public opposition.

Lastly, much has been written in the literature about strategies that should be applied to increase public acceptance of water reuse. However, as Dolnicar and Saunders (2006) point out, nobody has attempted to determine the effectiveness of any of these proposed measures. Guidelines and tools that can be used to evaluate a community engagement campaign are therefore provided in chapter 5. What follows is a case study of a successful water reuse project to provide further insight and guidance.

2.6 The case of NEWater – A successful water reuse project in Singapore

Successful non-potable and potable water reuse projects have been implemented all around the world. The NEWater project in Singapore is an often-cited example in the literature (Ching, 2010; Khan & Gerrard, 2006; Marks, 2006; Po et al., 2003), as it is one of the few potable reuse projects that met no significant public opposition due to well-organized and highly effective community outreach and involvement.

In 1998, Singapore's National Water Agency, the Public Utilities Board (PUB), and the Ministry of the Environment and Water Resources investigated the possibility of supplementing reservoir water with treated wastewater to mitigate water shortages and become more resource-independent from Malaysia. By 2001, high-grade treated wastewater termed "NEWater" was used for various non-potable purposes, and since 2003, NEWater is used to augment drinking water reservoirs during dry periods (Ching, 2010). NEWater now meets up to 40% of Singapore's water needs; it is planned to meet 55% by 2060 (Public Utilities Board, 2017). The gradually growing

level of human contact with NEWater is a strategy explicitly applied by the PUB in order to counteract the "yuck factor" in a sensible manner (Ching, 2010) (see also section 2.3).

According to employee Wai Kit Yap, the PUB practices a two-prong approach to increase NEWater acceptance (personal communication, May 25, 2016). First, the PUB ensures that their product is monitored closely and of high quality, thus safe to use[12]. Second, the PUB thoroughly educates the public on the process of creating NEWater to facilitate the understanding of the treatment technology and to build confidence in it (W. K. Yap, personal communication, May 25, 2016). Focusing on the treatment process also shifts the public's attention away from the reclaimed water's source, alleviating concerns and thus reducing psychological barriers that may exist (Ching, 2010). The NEWater Visitor Center is where most of the education takes place, providing daily interactive tours and educational workshops (Public Utilities Board, 2017). Other outreach strategies include the creation of numerous informational resources including educational films, involving the media as a strategic partner, conducting briefings to policy and decision-makers, and organizing informational events at community centers, workplaces, and schools (Po et al., 2003). According to Khan and Gerrard (2006), communities skeptical of water reuse can be reassured of a project's safety by demonstrating the enduring success of similar water reuse projects. In Singapore, this strategy is effectively applied, as the NEWater Visitor Center shows videos of Californian residents presenting the advantages of a reuse project in Orange County (Khan & Gerrard, 2006). Additionally, the PUB frequently emphasizes that NEWater is cleaner than tap water and even distributes samples to the community to allow them to taste it (W. K. Yap, personal communication, May 25, 2016). Moreover, trusted and respected political leaders are frequently shown drinking NEWater at public events (Ching, 2010).

[12] The PUB argues that NEWater is safe to use, because it meets WHO drinking water standards (Public Utilities Board, 2017). It should be noted that these do not include threshold values for contaminants of emerging concern.

Ching (2010) stresses the role of the media as a key strategic partner in creating public acceptance of NEWater: The PUB briefed the media before publicizing the project, providing them with information on existing water reuse projects and explaining the importance of overcoming the national water crisis. While the Singaporean media neither explicitly campaigned for or against water reuse, from 1998 to 2008, 171 out of 230 newspaper reports were in support of using reclaimed water. Only nine reports had a negative tone or opinion about reclaimed water, and most of them were about Malaysian politicians and media suggesting that NEWater was not safe (it is assumed that this was done to maintain Singapore's water dependency). Ching (2010) found that most reports were rather non-emotional and took on a more scientific and rational approach to the topic. By comparing media coverage of NEWater in Singapore with cases of failed water reuse projects, Ching (2010) recognizes the importance of strong, consistent key messages leading to rapid public learning, and positive, consistent terminology. In fact, the PUB avoided terms that had any negative connotation or had implications on the source of NEWater (such as "wastewater" and "sewage").

Among numerous other awards, the NEWater project received the United Nations' (UN) Water Best Practices Award in 2014. The UN especially recognized the public engagement program and that the PUB's work was effective in demonstrating to the public that NEWater is safe to drink and to industries that the water is suitable for their individual purposes (United Nations, 2014).

2.7 Public involvement in wastewater management

As pointed out in section 2.5, community support for water reuse projects has its roots in public involvement in broader water resource management efforts. Wastewater treatment necessarily precedes wastewater reuse, thus, involving the public in wastewater management is necessary

when planning to increase acceptance for reuse projects. Engaging and educating the public about wastewater treatment, however, is a challenge: Not only might the topic itself be boring, irrelevant, or unappealing to many, the wastewater infrastructure is also almost entirely invisible, which creates an "out of sight, out of mind" problem (United Nations Environment Programme, 2004).

Dodson (2013) suggests seven tools to effectively communicate with the public about wastewater treatment: a brief mission statement defining what the wastewater treatment plant does; community surveys to understand the public's perception of the provided service and to direct efforts for service improvements; presentations at public meetings, schools, civic groups, etc.; bill stuffer informational packets; newsletters; open house community events; and public service announcements in local media outlets. These tools can help to educate a community about how their wastewater is treated, announce and publicize community events, and even promote the advantages of consumer responsibility (such as environmental, public health, and source water protection) by supporting water quality efforts. An effective community engagement program can result in enhanced treatment plant capacity and performance, reduced treatment costs, conserved water, and an appreciation of the utility district's work (Dodson, 2013). The Water Environment Federation provides a variety of resources (including a series of fact sheets)[13] that can help public officials develop the content of a wastewater treatment education program. Note, however, that all education materials should be specific to the community's treatment plant and tailored to the information needs of the community itself.

Lastly, public involvement might be suggested or even required by federal and state water management agencies in the planning and/or permitting process of projects that aim to construct or enhance existing wastewater treatment facilities (United States Environmental Protection

[13] See http://www.wef.org/resources/for-the-public/public-information/.

Agency, 1979). For instance, wastewater treatment projects in the United States undertaken under the Clean Water Act, the Resource Conservation and Recovery Act, and the Safe Drinking Water Act are expected to meet minimum public participation requirements, which are to inform, involve, and consult the public in planning and decision-making processes (Public Participation in Programs under the Resource Conservation and Recovery Act, the Safe Drinking Water Act, and the Clean Water Act, 1979) . For example, the state permitting agency must provide an opportunity for public comment on proposed NPDES permits. State laws and regulations might further define requirements for public participation in the planning for and permitting of a wastewater treatment facility.

CHAPTER 3

PRE-EVALUATIVE RESEARCH CONDUCTED

Chapter 2 demonstrated that the successful implementation of water reuse projects requires communities that are well-informed, free of misperceptions and unwarranted concerns, and altogether, empowered to make reasoned decisions about local water supply options. Identifying strategies to effectively interact with community members is critical – in generic terms, this was discussed in section 2.5. However, as all communities are distinct, the development of effective message content and distribution strategies is increasingly guided by extensive evaluative research, for instance, on community-specific knowledge gaps, interests, or channel usage patterns (Atkin & Freimuth, 2013; Atkin & Rice, 2013; Coffman, 2002).

This chapter investigates how to most effectively communicate with the Sewanee community about both the CW pilot project and more general topics related to local water use. The aim of this chapter is to review studies that were conducted previously to optimize project-related communication, as well as other publicly-available information that can serve this objective, and explain the additional research undertaken to inform the development of a community engagement campaign for the pilot project.

3.1 Project-related research and communication in the past

This section provides an overview of research conducted by previous student groups to assess pre-existing knowledge and opinions about CWs and water reuse in Sewanee. It also summarizes how the pilot project has been portrayed in local and regional media prior to August 2015 when work on this thesis began. Finally, insights are summarized in a situation analysis.

3.1.1 Previously conducted research and recommendations made

As part of their work for the SUD (see section 1.2), graduate students in Professor Laurie Fowler's Environmental Practicum at UGA[14] collaborated with undergraduate students and faculty from UoS in the spring of 2012 to develop and conduct a survey on Sewanee residents' "understanding of wastewater treatment and their perception regarding alternative treatment techniques" (Barth et al., 2012, p. 54). Five major insights relevant to the development of a community engagement campaign for the pilot project were obtained:

1. Many survey participants seemed to lack knowledge of both CWs and water reuse.
2. Sixty-six percent of respondents were either opposed or unsure about using treated wastewater to augment drinking water supplies.
3. Eighty percent indicated having concerns with pharmaceuticals remaining in treated wastewater.
4. Eighty-one percent said they would feel more comfortable reusing treated wastewater if they knew more about the contaminant removal processes.
5. Seventy-six percent of participants said they mostly rely on online media for information and news.

Based on the survey results, Barth et al. (2012) recommended "a strong internet and web-based presence for information and a focus on defining wastewater reuse and CWs" (p. 55). Proposed educational materials included handouts, informational videos, and educational site tours.

A second group of graduate students enrolled in the Spring 2013 Environmental Practicum (Crawford, Heidingsfelder, Pringle, Skupien, & Woolford, 2013) proposed citizen science and on-site educational programs as additional strategies to facilitate public engagement in the project.

[14] See https://rivercenter.uga.edu/experiential-learning/environmental-practicum/.

They recommended using multiple media outlets to educate the Sewanee community about the goals and benefits of the project, how water quality is tested to determine whether the CW functions as intended, as well as existing water treatment processes. Recommended target audiences were the public, state and local officials, and the media. Crawford et al. (2013) also created two informational films, one about the possibility of using a CW to treat and reuse Sewanee's wastewater, another about the research collaboration that had formed around this project[15]. For these videos, the group worked with undergraduate students in Sewanee to conduct short face-to-face interviews with students, faculty, and community members about their knowledge and attitudes of CWs. As these filmed interviews were rather exploratory and not aimed at collecting data, no results were formally reported.

3.1.2 Introducing the idea of wastewater reuse

Both the survey and short interviews conducted by the 2012 and 2013 Environmental Practicum groups and UoS students had a wastewater reuse component, asking community members about their attitude towards such practice. Two problems with this rather direct approach were the introduction of negative terminology such as "toilet to tap" (see sections 2.1 and 2.2.7 for the importance of terminology), and (likely unintentionally) creating a direct connection between wastewater reuse and the pilot project, which may have influenced some residents' perception of the pilot study's "endgame". The following quotation, received per email on December 21, 2015, exemplifies these concerns:

> This [the pilot project] is an important issue especially since the endgame has been proposed as rerouting our treated wastewater into lake O'Donnell (our drinking water). I

[15] These videos were never published. This is likely because no appropriate channel existed at the time to share these videos; however, it is also possible that they were not published because of reasons explained in section 3.1.2.

find this deplorable and highly debatable due to studies concerning antibiotics and prescription drugs in our wastewater as significant contaminants.

Due to at least one perception of a somewhat "pre-defined" outcome of the project, it was decided to at least temporarily keep water reuse out of discussions; now is the time to reevaluate that decision, as discussed in section 4.4.3.

3.1.3 Past media coverage and community education

An overview of media platforms operated by the Odum School of Ecology at the University of Georgia, the University of the South, and the Sewanee Utility District, as well as of newspapers or other serial publications that reported on the pilot project in the past, is presented in Figure 8.

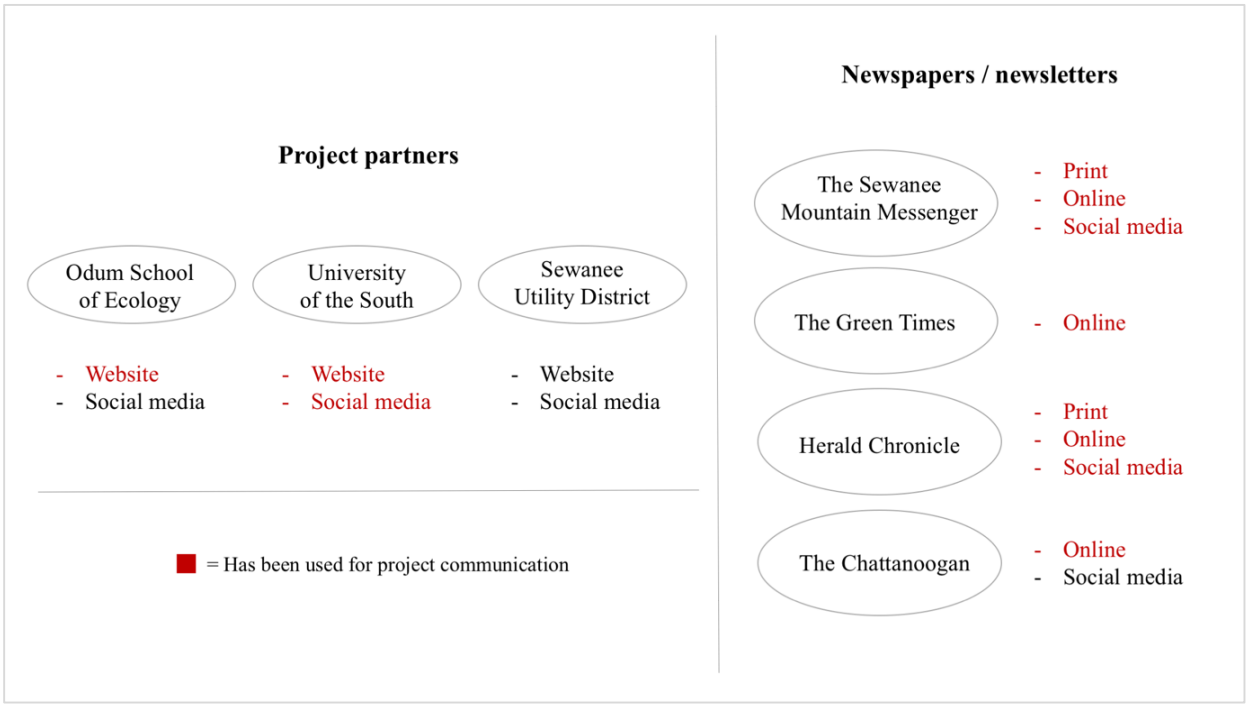


Figure 8: Media coverage of the constructed wetland pilot project before August 2015.

Prior to August 2015, when work on this thesis began, only a few of the media platforms operated by the three project partners had been used for project-related communication; in contrast,

the Sewanee Mountain Messenger extensively reported on the project. What follows is a survey of all articles, online announcements, and social media posts about the project published before August 2015 that had a potential to reach Sewanee community members.

The University of the South – The University of the South published an online news article[16] on their website on September 26, 2014, reporting that the University broke ground on the "Wetlands Research Station". This article was also shared on the University's Facebook and Twitter pages (Figure 9). On the same day, an article[17] about the ground-breaking was published on the Chemistry Department's section of the University website as well.

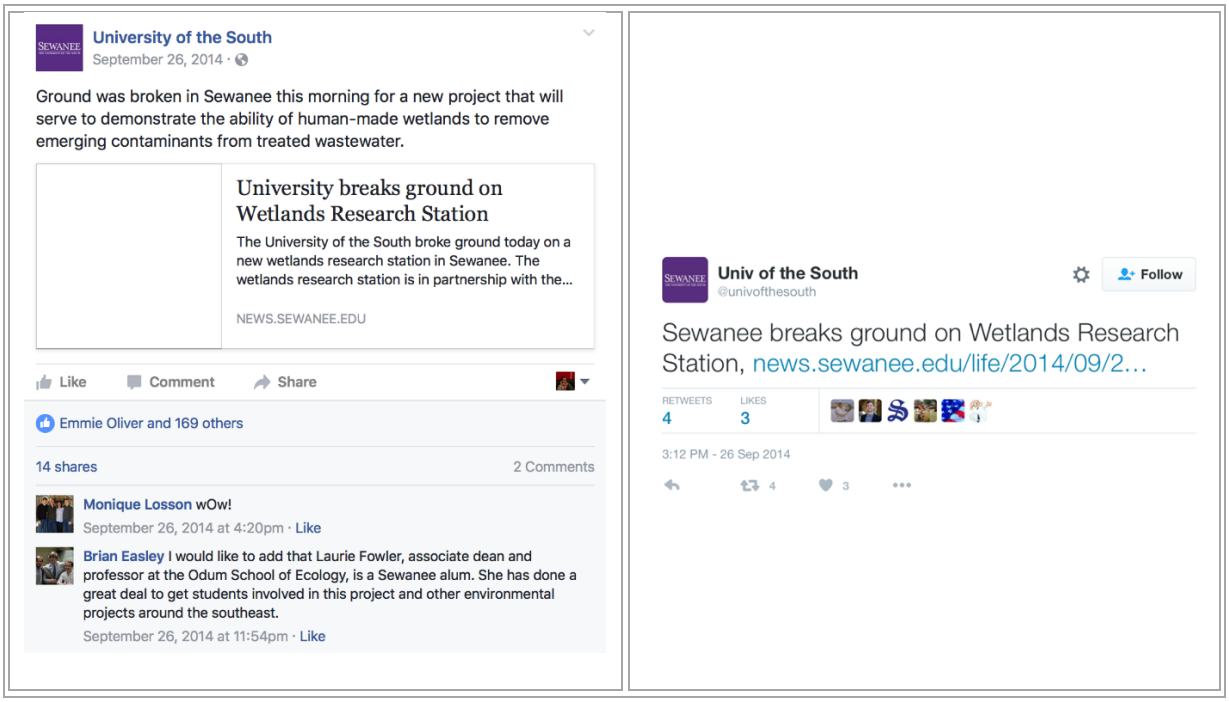


Figure 9: Social media posts by Sewanee: The University of the South announcing the ground-breaking of the pilot constructed wetland.

[16] See http://www.sewanee.edu/newstoday/life/all/university-breaks-ground-on-wetlands-research-station.php.
[17] See http://www.sewanee.edu/academics/chemistry/news/dr-emily-white-ceremonial-groundbreaking.php.

The Sewanee Mountain Messenger – The Sewanee Mountain Messenger (SMM) has by far provided the most information about the project to the community. As there is no daily local newspaper, the free, weekly-publishing SMM can be considered Sewanee's most prominent newspaper. According to editor and publisher Kiki Beavers, 3,700 copies are delivered to 96 pickup locations in Sewanee and Monteagle, as well as in Altamont, Beersheba Springs, Coalmont, Cowan, Gruetli-Laager, Pelham, Sherwood, Tracy City and Winchester. Circa 3,600 issues are picked up weekly; the SMM has 110 paid subscribers to whom the Messenger is mailed (personal communication, April 18, 2017). At the time this section was written, the newspaper's online archives went back to August 2008[18], and a search for "wetland"[19] revealed that most articles were published from 2012 onward (Figure 10). This was when graduate students at UGA began studying the feasibility of a pilot CW and developing a preliminary design of the research station in collaboration with students and faculty from UoS and the SUD. The SMM also mentioned the project on their Facebook page on April 25, 2013 and September 25, 2014.

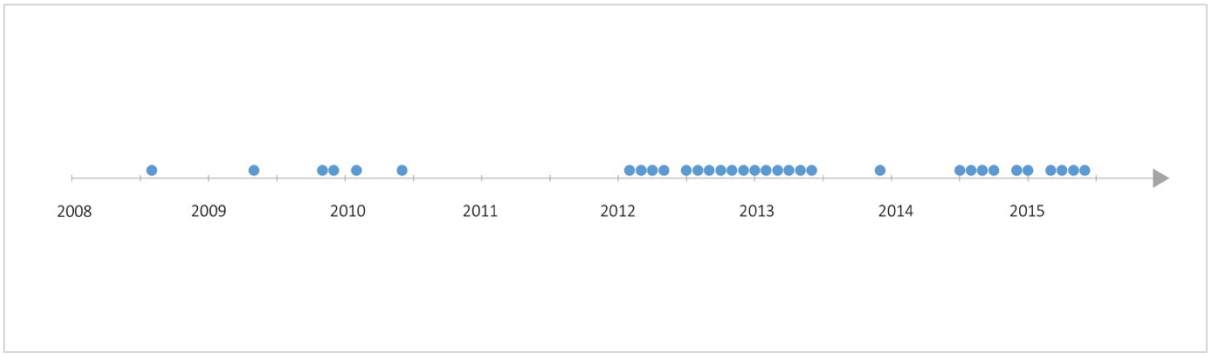


Figure 10: Articles in the Sewanee Mountain Messenger that reported on the constructed wetland project between August 2008 and August 2015.

[18] The newspapers' website is currently being renewed, thus, as of June 2017 the online archives only go back until January 2014.
[19] Articles identified by the keyword search were reviewed to ensure that they reported on the project and not on other wetlands-related topics.

Regional newspapers – Articles in regional (online) newspapers or publically accessible newsletters were published by the Associated Colleges of the South's Green Times[20] in August 2012 (a general description of the project)[21], the Herald Chronicle[22] on September 24, 2014[23], and the Chattanoogan[24] on September 26, 2014[25] (both about the ground-breaking). The Herald Chronicle shared their article on Facebook and Twitter as well.

University classes – Lastly, classes at UGA and UoS that were/are taught in the context of planning and implementing the project also increased awareness among university students, both in Athens and Sewanee. These classes include Laurie Fowler's Environmental Practicum at UGA and classes taught by Deborah McGrath (Human Health and the Environment), Emily White (Environmental Chemistry), and Scott Torreano (Water Policy) at UoS.

3.1.4 Situation analysis and insights gained

The strengths and weaknesses of previous research and communication efforts, as well as opportunities for future outreach activities, are summarized in Table 1. Overall, past communication has been mainly one-directional and more project-focused than community-focused. Future community engagement efforts should create more opportunities for two-way communication between the project partners and Sewanee residents. Community events, guided tours, town meetings, public presentations, and social media, for example, could enable

[20] The newsletter is currently defunct, and unfortunately, publishers did not keep distribution records for previous years (D. Morton, personal communication, April 19, 2017).
[21] See http://colleges.org/wp-content/uploads/2015/11/GreenTimes_Aug_12.pdf.
[22] The Herald Chronicle publishes twice a week. The newspaper has 2,800 subscribers and covers a 32-kilometer radius around Winchester, TN (P. Stubblefield, personal communication, April 20, 2017).
[23] See http://www.heraldchronicle.com/wetland-research-station-groundbreaking-set/.
[24] The Chattanoogan is an online newspaper that is constantly updated throughout the day. The newspaper covers Chattanooga, TN and surrounding counties. The website has circa 453,000 frequent users (J. Vilson, personal communication, April 19, 2017).
[25] See http://www.chattanoogan.com/2014/9/26/285188/Groundbreaking-For-Sewanee- Constructed.aspx.

Table 1: Strengths and weaknesses of previous research and communication efforts related to the constructed wetland pilot project, as well as opportunities for future outreach activities.

Strengths	Weaknesses	Opportunities
• Two studies were conducted to understand the community's perception towards CWs and water reuse, and to identify likely effective communication channels. • Recommendations for specific outreach strategies were made, and first communication tools were developed. • Three possible target audiences of a future community engagement campaign were identified.	• Use of negative terminology and (likely unintentionally) making the connection between the pilot CW and wastewater reuse. • Misperceptions about the pilot project may exist among some community members. • Few media platforms owned and operated by the project partners have been used for project-related communication. • There have not been many opportunities for two-way communication between the research team and the Sewanee community.	• Demonstrating CWs' effectiveness in removing contaminants, especially pharmaceuticals, from wastewater and providing information on treatment processes could help people become more comfortable with water reuse. • Providing information via online media could be an effective way to communicate with the Sewanee community. • Strong media coverage of the project by the SMM, which could potentially constitute the basis for a collaboration[26] with the newspaper.

community members to become more actively involved in the project by asking questions, providing comments, and making suggestions for improvement. So far, there has not been much digital feedback from the community following the release of newspaper articles or social media posts, which makes it difficult to evaluate whether the information provided was perceived as useful, valuable, or entertaining. While the few articles that were shared on social media received only positive feedback, some personal feedback has been negative, as mentioned in section 3.1.2.

[26] The goal of this collaboration would be to inform the public about the project. A "partnership" in this sense does not aim to jeopardize the newspaper's objectivity in any way.

Future outreach activities should therefore try to correct any misinformation and misperceptions that may exist among the community about the purpose of the pilot study.

Content-wise, communication has shifted from wastewater reuse towards investigating CWs' effectiveness in removing contaminants, especially pharmaceuticals, from municipal wastewater. The decision to at least temporarily keep water reuse out of discussions will be reevaluated in section 4.4.3, based on findings in the literature (chapter 2), as well as insights gained from research conducted for this thesis (section 3.3).

3.2 Data collection and analysis

I began working as a graduate research assistant at the University of Georgia in August 2015 to develop and implement a community engagement campaign for the pilot project. To inform the development of the campaign, I worked with UoS Environment and Sustainability major (C'16) Emmie Oliver to design both a quantitative and a qualitative study in the form of a pre-assessment survey and three focus groups. The next sections explain how these studies were designed, conducted, and how the results were analyzed.

3.2.1 Pre-assessment survey

We conducted a pre-assessment survey to understand the general level of water literacy in the Sewanee community. Questions were intended to gauge residents' current knowledge and perception of both global and local water issues, their interest in specific topics related to water, and the communication channels they rely on for this type of information. The pre-assessment survey contained sections on global water scarcity, water availability in Sewanee, wastewater treatment in Sewanee, information sources, and demographic information. The entire survey can be found in Appendix A. Before distributing it to the community, we pre-tested the survey and improved it based on feedback.

Paper-based surveys were distributed for self-completion at various locations in Sewanee on November 12 and 13, 2015; an identical online version of the survey was available on Qualtrics.com starting December 18, 2015. The data collection process ended on February 21, 2016. The survey was advertised in the SMM and via Sewanee Classifieds[27]. Donuts were offered to participants taking the survey in person, but no incentives were offered to those taking it online. Before starting the survey, all participants were asked to sign a consent form (or in the online survey to accept a statement identical to this form). Participants of the online survey were additionally asked whether they had taken the survey in November, which, if answered with "yes", prevented them from retaking the survey.

In total, 161 responses were collected (111 people took the survey in person, 50 online), representing approximately 6% of the Sewanee population (United States Census Bureau, 2015). We assigned all survey responses a unique identifier and entered them in a Microsoft Excel file for basic descriptive data analysis. One data sheet was created for each question and all 161 responses to this question; we coded responses in a way that *1* indicated the selection of an answer, whereas *0* indicated the opposite (exemplified in Figure 11).

If a respondent did not answer a question or answered it incorrectly[28], we termed the response for this question "invalid" and did not count it towards the total number of responses for that question. Therefore, *n* for specific questions may be lower than 161. We also investigated potential relationships between questions (such as whether preferred communication channels varied between different age groups), however, no analysis exceeded basic data description.

[27] Sewanee Classifieds is an email-based subscription service offered by the Sewanee Civic Association, open to all community members (Sewanee Civic Association, n.d.).
[28] An example of answering a question "incorrectly" is the selection of multiple answer options when participants were instructed to only choose one.

Survey ID \ Answer option	1	2	3	4	Valid (1: yes; 0: no)
1	0	0	0	1	1
2	0	1	0	0	1
3	0	1	0	0	1
4	0	1	0	0	1
5	0	1	0	0	1
6	0	1	0	0	1
7	0	0	0	1	1
8	0	1	0	0	1
9	0	0	0	1	1
10	-	-	-	-	0
...	...	...	...	...	...
155	0	1	0	0	1
156	0	1	0	0	1
157	0	1	0	0	1
158	0	1	0	0	1
159	0	1	0	0	1
160	0	1	0	0	1
161	0	1	0	0	1
Total	17	113	2	20	152

B2 Where do you think your tap water comes from? Choose one .

	Answer option	# times selected	%
1	A groundwater aquifer	17	11.18
2	A reservoir or lake	113	74.34
3	Directly from a stream	2	1.32
4	I don't know	20	13.16
	Total valid responses	152	

Figure 11: How the results of the pre-assessment survey were analyzed in Microsoft Excel. Simplified for explanatory purposes.

3.2.2 Focus groups

We also conducted three focus groups on February 11 and 12, 2016 at the Blue Chair Café, Bakery & Tavern in downtown Sewanee to further optimize future communication, education, and community engagement strategies. One focus group was held with K-12 teachers (two participants) and two with community leaders (four and six participants), broadly defined as "Sewanee residents who have numerous contacts and influence in the community". The focus groups were conducted following two protocols (attached in Appendix B) which we designed based on a general structure recommended by Krueger and Casey (2000). We pre-tested the protocols with two UGA graduate students and improved them based on their feedback. Interview questions aimed to:

1. Identify the most effective strategies to involve Sewanee residents in a community engagement campaign kickoff event.

2. Identify and discuss strategies to educate young and adult community members about both constructed wetlands in general and Sewanee's pilot constructed wetland specifically.
3. Receive feedback on the survey results and further discuss general outreach strategies and most effective communication channels.

Teachers at Sewanee Elementary School (SES) and St. Andrew's Sewanee School (SAS) (middle and high school) were invited via letters and emails, respectively. Community leaders were identified with the help of two Sewanee residents who were known to be actively involved in the community, then contacted via phone. As incentives, participants were offered snacks and beverages during the interviews. Prior to the interviews, all participants were briefed about the pilot project, as well as the purpose and procedure of the focus group, and asked to sign a consent form. Each discussion took between 40 and 60 minutes and was recorded using an audio recorder; notes were also taken.

We transcribed the audio recordings word for word. Participants were anonymized by replacing names with letters; statements that could be used to identify participants were anonymized as well (indicated in parentheses and italics). Statements by the moderator were marked, and remarks were added in parentheses and italics to indicate non-verbal comments such as laughter, if something said was unintelligible and therefore not included in the transcript, or if considered necessary to understand the broader context (Krueger & Casey, 2000).

Due to its flexibility and theoretical freedom, we used thematic analysis to analyze the focus group transcripts, following guidelines by Braun and Clarke (2006). Themes were identified on a semantic level via an inductive approach (not trying to fit the interview data into a pre-determined coding frame) and assuming a unidirectional relationship between meaning and

language, (i.e. using an essentialist/realist approach) (Braun and Clarke, 2006). We used qualitative data analysis software Nvivo to identify reemerging patterns or themes and sub-themes in the transcripts. We repeatedly coded the transcripts until the thematic map accurately reflected the data set. Coded data extracts for each theme were repeatedly reviewed until they formed coherent ideas or concepts.

Lastly, it should be noted that additional focus groups were planned with SUD board members and SES teachers (since both participants of the K-12 focus group taught at SAS). However, this effort failed due to lack of interest from these parties.

3.2.3 Institutional Review Board approval

Institutional Review Board (IRB) approval was sought for both the pre-assessment survey and the focus groups. The University of the South approved both studies; the University of Georgia found both studies to be exempt from IRB requirements.

3.3 Results

This section summarizes the results of the pre-assessment survey and the focus groups. It was decided to present the main results of the two studies separately but to combine insights when developing the community engagement campaign in chapter 4.

3.3.1 Pre-assessment survey

Campaign-relevant results of the pre-assessment survey were grouped into three main categories: knowledge and perception of global and local water issues, interest in water-related topics, and communicating information about water issues. All percentages refer to how often an answer option was chosen compared to the total number of valid responses received for that question (this number is displayed as *n* in all figures in this section).

3.3.1.1 Knowledge and perception of water issues

Water availability and scarcity – While many respondents associated water scarcity with insufficient quantity of water resources for people (59%), insufficient quality of water resources for people (57%), and inaccessibility of water resources for people (58%), 73% made a connection between water scarcity and environmental flows, simplified in the survey as "insufficient quantity and quality of water for ecosystems". While this section will be careful to not "over-interpret" results, this could indicate an increased environmental awareness among the community, especially since 88% of participants indicated that care for the environment was a dominant factor influencing their view on how to treat Sewanee's water resources. These results are promising for possible water reuse projects in the future, since high levels of environmental awareness often correlate with increased public acceptance of water reuse (Menegaki et al., 2007; Po et al., 2003).

When participants were asked if, from their perspective, clean water is becoming more scarce on a global scale, 85% believed this is the case, with 48% perceiving water is becoming more scarce very rapidly.[29] In contrast, 63% said they were worried about potential future water shortages in Sewanee, with 18% being very concerned (Figure 12). The result that participants were relatively less concerned about local water scarcity could be explained by the fact that Sewanee never actually ran out of water during the 2007 drought. It would be interesting to measure whether concern has increased following mandatory water use restrictions implemented more recently in November 2016 (Lytle, 2016). A community engagement campaign should aim to create similar levels of concern for both global and local water scarcity, since an increased awareness of water supply limitations usually correlates with a higher willingness to use reclaimed water (Dishman et al., 1989; Marks, 2006; Menegaki et al., 2007).

[29] It should be noted that *n* for this question is uncommonly low (107), which is due to an error made while replicating this question for the online survey.

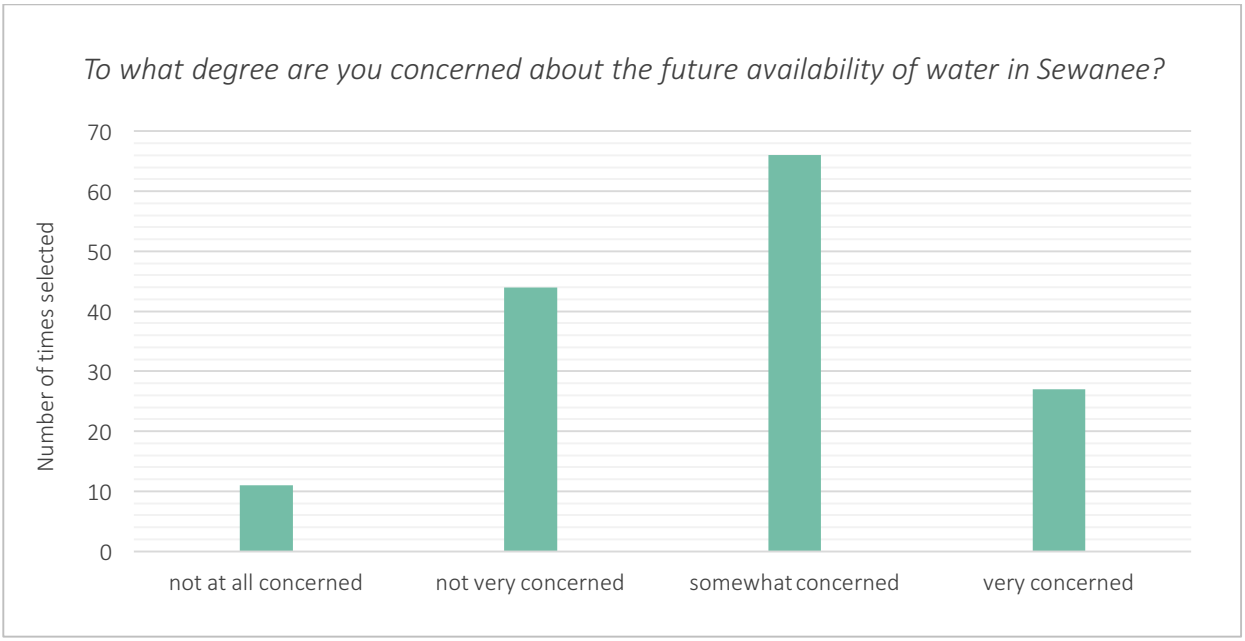


Figure 12: Assessing how survey participants perceive the development of local water availability in Sewanee, Tennessee (n=148). Survey conducted between November 2015 and February 2016.

Water conservation and reuse – An overwhelming majority (93%) of respondents believed that it was either somewhat important (37%) or very important (56%) to conserve water in Sewanee. In fact, most participants indicated that they took multiple actions to reduce the amount of water they used at their homes. These results are promising for possible water reuse projects in the future, since conservation is a clear benefit of water reuse. Interestingly, 31% of participants said they reuse water as a strategy to conserve water (for what purposes was not determined).

When asked what places that are experiencing drought should do in the face of water scarcity, the most popular answer was that municipalities should reuse wastewater for industrial and irrigation purposes (74%). In contrast, only 24% believed that wastewater should be introduced into the municipal drinking water supply. The idea that community members seem to be more supportive of using reclaimed water for low-contact uses, rather than for municipal

purposes including drinking, is in line with results by Barth et al. (2012) (see section 3.1.1), as well as with general findings in the literature (see section 2.3).

Drinking water supply – A community needs to be well-informed to make reasoned decisions about local water supply options (Khan & Gerrard, 2006; Po et al., 2003; Russell & Hampton, 2006). The pre-assessment survey therefore tried to assess the levels of community knowledge about local water issues such as drinking water sources or wastewater treatment. Most respondents (73%) were aware of where Sewanee's drinking water comes from; only 13% acknowledged they did not know the answer[30] (Figure 13).

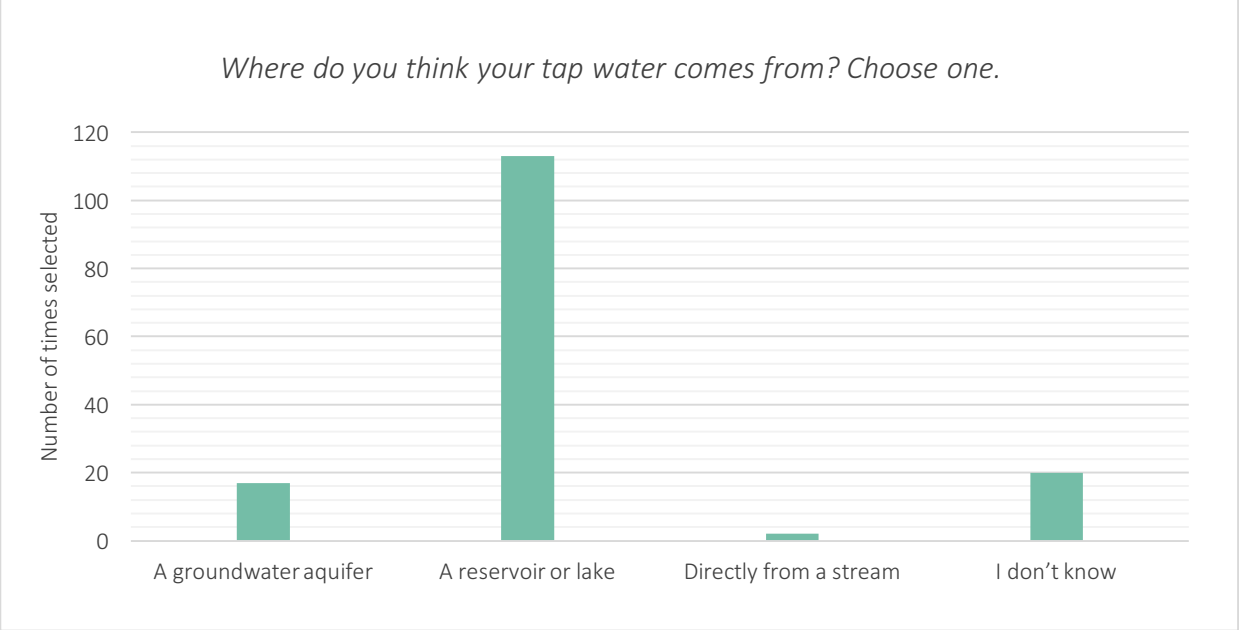


Figure 13: Assessing survey participants' knowledge about their drinking water source in Sewanee, Tennessee (n=152). Survey conducted between November 2015 and February 2016.

[30] 12% of respondents chose "a groundwater aquifer", which is not necessarily false, considering the possibility of being on a well.

Wastewater treatment and discharge – Compared to a relatively high awareness of Sewanee's drinking water source, only 41% were familiar with how the SUD treats wastewater (Figure 14)[31]. Approximately 32% admitted not knowing the answer, and 24% selected incorrect answers. One goal of a community engagement campaign therefore should be to create a community that is equally well-informed about various topics related to local water usage, with initial efforts focusing on increasing awareness of wastewater treatment in Sewanee.

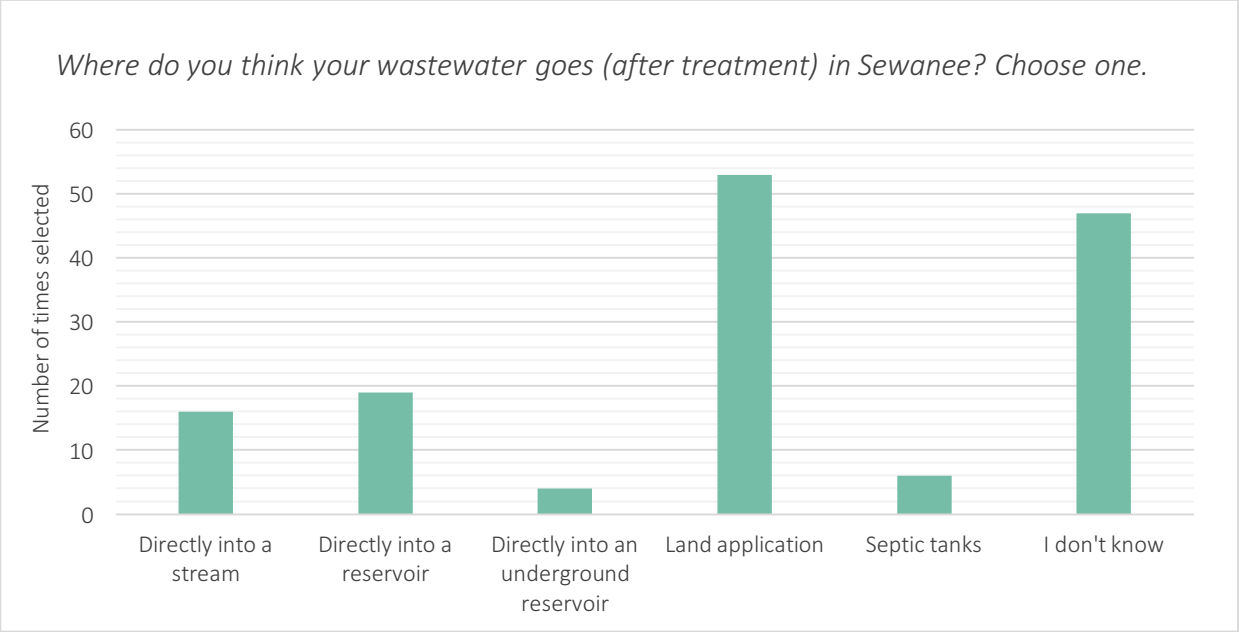


Figure 14: Assessing survey participants' knowledge about local wastewater treatment in Sewanee, Tennessee (n=145). Survey conducted between November 2015 and February 2016.

17% of participants had concerns about the way wastewater is being treated in Sewanee. These concerns included the general cleanliness of treated wastewater, pharmaceuticals surviving current treatment processes, reaching the facility's treatment capacity, and sustainability of current practices. Uncertainty about pharmaceuticals remaining in treated wastewater support previous

[31] Both "land application" and "septic tanks" were considered correct answers.

survey results by Barth et al. (2012) (see section 3.1.1). A community engagement campaign needs to address these concerns, since they are likely to extend to a water reuse project.

The Sewanee Utility District – Lastly, most survey participants considered the SUD either somewhat receptive (36%) or very receptive (22%) to concerns raised by its users. Twenty-nine percent were unsure how to answer the question, likely indicating no previous interactions with the SUD (Figure 15). Future communication efforts should encourage more interaction between the SUD and Sewanee community members, since trust and confidence in water utilities are usually associated with lower risk perception, which in turn may increase acceptance of water reuse (Dishman et al., 1989; Hartley, 2006; Marks, 2006; Po et al., 2003; Rock et al., 2012; Ross et al., 2014).

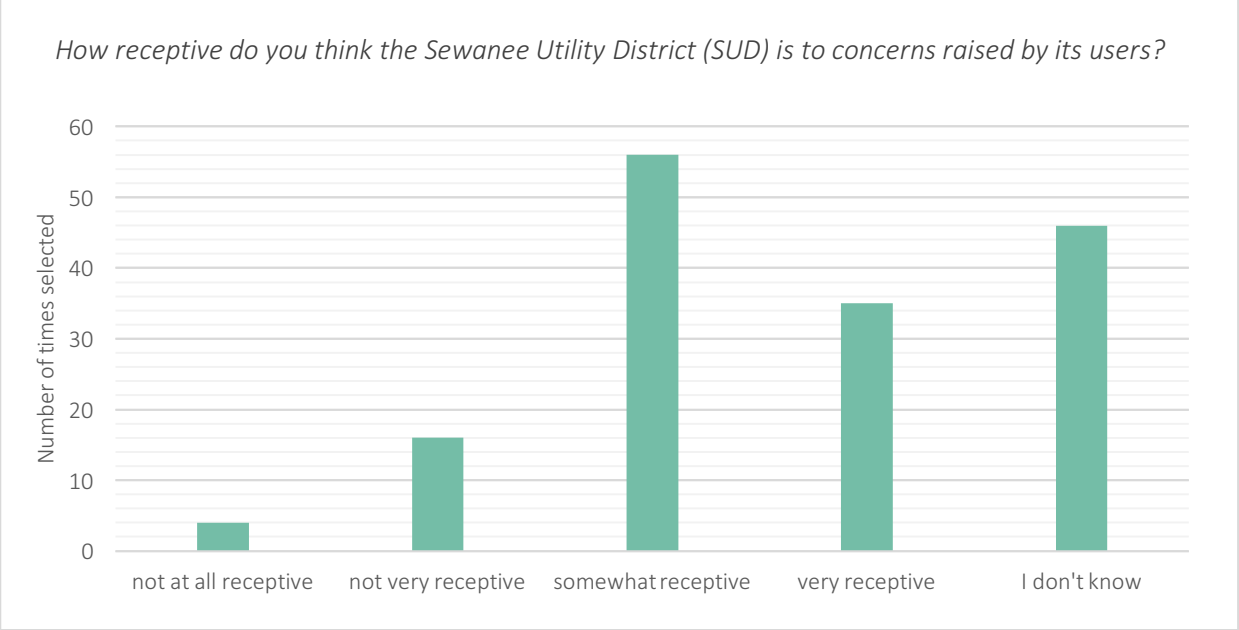


Figure 15: Assessing how survey participants perceive the Sewanee Utility District's receptiveness to user concerns in Sewanee, Tennessee (n=157). Survey conducted between November 2015 and February 2016.

3.3.1.2 Interest in water-related topics

Participants were asked to express their interest in a variety of water-related topics in Sewanee. A clear majority of respondents were either somewhat interested or very interested in knowing more about the quality of Sewanee's tap water (85%), local water availability and supply (90%), local drinking water treatment (87%), and local wastewater treatment (88%) (Figures 16, 17, 18, and 19).

In addition, it was found that 86% of those who were unaware of Sewanee's drinking water source expressed a certain "willingness to learn" and interest in knowing more about this topic. Similarly, 89% of respondents who did not know how Sewanee treats its wastewater were interested in improving their knowledge. *Overall, these results indicate a promising baseline situation for the community engagement campaign for the pilot project and educating community members about more general water issues in Sewanee.*

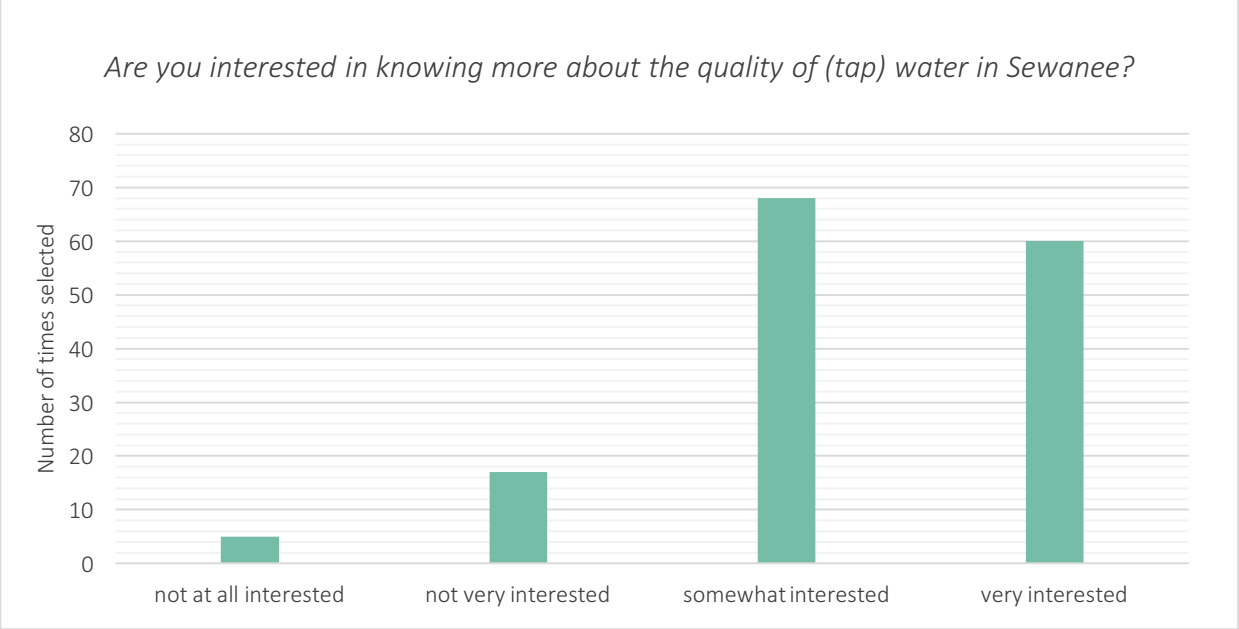


Figure 16: Assessing survey participants' interest in the quality of tap water in Sewanee, Tennessee (n=150). Survey conducted between November 2015 and February 2016.

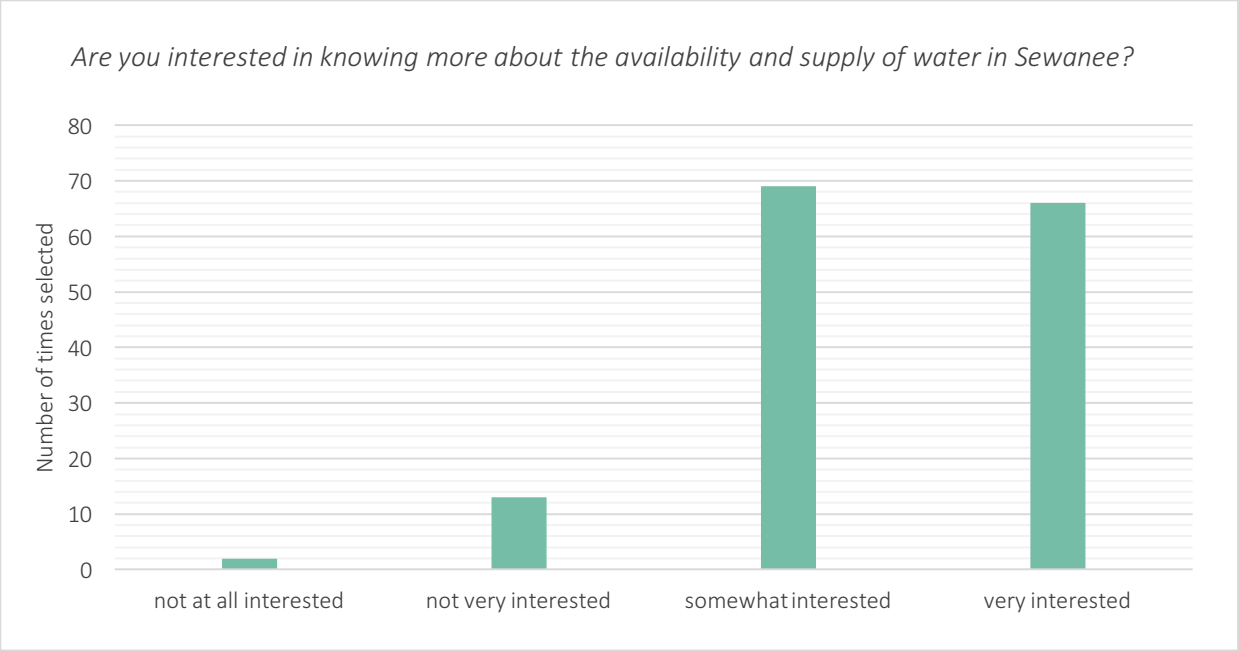


Figure 17: Assessing survey participants' interest in water availability and supply in Sewanee, Tennessee (n=150). Survey conducted between November 2015 and February 2016.

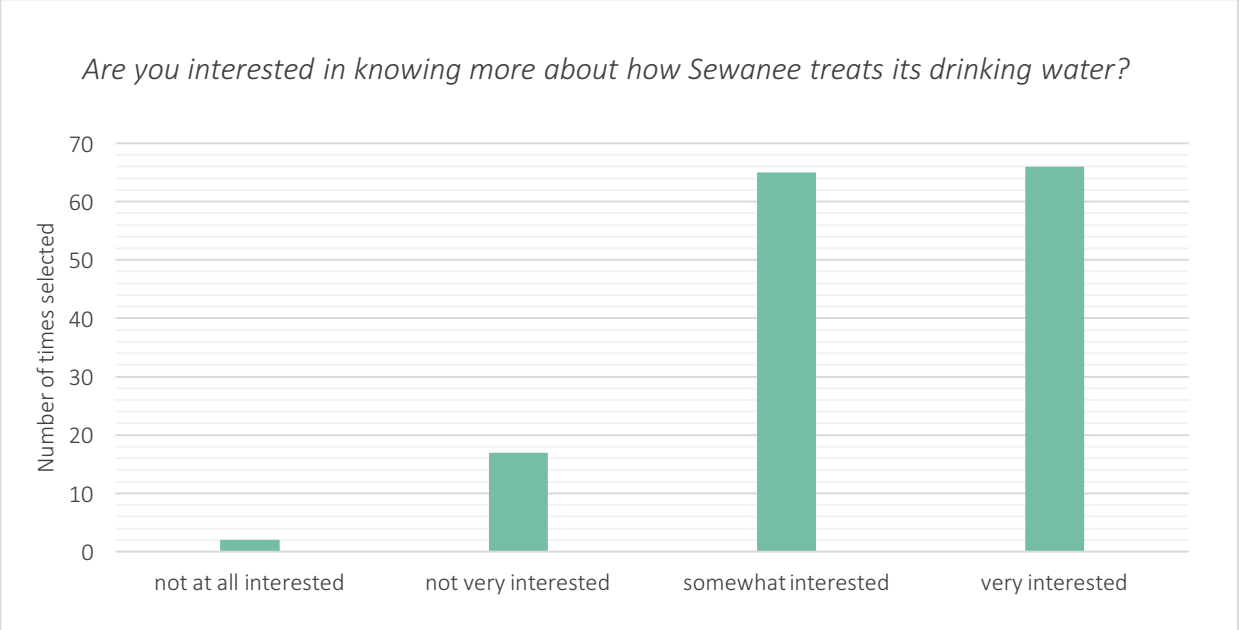


Figure 18: Assessing survey participants' interest in local drinking water treatment in Sewanee, Tennessee (n=150). Survey conducted between November 2015 and February 2016.

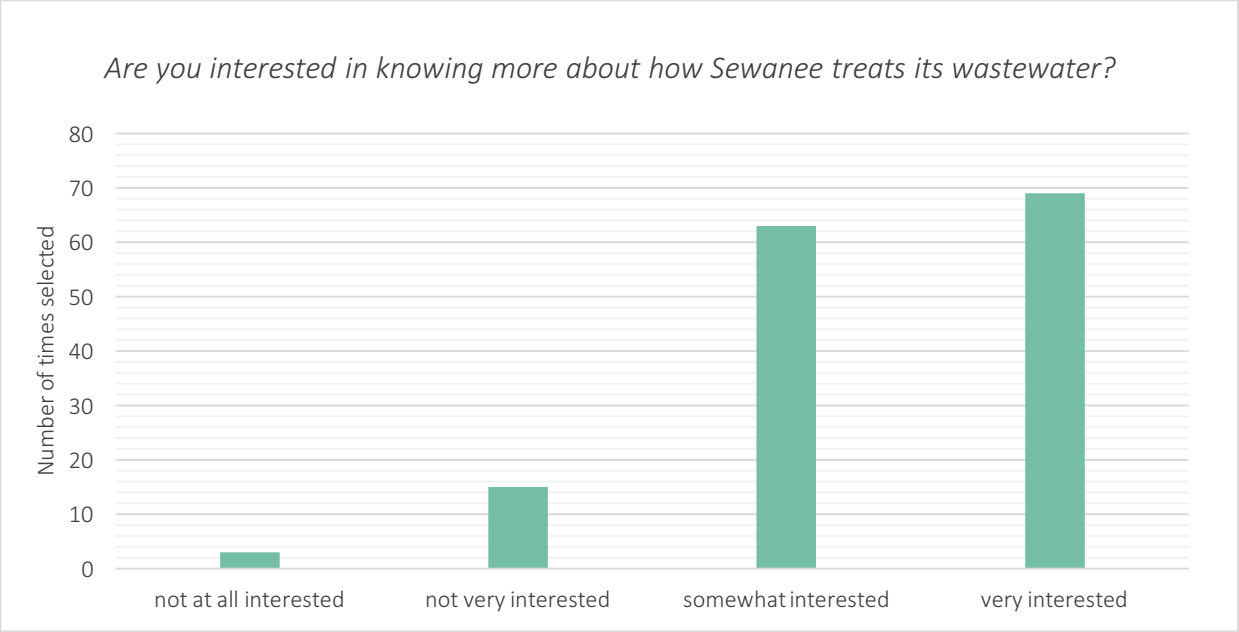


Figure 19: Assessing survey participants' interest in local wastewater treatment in Sewanee, Tennessee (n=150). Survey conducted between November 2015 and February 2016.

Of course, it must be acknowledged that an already existing interest in water-related topics could have triggered many people's decision to take part in the survey; however, this likely applies more to the online survey than the original, paper-based version. In retrospect, the decision to offer the survey online reflects a trade-off between an increased sample size (by approximately 50 responses) and an increasing possibility of selection bias.

3.3.1.3 Communicating water issues

When asked from what sources participants learn about water availability and quality in Sewanee, the three most popular answers were print newspapers and magazines (46%), friends or relatives (43%), and the local water supplier, i.e. the SUD (30%).

Possibly one of the most valuable contributions was participants' evaluation of different communication channels' potential to convey information about local water issues. An informational website (62%), articles published in local newspapers (61%), and social media

information sites (38%) appear to be the three most convenient media platforms for community members to obtain water-related information (Figure 20).

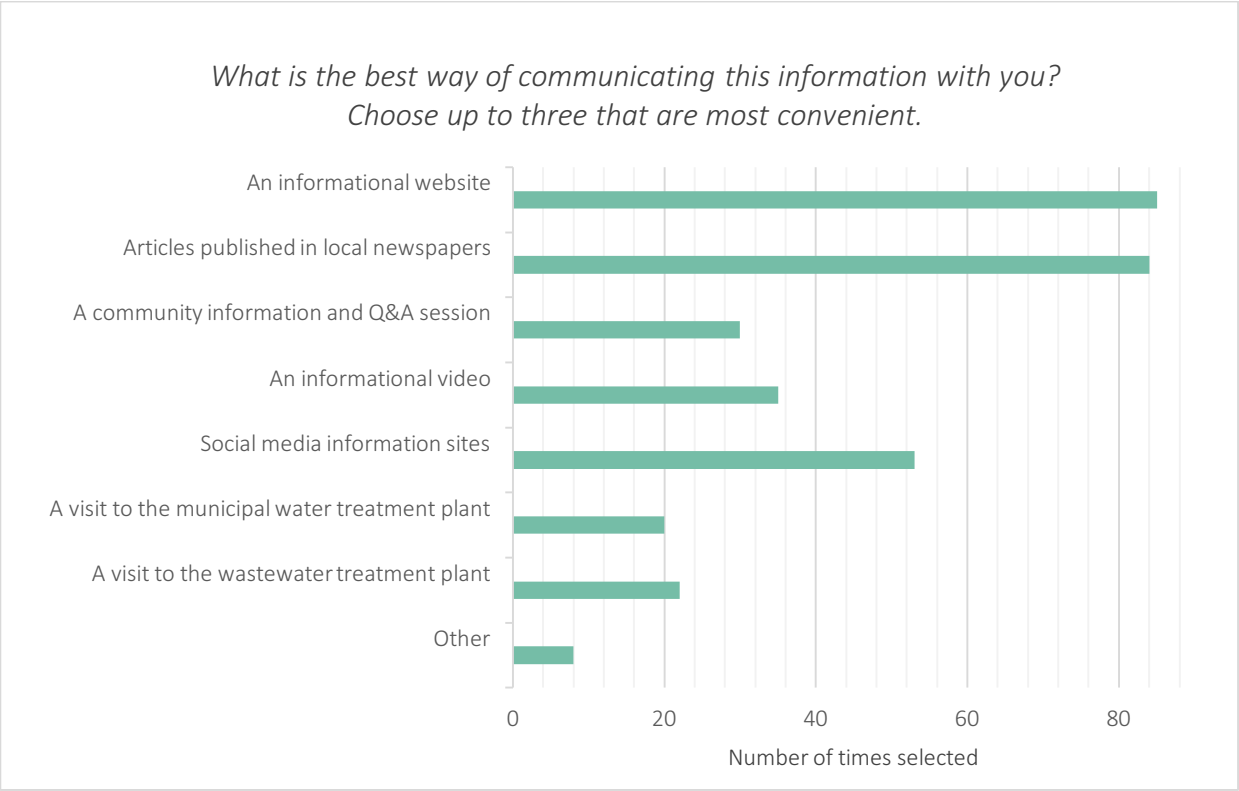


Figure 20: Assessing survey participants' evaluation of different communication channels' potential to convey information about local water issues (n=138). Survey conducted between November 2015 and February 2016. "This information" refers to the topics "quality of tap water in Sewanee", "availability and supply of water in Sewanee", "drinking water treatment in Sewanee", and "wastewater treatment in Sewanee".

As all three top answers can be considered online media – newspapers often publish both in print and online, as does the SMM – the survey results strongly support findings by Barth et al. (2012) (see section 3.1.1). Since all answer choices received a quite significant number of responses, though, all platforms or strategies should be considered for project-related outreach in the long-term. Additionally, some survey participants suggested media platforms independent

from the offered options; these included a local story on the National Public Radio station[32], pamphlets, an email newsletter, and Sewanee Classifieds.

Preferred communication channels noticeably differed depending on the respondent's age: While an informational website seemed to be similarly popular across all age groups, social media was the most popular answer among participants between 18 and 25 – in contrast to local newspaper articles chosen as the top answer by all age groups above 45. In addition, responses indicated that an informational video could potentially be effective in reaching a younger audience, and a community information and question and answer session seemed to be popular among older community members. Note that these are simply observations – they should by no means be considered generalizable trends.

3.3.1.4 Summary

The main results of the pre-assessment survey that are particularly relevant to the development of a community engagement campaign are summarized below:

- Decreasing water availability seems to be perceived by many as a problem occurring more on a global than local scale. The campaign should therefore aim to increase community members' awareness of local water scarcity.
- Water conservation was considered important by most respondents, and even reusing water was seen as an effective strategy to mitigate water shortages. However, few favored augmenting drinking water supplies with reclaimed water. As potable reuse seems to remain a sensitive topic among some community members, the campaign should demonstrate that CWs can compete with conventional potable reuse systems that have been proven safe.

[32] See http://local.npr.org/about.

- Compared to a high awareness of Sewanee's drinking water source, many participants were unfamiliar with how Sewanee treats its wastewater. The campaign should aim to increase familiarity with this topic to create a community that is overall well informed about local water issues.
- Concerns about wastewater treatment in Sewanee included the general cleanliness of treated wastewater and the possibility of pharmaceuticals surviving current treatment processes. The campaign needs to address these concerns as they are likely to extend to a water reuse project.
- A clear majority of participants were interested in knowing more about the quality of Sewanee's tap water, local water availability and supply, local drinking water treatment, and local wastewater treatment. This interest constitutes a promising baseline situation for the community engagement campaign.
- Lastly, the most effective ways of communicating water-related information with Sewanee community members seem to be an informational website, articles published in local newspapers, and social media. However, other media platforms should be considered as well in the long-term.

3.3.2 Focus groups

Four overarching themes were identified from the focus group transcripts: current water education and communication practices in Sewanee, factors increasing the difficulty of future outreach efforts, potential opportunities to create interest in water-related topics, and suggested communication platforms and strategies for community engagement in the pilot project and beyond. No structural distinction was made between the results of the *K-12 teachers* and the *community leaders* groups, as information on how to involve Sewanee residents in the CW pilot

project only differed in terms of target audience: young vs. adult community members. Quotations from the focus group transcripts serve to support the arguments made throughout this section. Some quotations were slightly edited to facilitate better readability, but none were changed in terms of content or meaning.

3.3.2.1 Current water education and communication practices

This section gives an overview of what institutions have communicated water-related information to Sewanee community members in the past, as perceived by the focus group participants.

Sewanee Utility District – Members of all focus groups praised Ben Beavers, general manager of the SUD, for his work educating school children about drinking water and wastewater treatment processes in Sewanee, as well as his responsiveness to concerns raised by community members during the 2007 drought. The SUD has offered educational tours at the treatment plants in the past, however, according to one participant, interest in the tours (or a lack of awareness) and therefore participation has been low. Lastly, one participant acknowledged SUD's annual announcements that Sewanee's drinking water has been inspected and meets state standards.

Sewanee K-12 schools – Both SAS teachers said they discuss water-related topics in their science classes. Several suggestions were made to improve current water education practices in K-12 schools: Most importantly, students often seem to lack an understanding of why what they learn in school is relevant: "Most kids are missing some sort of practical application (…), some sort of relevant, meaningful data collection" (Participant 1A). Other suggestions included to better educate students about the scientific details of the hydrologic cycle, local and regional droughts, and water conservation.

University of the South – Besides a variety of classes that aim to educate students about water-related topics in Sewanee and elsewhere, certain efforts to increase awareness among other

community members have been undertaken by university faculty and students as well. One example that was raised in both *community leaders* focus groups is the labeling of Sewanee's storm drains to indicate what water bodies the pipes drain to. In addition, approximately 150 UoS students per year taking an introductory Field Biology class visit the SUD water and wastewater treatment facility. At least another 100 to 120 students are exposed to SUD through lectures delivered by Ben Beavers to an introductory Environmental Studies seminar. Other upper level classes in Earth and Environmental Systems also use SUD as an educational and research site (D. McGrath, personal communication, July 12, 2017).

Sewanee Mountain Messenger – The SMM frequently covers the SUD and summarizes the main results of all their board meetings. As well-intended as these efforts may be, however, one participant admitted: "Honest-to-Pete, when I see the Messenger and I see the whole write-up from SUD, I glare over it and I keep going" (Participant 3C). Although this statement generated agreement, many participants also acknowledged and appreciated the SMM's educational efforts.

Sewanee Civic Association – Participant 3E explained that the Sewanee Civic Association has previously "had all the utilities make a brief presentation." However, he elaborates, "it was just a snapshot [of] what they do".

3.3.2.2 Factors increasing the challenge of future outreach efforts

Several factors contribute to the challenges inherent in motivating community and personal interest in the CW pilot project and more general water issues.

General lack of interest in local water issues – "The interest is so low", says one participant. "For most people, it's just there. You turn on the tap and there's water". Indeed, most focus group participants agreed that interest in local water issues among the community is low or merely "conditional".

First, many participants asserted that, to most people, water availability only becomes important when limited. Thus, provided that water comes out of the tap in sufficient quantity and quality and "everything is working" (Participant 3D), interest can be expected to remain low. This argument is somewhat in line with previously referenced studies that found an increase in "water awareness" during prolonged periods of drought (see section 2.2.5).

Second, educating people about wastewater treatment often means fighting an "out of sight, out of mind" problem (see section 2.7). That this is likely true for Sewanee as well was suggested in the pre-assessment survey and by several focus group participants: Participant 3C said: "It's a boring subject. I mean when it comes right down to it I really don't care". Overall, this lack of interest could be regarded as the major challenge this project is facing, as the primary purpose of the CW pilot project is to understand how municipal wastewater can be treated more effectively.

Third, several participants insisted that "nobody is interested unless it affects the pocketbook" (Participant 2D). In fact, Participant 3B identified "extremely high water bills" and a resulting "wall of negativity" as major contributors to the difficulty of communicating educational messages to the community.

Opposition towards water reuse – In 2012, Barth et al. found significant community opposition towards using treated wastewater to augment drinking water supplies. Four years later, the pre-assessment survey substantiated these results (section 3.3.1.1). When this issue was discussed in the focus groups, participants agreed that, due to contaminants that are currently not treated for such as caffeine, pharmaceuticals, and hormones, many community members would be suspicious about the prospect of reintroducing treated wastewater back into the reservoirs. Participant 3B believed that the only way to reduce this uncertainty is to conduct "a lot of research to make sure what's going back is definitely clean".

Further debated in this context were the potential impacts of water reuse in Sewanee on communities downstream of the SUD's wastewater treatment facility. According to the focus group participants, discussing water reuse with officials from the town of Cowan, for example, could result in two scenarios. First, since many people in Cowan might be unaware of their drinking water's origin, discussing water reuse might generate concerns about their future water supply – "'Don't take away our water!'" (Participant 2B). However, reusing treated wastewater in Sewanee could also significantly improve Cowan's drinking water quality, thus, many people in Cowan might be in favor of constructing a water reuse facility upstream.

3.3.2.3 Opportunities to create interest in water-related topics

Focus group participants indicated that community interest in local water issues is generally low or merely "conditional". This section looks at what people *are* interested in and how one could make use of these existing interests, even if they are conditional, to generate curiosity regarding more general water issues and encourage engagement in the CW pilot project.

Increased water awareness during droughts – Many participants stated that water awareness in the community significantly increased during the 2007 drought: "All the sudden people went from seeing the plateau as a place that had tons of water available all the time to recognizing that that's a false construct" (Participant 1A). The idea of increased water awareness during droughts of course goes hand in hand with the argument that water availability is only perceived important when limited, but this phenomenon could also be an opportunity to gain the community's attention and optimize the efficiency of educational efforts during this time. This temporary interest can possibly even be maintained beyond periods of water scarcity by reporting on strategies to mitigate shortages in the future.

Quality of drinking water – Good drinking water quality is valued ubiquitously, as the Flint water crisis and subsequent media coverage have demonstrated. This is not different in Sewanee: "Some people were asking Ben Beavers right after the news was hitting Flint. 'What about lead in ours?'" (Participant 2C). And while it is questionable whether Flint should be used as a tool to create interest in Sewanee's drinking water quality, people "actually do care" (Participant 3B) – "that's what (…) families are really concerned about" (Participant 3A).

Participant 3A strongly believed that tap water is "sometimes quite unsatisfactory in Sewanee". She elaborated that water quality is not always bound to the level of contaminants in the water but also to perceived indicators such as odor or color, for example, as these may determine the usability of the water. Accordingly, explaining how a successful outcome, or rather a CW-based indirect potable reuse project in Sewanee, could result in an increase in even perceived drinking water quality may be an effective strategy to generate interest in the pilot project (see also section 2.2.2).

Pharmaceuticals in municipal wastewater – An aspect of the pilot project that should be highlighted whenever possible is its investigation of CWs' effectiveness in removing contaminants that frequently survive conventional wastewater treatment (as mentioned in section 1.2, this also is true for SUD's LAS). This demonstration of innovation might even increase support for water reuse in the future: "If you can show that you can take the pharmaceuticals out, you really, really have something because that means you got cleaner water than any other option when it stops falling out of the sky" (Participant 2D).

Both *community leaders* focus groups agreed that discussing pharmaceutical removal would attract much attention; however, it could also serve as a platform for another educational

message: preventing incorrect pharmaceutical disposal[33]. It was suggested that people could bring their obsolete pharmaceuticals for safe disposal off-site when visiting the pilot CW. One could even organize pharmaceutical disposal events independently, possibly as part of more "universal" recycling and disposal events. These events might then generate interest in the pharmaceutical removal aspect of the pilot project and even motivate some people to visit the pilot CW.

Advantages, safety, and necessity of water reuse – Many focus group participants believed that, "instead of just sort of looking at a science experiment" (Participant 2C), making the potential connection between wastewater treatment and high-quality drinking water by openly discussing water reuse as a possible outcome of the pilot project would be a key strategy to generate interest. According to participants, demonstrating that water reuse could mitigate water shortages in the future, address expected (student) population growth, and possibly even improve drinking water quality might help community members better comprehend the significance of this project.

Providing information on how indirect potable reuse is very common among communities situated downstream of other municipalities could be an effective way of demonstrating the safety of such practice. Furthermore, sharing water quality data from the pilot CW that indicates pharmaceutical removal could contribute to this objective. One participant additionally suggested analyzing water at the intake of Cowan's municipal treatment plant, after it has undergone Sewanee's LAS and natural cleaning processes. In other words, people may become more supportive of reuse if they understand the quality of treated wastewater when introduced into reservoirs.

[33] Although this suggestion may seem somewhat paradoxical (since the hypothesis of the pilot study is that CWs can effectively remove these types of contaminants), preventing incorrect pharmaceutical disposal may help community members understand the importance of responsible stewardship of available water resources, as well as create interest in the pilot project.

3.3.2.4 Suggested community engagement tools and strategies

This last subsection describes the communication tools and strategies recommended to convey information about the pilot project and more general water issues to both young and adult Sewanee community members.

3.3.2.4.1 Strategies to educate and involve students

Focus group participants suggested numerous ways to educate and involve students in the CW pilot project. First, guest speakers, either from the research team or the SUD, could give presentations in K-12 or university classes. Second, all participating K-12 teachers agreed that field trips would be valuable in showing students how CWs compare to natural wetlands and explaining the concept of ecosystem services. When discussing the idea of combining field trips and guest speakers, both SAS teachers recommended an "open inquiry" approach, which in this case means to let students explore the pilot CW independently first and then have a guest speaker follow up by addressing questions and helping them to make sense of their experience.

Both K-12 teachers could imagine the possibility of media-based classroom discussions, for example, facilitated through SMM articles or educational videos on a website. For instance, it was suggested that a time-lapse video could show the process of constructing the pilot CW. Students could even be involved in media development, whether it was an extra-credit assignment or intrinsically part of the curriculum. In one of the *community leaders* focus groups, it was suggested that university students (possibly together with K-12 students) could write articles about local water issues that would be published in the SMM. This might even increase the chance of people reading the articles if they recognize the student who wrote it.

Students should also be involved in wetland monitoring to address the lack of practical application in many K-12 schools (see section 3.3.2.1). It would help students comprehend the significance of effective wastewater treatment and the implications of the pilot project.

In addition, one participant pointed out SES's "Friday School" program, where for four Fridays in the spring, community volunteers are invited to teach classes at the elementary school. The teacher recommended that SAS students could do "a project with those kids on [waste]water treatment (…) and take it down to that elementary school level."

Lastly, the benefits of educating and involving students in the project may extend to parents as well: "That's often one of the best ways to get to adults, to educate the children, because they go home and start talking about this. This has been my experience" (Participant 2D).

3.3.2.4.2 Use of communication platforms and strategies in general

Focus group participants emphasized that employing diverse communication channels is crucial, as each media platform may appeal to a different demographic and target audience (as suggested by the survey results). From a marketing point of view, media variety may also create more possibilities to share information in creative ways. At the same time, outreach efforts should initially be concentrated on the media platforms that presumably are most effective in communicating information to the community, as resources are limited.

Sewanee Mountain Messenger – Supporting the pre-assessment survey results, all focus group members agreed that the SMM will play a major role in reaching adult community members. Many participants said that educational efforts through the newspaper should be continuous; thus, a series of short articles written by students was suggested. Articles could inform about general water-related topics in Sewanee, explain the objectives of the project and how the pilot CW works,

and advertise community events. Visual information, such as diagrams showing recent water quality monitoring results, could be shared, too.

Informational website – Although the most popular media identified in the pre-assessment survey, many focus group members remained critical towards an informational website: "With any website or social media, you're still relying on people to have the energy and passion to go to it" (Participant 3B). Yet, others argued that a website would constitute a static informational resource that could conveniently be linked to in other media. One participant suggested that a website could inform about water usage in Sewanee, and then, becoming more specific, focus on the CW pilot project. Both SAS teachers thought a website would effectively reach younger people (which is in line with the survey results).

Social media – The survey results indicated that social media would be especially effective in reaching younger audiences. Most focus group members shared this opinion. Participant 1A, for example, confirmed: "Over the last five years I have seen a huge increase in social media use in our middle schoolers". The advantages of social media were seen in its ability to disseminate messages very rapidly, its interactivity, and its frequent and heavy use. One participant, however, believed that merely educational posts rarely generate attention. Instead, social media could, for example, be used to publicize community events and activities.

Sewanee Classifieds – As a local business owner, Participant 3C strongly recommended using Classifieds for advertising (or for this project publicizing) purposes: "Anybody that uses the Messenger for advertising purposes will tell you that they'll get better turnout from Classifieds than they'll get from the Messenger." Classifieds would thus be effective in announcing community events at the pilot CW or town meetings, for example.

Videos – A narrated time-lapse video or photo montage that shows the construction and vegetation establishment processes was suggested by two focus groups. While the possibility of using such video as a teaching tool in the classroom was discussed, participants believed it would generate interest among adult community members as well. Another idea for an educational video was to follow wastewater from Lagoon C through the three wetlands, while showing in simple bar graphs how the water quality changes. One could also do this on a larger scale by tracing Sewanee's reservoir water all the way to the point it is taken up by Cowan's drinking water treatment plant, demonstrating variations in water quality along the way.

Guided tours – Participants generally supported the idea of educational guided tours of both the SUD's treatment plants and the CW, but emphasized they would need to be publicized. Ideas for attracting people included building water quality demonstration stations and offering to collect unused pharmaceuticals for safe disposal. During the tour, one could then explain why adequate discharge is important.

Signage – One participant emphasized the value of well-constructed and designed signs to help otherwise unguided visitors interpret a landscape or human structure. Thus, permanent interpretive signs, combining aspects of science, technology, and art, would allow for self-guided tours at the pilot CW. Another participant added that QR codes on signs could even link to online resources such as a project website, educational videos, or social media sites.

Town meetings / forums – Some participants considered town meetings "the best idea on the list" (Participant 2D), especially since forums constitute great opportunities for two-way communication. Focus group members indicated that people usually attend town meetings if they know why the topic is relevant and feel an urge to acquire more information about it, which is why many meetings on controversial topics have attracted large crowds in the past (and which is also

why a forum on water reuse "might fill a room" (Participant 2C)). Thus, town meetings should be organized after initial interest has already been generated.

Tabletop model / traveling exhibition – Members of the first *community leaders* focus group suggested building or purchasing a tabletop model that would show what processes are taking place at what points of the pilot CW and what tests are performed to understand if the facility functions as intended. Participants of the second *community leaders* group took this idea one step further and recommended creating a travelling exhibition and setting it up at places where masses of people naturally gather, "so that it's less of a sit-down and come-and-listen, but come-and-see" (Participant 3A). The exhibit could also incorporate educational videos (as discussed above), refer to other online resources, and even have interactive elements.

Posters – Posters can be used to inform and educate about a topic, to attract attention and create interest, or to publicize events. What is displayed on a poster depends of course on its purpose; if it was, for instance, to generate interest in wastewater treatment, it could read "If you live in New Orleans, the water you drink has been through seven toilets upstream. Where does Sewanee's wastewater go? Let's get concerned about that!" (suggested by Participant 2A). The poster could then announce a town meeting on the topic, for example.

Mascot – Only barely discussed overall, one participant thought that "putting a face" on wastewater would help personalize it. He believed it would also create more attention among children. As an example, one participant jokingly proposed the mascot "Willy Wastewater". As the SUD already has a water-related mascot, a mascot more specific to wetlands might be more beneficial for this project.

Data sharing – While the idea of sharing research data with the community was never discussed as its own topic in either focus group, many participants assumed that it was going to be

done and implied that doing so would create confidence in the treatment capabilities of CWs, and trust in the research team and the SUD. Community members could even be involved in the process of collecting this data to create opportunities for citizen science. In terms of generating support for indirect potable reuse in Sewanee (assuming a successful outcome of the pilot project), it is unclear how much time would need to pass before a sufficient level of confidence is reached. Assessing the community's response to a public data sharing program on a regular basis would therefore constitute yet another opportunity to contribute to the existing body of scientific literature focusing on how to create public confidence in water reuse.

3.3.2.4.3 First community event

Regarding a community event at the pilot CW that would "kickoff" the overall community engagement campaign for the project, focus group participants suggested numerous ways of publicizing and incentivizing the event and proposed a variety of activities for young and adult community members. Participants also discussed when the event should take place.

Both *community leaders* groups, for several reasons, recommended scheduling the event in the fall instead of in the spring. Furthermore, most participants preferred a weekend over a weekday. However, one K-12 teacher also admitted, that, if not part of a mandatory field trip, few students might decide to attend an event that takes place during the weekend.

Various strategies were discussed to motivate people to attend the event: First, participants recommended that incentives or rewards should be offered. Furthermore, the event should be heavily publicized in K-12 schools and among scout groups, as well as other local groups that one might expect to be interested in the project.

Several participants suggested that docents should explain how the pilot CW works, where samples are taken and what they are tested for, and how the water quality changes. Furthermore, a

video showing the construction and vegetation establishment processes or illustrating first monitoring results could be presented. One participant also recommended a suggestion box that specifically asks for the visitor's input. Another idea was that the event could mark an official or "ceremonial" opening of the pilot CW. Overall, participants recommended planning a family-oriented event.

Both SAS teachers were open to collaborate on creating learning opportunities for students at the event. Guided by their teachers, students could, for example, sample and test the water that flows through the pilot CW (see section 3.3.2.4.1). Overall, both SAS teachers offered to be "as much or as little involved as you wanted" (Participant 1A).

3.3.2.5 Summary

The main results of the focus groups are summarized as follows:

- Various Sewanee institutions contribute to educating the community about local water issues, including the Sewanee Utility District, local K-12 schools, the University of the South, the Sewanee Mountain Messenger, and the Sewanee Civic Association.
- There is evidence, however, that average interest in local water issues, especially wastewater treatment, is low or, in some cases, merely conditional: Water availability only seems to be important when limited; most people's interest in the SUD appears to focus on water costs. Another factor that may increase the difficulty of future outreach efforts is some community members' opposition towards potable water reuse.
- Some topics, however, do attract interest: First, there seems to be an increase in water awareness during periods of water scarcity. Other areas of interest include drinking water quality, contaminants surviving traditional municipal wastewater treatment, potential of

more effective contaminant removal through CWs, and, despite it being a controversial topic, water reuse.

- Several strategies were proposed to involve students in the CW pilot project, and there are numerous platforms that can facilitate project-related communication in general. Since each one speaks to a different audience, all should be considered, yet used efficiently. Lastly, valuable advice was given about organizing the first community event at the pilot CW to "kickoff" the community engagement campaign.

CHAPTER 4

DEVELOPING A COMMUNITY ENGAGEMENT CAMPAIGN

This chapter employs insights from chapters 2 and 3 to develop a strategic community engagement campaign for the CW pilot project. In this thesis, "community engagement campaign" is defined as a two-way communication program that allows campaign managers to share information, as well as create opportunities for residents to become actively involved in the pilot project and local water resource management. The word "campaign" here does not imply any type of advocacy or marketing; instead, it merely emphasizes the strategic approach to facilitating communication and community engagement. The term "community engagement" was chosen over "outreach", because it more clearly emphasizes the necessity of involvement and dialogue rather than the sheer provision of information. Furthermore, it has been recommended in the literature that campaigns that intend to influence knowledge, attitudes, or behavior (Atkin & Rice, 2013; Neresini & Pellegrini, 2008; Paisley & Atkin, 2013) should increasingly focus on linking traditional communication channels and strategies with more interpersonal, "on-the-ground community action" (Coffman, 2002, p. 4).

Regardless of their exact objectives, all campaigns aim to generate some type of change among a large number of individuals within a specified timeframe (Atkin & Rice, 2013; Coffman, 2002). Following this definition, a conceptual campaign framework is developed in the first three sections of this chapter. What follows is a thematic outline of the campaign, introducing key informational areas and messages to be distributed by future campaign managers. Afterwards, a set of expectedly effective communication channels is presented. Many of these were implemented

as this thesis was written; these are discussed in greater detail. The remaining sections focus on the formation of a community advisory board, identifying potential campaign partners, and the definition of administrative responsibilities. This chapter concludes by making recommendations on how community engagement efforts should be continued after the campaign has concluded.

4.1 Campaign objectives

Overall, the community engagement campaign should aim to increase the general level of water literacy in the Sewanee community, raise awareness of the CW pilot project, and build public confidence in the process of evaluating the wastewater treatment capabilities of CWs. Assuming the campaign covers three years (see section 4.3), its objectives are defined as follows:

1. To ensure basic knowledge about local water issues such as drinking water and wastewater treatment among 1,000 adult Sewanee residents by July 2020.
2. To generate awareness and understanding of the constructed wetland pilot project, including familiarity with the water quality monitoring program, among 1,000 adult Sewanee residents by July 2020.
3. To create confidence and trust in the process of evaluating the wastewater treatment capabilities of constructed wetlands and the potential for an indirect potable water reuse project among 1,000 adult Sewanee residents and all five Sewanee Utility District board members by July 2020.

Objectives were developed following SMART guidelines: According to Quesenberry (2016), expressing goals that are specific, measurable, achievable, relevant, and timely ensures that achievement and therefore success can be demonstrated, which justifies efforts and resources spent on a campaign. In all three objectives, *adult Sewanee residents* are further defined as third and fourth-year university students, as well as adult permanent residents, as they are the only adults

who will in 2020 have lived in Sewanee for at least two campaign years. Using university enrollment data and general population estimates for Sewanee, it can be calculated that the entire population of interest (as defined above) equaled 1,442 community members in 2015 (Office of the University Registrar, 2015; United States Census Bureau, 2015). If Sewanee's population does not change significantly until 2020, 1,000 representatives of this group will constitute a clear majority of all adult community members who could realistically have been impacted by the campaign. University of Georgia Public Relations Associate Professor Karen Russell confirmed that a three-year campaign should be able to reach 1,000 Sewanee residents with the resources available (personal communication, January 13, 2017). Finally, as stated in section 1.2.3, Ben Beavers, head of the SUD, emphasized that all five board members need to be in favor of an indirect potable reuse project for it to be realized (personal communication, March 2, 2017).

4.2 Target audiences

Outreach efforts should be directed towards all adult Sewanee community members. To facilitate communication with different demographic groups and improve overall campaign efficiency (Atkin & Rice, 2013), residents were divided into three target audiences:

1. University students (especially those who will be juniors and seniors in 2020 – these cohorts will start school in 2017 and 2018)
2. (Other) adult community members
3. Sewanee Utility District board members

Although not represented in the campaign objectives, K-12 students should be targeted as well, since it was suggested in the focus groups that educating children may help to generate awareness among parents (i.e. members of target audience 2). Similarly to K-12 students, another "auxiliary" target audience (Asibey, Parras, & van Fleet, 2008) includes "community influencers"

– individuals and groups who can exert interpersonal influence at the community level and therefore have potential to lead conversations about water management in Sewanee. "Community influencers" will be treated here as potential campaign partners to promote successful communication with the other target audiences; this topic will be discussed further in section 4.7.

Communication tools and strategies that are assumed to be particularly effective in reaching target audience 1 include social media, films, and university programs. In contrast, newspaper articles in the Sewanee Mountain Messenger, Sewanee Classifieds, and town meetings are expected to be critical in communicating with target audience 2. Communication channels in general are discussed in section 4.5; educational messages that should be conveyed to these two groups are outlined in section 4.4.

Communication efforts targeting SUD board members, representing the final decision-makers of whether to realize an indirect potable reuse project, should focus on explaining the development and (expected) outcome of both the pilot project and the community engagement campaign. In terms of communication tools and strategies, the focus should be on conveying information face-to-face at SUD board meetings: At board meetings, campaign managers would frequently reach this entire target audience while at the same time enabling board members to ask questions and provide comments. On June 20, 2017, board members indicated they would like to be updated about the development of the campaign at least once per year.

4.3 Duration

The campaign was designed for a minimum duration of three years. Three years are considered a realistic time period for campaign managers to achieve the outlined campaign objectives. As work on this thesis, and therefore on the campaign framework, concluded in July 2017, the campaign objectives outlined in section 4.1 should be accomplished by the end of July 2020. In the case that

the pilot CW requires more than four years to become fully established and function as intended, and that the research team needs more time to obtain robust, longitudinal water quality monitoring data, the campaign can be extended as needed.

4.4 Thematic outline

This section provides a thematic outline of the campaign. Informational areas were developed based on insights gained from a literature review on public perception of water reuse (chapter 2), recommendations made by groups previously working on the project (section 3.1.1), as well as the results of the pre-assessment survey (section 3.3.1) and the focus groups (section 3.3.2) conducted for this thesis. A general overview of this outline is provided in Figure 21; the following three sections explain this "thematic map" in more detail.

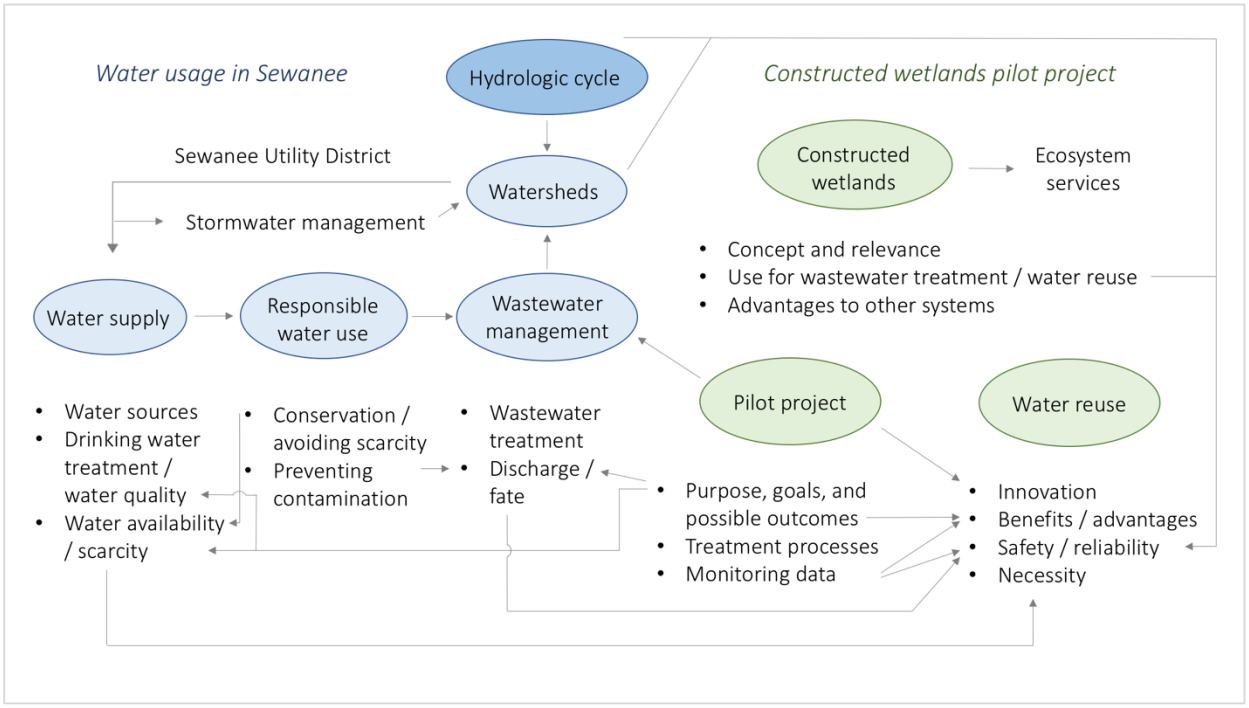


Figure 21: Thematic outline of the community engagement campaign developed for the constructed wetland pilot project.

4.4.1 Hydrologic cycle and watersheds

All water resources on earth are interconnected through the hydrologic cycle. Accordingly, water constantly undergoes natural recycling processes that, combined with anthropogenic enhancement (i.e. drinking water treatment), make water available again for use. A scientifically-sound, yet comprehensive explanation of the hydrologic cycle might accomplish a couple of objectives in illustrating: (1) that water recycling is a natural process that has been occurring for billions of years; thus, it could reduce peoples' fear of intentionally replicating (but accelerating) this process on a smaller scale in a more controlled manner (Khan & Gerrard, 2006); and (2) exactly how wastewater discharge affects downstream users, perhaps motivating personal actions to reduce pollutants at the source, such as keeping PPCPs out of the wastewater stream.

Effective wastewater treatment reduces the impact of water pollution on a watershed level. Especially since Sewanee is located on top of the Cumberland Plateau, exclusively obtaining their freshwater from rainwater-fed reservoirs (see section 1.2.1), the community has a responsibility to provide clean water to downstream users in the same watershed and beyond. Emphasizing Sewanee's unique position in this regional water supply chain, which in turn requires an explanation of the watershed concept, would illustrate the importance of using and treating water more conscientiously. Raising awareness of indirect (yet evidently safe) water reuse practices among downstream communities could reduce associated health concerns and create confidence in reusing water deliberately.

4.4.2 Water usage in Sewanee

The pre-assessment survey and focus group results indicate that most Sewanee community members do care about the availability and quality of drinking water. Thus, *water supply in Sewanee* needs to be a major focus area of the campaign. First, educational materials should

provide information on Sewanee's drinking water sources. Second, the campaign needs to address how the SUD treats reservoir water to drinking water quality. Frequent water quality reports can help to reassure community members that drinking water meets current regulations. Releasing these reports in turn requires an explanation of the constituents that are present in tap water and what levels of these compounds are, according to scientific findings, guidelines, and regulations, considered healthy and safe. As they have been controversial topics in the past, water fluoridation and the formation of disinfection byproducts while chlorinating reservoir water should be addressed as well. To generate interest, one should examine case studies and news from other areas of the US that demonstrate the importance of good water quality. Third, the campaign should stress the value of water as a resource and intensely report on droughts and water shortages impacting the Cumberland Plateau region or regions nearby for two major reasons: First, the community does care about water availability, and thus, most people do want to be informed. Second, as "water awareness" seems to increase during periods of water shortages and limitations, droughts constitute opportunities to extend this "temporal attention" to other water-related topics such as water conservation, water reuse, and other mitigation strategies. The campaign needs to explain that droughts are expected to increase in frequency, duration, and severity, and that water is likely to become more scarce[34]. If people are aware of how future developments may affect their water supply, more might understand the increasing importance and necessity of alternative water supply options to mitigate future water shortages (Ching, 2010; Dishman et al., 1989; Khan & Gerrard, 2006; Menegaki et al., 2007; Ormerod & Scott, 2013).

Another focus area is *responsible water use*; the campaign should promote both conservation and prevention of contamination. As focus group participants indicated that the

[34] According to Konrad and Fuhrmann (2013), annual summer precipitation in the southeastern US is expected to decrease through the 21st century, while mean temperatures are projected to increase.

importance of conservation might not be as clear among younger community members, K-12 teachers should actively promote sustainable water use and water-conserving strategies in their classes. Furthermore, demonstrating a reduction in water bills through conservation could convince more adult community members to become more conscious about their water use, since the focus groups showed how sensitive people are towards high water bills. To prevent residents from discharging contaminants that are currently not treated for in Sewanee (see section 1.2), the campaign should emphasize that contaminants of emerging concern can have detrimental impacts on aquatic wildlife and possibly downstream humans (see also section 2.2.4). Community members should be encouraged to dispose these compounds properly (as opposed to flushing them), for example, through pharmaceutical disposal or general recycling events. In this context, residents should also be educated about the potential of CWs to remove these contaminants from the wastewater.

Focus group participants assured that educating the community about local wastewater treatment will not be as easy as the pre-assessment survey results suggested (see section 3.3.1.2), as they believed that general interest in this topic is low (see section 3.3.2.2). To create interest, campaign managers could first concentrate on increasing awareness of the pilot project and then use community members' attention to discuss how the pilot CW was incorporated into the SUD's overall treatment system. Alternatively, one could initially focus on explaining how contaminants that survive current treatment can impact aquatic wildlife and illustrate the importance of effective wastewater treatment. Afterwards, one could shift conversations towards the pilot CW, which is expected to remove these compounds. Overall, the campaign should explain why wastewater treatment is relevant, what contaminant removal processes are applied in Sewanee, what contaminants survive current treatment, how the treated water is discharged, of what quality the

discharged water is, potential for removal of remaining contaminants by CWs, and where the water goes after discharge. Regarding the "fate" of Sewanee's treated wastewater, it should be emphasized that it enters streams that drain the watershed and ultimately supply downstream communities with drinking water. Providing water quality reports from downstream sites could perhaps even increase confidence in natural cleaning processes (i.e. the SUD's current land application system). Ideally, this confidence would then extend to CWs.

Lastly, community members should be encouraged to support management of storm water runoff as well. In addition to previous efforts by UoS to reduce impacts on aquatic wildlife by increasing community awareness of the destinations of storm drains, another commonly-applied strategy to reduce stormwater runoff and the pollutants it carries is the construction of rain gardens, vegetated swales, and other control measures. Thus, workshops or other educational materials on how to build rain gardens on private properties could be offered as part of the campaign to both increase awareness of nonpoint source pollution and improve water quality in the watershed. UoS is currently in the process of developing a "master plan" to address stormwater management on campus; this plan is scheduled to be finalized in 2018 (L. Fowler, personal communication, June 21, 2017). The university's efforts may constitute an opportunity to tie together the concepts of effective stormwater management and wastewater treatment to Sewanee community members.

4.4.3 Constructed wetland pilot project

Although it is possible that awareness of CWs has increased since Barth et al. conducted their study in 2012 as a result of communication efforts to date, the campaign should aim to create more wide-spread familiarity with this concept. The campaign should explain the relevance of CWs, their use for wastewater treatment and in some cases water reuse, their effectiveness and reliability in removing different types of contaminants, and their advantages over other wastewater polishing

systems. In this context, information should also be provided on natural wetlands and the variety of ecosystem services they provide to humans (such as flood protection and water quality enhancement). The campaign should illustrate that CWs are designed to make greater use of these naturally-occurring processes by creating more control over them. Lastly, it should refer specifically to the CWs that are already being successfully used for both wastewater treatment and water reuse – one case study is the E.L. Huie Jr. Constructed Treatment Wetlands in Clayton County, GA[35]. An example of another Tennessee community's constructed wetland education programs can be found in Appendix C.

The nature of the wetland as a pilot or demonstration project constitutes the next focus area of the campaign. First, it should be emphasized that the pilot CW potentially will serve as a model not only for a large-scale wastewater treatment facility in Sewanee, but also for communities throughout the southeastern U.S. and even internationally. The project represents an innovative approach to wastewater treatment (for example, the TDEC is closely following this project, because they think CWs have potential for widespread adoption across the state), which not only UoS and the SUD, but the community, too, can be proud of. The community should be informed about the purpose and goals of the project, as well as its potential long-term benefits to the community: improvement of Sewanee's current wastewater treatment system, decreased adverse impacts on water quality and aquatic wildlife, opportunities for biofuel production from harvested wetland vegetation, wildlife attraction, educational opportunities, and, depending on the outcome of the pilot study, mitigation of water shortages and an increase in water quality. It is important that benefits are emphasized as frequently as possible. Educational efforts should also address how the pilot CW was designed (including the types of vegetation planted) and constructed, the

[35] See, for example, United States Environmental Protection Agency (2012) for additional information.

treatment processes taking place, and testing procedures undertaken to understand whether the pilot CW functions as intended. Water quality monitoring data from the pilot CW needs to be shared with the public as well (further discussed in section 4.5.1.5), as data that demonstrates the removal of both common and emerging contaminants is likely to create public confidence in the wastewater treatment capabilities of CWs (Carr & Potter, 2013; Ross et al., 2014). Lastly, it should be explained what stakeholders and individuals are involved in the project to facilitate maximum transparency (Khan & Gerrard, 2006) – for example, it may help community members to become more confident in how monitoring data was generated.

The last focus area of the campaign is *water reuse*. This topic has been controversial in the past and has therefore been avoided in recent project-related conversations with the community (see section 3.1.2); however, findings in the literature (chapter 2), as well as the focus group results (section 3.3.2) suggest that after significant progress towards campaign objectives 1 and 2 has been made (see section 5.1), this topic should be addressed openly. First, numerous studies found that discomfort towards using reclaimed water tends to be higher among those with less knowledge about water reuse in general (Alhumoud & Madzikanda, 2010; Z. Chen et al., 2013; Dishman et al., 1989; Dolnicar et al., 2010). Second, not maintaining full transparency can result in rumors, concerns, suspicion, or distrust, which may generate or amplify unjustified perceptions of risk associated with a reuse project (Dishman et al., 1989; Hartley, 2006; Marks, 2006; Po et al., 2003; Rock et al., 2012; Ross et al., 2014). Third, focus group participants believed that explaining why and how a successful outcome of the pilot study can be beneficial to Sewanee residents may help community members better comprehend the significance of the project and therefore generate interest.

When discussing water reuse, one should focus on five main aspects: First, expected benefits, including, for example, water conservation, emergency preparedness during water shortages, and improvements in water quality. Second, advantages to other alternative water supply options – one could, for instance, compare the relative costs and pollution-removal efficiencies of each. Third, safety and reliability, meaning that the public health and environmental risks are acknowledged and deemed acceptable. Fourth, necessity, due to likely increasing water scarcity and possibly population growth. Fifth, innovation, as pride may correlate with support (Khan & Gerrard, 2006; Po et al., 2003). Since scientists play a key role in the provision of water reuse-related information (Carr and Potter, 2013; Dolnicar and Hurlimann, 2009), it should be specified that, for example, all website sections addressing any of these five aspects were written by one of the expert researchers involved in the pilot project. The same applies to water quality monitoring data that are publicly shared. For more information on how to communicate water reuse-related information, please refer to section 2.5.

4.5 Message distribution

The educational messages outlined in section 4.4 should be conveyed through a variety of communication channels.

4.5.1 Work conducted as part of this thesis

This section first describes the media platforms that have been developed and the outreach activities that were organized as part of this thesis. Recommendations on how these efforts should be continued follow.

4.5.1.1 Project website

The first media platform created for the campaign was a project website. This decision to first create a project website was made for four reasons: First, Barth et al. (2012) recommended a strong

web-based presence. Second, 62% of pre-assessment survey participants indicated that a website was one of the most convenient media platforms for obtaining water-related information. In addition, it seemed to be similarly popular across all age groups. Finally, as noted in the focus groups, a website constitutes a static informational resource that could easily be linked to other media and would thus be an optimal starting point for media development in general.

I began working on a project website with fellow UGA Ecology graduate students Darren Fraser and Destiny Loyd in February 2016. Due to limited experience in website design, we decided to use a third-party website-building platform that allowed for easy editing and did not require programming skills. After comparing numerous such platforms, we chose Squarespace due to its ease of use, flexible graphic design, relatively low subscription-costs, and compatibility with external performance evaluation tools. Based on the pre-assessment survey and focus group results, we developed content to address global water issues, topics related to water usage in Sewanee, and the pilot project. These topics were then used to create a website structure (Figure 22); afterwards, we decided on a matching Squarespace template.

Text was drafted and uploaded to according sections and reviewed by UGA and UoS faculty, as well as Ben Beavers, and edited based on their feedback. We purchased the domain *sewaneewetlands.org* on September 12, 2016; the website went online two days later. The domain was paired with a Google Analytics account on September 19, 2016[36] to monitor and analyze website traffic (further discussed in section 5.1.2.1).

The website has been used to publicize the first community event at the pilot CW (section 4.5.1.2), host a "first impressions" video (section 4.5.1.3), and share the first monitoring results

[36] Unfortunately, between September 14 and 19, the Google Analytics account was paired with a tracking ID associated with an alternate domain that had been used previously. According to Squarespace's own analytics tool, however, the website received 37 visits (29 unique visitors) and 157 page views before the domain was successfully paired with the Google Analytics account on September 19.

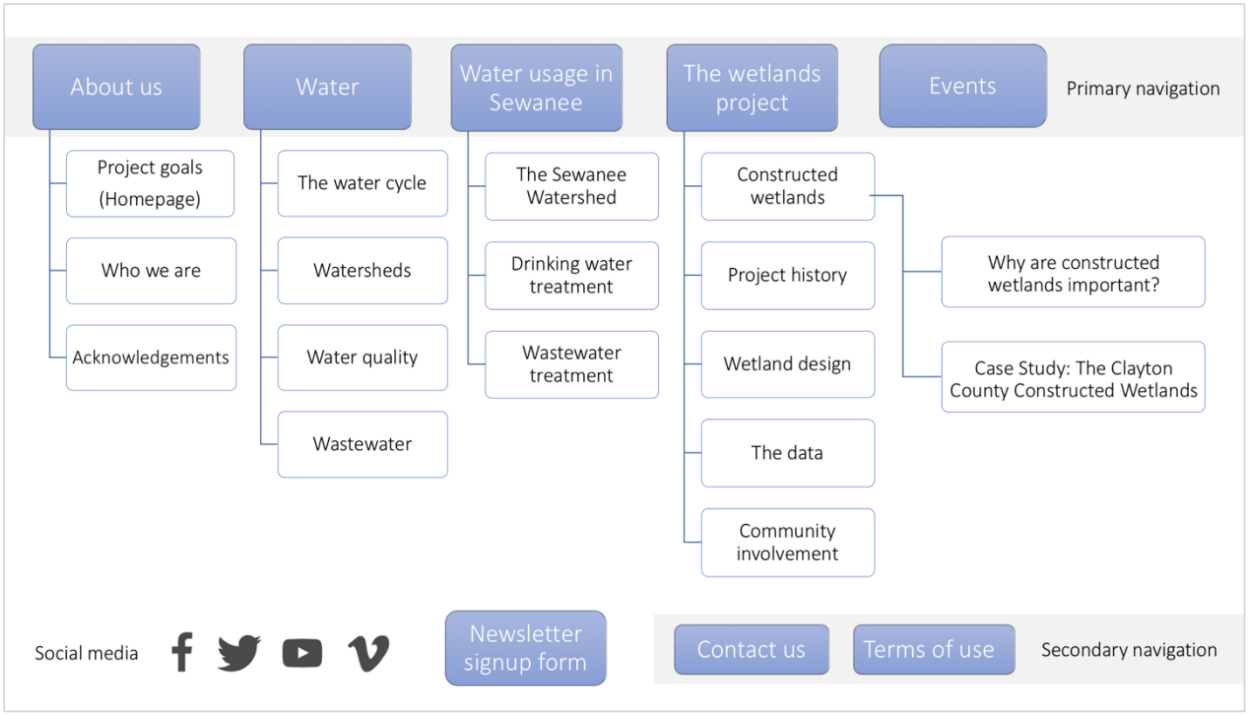


Figure 22: Current structure of the website *www.sewaneewetlands.org*, created as part of the community engagement campaign developed for the constructed wetland pilot project.

(section 4.5.1.5). The website is linked to four social media platforms (see section 4.5.1.6 and Figure 26) and a project newsletter (see section 4.5.1.9). All website content can be accessed at *www.sewaneewetlands.org*.

Several features should be added to the website in the future: First, a news section in blog form with recent project updates would work well as a new homepage. It could incorporate posts from UoS Professor of Geology Martin Knoll's blog Sewanee Water[37]. It should also provide general project updates and visualize and present the most recent monitoring results to the Sewanee community. New blog posts can then be shared via social media. In addition, an RSS feed should be added[38], so that updated content is automatically delivered to subscribers via email or a feed

[37] See www.sewaneewater.com.
[38] See https://support.squarespace.com/hc/en-us/articles/206543357-Using-the-RSS-Block for how to add an RSS Block to the website.

reader. The project-specific part of the website would profit from an FAQ section to include questions that are frequently asked during guided tours or presentations about the project. The website could even offer an "online tour" of the pilot CW with visual and audio explanations. It should also include sections that (1) explain how the community can get involved in the project, (2) allow visitors to sign up for a guided tour, and eventually (3) provide information on water reuse. Other things that should to be added are the CW's official name (which, as decided among the research team on June 20, 2017, will be "Sewanee Wetland Research Station"), a slogan, a mascot (section 4.5.1.6), educational videos about the project (section 4.5.1.3), and links to any social media sites that are created in the future (section 4.5.1.6). Furthermore, the "Events", "Project history", and – if added – "News" sections will need to be updated regularly. A guide on website management was developed and made available to all members of the research team.

Lastly, one should incorporate *sewaneewetlands.org* into the University of the South's website, simply to increase project exposure and to generate more website visitors. Bill McIndoo, web developer in the university's Office of Marketing & Communications, recommended building a "redirect" (such as *wetlands.sewanee.edu*) that would forward visitors to the original website domain (personal communication, August 8, 2016). The website would still be hosted on Squarespace but would be accessible with a *sewanee.edu* URL. Additionally, the website could be linked to the SUD's and UGA websites.

4.5.1.2 First community event

To "kickoff" the community engagement campaign, a community event was held on Saturday, October 29, 2016. The event reflected feedback received from focus group participants regarding timing, advertising efforts, and planned activities for young and adult community members (see section 3.3.2.4.3). A family-oriented community event was planned to raise awareness and create

enthusiasm for the project, explain how the pilot CW works, and describe the water quality monitoring processes in place. On October 28, 2016, the Sewanee Mountain Messenger announced the event as follows[39]:

> The University of the South and the University of Georgia wetland research group invites the community to come learn about the new constructed wetland, 9–11 a.m., Saturday, Oct. 29. The event will begin at the Sewanee Utility District (SUD) office on 150 Sherwood Rd., and a van will shuttle guests to the wetland. Coffee and breakfast snacks will be served at 8:30 a.m. before the tours begin. The event will include a tour of the wetland and treatment lagoons, educational activities for elementary and middle school students, tree-planting and a mascot contest. Ideas about future signage for the wetlands will also be discussed.

The event was also publicized via the project website[40] and Sewanee Classifieds. In addition, flyers and posters were designed using web-based infographic application Piktochart (both are attached in Appendix D) and given to SES and SAS to advertise the event among students. Posters were placed in university buildings and at various downtown locations. Furthermore, all focus group participants were invited to the event via email.

Upon arrival, visitors were asked to sign-in at the SUD office to record attendance and evaluate the research team's efforts to publicize the event. People were also invited to leave their email addresses if they wished to receive occasional updates about the development of the project (a project newsletter is discussed further in section 4.5.1.9). During the event, Sewanee undergraduate students explained the design and function of the pilot CW to community members, answered questions, and planted trees for beautification purposes. University of Georgia graduate

[39] Earlier announcements in the SMM were made on September 16 and October 21, 2016.
[40] See http://sewaneewetlands.org/events/2016/9/14/take-a-first-look-at-the-wetland.

student Liz French offered an interactive lesson on the water cycle and (constructed) wetlands for children who attended the event (for future use, the lesson plan and an associated handout are attached in Appendix E). Furthermore, children were given the opportunity to have their faces painted and to develop a mascot for the CW pilot project (further discussed in section 4.5.1.7). For documentation purposes, UGA graduate student Rachel Will photographed the entire event (a selection is shown in Figure 23).

Figure 23: Photos taken at the first community event at the pilot constructed wetland on October 29, 2016. Photos taken by University of Georgia graduate student Rachel Will.

Additional qualitative data was collected at the event to further optimize future community engagement efforts: Visitors were asked to tell the research team about their first impressions of the pilot CW, as well as to provide their input regarding public involvement in the project and educational signs. For this purpose, three easels with markers were set up at the site. Visitors found the pilot CW "terrific" and "poop-tacular", but also "stinky" and "smelly" (see section 2.2.7 for why this can be problematic). Other comments included:

- Thanks to everyone who is working on this excellent project!
- Must-see opportunity!
- Exciting to see!
- Natural capital – free work of nature!
- Happy to see native plants.
- Include hypotheses on signs: Why are you doing this project?
- Access hatches need safety tie-backs to prevent sudden closures due to wind or human interaction.
- Would like to see the treated wastewater used for agriculture instead of being sprayed out into the woods.

In regard to community involvement, visitors suggested uploading pictures from the construction process and addressing long-term expectations of the pilot study's outcome on the project website, organizing an elementary school mascot design contest ("Creature of the Constructed Wetlands"), offering field trips for students, educating the community on natural wetlands, inviting community members to help harvest wetland plants, involving citizens in water quality testing, and constructing wayside signage explaining treatment processes and expected benefits from the project. Input regarding signage is summarized in section 4.5.1.4.

To improve future community events at the pilot CW, it is recommended that publicizing efforts more effectively target K-12 and university students, for example, via social media. This event mainly attracted adult community members, and overall attendance was relatively low (39 visitors). In addition, some undergraduate students serving as guides were not sufficiently informed prior to the event about the exact goals of the project and the treatment processes that occur in each wetland and thus provided insufficient or inaccurate information. In the future, one should therefore provide information to assist students and clearly define responsibilities early in advance.

4.5.1.3 Videos

Two informational films about the project, six and fourteen minutes long, were developed by Crawford et al. in 2013 (see section 3.1.1). They should be used for educational purposes once significant progress towards campaign objectives 1 and 2 has been made, as both videos discuss the possibility of an indirect potable reuse project in Sewanee.

In addition, in February 2016, Thomas Sanders, Foundation Relations and Advancement Communications Officer at UoS, set up an outdoor camera at the pilot CW to film the construction and vegetation establishment processes. Work is currently underway to create a time-lapse video with this footage and make the video available on the website and social media for promotional purposes, as well as for use in local K-12 and college classes.

On October 28 and 29, 2016, I shot video footage for a "first impressions" video to generate interest in the project. These recordings were supplemented with drone footage filmed during the first community event by Brandon Moore, Associate Professor of Biology at the University of the South. Using video editing software Final Cut Pro, I produced and uploaded a two-minute film to

YouTube and Vimeo with accounts specifically created for the project.[41] The project website links to the video on its "Project goals" page as well. In the future, this video should be shared via social media or email newsletters to, for example, publicize guided tours at the pilot CW. It could also be shown in classes, at town meetings, presentations and other events, or as part of a travelling exhibition.

A vocal group performing at the community event was filmed by a UoS student; this video should be used to generate interest in the pilot project via social media. Furthermore, the master's thesis defense seminar of UGA graduate student Matt Carroll was recorded. It included a detailed explanation of how CWs are used for municipal wastewater treatment and should be uploaded to the project website as an additional educational resource.

Future educational videos about the pilot CW should focus on visualizing changes in water quality. The first (which would also introduce the project) could be developed by UoS students in the Fall 2017 semester. If possible, an additional video should be created at a later point that compares the water quality of reservoir water, tap water, untreated and treated wastewater, and water that supplies downstream communities. The use of video-hosting platforms such as YouTube and Vimeo is further discussed in section 4.5.1.6.

4.5.1.4 Signage and self-guided tours

At the first community event at the pilot CW (section 4.5.1.2), visitors revealed that they expected educational signs at the site to provide information on:

- Water depth and water flow (possibly through touchscreen displays)
- The names of all plant species present in the pilot CW

[41] The video is accessible via www.youtube.com/watch?v=2lLro4DsBEU and https://vimeo.com/209762481.

- The kind of wildlife the pilot CW attracts
- How each wetland functions (i.e. what treatment processes take place where)
- Types of contaminants being analzyed
- Project goals
- How the project and future findings will benefit the community
- Whether a full-scale CW would be less expensive and thus replace the current LAS
- The number of households that would be served by a full-scale CW
- Safe use (i.e. potential hazards during site visits)

Based on this input, I drafted text for five educational signs: Sign 1 (S1) introduces the project, explains its purpose and expected outcomes, and includes a site map. S2 describes Sewanee's current wastewater treatment system. S3, S4, and S5 provide information on each wetland's design, plant species, treatment processes, and how visitors can access water quality monitoring data. Beavers suggested that all visitors be provided with pamphlets that include safety instructions and a site map for guidance (personal communication, March 2, 2017). To assure that all visitors pick up such pamphlet, Beavers recommended that people sign in at the SUD office before driving to the pilot CW. This way, one can also keep track of visitor numbers for evaluative purposes.

Mike Wharton from Athens Clarke County's Leisure Service Department (who was involved in creating educational signs for the Sandy Creek Nature Center and the North Oconee River Greenway in Athens, GA) recommended that all text should be targeted towards sixth-grade students (personal communication, February 7, 2017). Wharton also emphasized the importance of conciseness and general readability. After draft text was edited based on Mr. Wharton's input, it was further revised by Laurie Fowler, Ron Carroll (Emeritus Professor at the Odum School of

Ecology at UGA), James Barlament (Charter System Director at the Clarke County School District), and UGA graduate students Kelsey Solomon and James Ammons.

UGA Environmental Design master's student Chencheng He is currently in the process of designing five interpretive signs; three preliminary drafts of S3, S4, and S5 are attached in Appendix F. On June 20, 2017, the research team decided that an additional sign (S6) is needed to explain a mesocosm study currently in the planning phase (ponds will receive effluent from wetland basin 3 before discharging into Lagoon C). To save costs, three kiosks will be constructed on-site to each host two signs back-to-back. As shown in Figure 24, the first kiosk (K1) will display S1 and S6, the second (K2) S2 and S3, and the third (K3) S4 and S5. All signs will be printed on posters, so that they can easily be exchanged with updated versions.

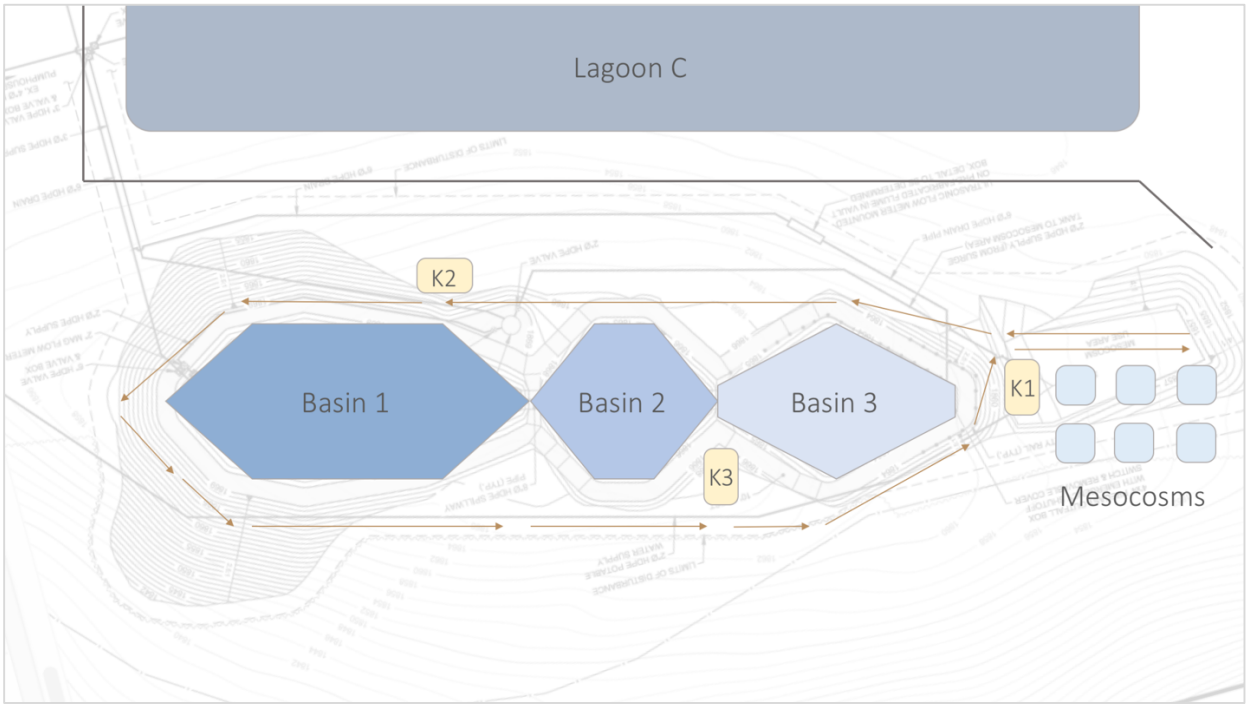


Figure 24: Position of three kiosks (K1, 2, and 3) which will each host two interpretative signs to provide visitors with information about the constructed wetland pilot project. Background: Golder Associates (2015).

As soon as the kiosks and signs are installed, the pilot CW should be publically accessible during SUD operational hours with visitors signing in at the SUD office. Self-guided tours should be publicized via the project website, social media, the Sewanee Mountain Messenger, and Sewanee Classifieds.

Lastly, one focus group participant noted that QR codes on the signs could link to online resources such as the project website, the most recent water quality monitoring results, educational videos, or social media sites. However, as several studies have shown that actual usage levels are low, the idea was, at least for now, abandoned (Demir, Kaynak, & Alpaslan, 2015; Sago, 2011; Schultz, 2013).

4.5.1.5 Sharing monitoring data and citizen science

To make water quality monitoring results publically available to Sewanee community members in a comprehensive, engaging, and relevant manner, Marsha Black, Associate Professor in the UGA Environmental Health Science Department of the School of Public Health, recommended sharing the monitoring results via infographics (personal communication, December 13, 2016). These can then be uploaded to the project website, be linked to other online media, and distributed along with context-providing lesson plans to K-12 and university instructors. Following Dr. Black's advice, a first infographic was developed explaining the basic sampling procedure and presenting preliminary results for the removal of nitrogen, phosphorus, and *E. coli*[42]. The infographic was created using web-based infographic application Piktochart and uploaded to the project website on June 15, 2017. It can be accessed via *www.sewaneewetlands.org/the-data*. This infographic can serve as a template for visual representations of monitoring data in the future.

[42] Results show measurements from June and July 2016 (immediately after water first started flowing through the pilot CW), November 2016, January 2017, and February 2017. All samples were taken and analyzed by UoS students Megan Hopson, Anna Williams, and Georgia Konstam, under the direction of Biology Professor Deborah McGrath.

Overall, however, simply sharing monitoring data with the public does not guarantee the community's attention. Community members should therefore actively be involved in the monitoring program. As Szukalski (2016) states, "the idea of providing open access to data in a way that engages the public is rapidly changing from something that would be nice to have to an essential element for success" ("Engagement, not openness, is the goal", para. 1). One way to create interest in the monitoring program and its outcomes could be to involve community members in the actual data collection process under the direction of trained faculty or students. In addition, community members could be encouraged to predict each month's monitoring results before the data are released (assuming data will eventually be shared monthly). Whoever makes the closest guess would then receive a prize (such as a voucher for a local restaurant). Such contests may help the community understand what concentrations of certain water pollutants are normal and safe and encourage the public to follow the data sharing program on a regular basis, so that they are in a better position to estimate subsequent results.

4.5.1.6 Social media

Both the pre-assessment survey and focus groups results suggested that social media is an effective medium to reach younger community members in particular. The Northeast Ohio Regional Sewer District (NEORSD) has demonstrated how social media can be used to successfully engage community members in local wastewater management. For example, the NEORSD frequently uses recent events to convey educational messages in a humorous way – an example is shown in Figure 25. Overall, the NEORS has established a considerable presence and follower bases on social media. Appendix G provides a summary of the NEORSD's social media accounts in the hope they can inspire future community engagement efforts for the pilot project.

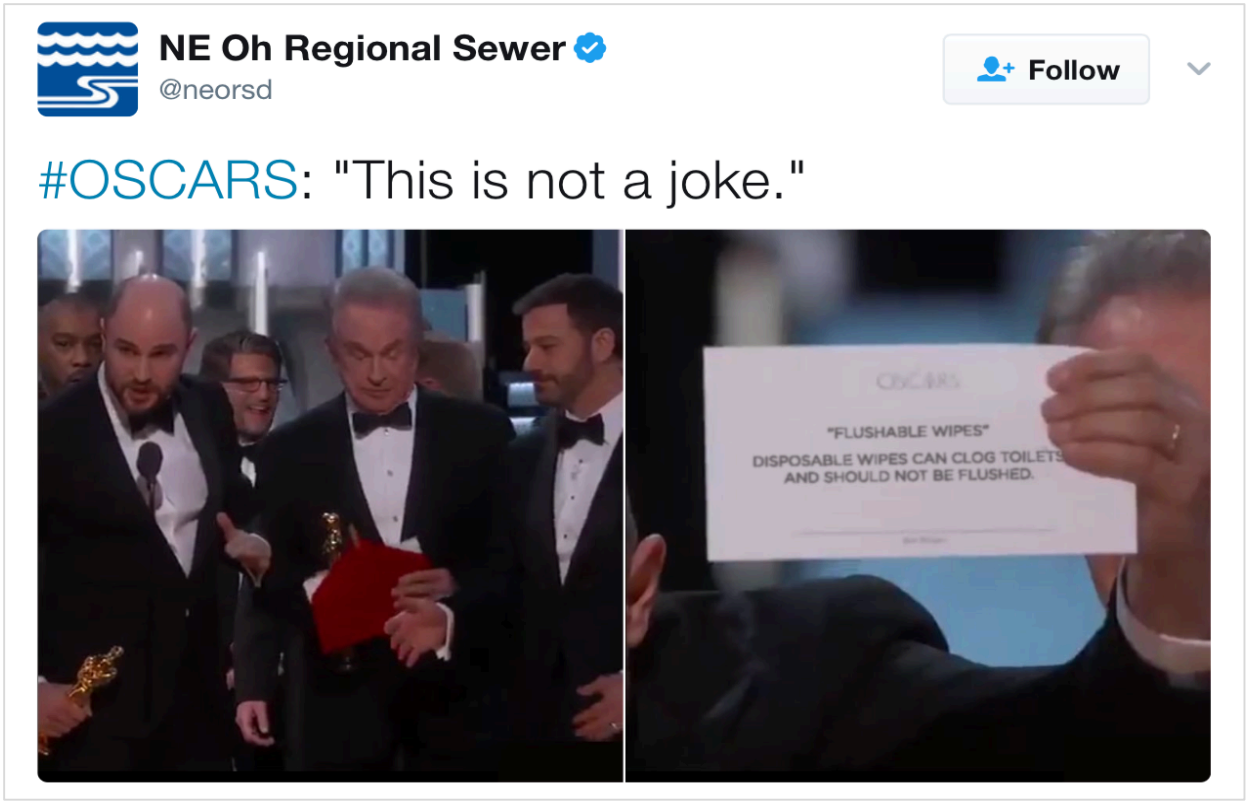


Figure 25: An example of how social media can be used to convey educational messages about wastewater management in a humorous way. Source: NE Oh Regional Sewer (2017).

In general, social media provides many opportunities to add crowdsourced content into the campaign. Via social media, community members could, for example, be invited to give general feedback on educational resources or develop or vote for a tagline, logo, and/or mascot. In addition, visitors should be motivated to take pictures and videos at the pilot CW and upload them to social media. Some of these pictures can be shared via the project's own social media sites. Overall, crowdsourced content encourages more interaction, community engagement, and representation in the project. However, it also requires campaign managers to more actively and frequently monitor their social media platforms for false information.

This section explains what social media platforms can be particularly useful for project-related communication. Recommendations are, if not indicated otherwise, based on platform-

specific information provided by Quesenberry (2016). Overall, it is suggested to first focus on increasing audience exposure on the most sustained social media platforms (such as Facebook). Afterwards, a broader social media presence should be established by becoming active on other platforms as well.

Social networks – A Facebook page for the project, titled "Sewanee Research Wetlands"[43], was acquired on April 17, 2017, however, it has – as any of the other social media platforms created so far – not actively been publicized and used for project-related communication yet. One way to promote the page and thus to increase audience exposure could, for example, be to ask visitors at community events to like the page and reward them with small gifts in return. Another possibility is that community members automatically enter a raffle when they like the Facebook page[44]. Furthermore, followers could be encouraged to take photographs at the pilot CW and upload them to the project's Facebook page. Prizes could be awarded for the best submission(s). In the long term, outreach efforts via Facebook should focus on sharing information that followers are presumed to find interesting, entertaining, and sharable; including, for example, "fun facts" that may create interest in any of the topics outlined in section 4.4, major project updates, photos of wildlife at the pilot CW and past events, and opportunities for community involvement. In addition, Facebook's events function should be used to increase awareness of upcoming community events.

Microblogging – A Twitter account – @SewaneeWetlands[45] – was created for the project as well; the page is publically accessible since March 2016. Many of the abovementioned strategies

[43] See www.facebook.com/SewaneeWetlandsRS. An attempt was made on June 21, 2017 to rename the page "Sewanee Wetland Research Station", however, at the time this thesis is being finalized, Facebook has not answered this request.
[44] For Facebook's policy on such contests or sweepstakes, see www.facebook.com/page_guidelines.php.
[45] See https://twitter.com/SewaneeWetlands.

for increasing audience exposure apply to Twitter, too. In the long-term, a Twitter account could, for example, be used to post short project updates, announce events at the wetland, report on community events at the pilot CW in real-time, and link to new website content. Furthermore, Twitter could be used to generate interest in the water quality monitoring program (see section 4.5.1.5).

Media sharing – The project would likely benefit from an Instagram account, considering the platform's popularity and young user base. The initial concern with an Instagram account was that the research station is a wastewater treatment facility and thus may not be visually appealing to everybody. An Instagram account could, however, focus on sharing photographs of wildlife sighted at the pilot CW[46], along with information about the particular species in the captions. Snapchat could specifically target college students. It could be used in a similar way as Instagram, but also, for example, to post videos from the latest community event. Furthermore, the project would benefit from uploading short videos to video-sharing platforms (see section 4.5.1.3). Vimeo[47] and YouTube[48] accounts have been created for the project in March and December 2016, respectively, and the "first impressions" video mentioned in section 4.5.1.3 was uploaded to YouTube on December 9, 2016 and to Vimeo on March 23, 2017. Overall, Vimeo is an excellent platform to share aesthetic videos with a community of film enthusiasts, however, the free weekly upload limit is 500 megabytes. YouTube does not have this upload limit, and videos would have a higher reach since YouTube is the more commonly known and independently-accessed platform of the two.

[46] Campaign managers might consider installing a motion-detection camera to capture wildlife at the site. If humans are photographed, they could be rewarded for being "captured" at the pilot CW.
[47] See https://vimeo.com/sewaneewetlands.
[48] See https://www.youtube.com/channel/UCrjCLqSjUOJ19ViUfoAwabg.

Forums – A forum would give people the opportunity to discuss their thoughts and possibly their concerns about the project with scientists from both UoS and UGA and other community members. This would be especially important when introducing and discussing the idea of indirect potable reuse. As a forum cannot be incorporated into the existing project website, it would have to be created on an external platform such as phpBB, Simple Machines Forum, or Zetaboards.

Social bookmarking – An AMA (Ask Me Anything) thread on Reddit could be used to host a community question and answer session online. Answering questions community members may have will be especially important when the idea of water reuse is introduced, but an AMA thread may also be helpful to educate community members about the CW pilot project in general. An existing Sewanee subreddit[49] could host this AMA thread. Additionally, the Sewanee subreddit should be monitored for any community-initiated discussions about the project.

Ratings and reviews – It is going to become increasingly important to frequently monitor popular rating and review platforms (such as Yelp) as well as the Facebook page as soon as guided tours are offered at the pilot CW. In the case that reviews and ratings are predominantly negative, the issue(s) that are brought up in these reviews should be addressed immediately.

Social knowledge – The project would greatly benefit from a Wikipedia entry, since nearly all Google searches return Wikipedia's listings in the top links. However, whether the project will have its own Wikipedia page depends on the level of independent media coverage (i.e. the project is mentioned in a significant number of reliable third-party sources)[50]. If the pilot CW does get its own Wikipedia page, it will be important to constantly monitor the page for incorrect information.

[49] See https://www.reddit.com/r/sewanee/.
[50] For more information, see Wikipedia's notability guidelines: https://en.wikipedia.org/wiki/Wikipedia:Notability#Self-promotion_and_publicity.

Geo-location – Lastly, visitors should be encouraged to geotag themselves at the pilot CW on Facebook and Instagram. The location is linked to the project's Facebook page; thus, geotagging would increase the page's exposure and generate more followers. A check-in location was created at the site on October 28, 2016. Facebook and Instagram users can now check-in to community events or (self-)guided tours and geotag their pilot CW-related posts.

4.5.1.6.1 Interconnectedness of social media channels

How the social media accounts that have been created for the project so far are interconnected with each other and the project website is illustrated in Figure 26. A new blog post on the website can automatically be shared via Facebook and Twitter if this option is chosen. Videos uploaded to YouTube are automatically shared on Twitter, videos uploaded to Vimeo on both Facebook and Twitter. Facebook posts are automatically shared on Twitter and vice versa.

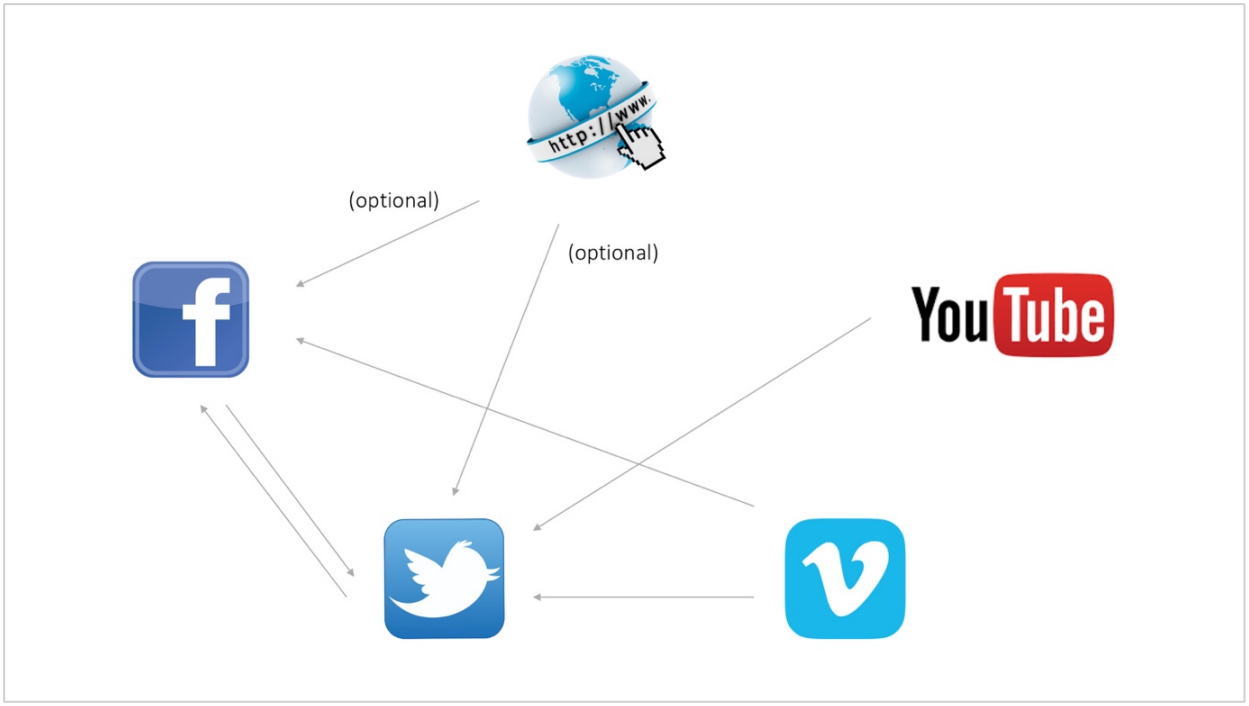


Figure 26: Interconnections between the website *www.sewaneewetlands.org* and social media channels created as part of the community engagement campaign developed for the constructed wetland pilot project.

4.5.1.6.2 Prioritization

To address the limited nature of campaign resources, this last subsection aims to prioritize the social media channels recommended above. This was done via a twofold approach: First, the popularity of each of the University of the South's social media channels was reviewed to estimate channel usage patterns in Sewanee. Channels that target similar demographics were compared to each other to additionally inform the prioritization process. Based on this research, recommendations are as follows:

Facebook should be prioritized over Twitter to communicate with older community members. Instagram should be prioritized over Snapchat to communicate with students (it is impossible at this point to determine the number of Snapchat users in Sewanee, but an Instagram post from June 16, 2017[51] demonstrates that an Instagram account can successfully be used for project-related communication exactly as described in section 4.5.1.6). To increase exposure and improve communication via Facebook and Instagram, the geo-location / "check-in" feature should be publicized as well. In terms of video-hosting platforms, YouTube should be preferred over Vimeo. All other platforms recommended in section 4.5.1.6 would be beneficial but are not vital. Note, however, that monitoring ratings and reviews platforms, as well as social knowledge platforms (such as Wikipedia) remains essential for the reasons explained above.

4.5.1.7 Project mascot

At the first community event (section 4.5.1.2), children had the opportunity to develop a mascot for the CW pilot project. As only three mascots were submitted at the event, the remaining templates were sent to Sewanee Elementary School on November 15, 2016, where teachers invited their students to submit their mascot ideas as well. An additional 15 submissions were picked up

[51] See https://www.instagram.com/p/BVZuVNOAUqc/?taken-by=univofthesouth.

at the school on March 3, 2017. Two examples of mascots submitted by SES students are provided in Figure 27; all 18 mascots received are attached in Appendix H.

Figure 27: Two designs received in a mascot design contest organized as part of the community engagement campaign developed for the constructed wetland pilot project. Mascots designed by Sewanee Elementary School students.

As soon as significant follower bases are generated on social media, all 18 mascots (plus any additional submissions that may have been received in the meantime) should be shared via the project's Facebook page, so that community members can vote for their favorite submission. The mascot that receives the most likes or shares in a defined period of time should then be redesigned professionally to become the official project mascot.

4.5.1.8 The Sewanee Mountain Messenger

Between August 2015 and June 2017, the Messenger released 17 issues in which the CW pilot project was mentioned. Articles reported on the progress of the project; explained the pilot CW's purpose, wetland design, and monitoring efforts; advertised and shared the results of the pre-

assessment survey; and publicized the first community event, the project website, and social media sites. Since focus group participants suggested developing a SMM series of short articles about local water issues and the CW pilot project, a possible framework of such series was developed (Table 2) based on the thematic outline of the campaign created in section 4.4.

Table 2: Recommended outline of an article series about local water issues and the constructed wetland pilot project in the Sewanee Mountain Messenger.

1	**Interconnectedness of water resources** The hydrologic cycle Importance of sustainable water use Watersheds (including a description of what watershed(s) Sewanee is in) Sewanee's setting in the regional water supply chain
2	**Water supply in Sewanee** Water sources Drinking water treatment and quality Water availability and scarcity (including expected future developments) Water conservation (including recommendations for specific measures)
3	**Wastewater management in Sewanee** Wastewater treatment and discharge Responsibilities towards downstream users (the "fate" of wastewater) Role of the pilot CW in the overall system
4	**Constructed wetlands** Wetland ecosystems Relevance and use of CWs (including advantages to alternative systems) Ecosystem services Pilot CW (wetland design, plant species, and treatment processes)
5	**Water quality monitoring** Sampling and analysis procedures to test effectiveness of the pilot CW Explanation of water quality indicators measured First monitoring results and implications
6	**Contaminants of emerging concern** Impacts on ecosystems and human health Regulations (including expected development on state and federal levels) Monitoring for emerging contaminants in the pilot CW (and first results) Preventing contamination (including correct disposal of pharmaceuticals)

7	**Learning opportunities** Involvement of classes Opportunities for field trips Educational tours at the pilot CW (guided and self-guided) Visitor policy
8	**Project development** Review of monitoring results Discussion of implications and possible outcomes of the pilot study Potential benefits of an indirect potable reuse system to the community Transferability to other regions

The eight articles could be written collaboratively by UoS and K-12 students; students should be guided and articles reviewed by UoS faculty. It would in fact be an ideal semester project; however, articles would have to be published weekly to allow for enough preparation time. The Fall 2017 semester, for example, spans over 15 weeks (Office of the University Registrar, n.d.). Accordingly, the first seven weeks of the semester could be used to set up working groups with SES and SAS students, define responsibilities, and conduct research on the topics, whereas the latter eight weeks would serve to write and publish the articles. Especially during the first seven weeks of the semester, the series should also be publicized, possibly via the project website, and social media; and upon release, articles should be shared on the same platforms. Lastly, the SMM of course needs to be approached to discuss the idea of hosting the series.

4.5.1.9 Classifieds and email newsletters

Sewanee Classifieds was, as recommended in the focus groups, used to publicize the first community event at the pilot CW (section 4.5.1.2). The email-based subscription service was also helpful in soliciting participation in the pre-assessment survey. In the future, Classifieds should be used to announce events including guided tours, town meetings, and presentations, and to share new website content.

As some focus group participants were unsure about the age distribution of Classifieds users, an independent, free newsletter was established for the project as well. A neutral-sounding email address[52] was created with free webmail provider Mail.com on March 24, 2017. To facilitate the process of sending out newsletter emails in the future, a MailChimp[53] account was set up on October 18, 2016. With this account, two subscriber lists were created: "Test List for New Campaigns" and "Constructed Wetlands Project Updates". The first list serves to test new campaigns (i.e. emails sent to all subscribers on a list), the second one to send new campaigns to newsletter subscribers. At the first community event (section 4.5.1.2), 20 visitors signed up to receive occasional updates about the development of the project, thus, all their names and email addresses were added to the "Constructed Wetlands Project Updates" list. People can also sign up for the newsletter via the project website, as well as the project's Facebook page[54]. Furthermore, new campaigns are automatically shared via the project's Twitter account. In the future, the project newsletter can be used in a similar way as Classifieds; in fact, emails could potentially even be synchronized.

4.5.2 Recommendations for additional outreach efforts

Long-term recommendations for community engagement – until and possibly beyond July 2020 – are mainly based on the focus group results (see section 3.3.2.4). To avoid repetition, this section rather serves as a summary of engagement tools and strategies that were suggested by focus group participants but were not yet put into practice at the time this thesis was written (and therefore not discussed in section 4.5.1).

[52] sewaneewetlands@mail.com
[53] See https://mailchimp.com/about/.
[54] Anybody who signs up for the newsletter via the project website or the project's Facebook page is automatically added to the "Constructed Wetlands Project Updates" list.

Additional community engagement efforts should include offering guided tours of the pilot CW and publicizing tours of the SUD's drinking and wastewater treatment plants, organizing town meetings and making other project-related presentations open to the public, and planning other community events (such as pharmaceutical disposal, general recycling, and wetland vegetation harvesting events). Guided tours, town meetings, and community events can all be publicized via numerous of the media platforms described in section 4.5.1. Furthermore, it is recommended to design and construct or purchase a travelling exhibition to both advertise and educate about the project, and to produce advertising materials such as posters, flyers, and stickers for promotional purposes.

To specifically target students, one should collaborate with K-12 and university instructors to create opportunities for guest speakers, field trips, and media-based classroom discussion. Students should also be involved in media development and water quality monitoring processes. Lastly, SES's Friday School program can serve to involve students across institutions.

4.5.3 Summary

A summary of recommendations regarding the future development and/or management of communication platforms and the organization of community engagement activities is provided in Appendix I. Some additional recommendations from focus group participants, which were too detailed to be discussed in section 3.3.2, were included in this appendix as well. If possible, each strategy should be implemented unless preliminary evaluation demonstrates that it does not significantly contribute to achieving the campaign objectives outlined in section 4.1 (evaluating the effectiveness and efficiency of particular campaign elements is discussed in section 5.1). If campaign resources are limited, the process of prioritizing strategies should be informed by the results of the pre-assessment survey (section 3.3.1.3) and the focus groups (section 3.3.2.4.2).

4.6 Formation of a community advisory board

A community advisory board (CAB) is a partnership between researchers and representatives of a community to ensure community engagement and empowerment in academic research that directly affects it. Their functions can vary considerably, and accordingly, CABs can be beneficial in various situations. In most cases, CABs work as "two way streets" that bridge cultural gaps and facilitate ongoing dialogue between a research team and a community (Kennedy, Vogel, Goldberg-Freeman, Kass, & Farfel, 2009; Koné et al., 2000; Quinn, 2004): Board members both convey information about a research project to the community and in turn inform academics about resulting perceptions, feedback, and concerns (Kennedy et al., 2009). Furthermore, CAB members can provide researchers with local knowledge and expertise, as well as consultation on specific matters. Therefore, creating a CAB representing the Sewanee community may continuously improve efforts to engage community members in the CW pilot project. A CAB would additionally underline the commitment of the research team to work with and for the community. The next paragraphs explain how advisory boards are formed, operated, and maintained.

Establishing specific inclusion criteria that reflect the intended purpose of a CAB and the envisioned roles of members are helpful in the process of selecting and recruiting board members that can bring the required expertise to the partnership (Newman et al., 2011). For the CW pilot project, board members should provide guidance on how to educate and engage community members; thus, one should consider K-12 and college instructors, media representatives, and residents who are actively involved with civic and social organizations as potential CAB members. In addition, at their June 20, 2017 board meeting, SUD board members expressed an interest to represent the utility district on a CAB as well. Overall, one should reflect on potential members' activities, reputation, and achievements in the community, their capability to contribute beneficial

resources to the CAB, their self-interests, and their potential conflicts (including conflicts of interests) (Newman et al., 2011; Pratt et al., 2015). Overall, CAB composition should reflect the community of interest in all its diversity (Koné et al., 2000; Pratt et al., 2015). There is no optimal number of participants; to provide an example, however, Pratt et al. (2015) referenced a CAB of 15 members.

Defining and revising operating procedures provides logistical guidance on how the board works to complete certain tasks, and helps to ensure agenda-setting and documentation of each meeting (Newman et al., 2011). Board members can act as co-decision-makers or merely as consultants (Koné et al., 2000; Newman et al., 2011), but as the decision-making body in this case is the SUD, a CAB for the CW pilot project would be advisory in nature. Board members may identify priority educational efforts, offer recommendations on effective communication strategies, help to develop educational materials for the campaign, assist in disseminating study results to Sewanee residents, provide feedback on ongoing activities, and suggest appropriate strategies to address community concerns and/or misperceptions about the project that may exist or develop in the community. Meetings should be open to the public and publicized, for example, in the SMM, so that interested community members can attend. How often a CAB should meet depends on the level of guidance the research team requires but is also limited by board members' other commitments. Again, Pratt et al. (2015) referenced a CAB that meets every four to six weeks. At the June 20, 2017 SUD board meeting, board members recommended meeting much less frequently (twice per year); though, campaign managers might contact CAB members individually or in group emails as help or advice is needed.

Evaluating partnership structure and processes, as well to what degree board members perceive their participation as relevant, beneficial, and overall satisfaction can help to constantly

improve and maintain CABs in the long-term (Newman et al., 2011). To further promote continued engagement, board members should be compensated for their time and efforts (Koné et al., 2000; Newman et al., 2011; Pratt et al., 2015). Compensations do not necessarily have to be monetary – Newman et al. (2011), for example, list potluck dinners and public recognition in local media as inexpensive strategies to value members' contributions. Ensuring sustainability also means to plan for periods of funding difficulties, for example; since resources allocated to the management of CABs are often limited (Newman et al., 2011; Strauss et al., 2001). If sustaining a CAB is not possible after all, clear communication among all stakeholders can leave the door open for future partnerships (Newman et al., 2011).

Lastly, a CAB representing the Sewanee community may even be continued past the duration of the CW pilot project. If the partnership has proven successful, both parties might agree to maintain or revive the collaboration for future research projects that affect the community. A strong and trusting partnership in the form of a CAB could therefore help to uphold positive relations between the Sewanee community and UoS in the long-term.

4.7 Potential campaign partners and community influencers

Atkin and Rice (2013) state that, rather than relying primarily on direct interaction, campaign managers may achieve a greater impact on their target audiences by "cultivating" individuals and groups who can exert interpersonal influence at the community level. These "community influencers" may affect other community members by reinforcing and customizing campaign messages to their individual audiences or demonstrating certain "role-model" behavior and activities (such as conserving water or visiting the pilot CW). Accordingly, an effort should be made to recruit them as campaign partners.

Several institutions have potential to lead conversations about (waste)water management in Sewanee – the five main institutions, as identified in the focus groups (see section 3.3.2.1), are the University of the South, K-12 schools, the Sewanee Utility District, the Sewanee Civic Association, and the Sewanee Mountain Messenger. All these institutions can help to accomplish the campaign objectives outlined in section 4.1. In general, it is recommended that campaign managers focus on gaining campaign partners' trust and understanding before discussing potentially controversial topics in general community settings (such as town meetings).

At the University, influential individuals and university bodies include Vice-Chancellor John M. McCardell Jr., Provost Nancy J. Berner, and the Board of Trustees. They might offer recommendations on how to communicate to students, faculty, and staff. In addition, along with the Office of University Advancement, they might be able to identify and secure funding opportunities for project-related research and outreach. The Trustees' Annual Meeting may be the simplest way to initiate this conversation – the next meeting will be on October 5-6, 2017 (Sewanee: The University of the South, n.d.). Other possible campaign partners include the university's Office of Environmental Stewardship and Sustainability (for example, to raise awareness of responsible water use) and the Office of Marketing & Communications (for instance, to increase project exposure through the university's website and social media channels). Lastly, faculty at the University of the South, as well as at Sewanee Elementary School and Saint Andrew's Sewanee School could help to increase awareness of the project through classes, student groups (such as environmental clubs or student newspapers), and family events.

Although the Sewanee Utility District is technically part of the research collaboration, they are also considered a key partner in publicizing the pilot project: The SUD could, for example, promote the project on their homepage and social media, and through bill stuffer announcements.

Other potential campaign partners include the Sewanee Civic Association, the Community Council, the Sewanee Leaseholders Association, and the Sewanee Women's Club. Furthermore, the Sewanee Mountain Messenger has and will play a major role in informing adult community members about the project. It will be critical to constantly reach out to the newspaper and convince reporters that the project is important and relevant to their audience.

Finally, as all focus group participants strongly supported the idea of engaging the community in the CW pilot project, considering their roles as community educators and leaders, one or two should be invited to become members of the community advisory board discussed in section 4.6. The same is of course true for representatives of all institutions mentioned in this section.

4.8 Management responsibilities

It is suggested that a work-study or other hourly position be created for either a UGA or Sewanee student to become the campaign coordinator during the first campaign year (an 8h/week position for a Sewanee student requires an annual budget of $1,800). During this time, it is recommended that the research team secure funding to hire a graduate research assistant at the University of Georgia who will take over as campaign manager during the second and third year. In the case that no funding is available to hire a research assistant, management responsibilities would need to be distributed among members of the research team. Alternatively, one could try to solicit for student volunteers who are looking to gain practical experience in the fields of communication or public relations. Many campaign elements (such as the travelling exhibition) could also be realized as semester projects at UoS or UGA.

Initially, it will be most important to monitor and manage the online platforms that have already been implemented (see sections 4.5.1.1, 4.5.1.6, and 4.5.1.9). In this regard, future student

assistants should have experience with online media, marketing, public relations, and/or journalism. Another responsibility will be to evaluate engagement via online media (this will be discussed in sections 5.1.2.1, 5.1.2.2, and 5.1.2.3). Prior to beginning their work, the student assistant should familiarize themselves with the project, especially with its implications and potential outcomes, and the insights gained from research conducted by previous student groups as well as for this thesis. The student assistant should refer to section 4.4 for the educational messages to be conveyed through online media. Most importantly, however, the student is expected to explain that the pilot CW will help to determine whether CWs can effectively remove pollutants, including emerging contaminants, from municipal wastewater. He or she needs to be aware that only if the water quality monitoring results, which the student is expected to share with the community (see section 4.5.1.5), show that this in fact is the case, will water reuse be considered as an alternative water supply option in Sewanee. Another obligation will be to make community members aware of the opportunities that exist for them to reach out to the research team via online media. Awareness of these media channels could be increased by publicizing them via local newspapers, Classifieds, and community events, for example.

Furthermore, the student assistant will be responsible for monitoring the project's email account and social media channels for messages and comments that require a direct response. Most questions will likely focus on the pilot CW itself, however, some people may be concerned about possible long-term implications of the project. The student assistant will be responsible for addressing these concerns and providing these people with correct information. To prevent misinformation from spreading, it is important to publically correct the person who is responsible for this post or comment as soon as possible. Accordingly, social media should be monitored several times a day, preferably seven days a week. Questions or comments that require a direct

response should never be ignored and optimally addressed within four hours (Sprout Social, 2016); within 24 hours at the latest. If concerns are indeed justified, it will be the student's responsibility to discuss these concerns with (1) the people who uttered them, and (2) with members of the research team, as justified concerns might in fact require project adjustments.

For guidance on how to access and manage the online platforms created for this project, two documents were created: First, a guide was developed on how to access and operate the project website. Second, login information for all remaining platforms, including all social media, as well as the project's email, MailChimp, and Google Analytics accounts were compiled in one comprehensive list. Both documents were made available to all members of the research team.

In the long term, it will become increasingly important for future student assistants to support the research team in areas such as media development, event organization, student involvement, and campaign evaluation and improvement. Overall, please refer to Appendix I for a more detailed list of channel-specific recommendations for future campaign managers.

4.9 Recommendations for community engagement after July 2020

How community education and engagement efforts should be carried further after July 2020 depends on the outcome of the pilot study, as well as the development of the campaign outlined in this chapter. Accordingly, it is difficult to make specific recommendations at this point.

If the pilot CW demonstrates that CWs can effectively and reliably remove pollutants (including emerging contaminants) from Sewanee's wastewater stream, a "follow-up" campaign should involve the Sewanee community in a dialogue regarding the feasibility of building a full-scale CW to introduce treated wastewater back into Sewanee's drinking water reservoirs (see section 1.2.3). To determine what remaining concerns and uncertainties a follow-up campaign should address, as well as to understand how communication strategies can be optimized,

evaluation guidelines and tools were developed for future use (discussed in chapter 5). Potentially, the CAB (see section 4.6) created for the pilot study can be maintained or revived for a campaign focusing on the feasibility of a full-scale CW. An additional target audience of this follow-up campaign would be regional decision-makers, i.e. officials from the Tennessee Department of Environment & Conservation, as they will make the final decision on whether to permit a reuse project.

If the pilot project proves successful, it is not recommended to follow a "decide, announce, and defense" approach (Po et al., 2003), but rather to continuingly focus on creating a community that is well-informed and therefore able to make reasoned decisions about their water supply options. If project managers can demonstrate that water reuse is necessary or at least beneficial, safe (i.e. that a full-scale CW works effectively and reliably), and more feasible than alternative options, a well-informed community should be expected to approve such practice. As this hypothesis has not yet been tested, this thesis calls for future studies (in Sewanee[55] and elsewhere) to generate evidence for or against its validity.

[55] This is further discussed in section 5.2.4.

CHAPTER 5

EVALUATION GUIDELINES AND TOOLS FOR FUTURE USE

Neresini and Pellegrini (2008) characterize communication as a "process able to engender change in those who take part in it" (p. 243). For this campaign, change is envisioned in the form of desired outcomes, measurably specified in objectives (see section 4.1). The process of assessing to what extent and how an intervention (here a communication campaign) produces intended change – or, in other words, achieves its objectives – is known as evaluation (Neresini & Pellegrini, 2008; Valente & Kwan, 2013). Evaluation is done through the continuous and systematic collection and analysis of data that serves as evidence of such change. This information can help campaign managers adapt to new, unforeseen situations and to improve current and future programs by optimizing the effectiveness of campaign messages, as well as communication channels and strategies. Undoubtedly, evaluation is a critical element of every communication campaign, especially considering their growing levels of complexity (Coffman, 2002; Neresini & Pellegrini, 2008; Rowe, Horlick-Jones, Walls, & Pidgeon, 2005; Valente & Kwan, 2013).

Numerous authors (Coffman, 2002; Neresini & Pellegrini, 2008; Rowe et al., 2005) emphasize the importance of incorporating evaluation planning into the development phase of a campaign. Hence, this chapter explains the evaluation tools and methodologies available to (1) improve campaign effectiveness and efficiency, and (2) determine campaign success. It is recommended that the tools outlined in section 5.1 be used throughout the campaign's implementation phase, whereas those discussed in section 5.2 should be applied after the program has concluded. Finally, as individual campaign elements may change over the course of the next

three years, all data-collection strategies discussed in this chapter are subject to evaluation themselves and should be revised as necessary.

5.1 Improving campaign effectiveness and efficiency

By assessing how target audiences respond to individual campaign elements, one can estimate to what extent each is effective in contributing to the achievement of the overall campaign objectives (Asibey et al., 2008; Atkin & Rice, 2013; Coffman, 2002). The ongoing collection and analysis of feedback can also facilitate the identification of sources of implementation problems; adaptation to change resulting from an unforeseen event, opportunity, or threat; and continuous refinement of the campaign program and communication strategies. It can also reveal the necessity to redistribute campaign resources to increase campaign efficiency. Overall, all adjustments resulting from the evaluation of campaign output and its effects are made to increase the probability of achieving the sought-for campaign outcomes most efficiently (Asibey et al., 2008; Neresini & Pellegrini, 2008; Valente & Kwan, 2013; W.K. Kellogg Foundation, 2004).

5.1.1 Evaluation questions

A list of questions that, when answered, will help those charged with implementing the community engagement program determine whether the campaign is on track towards reaching its objectives is provided in Table 3. As done by Asibey et al. (2008), evaluation questions are grouped into three categories to be posed during the early stages of the campaign, mid-course through its implementation, and in its advanced stages. Evaluation in the early stages of the campaign (here defined as the first campaign year) is most critical, as results will help campaign managers adjust the campaign's larger strategic direction and better understand what role, if any, each element plays in reaching the campaign objectives. Evaluation questions posed at later stages of the campaign (the second and third campaign years) mostly serve to forecast whether objectives are

likely to be achieved and, if not, what final adjustments need to be made (Asibey et al., 2008). Note that these questions are not meant to be conclusive; they should periodically be reexamined and revised if necessary.

Table 3: Evaluation questions that can help project managers measure the progress of the community engagement campaign developed for the constructed wetland pilot project. Modified from Asibey et al. (2008) and W.K. Kellogg Foundation (2004).

Early stages (Year 1)	• How do community members respond to our messages, communication channels and strategies, and spokespeople? • Are our communication channels suited for the messages we want to convey? How effective is each? • What evidence do we have that our messages are being absorbed by our target audiences? • How do community members perceive the quantity and quality of information provided? • Which internal processes and/or environmental factors are inhibiting or promoting progress? Can we create more supportive conditions? • Do our underlying assumptions and beliefs of how the communication program works seem correct? • How can strengths / successes be maximized and weaknesses / failures minimized? • Is the number of community members we have reached so far indicating progress towards reaching the campaign objectives (see section 4.1 for target numbers)? • Overall, what adjustments do we need to make?
Mid-course (Year 2)	• What evidence do we have that community members are more informed about local water issues than they were in late 2015 / early 2016 (see section 3.3.1 for baseline data)? • How many people are familiar with the CW pilot project? How many are actively involved in the project? What are possible reasons for low engagement? • Are our messages gaining visibility in independent media? How is the project portrayed? Has media coverage of the project changed since the start of our campaign? If so, is the change favorable to our objectives? • Have there been unforeseen events, news, or societal shifts that may affect our progress? If so, do these changes require that we change our communication tactics?

	• Can we make a valid claim of having contributed to the changes we observed since the campaign began? How? • Is the number of community members we have reached so far indicating progress? • Overall, what adjustments do we need to make?
Advanced stages (Year 3)	• Have water issues and the pilot project become part of the public discourse? What evidence do we have? If so, is the tone of conversations favorable to our objectives? Can we make a plausible case for having contributed to these results? • Has the prospect of indirect potable water reuse in Sewanee become more widely accepted in the community and among SUD board members? Are community members confident with our work to evaluate the effectiveness of constructed wetlands for this purpose? What evidence do we have? Can we make a plausible case for having contributed to these results? • If the pilot project seems to be successful, do any concerns with such project remain? If so, how can we address them? • Is the number of community members we have reached so far indicating progress? • Overall, what final adjustments do we need to make? • What lessons have we learned throughout the implementation of the campaign? Have we documented them? Can they help us to improve future outreach efforts? • Do we expect to reach the campaign objectives? How do we plan to move forward afterwards?

5.1.2 Tools and techniques for measuring progress

Collecting and comparing data from multiple sources and via a variety of methods is the key to robust and insightful evaluation (Neresini & Pellegrini, 2008; W.K. Kellogg Foundation, 2004). While it may not be possible logistically to conduct representative empirical studies such as surveys during the campaign (they are, however, essential to conclusively determine overall campaign success, as discussed in section 5.2), there exist multiple low-cost tools and techniques that can be used to track communication outputs and effects, and answer the questions listed in

section 5.1.1. Specifically, these tools and techniques can help campaign managers evaluate usage levels and patterns of individual media vehicles and the effectiveness of campaign messages by determining their consumption, comprehensibility, memorability, perceived relevance, as well as their generation of attention, interest, discussion, and concern (Atkin & Freimuth, 2013). Overall, each tool or technique should be used to assess whether a communication platform, activity, or event fulfills its individual purpose in the campaign (Gammon & Burch, 2006).

5.1.2.1 Measuring engagement via the project website

Although Squarespace has its own analytics tool, more data on engagement via the project website can be obtained through Google Analytics. Using the Google account that was created for this project, campaign managers can obtain information on site views / visitor numbers (new and returning visitors), individual page views, the average number of pages viewed during a site visit, and the average time spent on the website. Google Analytics also reveals the country and city website visitors are from; their language; their age, gender, and personal interests[56]; how they accessed the site (directly, through a search engine, by referral, or through social media); and the technology they used to do this[57]. For example, an overview of the Google Analytics interface (Figure 28) shows that, as of June 22, 2017, *www.sewaneewetlands.org* been accessed 813 times by 609 unique visitors since its launch in September 2016.

[56] Data related to age, gender, and personal interests is obtained through cookies and may therefore be limited. For more information, see https://support.google.com/analytics/answer/2799357?hl=en.

[57] To prevent corruption of this data, I created two types of filters: one to exclude traffic that is generated internally and one to exclude traffic generated by spam bots. Note that internal traffic cannot be excluded from the data in retrospective; therefore, website managers should always add a filter that prevents the recording of traffic generated through their own IP address(es). For assistance on how to set up this filter, please refer to the guide on website management referenced in sections 4.5.1.1 and 4.8. To exclude website traffic generated by spam bots before May 12, 2017 (which was when this problem became apparent and a filter was created to exclude future traffic of this type), click on "Add Segment" on the Google Analytics starting page, uncheck "All Users", check "Exclude Language Spam", and click on "Apply".

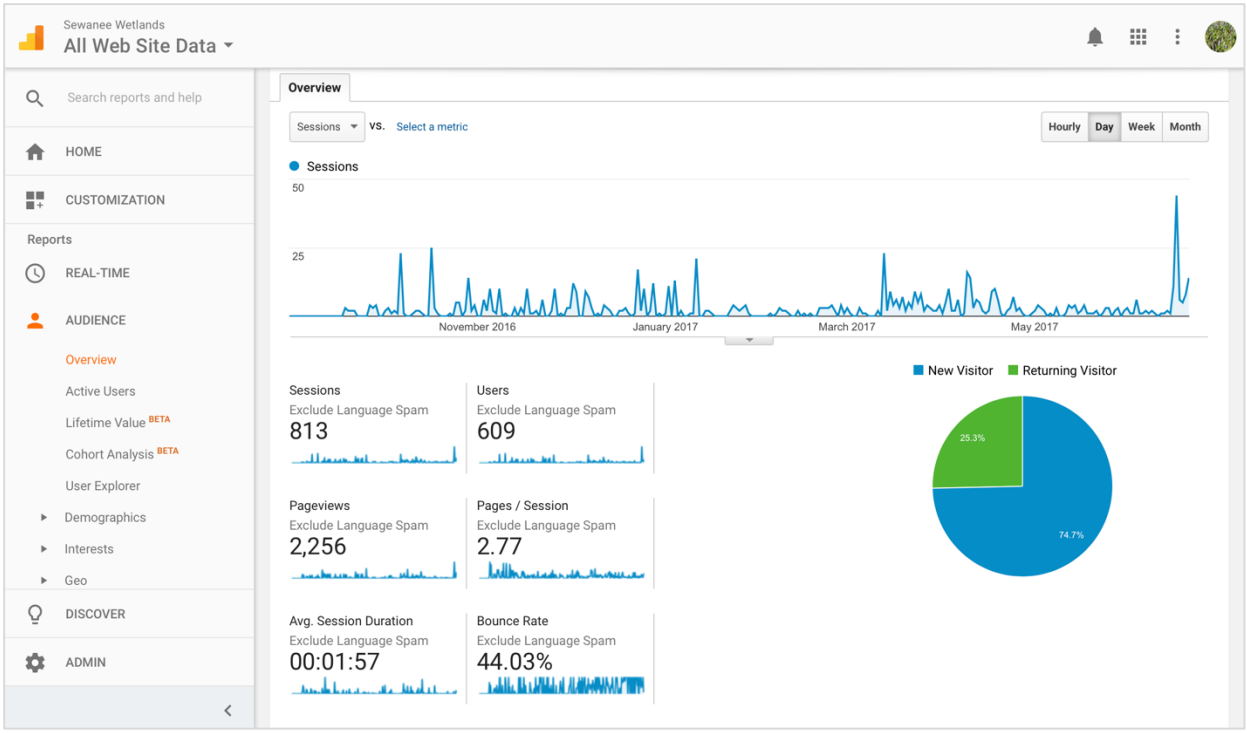


Figure 28: Overview of the Google Analytics interface, providing data on website traffic on *www.sewaneewetlands.org* since September 2016. Data captured on June 22, 2017.

To measure how blog posts are received, campaign managers should assess the number of views, likes, comments, and shares a post receives, as well as the tone of comments. Lastly, two additional measures may be useful to future campaign managers: the number of RSS feed subscribers and the number of people signing up for guided tours through the website. Squarespace's analytics tool gives an estimate of RSS subscribers, whereas campaign managers should manually keep track of tour registrations through the website to understand whether this option is publicized and incentivized sufficiently.

5.1.2.2 Measuring engagement via social media

Engagement via social media can be measured via platform-specific Key Performance Indicators (KPIs). Selected KPIs for each of the social media platforms recommended in section 4.5.1.6 are summarized in Table 4. Awareness and engagement can be measured, for instance, by the number

of followers, likes, comments, shares, and views; sentiment by reviewing the tone of comments and reviews. In general, measuring KPIs will help evaluators determine which platforms most contribute to reaching the campaign objectives and thus where to focus their energy (Jackson, 2016).

Table 4: Selected Key Performance Indicators for social media platforms recommended to be used as part of the community engagement campaign developed for the constructed wetland pilot project. Sources: Quesenberry (2016) and [1]Cicero (n.d.).

Media platform	Key Performance Indicators
Facebook	Page views; page likes; followers; status likes; comments; shares; views; tags; posts to page; direct messages; check-ins; ratings; number of reviews; participation in polls, sweepstakes, and contests; and sentiment.
Twitter	Page views; followers; likes; replies; retweets; views; mentions; direct messages; use of project-related hashtags; participation in polls, sweepstakes, and contests; and sentiment.
Instagram	Followers, likes, comments, shares, views, tags, use of project-related hashtags, participation in sweepstakes and contests, and sentiment.
Snapchat	Views, screenshots, story completions, and completion rate.[1]
YouTube	Subscribers, views, likes, dislikes, comments, shares, and sentiment.
Vimeo	Followers, views, likes, comments, shares, and sentiment.
Forums	Members, views, posts, comments, threads, and sentiment.
Yelp	Views, shares, comments, ratings, check-ins, number of reviews, and sentiment.
Reddit	Views, shares, upvotes, downvotes, ranking, subscribers to a Subreddit, Karma, and sentiment.
Wikipedia	Views, comments, and sentiment.

Many social media platforms include complimentary analytics tools (examples are Facebook Insights, Twitter Analytics, and YouTube Analytics) that can facilitate the measurement of these KPIs. Sentiment analysis, on the other hand, should be done manually since automatic monitoring sites such as SocialMention.com may, based on the author's experience with the platform, falsely interpret positive comments as negative and vice versa.

Lastly, it is possible to conduct quick polls via Facebook and Twitter. These could, for example, be used to gather opinions on a campaign logo, slogan, or mascot, or to ask for feedback on outreach activities or communication exchanges (which can be done through common posts, too, of course). As listed in Table 4, the number of people participating in these polls is yet another measurement of engagement.

5.1.2.3 Measuring engagement via newsletters

The effectiveness of the project newsletter can be measured through MailChimp's analytics tool – a performance report is provided automatically for each email sent. This report helps determine, among other things, how many emails were successfully delivered, how many people opened the email, whether they clicked on any linked content, and who unsubscribed from the newsletter (and why). MailChimp also keeps information on the total number of newsletter subscribers, their names, how they subscribed, and where they are from.

In addition, the number and tone of responses to newsletter emails may reveal specific interests of community members, as well as indicate support or opposition towards indirect potable reuse in Sewanee. This is of course true for all messages received via the project's email account.

5.1.2.4 Evaluating newspaper coverage and reception

It is recommended that campaign managers review all newspaper articles reporting on the project. Determining how an issue is framed and presented to target audiences in print media is generally

established through content analysis (Asibey et al., 2008; Coffman, 2002). This method can offer insights on how well messages are disseminated, whether any information is miscommunicated, and how coverage can be improved. It aims to answer the following questions (modified from Douglas Gould and Company, 2004):

- What topics are being covered? What are being ignored?
- How is the project presented? What messages are being used?
- How does the newspaper frame public discussion of the project?
- Does coverage reflect the intended framing of campaign messages?
- What individuals are quoted? If project-internal, do they effectively convey the campaign messages? If external, are they advocates of the project?
- Is the project front-page news? If not, where in the paper is it covered?
- What reporters cover the project?
- Does the volume or tone of coverage change over time? How can this change be explained?
- Are rebuttals or clarifications needed?

A detailed description of how to conduct this analysis is described in Douglas Gould and Company (2004). Overall, the focus should be on evaluating project coverage by the Sewanee Mountain Messenger, as it is Sewanee's most prominent newspaper and has, compared to regional newspapers, the greatest potential to influence residents' opinions about the project (D. McGrath, personal communication, June 15, 2017). Past and current issues can be obtained at no charge through the newspaper's online archives[58].

[58] See http://www.sewaneemessenger.com/archives/.

In addition, the SMM should be asked to forward any messages received in response to project-related articles. This way, one can keep track of how certain messages distributed through the newspaper were received. Similarly, reader reception can also be tracked by monitoring the SMM's Facebook page[59] for comments on project-related articles.

5.1.2.5 Measuring the success of community events

To measure attendance at community events, including citizen science activities, town meetings, and guided tours (both at the pilot CW and the SUD's water treatment plants), a sign-in-sheet template was created for future use and attached in Appendix J. This template can serve to track self-guided visits to the pilot CW as well, as discussed in section 4.5.1.4. By assessing attendance, campaign managers can determine whether they were successful in publicizing and incentivizing an event or self-guided tours. They can also use the contact information obtained to promote further involvement by sending participants a newsletter or inviting them to future events, for example. In addition, an increase in participants of a specific type of event could indicate that these events are well received, whereas a decline may indicate the opposite. Other indicators of success could include positive media coverage, interest on social media, and increased website traffic following an event. Moreover, it is recommended to frequently ask for direct feedback, either in person at the event (questions and comments should always be encouraged) or afterwards (for example, via social media), to improve future events. It can also be helpful to observe whether a certain audience (for example, older community members), dominates a specific type of event. If the event was meant to attract other age groups as well (such as university students), one can then target these individuals more consciously (in this example through social media or announcements in classes, for instance) to increase attendance at future events.

[59] See https://www.facebook.com/sewaneemessenger/.

5.1.2.6 Evaluating student learning and involvement

To evaluate and improve student involvement strategies, project-specific questions can be incorporated into general course evaluations conducted at SAS and UoS at the end of a semester or school year. The response rate would be relatively high as it would equal the typical class attendance rate. Alternatively, quick polls can be created using, for example, Google Forms and distributed to students via email or social media. Possible questions are:

- Are you familiar with the constructed wetland pilot project?
- If you heard about the project in school, in what classes or clubs did you learn about it?
- How did you learn about the project? (for possible answer options, see section 3.3.2.4.1)
- How would you rate each of your project-related experiences? (answer options should be identical to the ones provided for the previous questions)
- Did your instructor do a good job of explaining this project to you? If not, what could he or she have done better?
- Would you like to be more involved in the project? If so, how can we make that possible?
- How can we improve our communication efforts with students in general?

Lastly, questioning teachers about their experience discussing the project with their students can provide valuable insights as well. This can be particularly important for understanding how elementary school students perceive the project, as it may not be feasible to obtain this information directly through them (for example, due to communication barriers).

5.1.2.7 Evaluation through the community advisory board

While evaluating partnership structure and processes, as well as board members' overall satisfaction with their participation can help to improve and maintain a CAB[60] (Newman et al., 2011), the board itself can serve as an evaluation tool, too: As stated in section 4.6, board members may be able to provide feedback on ongoing activities and insights on how community members respond to them. Board members could also identify concerns and/or misperceptions about the project and suggest strategies to address them more effectively. Taking minutes at board meetings (which could even be posted on the project website) is therefore critical.

5.1.2.8 Observation

Finally, observing and documenting reactions can be a simple but powerful strategy to determine how certain messages are received by individuals or groups via all communication channels that involve some type of dialogue, discussion, or debate (see initiatives that are listed as "interactive" in Appendix I) (Asibey et al., 2008; Gammon & Burch, 2006; Neresini & Pellegrini, 2008; Rowe et al., 2005; W.K. Kellogg Foundation, 2004). Even the effectiveness of some one-directional communication channels (such as a travelling exhibition) could be assessed through this type of evaluation. Through observation, campaign managers may identify strengths and weaknesses in how messages are delivered, as well as opportunities for improvement (W.K. Kellogg Foundation, 2004). For example, at a town meeting, there are numerous indicators of success that can easily be observed, such as the physical and emotional comfort of attendants, active listening, request for additional information, or contribution to discussions (Gammon & Burch, 2006).

[60] This can, for example, be done by obtaining direct feedback during meetings or conducting quick polls via Google Forms.

5.1.3 Milestones

To answer the evaluation questions listed in Table 3, it can be helpful to define achievements to be accomplished by a certain point during the implementation of the campaign (Asibey et al., 2008; W.K. Kellogg Foundation, 2004): The accomplishment of these intermediate objectives, or milestones, indicates progress towards reaching the overall campaign objectives. Following recommendations by Asibey et al. (2008), three milestones were developed for each campaign objective (Table 5). All milestones were designed so that achievement can be measured using the tools and techniques outlined in section 5.1.2.

Table 5: Milestones that, if achieved, indicate progress towards reaching the objectives of the community engagement campaign developed for the constructed wetland pilot project. Structure adopted from Asibey et al. (2008).

Objective 1	Milestone 1A: There has been a noticeable increase in community members expressing interest in topics related to water usage in Sewanee.	Milestone 1B: There has been a noticeable increase in community members being aware of decreasing water availability in Sewanee and surrounding communities.	Milestone 1C: There has been a noticeable increase in community members recognizing the importance of responsible stewardship of available water resources.
	Possible measures: 1. Number of people signing up to visit the drinking water and wastewater treatment plants 2. Attendance at town meetings on these topics 3. Traffic on relevant website sections	Possible measures: 1. Attendance at town meetings on this topic 2. Engagement on social media regarding water availability in Sewanee	Possible measures: 1. Social media quick polls on water conservation or contamination prevention habits 2. Attendance at community events emphasizing this issue
	To be achieved by: The end of the first campaign year.	To be achieved by: The end of the first campaign year.	To be achieved by: The end of the first campaign year.

Objective 2	Milestone 2A 500 community members have visited the pilot CW.	Milestone 2B 500 community members regularly follow the development of the project.	Milestone 2C 500 community members are familiar with the water quality monitoring program.
	Possible measures 1. Attendance at (self-) guided tours, field trips, citizen science activities, and other on-site community events 2. Number of "check-ins" on social media	Possible measures: 1. Traffic on website sections that are frequently updated 2. Followers and engagement on social media 3. Number of newsletter subscribers	Possible measures: 1. Website traffic on this page 2. Attendance at citizen science activities 3. Estimates from teachers
	To be achieved by: The end of the first campaign year.	To be achieved by: The end of the first campaign year.	To be achieved by: The end of the first campaign year.
Objective 3	Milestone 3A Most community members recognize the benefits of potable water reuse and the feasibility of reuse projects in other parts of the world.	Milestone 3B 500 community members frequently follow the public water quality monitoring program.	Milestone 3C Most community members trust our efforts to evaluate the safety and reliability of a constructed wetland-based indirect potable reuse system.
	Possible measures: 1. Opinions expressed at town meetings or other community events 2. Sentiment of comments on social media and other messages received 3. Framing of newspaper articles reporting on this issue and reception	Possible measures: 1. Website traffic on this page (returning visitors) 2. Engagement on social media	Possible measures: 1. Opinions expressed at town meetings or other community events, as well as at SUD board meetings 2. Sentiment of comments on social media and other messages received 3. Framing of newspaper articles reporting on this issue and reception 4. Feedback from CAB members
	To be achieved by: The end of the second campaign year.	To be achieved by: The end of the second campaign year.	To be achieved by: The end of the second campaign year.

If a milestone is not reached, campaign managers should try to find an explanation and adjust communication tactics accordingly. However, no milestone developed here should be considered conclusive. If it is found that an intermediate objective cannot realistically be achieved in the given timeframe or that achievement is not measurable with the instruments available, it should be revisited (Asibey et al., 2008).

5.2 Determining campaign success

Summative evaluation describes the process of assessing the outcomes and changes resulting from a campaign after its completion (Atkin & Rice, 2013; Neresini & Pellegrini, 2008). Generally, this means testing whether and how predefined campaign objectives were accomplished; in other words, summative evaluation is essential to determine whether and why a program was effective[61] and successful, or failed (Gammon & Burch, 2006; Neresini & Pellegrini, 2008; Salmon & Murray-Johnson, 2013; Valente & Kwan, 2013). Whereas this type of evaluation is needed to quantify and demonstrate results (for example, to legitimize spent campaign resources), it can also improve future programs by systematically learning from successes and failures and building upon identified strengths while overcoming weaknesses (Coffman, 2002; Gammon & Burch, 2006; Neresini & Pellegrini, 2008; Valente & Kwan, 2013; W.K. Kellogg Foundation, 2004).

Summative evaluation is frequently done through the systematic collection and analysis of quantitative data, often to make generalizable statements about a population as a whole (Allen, Titsworth, & Hunt, 2009; Cowles & Nelson, 2015; Punch, 2003; Taylor-Powell & Hermann, 2000; Valente & Kwan, 2013). Since the objectives defined for this campaign are specified in numerical terms (aiming to impact 1,000 adult community members and all five SUD board members), a

[61] Both Rowe et al. (2005) and Salmon and Murray-Johnson (2013) emphasize the importance of defining "effectiveness" ahead of a campaign's implementation. Here, the campaign is considered effective when evaluation shows that it has reached its objectives, as specified in section 4.1.

quantitative study is best suited to measure achievement in this case as well. Examples of quantitative data collection methods include standardized interviews, self-administered questionnaires, and systematic observation. As questionnaires can, compared to interview-type surveys, be distributed to a larger number of potential respondents, it is recommended that this data collection method is used for evaluating this campaign. More specifically, campaign success should be determined by conducting two separate questionnaires: The first would collect a combined, representative sample of adult Sewanee community members (as further defined in section 4.1); the second would gauge opinions from all SUD board members.

5.2.1 Study design

First drafts of these two questionnaires were prepared for future use and are attached in Appendix K. This section explains what exactly the surveys were designed to measure. In general, both questionnaires include closed-ended questions (to collect quantitative data for statistical analysis and therefore determining campaign success), as well as open-ended questions (to collect additional qualitative data such as suggestions for improvements).

The first questionnaire (Q1) aims to collect a combined, representative sample of third and fourth-year university students, as well as other adult community members to measure whether at least 1,000 of them have been reached and positively impacted by the campaign (as envisioned in the campaign objectives). Q1 is divided into four sections: Questions in the "Water usage in Sewanee" section aim to measure participants' general knowledge of water-related topics (A1 – A4) and their perception of local water issues (A5 – A6). Section B focuses on the CW pilot project. Questions aim to determine whether the public has been reached by the campaign (B1 – B4)[62], as well as to evaluate the quantity and quality of provided information (B5 – B6), the

[62] The significance of determining campaign exposure is further discussed in section 5.2.4.

effectiveness of individual communication channels and community events (B7 – B9), respondents' awareness of and engagement with the water quality monitoring program (B10 – B14), and their levels of confidence in CWs' treatment capabilities (B15 – B16). Section C, "Water reuse in Sewanee", was prepared for the case that the pilot project is successful. Questions in this section aim to measure the public's knowledge and views of water reuse (C1 – C2) and community members' attitudes towards an indirect potable reuse project in Sewanee (C3 – C6). Furthermore, Questions C7 – C9 serve to assess concerns with such project. Lastly, C10 asks participants whether they require any additional information on water reuse in Sewanee. Finally, the "Demographic information" section asks participants for their gender (D1), age (D2), education level (D4), and income (D5). The significance of collecting demographic information is discussed in section 5.2.4.

Questionnaire Q2, which is targeted towards SUD board members, is a significantly shorter version of Q1: It only consists of two sections; one about the CW pilot project, another about water reuse in Sewanee (again, this section should only be included if the pilot project is successful). Questions A1 – A4 aim to evaluate the information provided to SUD board members about both the pilot project and the associated community engagement campaign. Questions A5 – A7 specifically focus on sharing water quality monitoring data with the board. Board members' trust and confidence in the wastewater treatment capabilities of CWs is assessed through A8 – A9. Questions in the "Water reuse in Sewanee" section then aim to measure board members' knowledge about water reuse (B1), their attitudes towards an indirect potable reuse project in Sewanee (B2 – B5), and whether any concerns remain among the board (B6). Note that Q2 should be conducted after the results of Q1 (which in the case of a successful pilot project ideally suggest

community support) have been presented to the SUD board (as discussed in section 1.2.3). A detailed implementation timeline of the two studies is proposed in section 5.2.6.

5.2.2 Pretesting and survey distribution

At this point, it should be emphasized that Q1 and 2 are merely drafts. As the campaign is implemented, individual elements or strategies might change, which may require editing of survey questions. Furthermore, new questions may have to be added while others may become irrelevant. In addition, all introductory text should be reevaluated and routing instructions (in Appendix K, these are highlighted in blue) should be double-checked.

Next, each survey needs to be pilot tested (Atkin & Freimuth, 2013; Brace, 2008; Cowles & Nelson, 2015; Punch, 2003; Regmi, Waithaka, Paudyal, Simkhada, & van Teijlingen, 2016): Having a small number of people (25 – 40, according to Cowles and Nelson, 2015) taking each survey and giving feedback afterwards not only helps to eliminate general errors, but also to understand whether instructions and questions are clear, universally comprehensive, and interpreted equally by all respondents, whether questions and answer options provide relevant, meaningful, and sought-for information, and how long participants require to complete the survey (Brace, 2008; Cowles & Nelson, 2015; Punch, 2003; Taylor-Powell & Hermann, 2000). Piloting the surveys can also help to test distribution technology and the general administration procedure (Brace, 2008; Cowles & Nelson, 2015; Punch, 2003; Regmi et al., 2016). When possible, people participating in the pilot studies should meet the same eligibility criteria as actual survey participants (Punch, 2003). Note that data originating from the pilot phase should not be included in the actual survey data set (Cowles & Nelson, 2015), and neither should respondents who participated in the pretesting phase take the large-scale survey (Taylor-Powell & Hermann, 2000).

Upon finalization, the two surveys need to be distributed to prospective study participants. In this case, different distribution methods are recommended for each target audience: University students should be asked to complete Q1 in print, ideally at the beginning or end of a class, to achieve high response rates. The best strategy to facilitate participation by other adult community members would be to administer Q1 online, for example, through Qualtrics.com. A web-based questionnaire would be simple to construct, easy to access by most community members[63], thus accelerating the data collection process, and prove more resource-efficient than a paper-based version (Allen et al., 2009; Asibey et al., 2008; Atkin & Freimuth, 2013; Regmi et al., 2016). In addition, the quantitative study conducted as part of this thesis (see sections 3.2.1 and 3.3.1) showed that response rates are high when the survey is publicized through the right media (i.e. Classifieds, although the project newsletter and social media will likely be effective as well). To further increase the response rate, incentives[64] could be offered (Cowles & Nelson, 2015; Taylor-Powell & Hermann, 2000). Note that for data analysis, however, it is critical that the paper-based and the online survey remain identical in design, despite the different distribution methods used. Lastly, the best way to simultaneously reach all five SUD board members is at a board meeting (contacting and obtaining a response from each board member individually would simply be more time-consuming). Accordingly, Q2 should be given to board members in print. In summary, all three surveys would be self-administered. As students and SUD board members would complete paper-based surveys, however, they would have the opportunity to ask questions if researchers are present.

[63] Older community members may have to be approached in person (for example, at the Sewanee Civic Association's Senior Citizen Center) with a paper-based version of this questionnaire to guarantee this age group's representation.

[64] Examples are vouchers to local restaurants or Amazon gift cards. One could also make a small donation to a charity organization for each received response.

5.2.3 Selecting a sample and defining favorable results

For a sample to accurately represent an overall population, every individual must have an equal chance of being selected as a study participant. This generally requires random sampling (Allen et al., 2009; Cowles & Nelson, 2015). At the same time, a representative sample should proportionately reflect different, homogeneous subpopulations (Cowles & Nelson, 2015). What follows is an explanation of what in 2015[65] would have constituted a representative sample of adult Sewanee residents (as defined in section 4.1).

Using university enrollment data and general population estimates for Sewanee, it can be calculated that the entire population of interest for the Q1 study would in 2015 have equaled 1,442 community members (404 juniors and 382 seniors were enrolled at the university, whereas 656 can be classified as non-student, adult community members) (Office of the University Registrar, 2015, United States Census Bureau, 2015). A perfectly representative sample of all target participants would therefore have consisted to 28.02% of juniors at the university, to 26.49% of seniors at the university, and to 45.49% of other adult community members (non-students).

Another factor that affects a sample's ability to be representative is its size. A larger sample is more likely to accurately reflect the overall population. The needed sample size depends on the degree of required certainty that the sample is in fact representative, which is usually expressed in two variables: confidence interval (or "margin of error") and confidence level (Cowles & Nelson, 2015). The confidence interval is the range around an observed value that likely contains the "true" value (detectible only by collecting responses from every single individual in a population). The confidence level then describes how certain one can be that the true value lies within this interval

[65] This could not be done for 2016 or 2017 for reasons of data availability.

at all[66]. The smaller the confidence interval and the greater the confidence level, the larger the required sample size: In the 2015 example, using a target population of 1,442, a 5% margin of error and 95% confidence level (which, according to Cowles and Nelson, 2015, are commonly used in social science research) would require a sample size of 304; a 3% margin of error and 99% confidence level would require a sample size of 810[67]. Taken the percentages calculated earlier in this section, a sample of 304 responses would then ideally consist of 138 responses from non-student, adult community members, as well as of 85 responses from juniors and 81 responses from seniors at the university. Note, however, that, in this example, collecting closer to 400 responses might be a "safer" approach to achieve the desired confidence interval and confidence level, as participants sometimes skip questions or answer them incorrectly (see section 3.2.1).

To determine whether the campaign objectives were accomplished, it is critical to define "key questions". In Q1, these are A1, A3, and A4 (to determine achievement of objective 1); B1, B4, and B10 (to determine achievement of objective 2); and B6, B12, and B13 (to determine partial achievement of objective 3[68]). A percentage of survey participants equivalent to at least 1,000 out of all adult Sewanee residents (as specified in section 4.1) then needs to select answers that indicate the achievement of the campaign objectives; in Appendix K, these answers are highlighted in red. In Q2, key questions that serve to measure achievement of campaign objective 3 are A2, A5, and A6; all five SUD board members need to select the answers that are highlighted in red. In the case that the pilot project is successful, all five board members additionally need to indicate that they

[66] For example, in a marketing survey, 60% of study participants indicate to prefer Product A over Product B. Applying a 3% margin of error and a 95% confidence interval to these results means that researchers can be 95% sure that between 57 and 63% of the overall population prefer Product A over Product B.
[67] Sample size calculators are available online. See, for instance, https://www.surveymonkey.com/mp/sample-size-calculator/.
[68] If the pilot project is successful, additional key questions include B16 and C3.

are confident in CWs' wastewater treatment capabilities (A9) and support an indirect potable reuse project in Sewanee (B2).

5.2.4 Campaign exposure and socio-demographic variables

Valente and Kwan (2013) emphasize the importance of including a variable for campaign exposure in campaign evaluation studies, so that researchers can determine what impact a campaign had (i.e. who it reached and how it influenced them). People who were not reached by the campaign can then serve as a comparison or "control" group, so that evaluators can compare whether answers received from exposure and control groups are significantly different from each other (Coffman, 2002; Neresini & Pellegrini, 2008; Valente & Kwan, 2013). This would mean that the campaign had a measurable effect (however, this effect could also be negative). A campaign exposure variable therefore enables researchers to go further than merely determining whether the campaign objectives were reached (see section 5.2.3), as it helps them understand *how* and *why* the campaign did this (or did not).

Accordingly, a question was included in Q1 to measure campaign exposure via self-determination (Coffman, 2002): B1 – "Prior to participating in this study, were you familiar with the constructed wetland pilot project undertaken by the Sewanee Utility District, the University of the South, and the University of Georgia?" As this question assumes that familiarity with the CW pilot project is an indicator of campaign exposure, it should be emphasized at all project-related events (especially those that seem unrelated) that they were organized by the Sewanee-UGA-research group as part of the campaign. Determining campaign exposure will be most useful to investigate whether the campaign has significantly influenced community members' views on indirect potable reuse in Sewanee: In the case the pilot project is successful, the result that people

familiar with the CW pilot project are significantly more supportive of such proposal would strongly suggest that the campaign was responsible for this increase in support.

As discussed in section 2.4, various socio-demographic factors have repeatedly been found to have a significant impact on the level of water reuse acceptance. To test for any of these relationships in Sewanee following the implementation of the campaign, variables were included in Q1 to assess study participants' gender (D1), age (D2), level of education (D4), and income (D5). In addition, C1 measures respondents' general knowledge about water reuse. Statistical analysis on whether any of these factors influence community members' attitude towards a reuse project will provide valuable insights for a potential follow-up campaign that more specifically focuses on such a project. Future campaign managers can then more directly target and provide tailored information to those groups that are relatively more opposed to water reuse, as well as more efficiently seek dialogue with these people to address their concerns (Aitken et al., 2014; Khan & Gerrard, 2006; Wester et al., 2015). Question D3 enables evaluators to differentiate between responses obtained from University of the South students and permanent adult community members. This allows the SUD to distinguish the opinions of long-term residents who are more likely to be affected by a water reuse project. Lastly, it should be noted that religious beliefs have been found to influence people's views on water reuse as well (see section 2.4); however, the Sewanee community is believed to be too homogeneous in this regard (see, for example, Office of the University Registrar, 2017), which is why no such variable was included.

Although these relationships will likely be most insightful, statistical analysis should not be limited to comparing control and exposure groups and determining socio-demographic effects. Simple and multiple linear regression analysis is powerful to explain how different variables relate to each other and why (Allen et al., 2009; Punch, 2003) – it would be interesting, for example, to

investigate whether (and how well) community members' level of concern about the future availability of water in Sewanee predicts their attitude towards a water reuse project. One more possible relationship should be pointed out in this context: In section 4.9 it was proposed that, if project managers can prove that water reuse is necessary or at least beneficial, safe, and more feasible than alternative options, a well-informed community can be expected to approve such practice. This hypothesis is reflected in question C4 in Q1: If this hypothesis holds true, a respondent who answers all sub-questions with "yes" should support the idea of potable water reuse (i.e. answer question C3 favorably)[69].

5.2.5 Sharing results

Once the data has been analyzed and interpreted, it is recommended that results are shared with the following audiences:

1. *The Sewanee Utility District.* As explained in section 1.2.3, the board needs to be informed about the outcome of the community engagement campaign to decide whether to move forward with a full-scale reuse project.

2. Findings should also be shared with *community members* in general, especially those who participated in the evaluation study, as the results might influence future water resources management decisions in Sewanee (see also section 2.2.9 for the importance of transparency when planning a water reuse project).

3. As argued in section 5.2, one purpose of outcome evaluation is the improvement of future programs. If the pilot project is successful, insights may therefore assist *researchers charged with developing a community engagement campaign for a full-scale reuse project* (see section 5.2.4 for how evaluation results can help to determine future target audiences, for example).

[69] Note that SUD board members additionally require the general support of the Sewanee community to approve of the project themselves. In Q2, this is reflected in question B3.

4. *Current and potential future funders,* since they will likely want to know whether the resources they provided were used effectively (Rowe et al., 2005). In addition, being able to validate the effectiveness and success of this campaign might help to secure additional funding for developing future campaigns, either in Sewanee for a full-scale reuse project or in other communities (W.K. Kellogg Foundation, 2004).

5. Study results that indicate community support for an indirect potable reuse project may help to create a better environment for potable water reuse regulations in Tennessee. It can therefore be beneficial to share evaluation results with the *Tennessee state government* (or more specifically, the Tennessee Department of Environment & Conservation).

6. Study results may also contribute to the discovery of new knowledge about effective practices related to both communication and evaluation (Asibey et al., 2008; Rowe et al., 2005; W.K. Kellogg Foundation, 2004). They should therefore be shared with the *scientific community*, for example, through journal articles or at professional conferences (Allen et al., 2009; Coffman, 2002).

7. Lastly, study results can be useful to *other utility districts or local governments* who are considering similar projects in their community (W.K. Kellogg Foundation, 2004).

According to Cowles and Nelson (2015), there are three major considerations in the presentation of evaluation results: audience, content, and expression. The main recommendations that go along with these considerations are as follows:

- Understand the different information needs of the target audiences. Prepare custom presentations for each audience, both in terms of content and form (Cowles & Nelson, 2015).

- Explain the purpose of the study, how data was collected, how data was analyzed, what the results are, and what they mean (i.e. explain implications and, if appropriate, make recommendation) (Cowles & Nelson, 2015; Punch, 2003). Only include the information that is relevant to the target audience, however.
- Know that each audience requires a different level of simplicity when presented with this information. Only use professional jargon when appropriate. Besides text, use graphs and tables to make findings more concise, clear, comprehensive, and compelling. Results can be shared through formal reports, executive summaries, or other publications, (PowerPoint-based) oral presentations, websites, social media, and even informal conversations (Cowles & Nelson, 2015; Valente & Kwan, 2013; W.K. Kellogg Foundation, 2004).

5.2.6 Implementation timeline

An overview of all summative evaluation-related tasks and a proposed timeline for their implementation are provided in Figure 29. This "roadmap" is presented in the form of a Gantt chart, a common tool in project planning and management, as it visualizes when each project step is scheduled to begin and how long it expectedly will take to be completed (Duffy, 2016; Wilson, 2003). It reads from left to right and from top to bottom. All general, preparatory tasks are displayed in red. Tasks specifically related to the administration of Q1 are shown in green, those related to Q2 in blue. Following the conclusion of the campaign in July 2020, the first data should be collected in September to guarantee that sufficient students are present to be surveyed. Altogether, I conservatively estimate the evaluation process will take seven months. Note, however, that the timeline displayed in Figure 29 is merely suggestive and should be adjusted as needed (for example, if funders require evaluation results earlier than December).

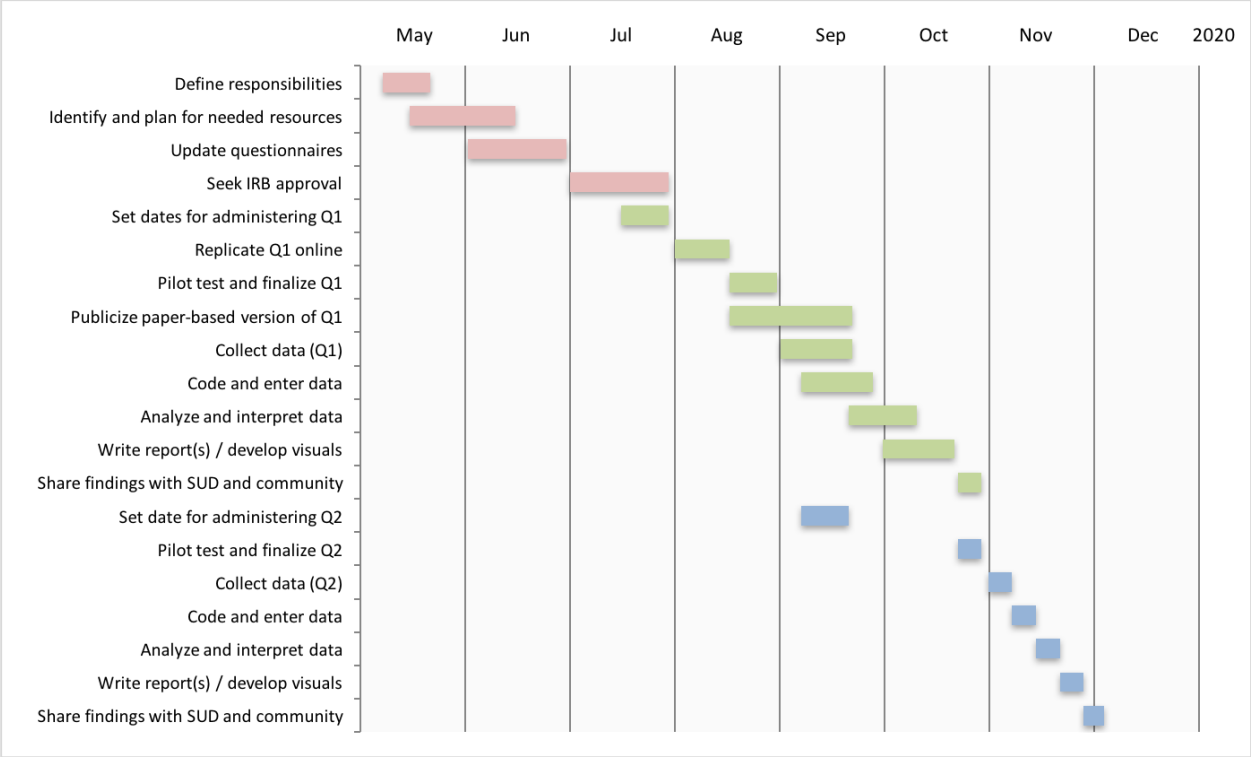


Figure 29: Possible timeline for evaluating the outcome of the community engagement campaign developed for the constructed wetland pilot project. Modified from Taylor-Powell and Hermann (2000).

CHAPTER 6

CONCLUSIONS

As further population growth and climate change exacerbate water scarcity in many parts of the world (Schewe et al., 2014), constructed wetlands have been proposed as a cost-effective wastewater treatment, storage, and reuse solution for small communities who seek to address current or expected water shortages (Ávila et al., 2015; Ávila et al., 2013; Greenway, 2005; United States Environmental Protection Agency, 2000b). As a major barrier to water reuse is public resistance (Dishman et al., 1989; Dolnicar et al., 2010; Ormerod & Scott, 2013), this thesis identifies community engagement strategies that can build public confidence in the process of evaluating the potential for CW-based water reuse systems. This was done in the context of a pilot study currently undertaken in Sewanee, TN.

In chapter 2, the scientific literature was reviewed to understand how social, cultural, and psychological factors can influence public acceptance of water reuse. It was found that, to increase community support, project managers should, for example, explain that using reclaimed water has no adverse effects on human health (Bruvold, 1988; Dishman et al., 1989; Hartley, 2006; Khan & Gerrard, 2006; Nancarrow et al., 2008; Ormerod & Scott, 2013; Po et al., 2003), that water conservation is a clear benefit of water reuse (Bruvold, 1988; Hartley, 2006), and that the costs associated with water reuse are reasonable (Bruvold, 1988; Hartley, 2006; Khan & Gerrard, 2006; Rock et al., 2012). Furthermore, it was discovered that positive experiences with low-contact water reuse can build public confidence and trust for higher-contact uses (Dishman et al., 1989; Marks, 2006), as well as that a greater understanding of the socio-demographic factors which correlate

with acceptance or opposition towards reclaimed water in a particular community can help to tailor more successful communication programs (Aitken et al., 2014; Khan & Gerrard, 2006; Wester et al., 2015). The chapter concluded that community engagement is crucial for the successful implementation of water reuse projects and that project managers should aim to create communities that are well-informed, free of misperceptions and unwarranted concerns, and altogether, empowered to make reasoned decisions about local water supply options.

Chapter 3 argued that the development of effective message content and distribution strategies should be guided by extensive evaluative research, for instance, on community-specific knowledge gaps, interests, or channel usage patterns (Atkin & Freimuth, 2013; Atkin & Rice, 2013; Coffman, 2002). To inform the development of a community engagement campaign for the pilot project in Sewanee, a pre-assessment survey and three focus groups were conducted. The survey helped to understand residents' current knowledge and perception of both global and local water issues, their interest in specific topics related to water, and the communication channels they rely on for this type of information. Focus groups participants explained how water issues are currently communicated in Sewanee, discussed what factors may increase the challenge of future outreach efforts, and identified opportunities to create interest in water-related topics. In addition, participants recommended community engagement tools and strategies to increase public knowledge of local water issues and the CW pilot project, and to create public confidence in the process of evaluating CWs' wastewater treatment potential.

In chapter 4, gained insights from previous chapters were used to develop the community engagement campaign for the pilot project: For the next three years, the campaign will aim to increase the general level of water literacy in the Sewanee community, raise awareness of the CW pilot project, and build public confidence in the process of evaluating the potential for a CW-based

indirect potable reuse project. Three target audiences were identified: (1) University students, (2) (other) adult community members, and (3) SUD board members. Informational areas of the campaign include the hydrologic cycle, watersheds, water usage in Sewanee, CWs, the pilot project, and water reuse. Messages should be distributed through a variety of communication channels; a comprehensive list of recommendations regarding the future development and/or management of communication platforms and the organization of community engagement activities is provided in Appendix I. A work study or other hourly position should be created for a UGA or Sewanee student to become the campaign coordinator during the first campaign year, and a graduate research assistant at UGA should take over as campaign manager during the second and third year.

Finally, chapter 5 explained what evaluation tools and methodologies will be available to future campaign managers to improve campaign effectiveness and efficiency. After defining evaluation questions to be posed throughout the campaign's implementation phase, multiple low-cost tools and techniques were presented that can be used to track communication outputs and effects. Three milestones were developed for each campaign objective to measure overall campaign progress. To determine campaign success, two questionnaires were prepared for future use (attached in Appendix K). The first aims to collect a representative sample of university students and other adult community members to measure whether a relevant percentage of the community has been reached and impacted by the campaign; the purpose of the second questionnaire is to gauge opinions from SUD board members. Besides measuring campaign success, these surveys will provide valuable insights for future outreach efforts (post 2020).

Although much research is still needed to fully understand how community engagement can build the basis for public acceptance of water reuse, this thesis has presented a detailed

description of how community engagement strategies can be developed in small communities that are in the process of evaluating the potential of an indirect potable reuse project. The evaluation guidelines and tools developed in chapter 5 will help to revisit and improve this initial framework over time.

My hope is that this work will benefit communities throughout the southeastern United States and possibly even internationally who seek to address current or expected water shortages through wastewater recycling. After all, the prospect of a global freshwater deficit remains, while demand keeps rising. Concluding this thesis, I believe that no water reuse project that is beneficial in nature is predetermined to fail, as long as project managers can address all concerns and unfounded opposition through effective communication.

REFERENCES

Addams, L., Boccaletti, G., Kerlin, M., & Stuchtey, M. (2009). *Charting our water future: Economic frameworks to inform decision-making*. Retrieved from 2030 Water Resources Group website: http://www.2030wrg.org/wp-content/uploads/2014/07/Charting-Our-Water-Future-Final.pdf

Agreed Order, Sewanee Utility District & Severn Trent Environmental Services, Inc.-Tennessee Department of Environment & Conservation, Division of Water Pollution Control, December 18, 2005, case no.: 05-0202; docket no.: 04.30-081460A.

Aitken, V., Bell, S., Hills, S., & Rees, L. (2014). Public acceptability of indirect potable water reuse in the south-east of England. *Water Science & Technology, 14*(5), 875-885. doi:10 .2166/ws.2014.051

Alhumoud, J. M., & Madzikanda, D. (2010). Public perceptions on water reuse options: The case of Sulaibiya wastewater treatment plant in Kuwait. *International Business & Economics Research Journal, 9*(1), 141-158. doi:10.19030/iber.v9i1.515

Allen, M., Titsworth, S., & Hunt, S. K. (2009). *Quantitative research in communication* [Adobe Digital Editions version]. doi:10.4135/9781452274881

Asibey, E., Parras, T., & van Fleet, J. (2008). *Are we there yet? A communications evaluation guide*. Retrieved from The Communications Network website: http://www.comnetwork .org/resources/a-guide-to-evaluating-foundationnonprofit-communications/

Atkin, C. K., & Freimuth, V. (2013). Guidelines for formative evaluation research in campaign design. In R. E. Rice & C. K. Atkin (Eds.), *Public communication campaigns* (4th ed., pp. 53-68). Thousand Oaks, CA: Sage.

Atkin, C. K., & Rice, R. E. (2013). Theory and principles of public comunication camaigns. In R. E. Rice & C. K. Atkin (Eds.), *Public communication campaigns* (4th ed., pp. 3-19). Thousand Oaks, CA: Sage.

Ávila, C., Bayona, J. M., Martín, I., Salas, J. J., & García, J. (2015). Emerging organic contaminant removal in a full-scale hybrid constructed wetland system for wastewater treatment and reuse. *Ecological Engineering, 80*, 108-116. doi:10.1016/j.ecoleng.2014.07.056

Ávila, C., Garfí, M., & García, J. (2013). Three-stage hybrid constructed wetland system for wastewater treatment and reuse in warm climate regions. *Ecological Engineering, 61*, 43-49. doi:10.1016/j.ecoleng.2013.09.048

Barbagallo, S., Barbera, A. C., Cirelli, G. L., Milani, M., & Toscano, A. (2014). Reuse of constructed wetland effluents for irrigation of energy crops. *Water Science & Technology, 70*(9), 1465-1472. doi:10.2166/wst.2014.383

Barth, B., Bevington, J., Biddle, L., Blaikie, H., Gore, A., Khan, R., . . . Suppakittpaisarn, T. (2012). *Sewanee Utility District constructed wetlands pilot project: A laboratory for applied ecology research: Section 1 Spring 2012 Environmental Practicum*. Unpublished student report, River Basin Center, Odum School of Ecology, University of Georgia, Athens, GA.

Brace, I. (2008). *Questionnaire design: How to plan, structure and write survey material for effective market research* (2nd ed.) [Adobe Digital Editions version]. Retrieved from http://www.libs.uga.edu

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101. doi:10.1191/1478088706qp063oa

Bruvold, W. H. (1988). Public opinion on water reuse options. *Journal (Water Pollution Control Federation), 60*(1), 45-49. Retrieved from https://www.jstor.org/journal/jwatpollcontfed

Carr, G., & Potter, R. B. (2013). Towards effective water reuse: Drivers, challenges and strategies shaping the organisational management of reclaimed water in Jordan. *The Geographical Journal, 179*(1), 61-73. doi:10.1111/j.1475-4959.2012.00478.x

Carr, G., Potter, R. B., & Nortcliff, S. (2011). Water reuse for irrigation in Jordan: Perceptions of water quality among farmers. *Agricultural Water Management, 98*(5), 847-854. doi:10 .1016/j.agwat.2010.12.011

Challis, J. K., Hanson, M. L., Friesenc, K. J., & Wong, C. S. (2014). A critical assessment of the photodegradation of pharmaceuticals in aquatic environments: Defining our current understanding and identifying knowledge gaps. *Environmental Science, 16*(4), 672-696. doi:10.1039/c3em00615h

Chen, Y., Vymazal, J., Březinová, T., Koželuh, M., Kule, L., Huang, J., & Chena, Z. (2016). Occurrence, removal and environmental risk assessment of pharmaceuticals and personal care products in rural wastewater treatment wetlands. *Science of the Total Environment, 566-567*, 1660-1669. doi: 10.1016/j.scitotenv.2016.06.069

Chen, Z., Ngo, H. H., Guo, W., Wang, X. C., Miechel, C., Corby, N., . . . O'Halloran, K. (2013). Analysis of social attitude to the new end use of recycled water for household laundry in

Australia by the regression models. *Journal of Environmental Management, 126*, 79-84. doi:10.1016/j.jenvman.2013.04.012

Ching, L. (2010). Eliminating 'yuck': A simple exposition of media and social change in water reuse policies. *International Journal of Water Resources Development, 26*(1), 111-124. doi:10.1080/07900620903392174

Cicero, N. (n.d.). 4 important Snapchat metrics your brand should be measuring. Retrieved from http://www.convinceandconvert.com/social-media-measurement/snapchat-measuring/

City of Athens, TN. (n.d.). Wetlands trail. Retrieved from http://www.cityofathenstn.com/trails/wetlands/index.html

Clayton County Water Authority. (n.d.). Water reuse. Retrieved from http://www.ccwa.us/water-use

Coffman, J. (2002). *Public communication campaign evaluation: An environmental scan of challenges, criticisms, practice, and opportunities*. Retrieved from Harvard Family Research Project website: http://www.hfrp.org/content/download/1116/48621/file/pcce.pdf

Cowles, E. L., & Nelson, E. (2015). *An introduction to survey research* [Adobe Digital Editions version]. Retrieved from http://www.libs.uga.edu

Crawford, B., Heidingsfelder, L., Pringle, R., Skupien, G., & Woolford, S. (2013). *Sewanee Utility District constructed wetlands pilot project: A laboratory for applied ecology research: Section 2 Spring 2013 Environmental Practicum*. Unpublished student report, River Basin Center, Odum School of Ecology, University of Georgia, Athens, GA.

Dakua, M., Mahmood, M., Bhowmik, S., & Khaled, F. (2016). Potential of grey water recycling in water scarce urban areas in Bangladesh. *International Journal of Environmental Science and Development, 7*(8), 563-567. doi:10.18178/ijesd.2016.7.8.840

Deeptha, V. T., Sudarsan, J. S., & Baskar, G. (2015). Performance and cost evaluation of constructed wetland for domestic waste water treatment. *Journal of Environmental Biology, 36*(5), 1071-1074. Retrieved from http://www.jeb.co.in

Demir, S., Kaynak, R., & Alpaslan, K. (2015). Usage level and future intent of use of Quick Response (QR) Codes for mobile marketing among college students in Turkey. *Procedia - Social and Behavioral Sciences, 181*, 405-413. doi:10.1016/j.sbspro.2015.04.903

Deo, R. P., & Halden, R. U. (2013). Pharmaceuticals in the built and natural water environment of the United States. *Water, 5*(3), 1346-1365. doi:10.3390/w5031346

Devakaram, D. S. E. (2007). *Determination of a water quality marker reflecting the effectiveness of the Sewanee Utility District land application system* (Unpublished master's thesis). Tennessee Technological University, Cookeville, TN.

Dishman, C. M., Sherrard, J. H., & Rebhun, M. (1989). Gaining support for direct potable water reuse. *Journal of Professional Issues in Engineering, 115*(2), 154-161. doi:10.1061 /(ASCE)1052-3928(1989)115:2(154)

Dodson, K. (2013). Educating and engaging the public on wastewater treatment: Tools & tips. In P. Cerro-Reehil, B. DeFrees, K. Dodson, & T. Taber (Eds.), *Wastewater management handbook for local representatives* (2nd ed., pp. 64-73). Retrieved from New York Water Environment Association website: https://nywea.org/images/temp/uploads /Wastewaterhandbook013013.pdf.

Dolnicar, S., & Hurlimann, A. (2009). Drinking water from alternative water sources: Differences in beliefs, social norms and factors of perceived behavioural control across eight Australian locations. *Water Science & Technology, 60*(6), 1433-1444. doi:10.2166/wst.2009.325

Dolnicar, S., Hurlimann, A., & Nghiem, L. D. (2010). The effect of information on public acceptance - The case of water from alternative sources. *Journal of Environmental Management, 91*(6), 1288-1293. doi:10.1016/j.jenvman.2010.02.003

Dolnicar, S., & Saunders, C. (2006). Recycled water for consumer markets - A marketing research review and agenda. *Desalination, 187*(1-3), 203-214. doi:10.1016/j.desal.2005.04.080

Dolnicar, S., & Schäfer, A. I. (2009). Desalinated versus recycled water: Public perceptions and profiles of the accepters. *Journal of Environmental Management, 90*(2), 888-900. doi:10.1016/j.jenvman.2008.02.003

Douglas Gould and Company. (2004). *Writing a media analysis*. Retrieved from Point K Learning Center website: http://www.issuelab.org/resources/1337/1337.pdf

Du, B., Price, A. E., Scott, W. C., Kristofco, L. A., Ramirez, A. J., Chambliss, C. K., . . . Brooks, B. W. (2014). Comparison of contaminants of emerging concern removal, discharge, and water quality hazards among centralized and on-site wastewater treatment system effluents receiving common wastewater influent. *Science of the Total Environment, 466-467*, 976-984. doi:doi.org/10.1016/j.scitotenv.2013.07.126

Duffy, J. (2016, October 31). 5 simple steps for getting started with Gantt charts. *PC Magazine*. Retrieved from http://www.pcmag.com/article/349109/5-simple-steps-for-getting-started-with-gantt-charts

E.G. Fisher Public Library. (n.d.-a). Tennessee Wetlands Festival. Retrieved from http://www .fisherlibrary.org/index.php/tennessee-wetlands-festival

E.G. Fisher Public Library. (n.d.-b). Wetlands. Retrieved from http://www.fisherlibrary.org /index.php/about/wetlands

Franklin, A. M., Williams, C. F., Andrews, D. M., Woodward, E. E., & Watson, J. E. (2016). Uptake of three antibiotics and an antiepileptic drug by wheat crops spray irrigated with wastewater treatment plant effluent. *Journal of Environmental Quality, 45*(2), 546-554. doi:10.2134/jeq2015.05.0257

Gammon, B., & Burch, A. (2006). A guide for successfully evaluating science engagement events. In J. Turney (Ed.), *Engaging science: Thoughts, deeds, analysis and action* (pp. 80-85). Retrieved from https://dlcs.io/file/wellcome/1/35763a4c-212e-45cf-93a6-f646e2b1e64f

Garcia, X., & Pargament, D. (2015). Reusing wastewater to cope with water scarcity: Economic, social and environmental considerations for decision-making. *Resources, Conservation and Recycling, 101*, 154-166. doi:10.1016/j.resconrec.2015.05.015

Garden, G. (2011, March/April). Sewanee's WT plant uses membrane system. *Tennessee Public Works, 28*(7), 4-5. Retrieved from http://www.bargewaggoner.com/media/k2/attachments /Tennessee_Public_Works_Magazine_Article.pdf

Ghermandi, A., Bixio, D., & Thoeye, C. (2007). The role of free water surface constructed wetlands as polishing step in municipal wastewater reclamation and reuse. *Science of the Total Environment, 380*(1-3), 247-258. doi:10.1016/j.ecoleng.2006.12.038

Ghrabi, A., Bousselmi, L., Masi, F., & Regelsberger, M. (2011). Constructed wetland as a low cost and sustainable solution for wastewater treatment adapted to rural settlements: The

Chorfech wastewater treatment pilot plant. *Water Science & Technology, 63*(12), 3006-3012. doi:10.2166/wst.2011.563

Gkika, D., Gikas, G. D., & Tsihrintzis, V. A. (2014). Construction and operation costs of constructed wetlands treating wastewater. *Water Science & Technology, 70*(5), 803-810. doi:10.2166/wst.2014.294

Golder Associates. (2015, November 9). *Re: Scope of work, cost and contract for constructed wetlands; Sewanee, Tennessee* [Letter to Dr. Deborah McGrath]. Copy in possession of Dr. Deborah McGrath (Department of Biology, Sewanee: The University of the South).

Google (Cartographer). (n.d.). [Google Maps - initial search term: Sewanee, Tennessee]. Retrieved June 23, 2017 from: https://www.google.com/maps/place/Sewanee,+TN/@35.2005185,-85.9580805,13z/data=!3m1!4b1!4m5!3m4!1s0x88610b306e98756d:0x2e64048b1c8af138!8m2!3d35.2031373!4d-85.9210899

Greenway, M. (2005). The role of constructed wetlands in secondary effluent treatment and water reuse in subtropical and arid Australia. *Ecological Engineering, 25*(5), 501-509. doi:10.1016/j.ecoleng.2005.07.008

Hartley, T. W. (2006). Public perception and participation in water reuse. *Desalination, 187*(1-3), 115-126. doi:10.1016/j.desal.2005.04.072

Hendon, D., & White, E. M. (2015). *Presence and removal of pharmaceuticals and personal care products in a rural wastewater treatment plant*. Unpublished research poster, Department of Chemistry, Sewanee: The University of the South, Sewanee, TN.

Higgins, R. (2011, July 6). Athens gets rain garden features. *Times Free Press*. Retrieved from http://www.timesfreepress.com/news/news/story/2011/jul/06/athens-gets-rain-garden-features/53373/

Hijazi, A., Parameswar, C., Pasch, J. R., McCornick, P. G., & Haddadin, M. (2006). Building sustainable reuse in Jordan using social marketing tools. *Proceedings of the Water Environment Federation, 2006*(Session 71 through Session 80), 6205-6218. doi:10.2175/193864706783775685

Hopson, M. N., Williams, A. C., McGrath, D., & White, E. (2016). Fluctuations in water chemistry during the early establishment of a surface wetland constructed for wastewater treatment. *Journal of Sewanee Science, 2*(1), 7-11. Retrieved from http://www.sewanee.edu/joss/

Houtman, C. J., Kroesbergen, J., Lekkerkerker-Teunissen, K., & van der Hoek, J. P. (2014). Human health risk assessment of the mixture of pharmaceuticals in Dutch drinking water and its sources based on frequent monitoring data. *Science of the Total Environment, 496*, 54-62. doi:10.1016/j.scitotenv.2014.07.022

Hughes, S. R., Kay, P., & Brown, L. E. (2013). Global synthesis and critical evaluation of pharmaceutical data sets collected from river systems. *Environmental Science & Technology, 47*(2), 661-677. doi:10.1021/es3030148

Hurlimann, A., & Dolnicar, S. (2010). When public opposition defeats alternative water projects – The case of Toowoomba Australia. *Water Research, 44*(1), 287-297. doi:10.1016/j.watres.2009.09.020

Interstate Technology & Regulatory Council. (2003). *Technical and regulatory guidance document for constructed treatment wetlands*. Retrieved from http://www.itrcweb.org/GuidanceDocuments/WTLND-1.pdf

Jackson, D. (2016, October 24). All of the social media metrics that matter. Retrieved from http://sproutsocial.com/insights/social-media-metrics-that-matter/

Kadlec, R. H., & Wallace, S. D. (2009). *Treatment wetlands* (2nd ed.). Boca Raton, FL: CRC Press.

Kaushal, M., Wani, S. P., Patil, M. D., & Datta, A. (2016). Monitoring efficacy of constructed wetland for treating domestic effluent - Microbiological approach. *Current Science, 110*(9), 1710-1715. doi:10.18520/cs/v110/i9/1710-1715

Kennedy, C., Vogel, A., Goldberg-Freeman, C., Kass, N., & Farfel, M. (2009). Faculty perspectives on community-based research: "I see this still as a journey". *Journal of Empirical Research on Human Research Ethics, 4*(2), 3-16. doi:10.1525/jer.2009.4.2.3

Khan, S. J., & Gerrard, L. E. (2006). Stakeholder communications for successful water reuse operations. *Desalination, 187*(1-3), 191-202. doi:10.1016/j.desal.2005.04.079

Kidd, K. A., Blanchfield, P. J., Mills, K. H., Palace, V. P., Evans, R. E., Lazorchak, J. M., & Flick, R. W. (2007). Collapse of a fish population after exposure to a synthetic estrogen. *Proceedings of the National Academy of Sciences of the United States of America, 104*(21), 8897-8901. doi:10.1073/pnas.0609568104

Kivaisi, A. K. (2001). The potential for constructed wetlands for wastewater treatment and reuse in developing countries: A review. *Ecological Engineering, 16*(4), 545-560. doi:10.1016/S0925-8574(00)00113-0

Knoll, M. A., Potter, D. B., & Van De Ven, C. (2015). Geology, hydrology, and water use history atop the Cumberland Plateau in the Sewanee and Tracy City, Tennessee, area. *GSA Field Guides, 39*, 197-218. doi:10.1130/2015.0039(07)

Kolpin, D. W., Furlong, E. T., Meyer, M. T., Thurman, E. M., Zaugg, S. D., Barber, L. B., & Buxton, H. T. (2002). Pharmaceuticals, hormones, and other organic wastewater

contaminants in U.S. streams, 1999−2000: A national reconnaissance. *Environmental Science & Technology, 36*(6), 1202-1211. doi:10.1021/es011055j

Kolpin, D. W., Skopec, M., Meyer, M. T., Furlong, E. T., & Zaugg, S. D. (2004). Urban contribution of pharmaceuticals and other organic wastewater contaminants to streams during differing flow conditions. *Science of the Total Environment, 328*(1–3), 119-130. doi:10.1016/j.scitotenv.2004.01.015

Koné, A., Sullivan, M., Senturia, K. D., Chrisman, N. J., Ciske, S. J., & Krieger, J. W. (2000). Improving collaboration between researchers and communities. *Public Health Reports, 115*(2-3), 243-248. Retrieved from http://journals.sagepub.com/home/phr

Konrad, C. E., II., & Fuhrmann, C. M. (2013). Climate of the southeast USA: Past, present, and future. In K. T. Ingram, K. Dow, L. Carter, & J. Anderson (Eds.), *Climate of the southeast United States: Variability, change, impacts, and vulnerability* [PDF version] (pp. 8-42). Retrieved from https://www.sercc.com/ClimateoftheSoutheastUnitedStates.pdf

Krueger, R. A., & Casey, M. A. (2000). *Focus groups: A practical guide for applied research* (3rd ed.). Thousand Oaks, CA: Sage.

Lee, E., Lee, S., Park, J., Kim, Y., & Cho, J. (2013). Removal and transformation of pharmaceuticals in wastewater treatment plants and constructed wetlands. *Drinking Water Engineering and Science, 6*(2), 89-98. doi:10.5194/dwes-6-89-2013

Li, W. C. (2014). Occurrence, sources, and fate of pharmaceuticals in aquatic environment and soil. *Environmental Pollution, 187*, 193-201. doi:10.1016/j.envpol.2014.01.015

Li, Y., Zhu, G., Ng, W. J., & Tan, S. K. (2014). A review on removing pharmaceutical contaminants from wastewater by constructed wetlands: Design, performance and

mechanism. *Science of the Total Environment, 468-469*, 908-932. doi: 10.1016/j.scitotenv .2013.09.018

Lohman, L. C., & Milliken, J. G. (1985). Public attitudes toward potable wastewater reuse: A longitudinal case study. In AWWA Research Foundation (Ed.), *Future of water reuse: Proceedings of the Water Reuse Symposium III: August 26-31, 1984: San Diego, California* (Vol. 1, pp. 109-121). Denver, CO: AWWA Research Foundation.

Lytle, L. (2016, November 22). SUD announces water restrictions. *Sewanee Mountain Messenger*. Retrieved from http://www.sewaneemessenger.com/headlines/?post _id=68&title=%E2%80%8Bsud-announces-water-restrictions

Marks, J. S. (2006). Taking the public seriously: The case of potable and non potable reuse. *Desalination, 187*(1-3), 137-147. doi:10.1016/j.desal.2005.04.074

Menegaki, A. N., Hanley, N., & Tsagarakis, K. P. (2007). The social acceptability and valuation of recycled water in Crete: A study of consumers' and farmers' attitudes. *Ecological Economics, 62*(1), 7-18. doi:10.1016/j.ecolecon.2007.01.008

Møller, K. A., Fryd, O., De Neergaard, A., & Magid, J. (2012). Economic, environmental and socio-cultural sustainability of three constructed wetlands in Thailand. *Environment & Urbanization, 24*(1), 305-323. doi:10.1177/0956247811434259

Murray, C. G., & Hamilton, A. J. (2010). Perspectives on wastewater treatment wetlands and waterbird conservation. *Journal of Applied Ecology, 47*(5), 976-985. doi:10.1111/j.1365-2664.2010.01853.x

Mustafa, A. (2013). Constructed wetland for wastewater treatment and reuse: A case study of developing country. *International Journal of Environmental Science and Development, 4*(1), 20-24. doi:10.7763/IJESD.2013.V4.296

Nancarrow, B. E., Leviston, Z., Po, M., Porter, N. B., & Tucker, D. I. (2008). What drives communities' decisions and behaviours in the reuse of wastewater. *Water Science & Technology, 57*(4), 485-491. doi:10.2166/wst.2008.160.

NE Oh Regional Sewer. (2017, February 27). #OSCARS: "This is not a joke." [Twitter post]. Retrieved from https://twitter.com/neorsd/status/836198320754294788

Nelson, M., Finn, M., Wilson, C., Zabel, B., van Thillo, M., Hawes, P., & Fernandez, R. (1999). Bioregenerative recycling of wastewater in Biosphere 2 using a constructed wetland: 2-year results. *Ecological Engineering, 13*(1-4), 189-197. doi:10.1016/S0925-8574(98)00099-8

Neresini, F., & Pellegrini, G. (2008). Evaluating public communication of science and technology. In M. Bucchi & B. Trench (Eds.), *Handbook of public communication of science and technology* [PDF version] (pp. 237-251). Retrieved from https://moodle.ufsc.br/pluginfile.php/1485212/mod_resource/content/1/Handbook-of-Public-Communication-of-Science-and-Technology.pdf

Newman, S. D., Andrews, J. O., Magwood, G. S., Jenkins, C., Cox, M. J., & Williamson, D. C. (2011). Community advisory boards in community-based participatory research: A synthesis of best processes. *Preventing Chronic Disease, 8*(3), A70. Retrieved from https://www.cdc.gov/pcd/

Office of the University Registrar. (2015). *Enrollment report: Advent 2015*. Retrieved from Sewanee: The University of the South website: https://registrar.sewanee.edu/downloads/enrollment-reports/U_of_South_Enrollment_Report,_Advent_2015.pdf

Office of the University Registrar. (2017). *Enrollment report: Easter 2017*. Retrieved from Sewanee: The University of the South website: https://registrar.sewanee.edu/downloads/enrollment-reports/U_of_South_Enrollment_Report,_Easter_2017.pdf

Office of the University Registrar. (n.d.). Combined Academic Calendar 2017–2018. Retrieved from https://registrar.sewanee.edu/calendars/combined/?school-year=2017-2018&show=combined

Olson, B. H., & Bruvold, W. (1982). Influence of social factors on public acceptance of renovated wastewater. In E. J. Middlebrooks (Ed.), *Water reuse* (pp. 55-73). Ann Arbor, MI: Ann Arbor Science Publishers.

Ormerod, K. J., & Scott, C. A. (2013). Drinking wastewater: Public trust in potable reuse. *Science, Technology & Human Values, 38*(3), 351-373. doi:10.1177/0162243912444736

Paisley, W., & Atkin, C. K. (2013). Public communication campaigns - The American experience. In R. E. Rice & C. K. Atkin (Eds.), *Public communication campaigns* (4th ed., pp. 21-33). Thousand Oaks, CA: Sage.

Pauling, C., & Ataria, J. (2010). *A study of Ngāi Tahu values and issues regarding waste* [PDF version]. Retrieved from http://www.mwpress.co.nz/__data/assets/pdf_file/0016/70513/LRSS_39_Tiaki_Para.pdf

Petrie, B., Barden, R., & Kasprzyk-Hordern, B. (2015). A review on emerging contaminants in wastewaters and the environment: Current knowledge, understudied areas and recommendations for future monitoring. *Water Research, 72*, 3-27. doi:10.1016/j.watres.2014.08.053

Po, M., Kaercher, J. D., & Nancarrow, B. E. (2003). *Literature review of factors influencing public perceptions of water reuse* (Technical Report 54/03). Retrieved from Clearwater

website: https://www.clearwater.asn.au/user-data/research-projects/swf-files/16-laying-the-foundation-for-confident-barrier-free-water-conservation-and-reuse-literature-review.pdf

Pratt, B., Lwin, K. M., Zion, D., Nosten, F., Loff, B., & Cheah, P. Y. (2015). Exploitation and community engagement: Can community advisory boards successfully assume a role minimising exploitation in international research? *Developing world bioethics, 15*(1), 18-26. doi:10.1111/dewb.12031

Project for Public Spaces. (2009, January 3). The Power of 10+: Applying placemaking at every scale. Retrieved from https://www.pps.org/reference/the-power-of-10/

Public Participation in Programs under the Resource Conservation and Recovery Act, the Safe Drinking Water Act, and the Clean Water Act, 40 C.F.R. § 25 (1979).

Public Utilities Board. (2017, May 4). NEWater. Retrieved from https://www.pub.gov.sg/watersupply/fournationaltaps/newater

Punch, K. F. (2003). *Survey research: The basics* [Adobe Digital Editions version]. Retrieved from http://www.libs.uga.edu

Quesenberry, K. A. (2016). *Social media strategy: Marketing and advertising in the consumer revolution*. Lanham, MD: Rowman & Littlefield.

Quinn, S. C. (2004). Ethics in public health research: Protecting human subjects: The role of community advisory boards. *American Journal of Public Health, 94*(6), 918-922. doi:10.2105/AJPH.94.6.918

Regmi, P. R., Waithaka, E., Paudyal, A., Simkhada, P., & van Teijlingen, E. (2016). Guide to the design and application of online questionnaire surveys. *Nepal Journal of Epidemiology, 6*(4), 640-644. doi:10.3126/nje.v6i4.17258

Rock, C., Solop, F. I., & Gerrity, D. (2012). Survey of statewide public perceptions regarding water reuse in Arizona. *Journal of Water Supply, 61*(8), 506-517. doi:10.2166/aqua,2012 .070

Ross, V. L., Fielding, K. S., & Louis, W. R. (2014). Social trust, risk perceptions and public acceptance of recycled water: Testing a social-psychological model. *Journal of Environmental Management, 137*, 61-68. doi:10.1016/j.jenvman.2014.01.039

Rowe, G., Horlick-Jones, T., Walls, J., & Pidgeon, N. (2005). Difficulties in evaluating public engagement initiatives: Reflections on an evaluation of the UK GM Nation? Public debate about transgenic crops. *Public Understanding of Science, 14*(4), 331-352. doi:10 .1177/0963662505056611

Russell, S., & Hampton, G. (2006). Challenges in understanding public responses and providing effective public consultation on water reuse. *Desalination, 187*(1-3), 215-227. doi:10 .1016/j.desal.2005.04.081

Sago, B. (2011). The usage level and effectiveness of Quick Response (QR) Codes for Integrated Marketing Communication purposes among college students. *International Journal of Integrated Marketing Communications, 3*(2), 7-17. Retrieved from http://jimc.medill .northwestern.edu

Salmon, C. T., & Murray-Johnson, L. (2013). Communication campaign effectiveness and effects: Some critical distinction. In R. E. Rice & C. K. Atkin (Eds.), *Public communication campaigns* (4th ed., pp. 99-112). Thousand Oaks, CA: Sage.

Schewe, J., Heinke, J., Gerten, D., Haddeland, I., Arnell, N. W., Clark, D. B., . . . Kabat, P. (2014). Multimodel assessment of water scarcity under climate change. *Proceedings of*

the National Academy of Sciences of the United States of America, 111(9), 3245-3250. doi:10.1073/pnas.1222460110

Schultz, M. K. (2013). A case study on the appropriateness of using Quick Response (QR) Codes in libraries and museums. *Library & Information Science Research, 35*(3), 207-215. doi:10.1016/j.lisr.2013.03.002

Schwartz, J. (2015, May 8). Water flowing from toilet to tap may be hard to swallow. *The New York Times*. Retrieved from https://www.nytimes.com/2015/05/12/science/recycled-drinking-water-getting-past-the-yuck-factor.html?_r=1

Sewanee Civic Association. (n.d.). Sewanee Classifieds. Retrieved from https://sewaneecivic .wordpress.com/sewanee-classifieds/

Sewanee Mountain Messenger. (2016, October 26). Upcoming meetings & events: Wetland tour [news release]. Retrieved from http://www.sewaneemessenger.com/resources/2016/10-28-16.pdf

Sewanee Utility District of Franklin and Marion Counties. (2015). *Water quality report 2015*. Retrieved from http://www.sewaneeutility.org/2015_SUD_CCR.pdf

Sewanee: The University of the South. (n.d.). Dates of interest: Future meeting dates. Retrieved from http://www.sewanee.edu/offices/trustees/dates-of-interest/

Shiklomanov, I. A. (1993). World fresh water resources. In P. H. Gleick (Ed.), *Water in crisis: A guide to the world's fresh water resources* (pp. 13-24). New York, NY: Oxford University Press.

Smith, M. (2017). *Evaluating the effectiveness of a constructed wetland in removing emerging contaminants from wastewater* (Unpublished capstone paper). Deptartment of

Environmental Health Science, College of Public Health, University of Georgia, Athens, GA.

Sprout Social. (2016). Shunning your customers on social? Retrieved from https://sproutsocial .com/insights/data/q2-2016/

Stein, S., & Hanson, L. (2009). *Water resources regional planning pilot study for the Southern Cumberland Plateau: Phase II: Critical regional drought evaluation: Final report*. Retrieved from Tennessee State Government website: http://www.tennessee.gov/assets /entities/environment/attachments/so_cumberland_drought_analysis102609.pdf

Strauss, R. P., Sengupta, S., Quinn, S. C., Goeppinger, J., Spaulding, C., Kegeles, S. M., & Millett, G. (2001). The role of community advisory boards: Involving communities in the informed consent process. *American Journal of Public Health, 91*(12), 1938-1943. doi:10 .2105/AJPH.91.12.1938

Szukalski, B. (2016). From open data to data engagement. Retrieved from http://www.esri.com /esri-news/arcuser/winter-2016/from-open-data-to-data-engagement

Taylor-Powell, E., & Hermann, C. (2000). *Collecting evaluation data: Surveys* (G3658-10). Retrieved from University of Wisconsin-Extension website: https://learningstore.uwex .edu/Assets/pdfs/G3658-10.pdf

Teasley, E., Bennett, J., Crider, C., McGrath, D., & Smith, K. (2011). *Pharmaceuticals from wastewater in streams draining a forested watershed on the Cumberland Plateau*. Unpublished research poster, Departments of Biology, Chemistry, Forestry, and Geology, Sewanee: The University of the South, Sewanee, TN.

Touraud, E., Roig, B., Sumpter, J. P., & Coetsier, C. (2011). Drug residues and endocrine disruptors in drinking water: Risk for humans? *International Journal of Hygiene and Environmental Health, 214*(6), 437-441. doi:10.1016/j.ijheh.2011.06.003

United Nations. (2014). 'Water for Life' UN-Water Best Practices Award: 2014 edition: Winners. Retrieved from http://www.un.org/waterforlifedecade/winners2014.shtml

United Nations Department of Economic and Social Affairs. (2015). *World population prospects: The 2015 revision: Key findings and advance tables* (ESA/P/WP.241). Retrieved from https://esa.un.org/unpd/wpp/Publications/Files/Key_Findings_WPP_2015.pdf

United Nations Environment Programme. (2004). *Guidelines on municipal wastewater management: A practical guide for decision-makers and professionals on how to plan, design, and finance appropriate and environmentally sound municipal wastewater discharge systems*. Retrieved from United Nations Department of Economic and Social Affairs website: https://esa.un.org/iys/docs/san_lib_docs/guidelines_on_municipal_wastewater_english.pdf

United Nations World Water Assessment Programme. (2015). *The United Nations World Water Development Report 2015: Water for a sustainable world*. Retrieved from United Nations Educational, Scientific and Cultural Organization website: http://unesdoc.unesco.org/images/0023/002318/231823E.pdf

United Nations World Water Assessment Programme. (2017). *The United Nations World Water Development Report 2017: Wastewater: The untapped resource*. Retrieved from United Nations Educational, Scientific and Cultural Organization website: http://unesdoc.unesco.org/images/0024/002471/247153e.pdf

United States Bureau of Economic Analysis. (2016, November 17). Personal income for Franklin. Retrieved from https://www.bea.gov/regional/bearfacts/action.cfm ?geoType=4&fips=47051&areatype=47051

United States Census Bureau. (2015). *Demographic and housing estimates, 2011-2015 American Community Survey 5-year estimates* [initital search term: Sewanee CDP, Tennessee]. Retrieved from: https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml

United States Census Bureau. (2016). QuickFacts: Athens city, Tennessee. Retrieved from https://www.census.gov/quickfacts/fact/table/athenscitytennessee#viewtop

United States Census Bureau. (2017, June 30). U.S. and world population clock. Retrieved June 30, 2017 from https://www.census.gov/popclock/

United States Environmental Protection Agency. (1979). *Municipal wastewater management: Public involvement activities guide* (EPA-430/9-79-005). Retrieved from National Service Center for Environmental Publications website: https://nepis.epa.gov/Exe/ZyNET .exe/9101811A.TXT?ZyActionD=ZyDocument&Client=EPA&Index=1976+Thru+1980 &Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocE ntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFi eldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C76thru80%5CT xt%5C00000025%5C9101811A.txt&User=ANONYMOUS&Password=anonymous&Sor tMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8 /r75g8/x150y150g16/i425&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&B ack=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPa ge=x&ZyPURL#

United States Environmental Protection Agency. (2000a). *Guiding principles for constructed treatment wetlands providing for water quality and wildlife habitat* (EPA 843-B-00-003). Retrieved from National Service Center for Environmental Publications website: https://nepis.epa.gov/Exe/ZyPDF.cgi/2000536S.PDF?Dockey=2000536S.PDF

United States Environmental Protection Agency. (2000b). *Manual: Constructed wetlands treatment of municipal wastewaters* (EPA/625/R-99/010). Retrieved from National Service Center for Environmental Publications website: https://nepis.epa.gov/Exe/ZyPDF .cgi/30004TBD.PDF?Dockey=30004TBD.PDF

United States Environmental Protection Agency. (2012). *2012 guidelines for water reuse* (EPA/600/R-12/618). Retrieved from National Service Center for Environmental Publications website: https://nepis.epa.gov/Adobe/PDF/P100FS7K.pdf

Valente, T. W., & Kwan, P. P. (2013). Evaluating communication campaigns. In R. E. Rice & C. K. Atkin (Eds.), *Public communication campaigns* (4th ed., pp. 83-97). Thousand Oaks, CA: Sage.

Verlicchi, P., & Zambello, E. (2014). How efficient are constructed wetlands in removing pharmaceuticals from untreated and treated urban wastewaters? A review. *Science of the Total Environment, 470-471*, 1281-1306. doi:10.1016/j.scitotenv.2013.10.085

Vymazal, J. (2010). Constructed wetlands for wastewater treatment. *Water, 2*(3), 530-549. doi:10 .3390/w2030530

W.K. Kellogg Foundation. (2004). *W.K. Kellogg Foundation Evaluation Handbook* (Item#1203). Retrieved from https://www.wkkf.org/resource-directory/resource/2010/w-k-kellogg-foundation-evaluation-handbook

Wang, C.-Y., & Sample, D. J. (2014). Assessment of the nutrient removal effectiveness of floating treatment wetlands applied to urban retention ponds. *Journal of Environmental Management, 137*, 23-35. doi:10.1016/j.jenvman.2014.02.008

Wester, J., Timpano, K. R., Çek, D., Lieberman, D., Fieldstone, S. C., & Broad, K. (2015). Psychological and social factors associated with wastewater reuse emotional discomfort. *Journal of Environmental Psychology, 42*, 16-23. doi:10.1016/j.jenvp.2015.01.003

Wilson, J. M. (2003). Gantt charts: A centenary appreciation. *European Journal of Operational Research, 149*(2), 430-437. doi:10.1016/S0377-2217(02)00769-5

Zhang, D., Gersberg, R. M., Ng, W. J., & Tan, S. K. (2014). Removal of pharmaceuticals and personal care products in aquatic plant-based systems: A review. *Environmental Pollution, 184*, 620-639. doi:10.1016/j.envpol.2013.09.009

Zhang, D., Ni, W., Gersberg, R. M., Ng, W. J., & Tan, S. K. (2015). Performance characterization of pharmaceutical removal by horizontal subsurface flow constructed wetlands using multivariate analysis. *CLEAN - Soil, Air, Water, 43*(8), 1181-1189. doi:10 .1002/clen.201400294

Zhu, S., & Chen, H. (2014). The fate and risk of selected pharmaceutical and personal care products in wastewater treatment plants and a pilot-scale multistage constructed wetland system. *Environmental Science and Pollution Research, 21*(2), 1466-1479. doi:10.1007 /s11356-013-2025-y

APPENDIX A

PRE-ASSESSMENT SURVEY

Dear Participant,

Our objective is to understand the general level of water literacy in our community. From this survey, we hope to learn about areas in which residents are well-informed, as well as gaps in knowledge, about water issues in Sewanee and beyond. Additionally, we want to gauge levels of confidence in the quality and quantity of Sewanee's water supply. The results from this survey will help identify the most effective ways of communicating local water issues. The goal is to design outreach campaigns that involve residents as active participants and encourage informed decisions on water management in our community.

We kindly thank you for your participation!

A Global water scarcity

A1 How would you define water scarcity? Check all that apply.

____ Insufficient **quantity** of water resources for people

____ Insufficient **quality** of water resources for people

____ Inaccessibility of water resources for people

____ Insufficient quantity and quality of water for ecosystems

A2 To what degree do you think clean water is becoming more scarce globally?
(1: water is not becoming more scarce at all; 2: water is probably not becoming more scarce; 3: water is slowly becoming more scarce; 4: water is very rapidly becoming more scarce)

1 2 3 4 ____ I don't know

A3 What do you think are the **biggest** factors, if any, driving global water scarcity? **Choose up to three**.

____ Global climate change

____ Seasonal droughts

____ Increase in human population

____ Water overuse / unsustainable water withdrawals

____ Pollution

____ Lack of supplying infrastructure

____ Lack of treatment technology

____ Increase in water demand

____ Inadequate water resource management

____ Other: _____

A4 What do you think that places that are experiencing drought (such as California) should do in the face of water scarcity? **Choose up to three**.

____ Citizens should take personal measures to conserve water.

____ Governments should require water conservation by industries and individuals.

____ Governments should financially reward citizens who conserve water.

____ The price of water should be more expensive for intensive users.

____ Municipalities should recycle wastewater for industrial and irrigation purposes.

____ Municipalities should recycle wastewater into the municipal water (tap) supply.

____ Other: _____

B Water availability in Sewanee

B1 How would you rate your level of knowledge about Sewanee's water supply in general? (1: not at all knowledgeable; 2: not very knowledgeable; 3: somewhat knowledgeable; 4 very knowledgeable)

1 2 3 4

B2 Where do you think your tap water comes from? **Choose one**.

____ A groundwater aquifer

____ A reservoir or lake

____ Directly from a stream

____ I don't know

B3 How would you rate your tap water?
(1: very poor; 2: poor; 3: fair; 4: good; 5: very good)

1 2 3 4 5 ____ I don't know

B4 How would you rate the current availability of water in Sewanee?
(1: very scarce; 2: rather scarce; 3: sufficient; 4: abundant)

1 2 3 4 ____ I don't know

B5 To what degree do you think it is important to conserve water in Sewanee?
(1: not at all important; 2: not very important; 3: somewhat important; 4: very important)

1 2 3 4 ____ I don't know

B6 To what degree are you concerned about the future availability of water in Sewanee?
(1; not at all concerned; 2: not very concerned; 3: somewhat concerned; 4: very concerned)

1 2 3 4

B7 How receptive do you think the Sewanee Utility District (SUD) is to concerns raised by its users?
(1: not at all receptive to concerns; 2: not very receptive; 3: somewhat receptive; 4: very receptive to concerns)

1 2 3 4 ____ I don't know

B8 What do you do to reduce the amount of water you use at home? Check all that apply.

____ Take shorter showers

____ Use rainwater (such as for watering plants)

____ Use water-conserving technologies (such as low-flush toilets)

____ Reuse water for different purposes

____ Look for and repair leaks (for example, a dripping tap)

____ Use a dishwasher rather than washing dishes by hand

____ Turn off water more often (for example while brushing teeth)

____ Run washing machine with full loads

____ Reduce lawn watering

____ Other: _____

B10 Approximately how much is your monthly water bill, on average?

_____

____ I do not receive a water bill (it is included in my rent / room and board)

____ I don't know

B11 Do you use any other sources besides tap water for drinking? Check all that apply.

____ Bottled water

____ Well water

____ Water collected from a spring

____ I use no other sources besides tap water for drinking

B12 Do you usually filter your tap water before drinking it?

____ Yes ____ No

C Wastewater treatment in Sewanee

C1 Have you ever visited Sewanee's Wastewater Treatment Plant?

____ Yes ____ No

C1a If yes: When? _____ (year)

For what purpose did you visit SUD?

_____

How have you heard about it?

_____

C2 What do you know about municipal water treatment and wastewater treatment in Sewanee? Check all that apply.

____ They both treat water so it meets standards for safe drinking.

____ **Municipal water treatment** results in a product that meets standards for safe drinking.

____ **Wastewater treatment** results in a product that meets standards for safe drinking.

____ **Municipal water treatment** results in a product that meets standards for discharge back to the environment.

____ **Wastewater treatment** results in a product that meets standards for discharge back to the environment.

____ I don't know

C3 Where do you think your wastewater goes (after treatment) in Sewanee? **Choose one.**

____ Directly into a stream

____ Directly into a reservoir

____ Directly into an underground reservoir

____ Land application

____ Septic tanks

____ I don't know

C4 Do you have any concerns about the way wastewater is being treated in Sewanee?

____ Yes ____ No

C4a If yes, what are they?

_____

D Information sources

D1 From what sources do you learn about water availability and quality **in other parts of the world**? Check all that apply.

____ Print newspapers and magazines

____ Radio

____ Television

____ Online news websites

____ Social media (Facebook, twitter, etc.)

____ Coworkers

____ Friends or relatives

____ Classes

____ Other: _____

D2 From what sources do you learn about water availability and quality in **Sewanee**? Check all that apply.

____ Print newspapers and magazines

____ Radio

____ Online news websites

____ Social media (Facebook, twitter, etc.)

____ Classes

____ Coworkers

____ Friends or relatives

____ Local Water Supplier

____ Other: _____

D3 What factors influence your view on how to treat our water resources? Check all that apply.

____ Religious beliefs

____ Ethics

____ Personal values

____ Educational background

____ Professional training

____ Concern for future generations

____ Care for the environment

____ Other: _____

D4 Are you interested in knowing more about:

D4a The quality of (tap) water in Sewanee?
(1: not at all interested; 2: not very interested; 3: somewhat interested; 4: very interested)

1 2 3 4

D4b The availability and supply of water in Sewanee?
(1: not at all interested; 2: not very interested; 3: somewhat interested; 4: very interested)

1 2 3 4

D4c How Sewanee treats its drinking water?
(1: not at all interested; 2: not very interested; 3: somewhat interested; 4: very interested)

1 2 3 4

D4d How Sewanee treats its wastewater?
(1: not at all interested; 2: not very interested; 3: somewhat interested; 4: very interested)

1 2 3 4

D5 What is the best way of communicating this information with you? **Choose up to three** that are most convenient.

____ An informational website

____ Articles published in local newspapers

____ A community information and question and answer session

____ An informational video

____ Social media information sites (Facebook, twitter, etc.)

____ A visit to the municipal water treatment plant

____ A visit to the wastewater treatment plant

____ Other: _____

E Demographic information

E1 Sex: Male Female

E2 Age: 18-25 26-35 36-45 46-55 56-65 Over 65

E3 Occupation: _____

APPENDIX B

FOCUS GROUP PROTOCOLS

Focus group 1 – Educators (February 11, 2016)

Before we begin:

1. I would like you to read through this consent form, and if you agree with this statement, to sign with your name and enter today's date at the bottom.
2. Are you comfortable with me recording this group discussion? (Please know that all of the recorded information will be kept confidential and that your identities will be kept anonymous.)
3. As soon as I start the recorder, I will read a brief introduction, the discussion questions we have prepared for today, and a closing statement directly from protocol. This will help me to avoid any unintentional omission of information that might be relevant to you and to guarantee that we get the information we are aiming for.

Protocol

My name is Philipp Nussbaum and I am a master's student in the Conservation Ecology and Sustainable Development program at the University of Georgia. Thank you very much for your time today. As you know, the University of the South, together with the Odum School of Ecology at UGA, is undertaking a constructed wastewater treatment wetland project here in Sewanee. This research collaboration aims at determining whether constructed wetlands are cost-effective in removing emerging contaminants such as pharmaceuticals from municipal wastewater, as well as at building public confidence in and awareness of constructed wetlands through a comprehensive public education campaign. Due to your occupation as local k-12 teachers, I believe that you are able to provide significant input.

Our discussion should take approximately 40 minutes. I would like to ask you questions specifically about what communication channels you believe are most effective in conveying water-related information to students and how to involve students in our constructed wetland kickoff event planned for spring. Please know that participation in this focus group is completely optional. If at any time during the interview, you would like to stop participation, you are free to do so. You may also refuse to answer any question you would not like to answer. All of the recorded information will be kept confidential and your identities will be kept anonymous. May we continue with your permission? As I have asked you previously before starting the recorder,

are you still comfortable with recording our interview? Do you have any further objections, concerns, or questions before we begin? Let's get started.

(Opening question)

- In order to introduce yourselves to each other, I would first like to ask each of you where you work, what subjects you teach, and what the typical age group of your students is.

(Introductory questions)

Now I would like to discuss the role of classroom education in raising awareness of local water issues, such as water availability and sources, water quality, and wastewater treatment.

- Do you think that k-12 teachers share a responsibility of educating young people about water issues in their community? If so, how is this already being done and what else could or has to be done?

(Transition questions)

I would now like to remind you that, in our pre-assessment survey, we identified an informational website, social media sites, and articles published in local newspapers as the most effective communication channels to convey water-related information to the public.

- To what degree do you believe would these communication channels be effective in educating k-12 students in Sewanee about local water issues?
- Do you think that we should involve students in the process of establishing these communication channels? If so, how?

(Key questions)

As you know, we are planning a major kickoff event for our constructed wetland project in spring.

- What would, in your opinion, be the most effective strategy to invite students to participate in this event and, once they decide to attend, what activities should we plan for them?

Let us now talk about how we can educate community members about constructed wetlands in general and Sewanee's wetland and its role in treating the community's wastewater specifically.

- Do you think that visiting the constructed wetland, which would, for example, include an informational tour, would be an effective education method?
- What other education methods would, in your opinion, be useful to introduce students to the wetland?
- How can we manage to also inform and involve parents via their children's education?

(Ending question)

That brings us to the end of our discussion.

- Is there anything else you would like to add that has not been mentioned today?

Thank you for your time and sharing your thoughts and experiences with me today. If I have any further questions, could I follow up with you again? Thank you once again, and I would be glad to share any updates about the development of our project with you.

Focus groups 2 and 3 – Community leaders (February 11/12, 2016)

Before we begin:

1. I would like you to read through this consent form, and if you agree with this statement, to sign with your name and enter today's date at the bottom.
2. Are you comfortable with me recording this group discussion? (Please know that all of the recorded information will be kept confidential and that your identities will be kept anonymous.)
3. As soon as I start the recorder, I will read a brief introduction, the discussion questions we have prepared for today, and a closing statement directly from protocol. This will help me to avoid any unintentional omission of information that might be relevant to you and to guarantee that we get the information we are aiming for.

Protocol

My name is Philipp Nussbaum and I am a master's student in the Conservation Ecology and Sustainable Development program at the University of Georgia. Thank you very much for your time today. As you know, the University of the South, together with the Odum School of Ecology at UGA, is undertaking a constructed wastewater treatment wetland project here in Sewanee. This research collaboration aims at determining whether constructed wetlands are cost-effective in removing emerging contaminants such as pharmaceuticals from municipal wastewater, as well as at building public confidence in and awareness of constructed wetlands through a comprehensive public education campaign. Due to your role as a leader in this community, I believe that you are able to provide significant input.

Our discussion should take approximately 40 minutes. I would like to ask you questions specifically about how we can most effectively convey water-related information to Sewanee community members and how to involve community members in our constructed wetland kickoff event planned for spring. Please know that participation in this focus group is completely optional. If at any time during the interview, you would like to stop participation, you are free to do so. You may also refuse to answer any question you would not like to answer. All of the recorded information will be kept confidential and your identities will be kept anonymous. May we continue

with your permission? As I have asked you previously before starting the recorder, are you still comfortable with recording our interview? Do you have any further objections, concerns, or questions before we begin? Let's get started.

(Opening question)

- In order to introduce yourselves to each other, I would first like to ask each of you where you work, what your job is, and about your role in this community.

(Introductory questions)

Now I would like to discuss the importance of increasing public awareness of local water issues, such as water availability and sources, water quality, and wastewater treatment, in this community.

- Who do you believe is responsible for educating community members about local water issues? How is this currently being done and what else could or has to be done?

(Transition questions)

I would now like to remind you that, in our pre-assessment survey, we identified an informational website, social media sites, and articles published in local newspapers as the most effective communication channels to convey water-related information to the public.

- What content do you believe should be covered on an informational website and what do you think would be the most effective strategy to promote this website?
- What types of social media do you think would be most effective in communicating water-related information with the community?
- What type of messages should we send out via what social media channels specifically? What type of messages should we send out in a possible newsletter that we could operate through the website?

(Key questions)

As you know, we are planning a major kickoff event for our constructed wetland project in spring.

- What would, in your opinion, be the most effective strategy to invite community members to participate in this event and, once they decide to attend, what activities should we plan for them?

Let us now talk about how we can educate community members about constructed wetlands in general and Sewanee's wetland and its role in treating the community's wastewater specifically.

- Do you think that visiting the constructed wetland, which would, for example, include an informational tour, would be an effective education method?

- What other education methods would, in your opinion, be useful to introduce community members to the wetland?

(Ending question)

That brings us to the end of our discussion.

- Is there anything else you would like to add that has not been mentioned today?

Thank you for your time and sharing your thoughts and experiences with me today. If I have any further questions, could I follow up with you again? Thank you once again, and I would be glad to share any updates about the development of our project with you.

APPENDIX C

CONSTRUCTED WETLAND EDUCATION PROGRAMS IN ATHENS, TN

The Public Works Department of the City of Athens, Tennessee – located halfway between Chattanooga and Knoxville with a population of 13,748 (United States Census Bureau, 2016) – has under director Shawn Lindsey developed an innovative and cost-effective strategy to optimize the municipal services the Department provides to the community: creating environmental systems such as artificial wetlands and rain gardens that serve functions such as flood protection and water quality enhancement. As part of this strategy, the Public Works Department has built a CW adjacent to the E.G. Fisher Public Library for flood mitigation, streambank restoration, and wetland reclamation (E.G. Fisher Public Library, n.d.-b). The CW was opened to the public in July 2011 and also serves as an outdoor recreation and education space to increase knowledge about wetlands and to raise environmental awareness in general (E.G. Fisher Public Library, n.d.-b; Higgins, 2011).

Athens' Public Works Department bases many of its projects that involve the creation of public spaces on the "The Power of 10+" concept. Developed by the nonprofit organization "Project for Public Spaces" (PPS), The Power of 10+ describes the idea that a public space thrives when visitors have at least ten reasons to go there. These reasons might include a playground to enjoy, a place to sit, people to meet, food to eat, or music to hear (Project for Public Spaces, 2009). The CW at the E.G. Fisher Public Library, including the surrounding area, was designed and built based on this idea.

The Athens community was involved during various stages of the project: While the CW was constructed, for example, community members were invited to help the Public Works Department plant trees at the site. Participants had to fill out a release form, which enabled the Public Works Department to keep track of how many people attended these events (S. Lindsey, personal communication, September 7, 2016). Community members were also asked to participate in an opening celebration on Friday, July 8th, 2011, from 5.30 – 10.00 p.m. Doug Elliot, a North Carolina naturalist, herbalist, and storyteller spoke at the event, and vendors sold, among other things, native plants and rain barrels (Higgins, 2011). The events were advertised through email, the local newspaper "The Daily Post-Athenian", and a public access television channel. Volunteers were also recruited from scout troops, churches, civic groups, and Tennessee Wesleyan University (S. Lindsey, personal communication, September 7, 2016).

Since 2014, the E. G. Fisher Public Library hosts an annual "Tennessee Wetlands Festival" at the CW that is sponsored by public institutions, private businesses, organizations, and individuals. The E.G. Fisher Public Library (n.d.-a) advertised the second annual festival in 2015 on their website as follows:

> Explore the Wetlands with hourly nature classes on topics ranging from the aquatic ecology of Tennessee wildlife to constructing rain gardens. Enjoy interactive nature walks, a variety of local food vendors, artisan crafts, a wetland art contest, live music from local musicians,

kids activities, Boy Scout demonstrations, and outdoor recreational exhibits. ("Tennessee Wetlands Festival", para. 2)

The festival organizers also created a festival guide that people could download to their mobile devices (E.G. Fisher Public Library, n.d.-a). According to Public Works director Shawn Lindsey, three times as many people attended the festival in 2016 compared to 2015 (personal communication, September 7, 2016). In addition, catered dinners and shows are annually held at the CW the night before the Wetlands Festival (this event is called "Wetlands Night Out"). Social media is, among other channels, used to advertise these events. Attendance to both the Wetlands Festival and Wetlands Night Out events is measured by keeping track of ticket sales (S. Lindsey, personal communication, September 7, 2016).

The Public Works Department built 0.64 kilometers of trails at the CW that allow for leisurely walks and guided tours (J. Riggsbee, personal communication, September 28, 2016). Guided tours are primarily offered by the Public Works Department's director and staff, but also by the nonprofit governmental organization "Keep McMinn Beautiful" and the E.G. Fisher Library, for example (S. Lindsey, personal communication, September 7, 2016). The tour informs visitors about how exactly the CW benefits the community in terms of flood control and mitigation. It also explains how each wetland plant species contributes to the functionality of the overall environmental system and how the plants have been used by humans and wildlife in the present and/or the past (City of Athens, TN, n.d.). Story-telling, rather than the presentation of simple facts, is thus an important element that is used to generate interest during the tour. Story-telling is combined with comparison and humor (Figure C1).

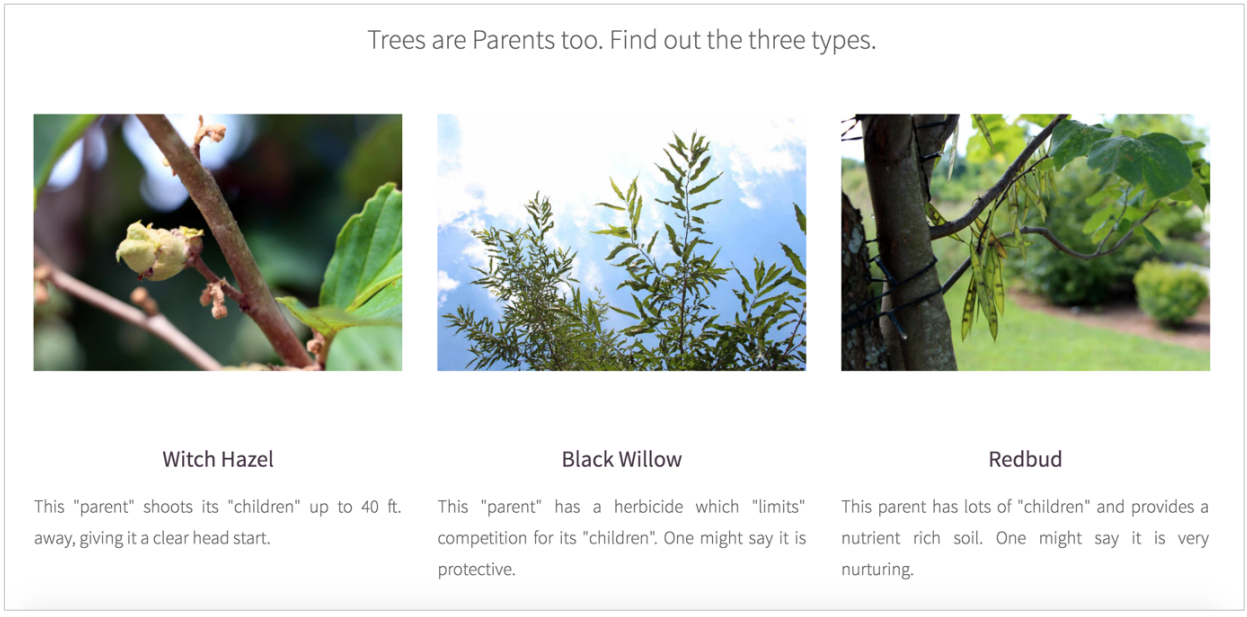


Figure C1: How comparison is used to educate community members about a constructed wetland in Athens, Tennessee. Source: City of Athens, TN (n.d.).

Furthermore, several kiosks allow for self-guided tours. All kiosks are designed in the same manner and, as the guided tours, inform visitors on environmental processes and how plant species have been used by man. What distinguishes the signs from the guided tours are nature poems and

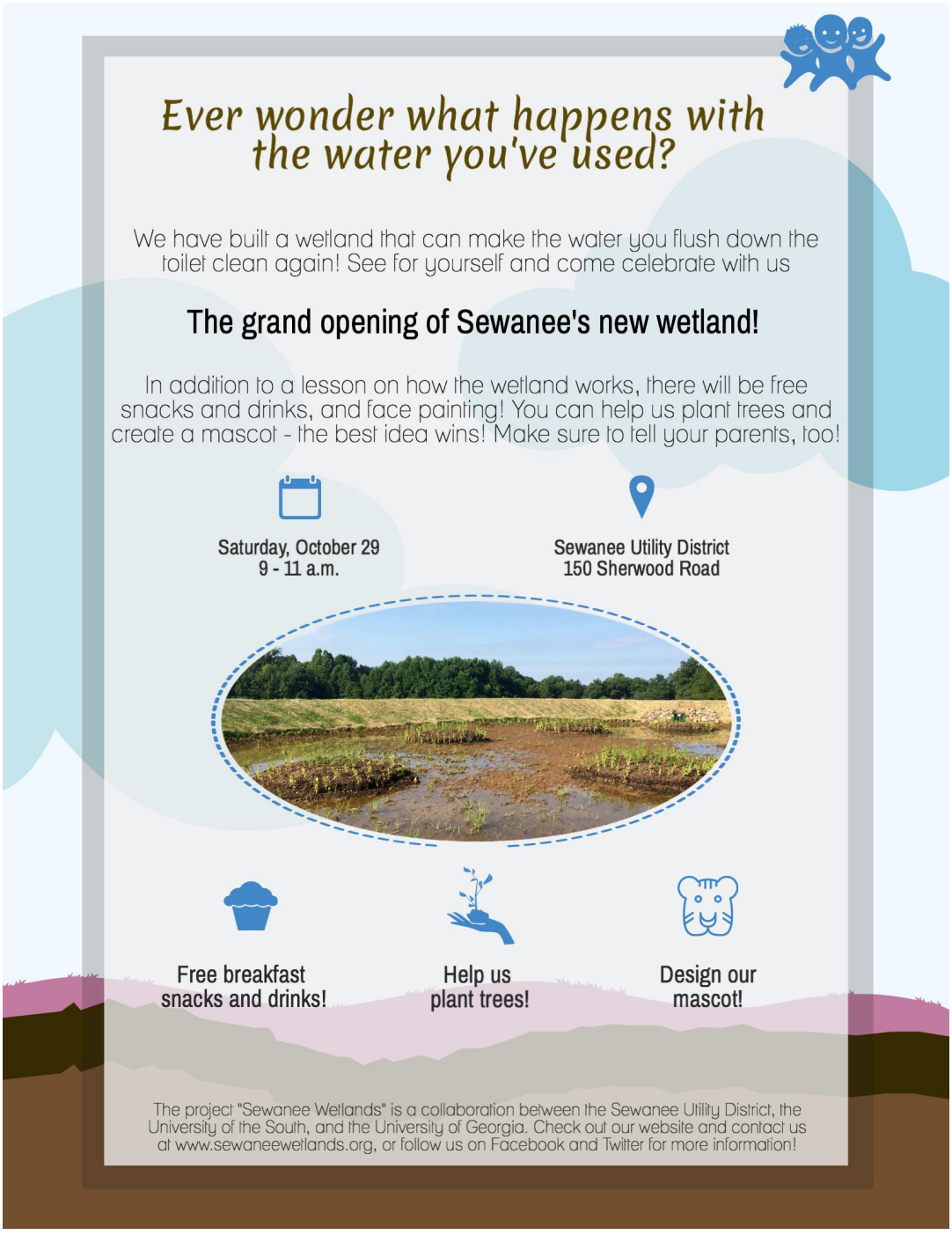
quotes – one is written on each sign. Other elements that facilitate recreation at the CW are a pergola, which can seat up to 60 people during social events, and a small stone amphitheater (City of Athens, TN, n.d.). The most important information from the kiosks and the guided-tour can also be found on a project website, which presents the information along with pictures that were taken at the CW. Website-content can be shared on social media via Facebook and Twitter buttons.

The effectiveness of the Public Works Department's outreach efforts has not been evaluated through surveys or other evaluation methods. However, Public Works director Shawn Lindsey has observed that more and more people visit the CW to walk the trails, read the kiosks, use the picnic areas, or to fish. He also notes how guided tours change many people's attitudes and appreciation of the CW: For example, many visitors expect to see stagnant water and mosquitos but find a healthy ecosystem with clean water, flowering plants, and plenty of wildlife instead (personal communication, September 7, 2016).

The key lesson that can be learned from this case study is that, to effectively educate the public about CWs, individuals of a specific community need to have a variety of reasons to actually visit one. These reasons may include an informative and entertaining guided tour, a trail that allows for leisurely nature walks, signs that help one understand the ecosystem processes that are taking place, the ability to see wildlife, or attending social events such as music festivals.

APPENDIX D

FLYERS AND POSTERS USED TO PUBLICIZE THE KICKOFF EVENT



Ever wonder what happens with the water you've used?

We have built a wetland that can treat your wastewater! Sounds pretty weird? We know, but it works! See for yourself and come celebrate with us

The grand opening of Sewanee's new research wetland!

There will be free breakfast snacks and refreshments, we will be planting trees together to make the wetland even more beautiful, and we will show you how we test the water that comes out of the wetland. There will also be activities for children!

Saturday, October 29
9 - 11 a.m.

Sewanee Utility District
150 Sherwood Road

Free breakfast snacks and drinks!

Help us plant trees!

See how we test the water!

Activities for children!

The project "Sewanee Wetlands" is a collaboration between the Sewanee Utility District, the University of the South, and the University of Georgia. Check out our website and contact us at www.sewaneewetlands.org, or follow us on Facebook and Twitter for more information!

APPENDIX E

LESSON PLAN ON THE WATER CYCLE AND WETLANDS

Length: 15 – 20 minutes

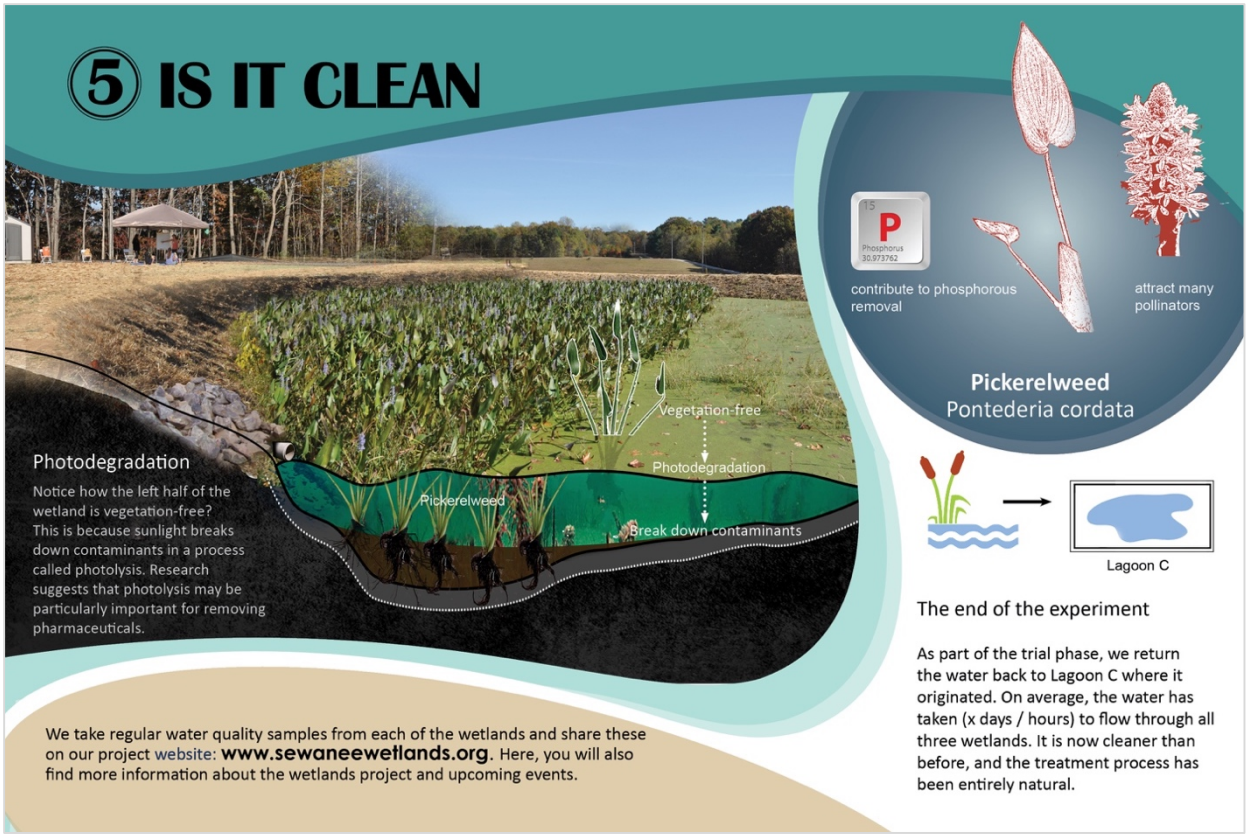
I. The water cycle – water is vital to our environment
   a. Draw the water cycle
      i. Use a small white board/ flip chart on easel
   b. Key terms: precipitation, runoff, evaporation, condensation
      i. Emphasize that water is recycled
      ii. Define wastewater treatment – convert wastewater into water that can be returned to the water cycle

II. Wetlands in wastewater treatment
   a. Role of wetlands in natural environment
      i. Ask students what they know about wetlands/ have they ever seen wetlands
      ii. What wetlands do: Stabilize river shores, filter water, control and store water
   b. Constructed wetlands
      i. Use natural processes to improve water quality (water filtration) and may also support wildlife habitat
         1. Filter out chemicals and pharmaceuticals
      ii. Cost-effective approach to treating wastewater
      iii. What would you find in a wetland?

APPENDIX F

SIGNAGE TEMPLATES


WHAT'S NEXT? 4
Monarch butterfly
Nine "islands"
Many pollutants such as phosphorous are mainly taken up by sediment, where they are stored or processed by plants and bacteria. The nine "islands" in this wetland provide a larger area where these processes can occur and help with the mixing of water. Over time, the sediment is removed and replaced as pollutants accumulate.
caterpillar food source
Swamp milkweed
Asclepias incarnate
Boneset Rose Mallow
Hibiscus moscheutos
Boneset
Eupatorium perfoliatum
Blue Flag Iris
ablue flag iris (Iris versicolor
phosphorous
sediment
Plant species
Four plant species inhabit this wetland. All are native to this region. The mixture is meant to show the beauty of the plants and attract a variety of pollinators. Swamp milkweed is a critical caterpillar food source for the endangered Monarch butterfly.


5 IS IT CLEAN
Vegetation-free
Photodegradation
Pickerelweed
Break down contaminants
Photodegradation
Notice how the left half of the wetland is vegetation-free? This is because sunlight breaks down contaminants in a process called photolysis. Research suggests that photolysis may be particularly important for removing pharmaceuticals.
15
P
Phosphorus
30.973762
contribute to phosphorous removal
attract many pollinators
Pickerelweed
Pontederia cordata
Lagoon C
The end of the experiment
As part of the trial phase, we return the water back to Lagoon C where it originated. On average, the water has taken (x days / hours) to flow through all three wetlands. It is now cleaner than before, and the treatment process has been entirely natural.
We take regular water quality samples from each of the wetlands and share these on our project website: www.sewaneewetlands.org. Here, you will also find more information about the wetlands project and upcoming events.

APPENDIX G

SOCIAL MEDIA CHANNELS OF THE NEORSD

YouTube: https://www.youtube.com/user/neorsdccr
Vimeo: https://vimeo.com/wally
Google+: https://plus.google.com/105489142852863726229
Facebook: https://www.facebook.com/yoursewerdistrict/
Twitter: https://twitter.com/wallywaterdrop / https://twitter.com/neorsd
LinkedIn: https://www.linkedin.com/company/northeast-ohio-regional-sewer-district
Blogger: http://neorsd.blogspot.com
Instagram: https://www.instagram.com/neorsd/
Pinterest: https://www.pinterest.com/wallywaterdrop/
Li.st: https://li.st/neorsd
Storify: https://storify.com/wallywaterdrop

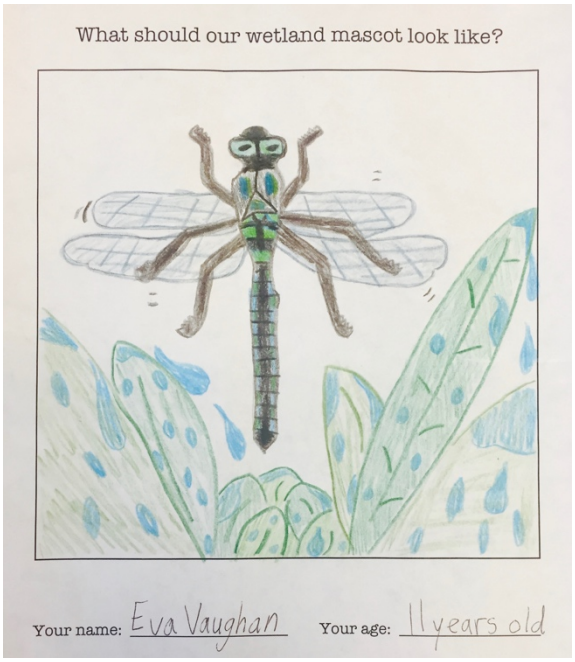
Other useful information and links:

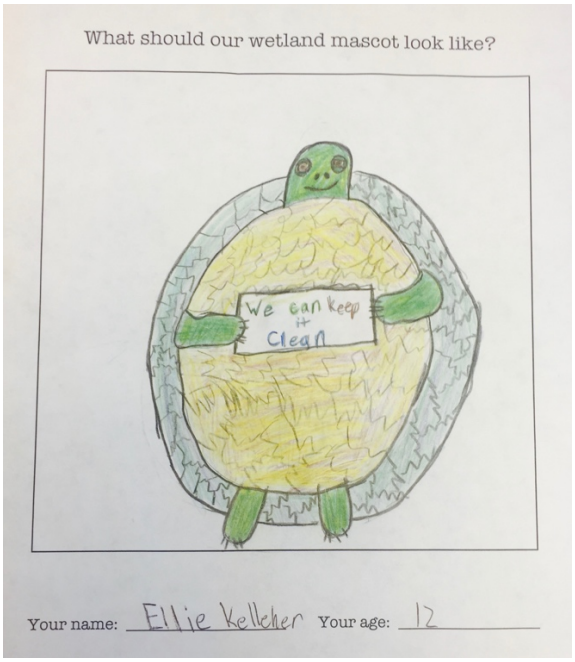
Slogan: Your Sewer District… Keeping our Great Lake great.
Mascot: Wally Waterdrop

App: http://www.neorsd.org/app.php
Guided tours: http://www.neorsd.org/req_tour.php
Student programs: http://www.neorsd.org/neorsdstep.php
Educational resources: http://www.neorsd.org/products.php
Open House 2016: http://www.neorsd.org/openhouse2016.php
Newsletter: http://neorsd.us2.list-manage.com/subscribe?u=d4265d16bb3d3b727134d9ba6&id=f9e6fd6e29

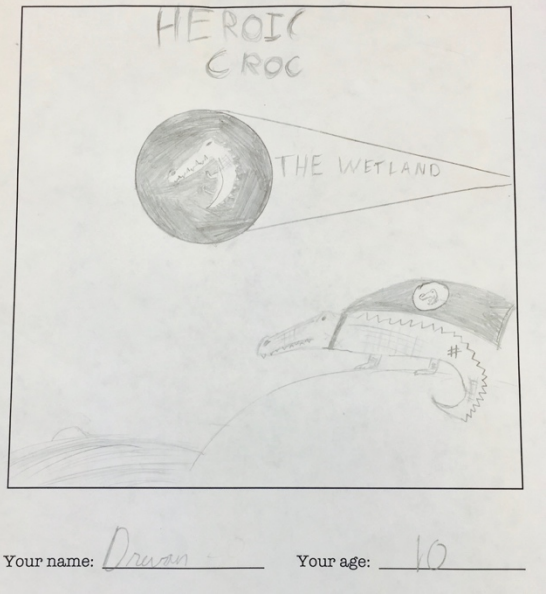
APPENDIX H

MASCOTS SUBMITTED IN THE MASCOT DESIGN COMPETITION



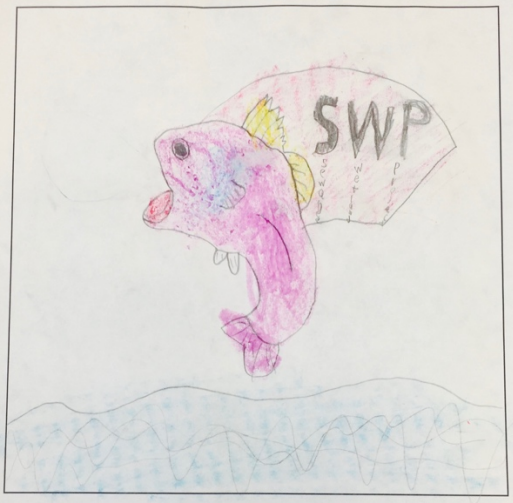


What should our wetland mascot look like?



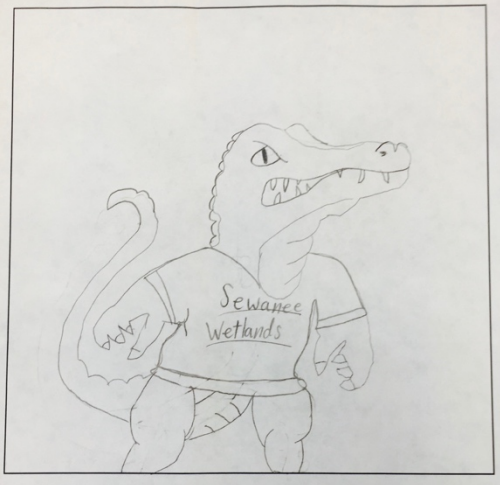
Your name: Drevan Your age: 10

What should our wetland mascot look like?



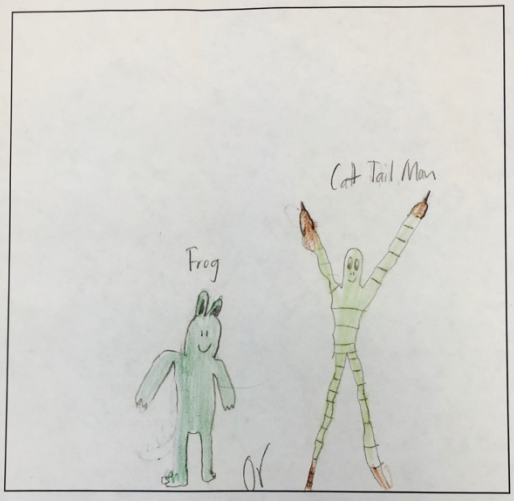
Your name: Ethan Your age: 11

What should our wetland mascot look like?



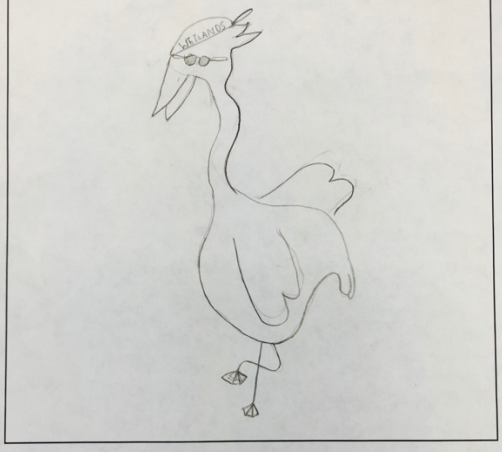
Your name: Amelia Hane Your age: 10

What should our wetland mascot look like?



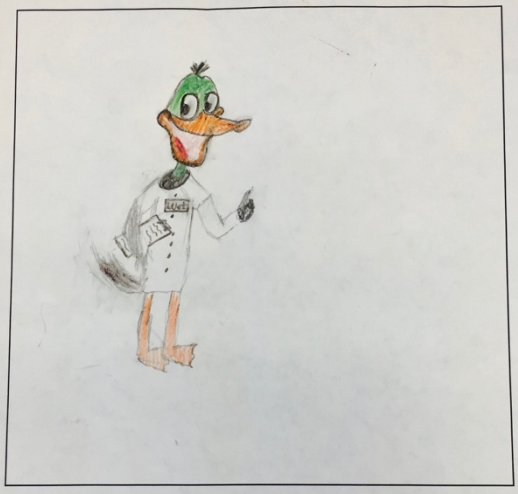
Your name: Isaiah Your age: 11

What should our wetland mascot look like?



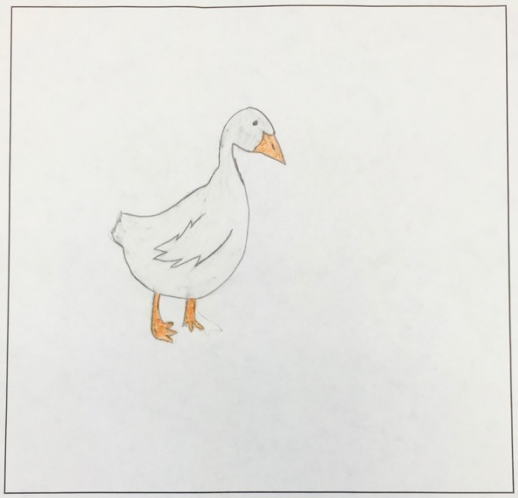
Your name: Sara Knight Your age: 10 yrs old

What should our wetland mascot look like?



Your name: Case Hoosier Your age: 10

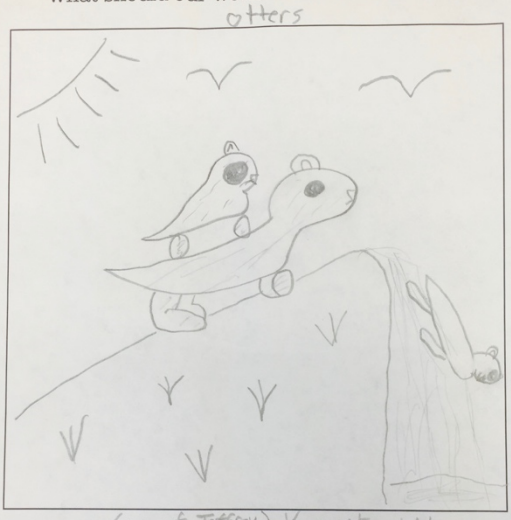
What should our wetland mascot look like?



Your name: Mary Mingledorff Your age: 11

What should our wetland mascot look like?

otters



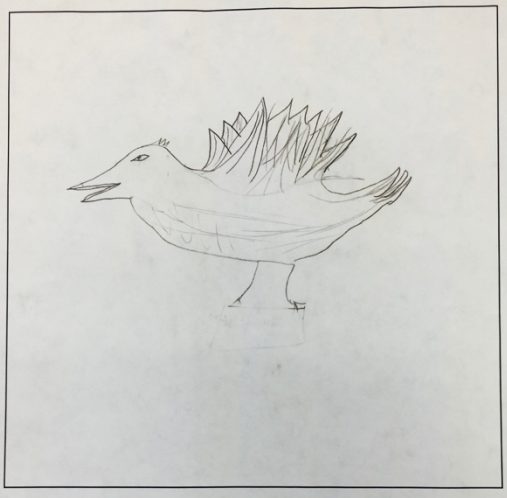
(son of Jeffrey) You work with

Your name: Jackson Frazier Your age: 11

What should our wetland mascot look like?

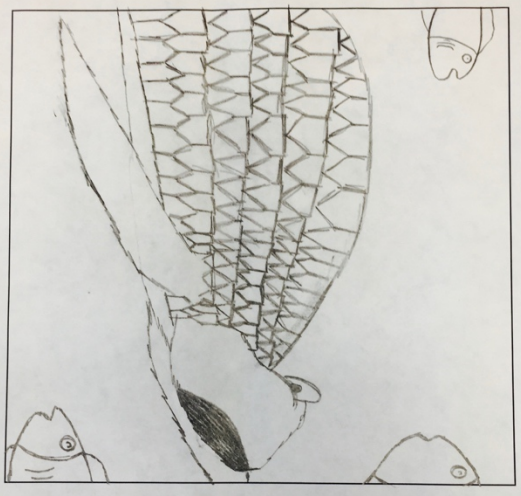
Your name: Haley Sells Your age: 10 years old

What should our wetland mascot look like?



Your name: Sarah Brewster Your age: 11

What should our wetland mascot look like?



Your name: Ellie Taylor Your age: 11

What should our wetland mascot look like?

Your name: Elliott Benson Your age: 10

What should our wetland mascot look like?

Your name: Drew Drew Your age: 10 10

What should our wetland mascot look like?

Your name: Trevor Your age: 7

What should our wetland mascot look like?

Your name: Fiona Your age: 10

What should our wetland mascot look like?

Your name: Cabell Thompson Your age: 5

APPENDIX I

COMMUNICATION PLATFORMS AND OUTREACH ACTIVITIES

Education and information	
Medium	*Main recommendations*
Project website	o Before managing website content, create an IP filter to exclude internal traffic that is generated by yourself o Add the following sections / features to the website: • News section in blog form (add an RSS feed): Incorporate blog posts from *www.sewaneewater.com,* share recent monitoring results, publicize upcoming events and activities, provide information on major project updates, etc. • Section on water reuse (when measurable progress towards campaign objectives 1 and 2 has been made) • Educational resources (such as films or infographics) • Sign-up form for guided tours • "Online tour" feature • FAQs section • Information on opportunities for community involvement • Branding (official name: "Sewanee Wetland Research Station", logo, slogan, mascot, etc.) • Links to new social media accounts o Incorporate *www.sewaneewetlands.org* into the University of the South's website using a "redirect" (such as *wetlands.sewanee.edu*) o Evaluate engagement via Google Analytics and Squarespace's analytics tool. Manually assess how blog posts are received and how many people sign up for guided tours through the website
Films	o Use as educational or promotional resources: • Videos created by the second Environmental Practicum group on (1) using a CW to augment Sewanee's drinking water reservoirs with treated wastewater, and (2) the research collaboration between SUD, UoS, and UGA that has formed around the project (publish both videos when measurable progress towards campaign objectives 1 and 2 has been made) • Time-lapse video of construction and vegetation establishment processes • "First impressions" video created by the author of this thesis • Video of singer group performing at the first community event • Video showing the part of former UGA graduate student Matt Carroll's master's thesis defense that explained how CWs are used for municipal wastewater treatment o Develop educational videos that visualize:

	• Changes in water quality throughout the pilot CW (the first, which should also introduce the project, could be developed by UoS students in the Fall 2017 semester) • Changes in water quality from Sewanee to downstream locations o Distribute videos via online media, and play at town meetings, public presentations, events, in school, etc. as needed o Evaluate reception via channel that is used to share a particular video
Newsletter / Classifieds	o Promote MailChimp newsletter through sign-in sheets and online media (especially via the website and Facebook) o Use MailChimp newsletter and Classifieds to: • Publicize events and activities • Inform on major project updates • Share new website content o Monitor the project's email address for questions and comments; evaluate the number and tone of responses to newsletter emails o Measure effectiveness of the project newsletter via MailChimp's analytics tool
Newspaper articles	o Collaborate with the Sewanee Mountain Messenger to: • Publicize events and activities • Share monitoring results • Inform on major project updates o In the Fall 2017 semester, work with K-12 and university students to write eight short articles to be released weekly. Topics include: • Interconnectedness of water resources • Water supply in Sewanee • Wastewater management in Sewanee • Constructed wetlands • Water quality monitoring • Contaminants of emerging concern • Learning opportunities • Project development o Publicize article series via project website and social media. Upon release, share articles on the same platforms o Evaluate independent coverage by the Messenger through content analysis, ask the SMM to forward any messages received in response to project-related articles, and monitor the SMM's Facebook page for project-related comments
Signage / self-guided tours	o Create additional sign (S6) to explain mesocosm study (text should be targeted towards sixth-grade students) o Construct three kiosks to each host two signs (back-to-back) o Print signs on (replaceable) posters or panels o Create pamphlets that include safety instructions and a site map for guidance o Make pilot CW publically accessible during SUD operational hours o Publicize self-guided tours via online media and newspaper articles o Make sure that all visitors pick up a guiding pamphlet, as well as sign in at the SUD office for evaluative purposes
Travelling exhibition	o Work with student groups to develop a concept for the exhibition o The exhibition should show the treatment processes taking place in the pilot CW and inform on what tests are performed to measure its effectiveness

	○ Build or purchase an exhibition ○ Possible locations: • K12 schools (especially during family nights, parent weekends, or parent-teacher-conferences) • UoS's library or dining hall • Angel Park ○ Possible events to set up the exhibition: • Angel Fest • Earth Day • 4th of July celebrations • Summer Music Festival • Project-related events ○ To evaluate the exhibition, observe and document reactions
Infographics / reports	○ Develop and use infographics and reports to share water quality monitoring results from: • The pilot CW • Sewanee's drinking water reservoirs • SUD's municipal treatment plant • Cowan's municipal treatment plant's intake ○ Upload to project website and share/visualize via other media platforms ○ Distribute to schools along with lesson plans ○ Generate interest in monitoring results via citizen science and social media ○ Evaluate reception via channel that is used to share the data
Promotional tools	○ Develop posters and flyers to publicize events or create interest in project-related topics; use for promotional purposes at public places, in schools, at the pilot CW, in newspaper articles, and digital media ○ Upload mascots received by elementary school students to social media, let followers vote for favorite submission, and professionally redesign the most popular mascot ○ Develop other branded content: • Create a logo and slogan for the project • If needed, create stickers
Interaction and dialogue	
Medium / activity	*Main recommendations*
Social media	○ Use social media to: • Add crowdsourced content into the campaign • Share interesting, entertaining, and sharable information • Share new website content (such as blog posts and monitoring data) • Publicize community events and activities • Conduct quick polls on Facebook and Twitter (for evaluative purposes) ○ First focus on Facebook, Instagram (need to create an account), and YouTube ○ Promote geotagging on Facebook and Instagram ○ Monitor platforms for questions and comments and correct false information ○ Monitor popular review and rating sites and Wikipedia ○ If possible, become active on Twitter and Vimeo as well (accounts already exist) ○ If possible, create accounts on Snapchat, Reddit, and a forum-hosting platform

	○ Evaluate engagement by measuring platform-specific Key Performance Indicators (manually and through analytics tools such as Facebook Insights)
School programs	○ Apply the following strategies to involve and educate K-12 and UoS students: • Guest speakers (from the research team or SUD) • Field trips to the SUD's treatment plants and the pilot CW. Create a combined "sustainability package" that also includes a trip to the university farm. Promote field trips in and outside of Sewanee • Combine guest speakers and field trips (use an "open inquiry" approach) • Media-based classroom discussions (use videos, website content, or newspaper articles) • Student involvement in media development (such as newspaper articles) • Student involvement in wetland monitoring • SES's "Friday School" Program ○ If possible, incorporate evaluation questions in general course evaluations. Otherwise create quick polls using, for example, Google Forms, and distribute to students via email or social media. Obtain general feedback from teachers.
Guided tours	○ Organize guided tours of the SUD's treatment plants and the pilot CW: • Possible tour guides: Research team members, UoS students, or SUD personnel • Possible incentive: Offer visitors to bring their obsolete pharmaceuticals • Create water quality demonstrations stations • Tours should be held on weekends • Important: Publicize tours (in and outside of Sewanee) ○ Measure attendance via sign-in sheets; evaluate media coverage, interest on social media, and website traffic following an event; ask for direct feedback; and observe and document reactions
Community events	○ Organize family-oriented events: • For example, plan an event that encourages community members to dispose of their obsolete pharmaceuticals correctly (could be part of a more general "recycling" event) ○ Hold events on evenings or weekends ○ Offer incentives ○ Work with teachers and university instructors to create opportunities for student involvement ○ Publicize events via online media, newspaper articles, posters, and flyers ○ Provide information to assist students helping with the event and clearly define responsibilities early in advance ○ Measure attendance via sign-in sheets; evaluate media coverage, interest on social media, and website traffic following an event; ask for direct feedback; and observe and document reactions
Town meetings / public presentations	○ Conduct briefings to SUD board about the development of the pilot project and the community engagement campaign (at least once per year) ○ Organize town meetings on topics such as: • CECs surviving wastewater treatment • Water reuse and other strategies to mitigate future water shortages • Controversial topics related to drinking water treatment (such as addition of fluoride and formation of disinfection byproducts) • Strategies to improve drinking water quality

	○ Possible hosts: • Sewanee Civic Association • Women's Club • Leaseholders Association • SES, SAS, or UoS • SUD ○ Hold town meetings on weekends ○ Publicize among groups that one might expect to be interested (environmental groups, scout groups, or certain student clubs) ○ Measure attendance via sign-in sheets; evaluate media coverage, interest on social media, and website traffic following an event; ask for direct feedback; and observe and document reactions
Citizen science	○ Involve citizens in collecting and analyzing monitoring data from the pilot CW ○ Promote opportunities for citizens to become involved in the monitoring process through social media, for example ○ Measure attendance via sign-in sheets; evaluate media coverage, interest on social media, and website traffic following an event; ask for direct feedback; and observe and document reactions
Citizen advisory board	○ Select and recruit board members (could be K12 teachers, university instructors, media representatives, or citizens who are actively involved in the community; SUD board members expressed an interest to participate as well) ○ Provide logistical guidance (such as agenda-setting and documentation) ○ Offer compensation ○ You may ask board members to: • Identify priority educational efforts • Offer recommendations on effective communication strategies • Help develop educational materials • Disseminate study results to community members • Provide feedback on ongoing activities • Suggest appropriate strategies to address concerns and/or misperceptions in the community ○ In general, use for evaluative purposes (document meetings, i.e. take minutes) ○ Possible number of members: 15 ○ Recommended frequency of meetings: Twice per year (although you may contact CAB members individually or in group emails as help or advice is needed) ○ Evaluate partnership structure and processes, as well as board members' overall satisfaction by obtaining direct feedback during meetings or conducting quick polls via Google Forms

APPENDIX J

SIGN-IN SHEET TEMPLATE TO MEASURE EVENT ATTENDANCE

Sign-in sheet – [event / date]

#	First name	Last name	Email address	How did you hear about the event?
1				
2				
3				
4				
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24				
25				

APPENDIX K

DETERMINING CAMPAIGN SUCCESS – SURVEYS FOR FUTURE USE

Questionnaire 1:

Dear Participant,

Over the past three years, we – the University of the South, the University of Georgia, and the Sewanee Utility District – have worked to increase the general level of water literacy in our community. In this context, we also tried to engage community members in a pilot project undertaken by us to investigate the effectiveness of using artificial wetlands to treat municipal wastewater. With this survey, we would like to assess the impacts of our communication efforts and understand how we can do better in the future. [If the pilot project is successful, add: We also want to hear your opinions on the prospect of constructing a full-scale wetland to recycle treated, high-quality wastewater back into our reservoirs to mitigate future water shortages in Sewanee.]

Please know that your answers will not be attached to your name or identity in any way. Furthermore, participation in this study is completely optional. You can withdraw from the survey at any point or refuse to answer any of the questions asked.

We kindly thank you for your participation!

A Water usage in Sewanee

A1 How would you rate your knowledge about each of the following topics?

	Very poor	Poor	Fair	Good	Very good
The hydrologic cycle	❑	❑	❑	❑	❑
Watersheds	❑	❑	❑	❑	❑
Water sources and availability in Sewanee	❑	❑	❑	❑	❑
Drinking water treatment in Sewanee	❑	❑	❑	❑	❑
Wastewater treatment and discharge in Sewanee	❑	❑	❑	❑	❑
Stormwater management in Sewanee	❑	❑	❑	❑	❑

A2 Would you like to know more about any of these topics?

If so, please explain what specifically you are interested in:

A3 Where do you think your drinking water comes from? Choose one.

- ❑ A groundwater aquifer (I'm on a well)
- ❑ A reservoir or lake
- ❑ Directly from a stream
- ❑ I don't know

A4 Where do you think your wastewater goes (after treatment)? Choose one.

- ❑ I have a septic tank
- ❑ Directly into a reservoir
- ❑ Directly into an underground reservoir
- ❑ Land application
- ❑ I don't know

A5 To what degree are you concerned about the future availability of water in Sewanee?

❑ Not at all concerned ❑ Not very concerned ❑ Somewhat concerned ❑ Very concerned

A6 To what degree do you think it is important to…

	Not at all important	Not very important	Somewhat important	Very important
… treat drinking water to high quality in Sewanee?	❑	❑	❑	❑
… conserve water in Sewanee?	❑	❑	❑	❑
… prevent water contamination in Sewanee?	❑	❑	❑	❑
… treat wastewater effectively in Sewanee?	❑	❑	❑	❑

B The constructed wetland pilot project

B1 Prior to participating in this study, were you familiar with the constructed wetland pilot project undertaken by the Sewanee Utility District, the University of the South, and the University of Georgia?

❑ Yes ❑ No (please go to section C [or D])

B2 How did you hear about the project?

Please specify here:

B3 Have you visited the pilot constructed wetland?

❑ Yes ❑ No

If so, please specify in what year(s) you visited the pilot constructed wetland and for what purpose:

B4 How would you rate your knowledge about…

	Very poor	Poor	Fair	Good	Very good
… the purpose of the project?	❑	❑	❑	❑	❑
… how it can benefit the community?	❑	❑	❑	❑	❑
… how the pilot constructed wetland works?	❑	❑	❑	❑	❑
… how we test the water flowing through it?	❑	❑	❑	❑	❑
… constructed wetlands in general?	❑	❑	❑	❑	❑

B5 How would you rate the <u>quantity</u> of information provided to you?

❑ Too little ❑ About right ❑ Too much

B6 How would you rate the <u>quality</u> of information provided to you?

	Strongly disagree	Disagree	Agree	Strongly agree	I don't know
It is accessible.	❑	❑	❑	❑	❑
It is comprehensive.	❑	❑	❑	❑	❑
It is trustworthy.	❑	❑	❑	❑	❑
It is interesting.	❑	❑	❑	❑	❑
It is relevant.	❑	❑	❑	❑	❑

B7 How would you rate each of the communication channels we have used to convey project-related information to community members? Please rate only the channels you have used.

	N/A	Very poor	Poor	Fair	Good	Very good
Project website	❑	❑	❑	❑	❑	❑
Social media sites	❑	❑	❑	❑	❑	❑
Newsletter and other emails	❑	❑	❑	❑	❑	❑
Newspaper articles	❑	❑	❑	❑	❑	❑
Water quality reports	❑	❑	❑	❑	❑	❑
Videos	❑	❑	❑	❑	❑	❑
Travelling exhibition	❑	❑	❑	❑	❑	❑
Self-guided tours and signage	❑	❑	❑	❑	❑	❑
Guided tours	❑	❑	❑	❑	❑	❑
Town meetings and presentations	❑	❑	❑	❑	❑	❑
Community events	❑	❑	❑	❑	❑	❑
Citizen science activities	❑	❑	❑	❑	❑	❑
Classes and other school programs	❑	❑	❑	❑	❑	❑
Promotional media (e.g., posters)	❑	❑	❑	❑	❑	❑

B8 Overall, how can we do a better job of communicating project-related information to you?

Please specify here:

B9 Overall, how can we do a better job of engaging community members in this project?

Please specify here:

B10 Do you know that we make our monitoring data from the pilot constructed wetland publically available?

❑ Yes ❑ No (please go to question B15)

B11 How frequently do you follow the water quality monitoring program?

❑ Never ❑ Not very frequently ❑ Several times a year ❑ Every month

B12 How would you rate the quality of monitoring data provided to you?

	Strongly disagree	Disagree	Agree	Strongly agree	I don't know
It is accessible.	❑	❑	❑	❑	❑
It is comprehensive.	❑	❑	❑	❑	❑
It is trustworthy.	❑	❑	❑	❑	❑
It is interesting.	❑	❑	❑	❑	❑
It is relevant.	❑	❑	❑	❑	❑

B13 Do you have any concerns about the monitoring program?

❑ Yes ❑ No

If so, please explain your concerns:

B14 How could we improve our ways of sharing monitoring data with community members?

Please specify here:

B15 Do you think the water that leaves the pilot constructed wetland is of good quality?

❑ Yes ❑ No ❑ I don't know

B16 Are you confident in using a (full-scale) constructed wetland to treat Sewanee's wastewater?

❑ Yes ❑ No ❑ I don't know

If you selected "no" or "I don't know", please specify what concerns you have:

C Water reuse in Sewanee

[this section should only be included if the pilot project is successful]

C1 How would you rate your knowledge about water reuse in general?

- ❑ Not at all knowledgeable
- ❑ Not very knowledgeable
- ❑ Somewhat knowledgeable
- ❑ Very knowledgeable

C2 What uses of recycled, treated wastewater would you approve of in Sewanee (assuming the water meets safety regulations for that intended use)? Check all that apply.

Fire fighting	❑	Watering the lawn or garden	❑
Road construction	❑	Toilet flushing	❑
Golf course irrigation	❑	Laundry	❑
Irrigation of public lands, parks, etc.	❑	Washing dishes	❑
Pleasure boating	❑	Bathing and showering	❑
Fishing	❑	Food preparation	❑
Swimming	❑	Drinking water reservoir recharge	❑

C3 In general, how do you feel about using a constructed wetland to treat and introduce municipal wastewater in Sewanee's drinking water supply (assuming the water meets safety regulations)?

❑ Strongly oppose ❑ Oppose ❑ Support ❑ Strongly support ❑ Unsure

C4 Do you believe…

	Yes	No	Unsure
… it is or will be necessary or at least beneficial to augment Sewanee's drinking water supplies with treated wastewater?	❑	❑	❑
… constructed wetlands are a safe (effective and reliable) solution to do this?	❑	❑	❑
… constructed wetlands are the most cost-effective solution to do this?	❑	❑	❑

C5 Over the past three years, has your opinion about using treated wastewater for reservoir recharge in Sewanee changed?

- ❑ No, I am generally opposed (please go to question C7)
- ❑ I have become opposed (please go to question C7)
- ❑ No, I am generally supportive (please go to question C7)
- ❑ I have become supportive

C6 What has changed your mind? Check all that apply.

Knowing that all water constantly undergoes recycling	❑
Learning about case studies on safe reuse practices	❑
Increased knowledge about water reuse in general	❑
Water quality data that demonstrates the cleanliness of treated wastewater	❑
Knowing that the water meets reuse guidelines and safety standards	❑
Knowing that water reuse can benefit the environment and downstream users	❑
Knowing that it can mitigate future water scarcity and shortages	❑
Knowing that it can address expected (student) population growth	❑
A possible increase in drinking water quality	❑
Trust in the Sewanee Utility District and the research team	❑
Other: _____	❑

C7 Do you have any concerns with using a constructed wetland to augment our drinking water reservoirs with treated wastewater?

❑ Yes ❑ No (please go to question C9)

If so, please list and explain your concerns:

C8 Have you contacted the Sewanee Utility District or the research team about your concerns in the past?

❑ Yes ❑ No

If so, please explain whether you were satisfied with the response you received, to what degree you believe your input was valued, and whether your concerns were addressed:

C9 Do you trust the Sewanee Utility District to make responsible decisions managing our water resources?

❑ Yes ❑ No ❑ I don't know

C10 Would you like to know more water reuse in Sewanee?

If so, please explain what specifically you are interested in:

D Demographic information

D1 What is your gender?

❑ Male ❑ Female

D2 What is your age?

❑ 18 - 25 ❑ 26 - 35 ❑ 36 - 45 ❑ 46 - 55 ❑ 56 - 65 ❑ Over 65

D3 Are you a student at the University of the South?

❑ Yes ❑ No

D4 What is the highest level of education you have completed?

❑ Less than high school
❑ High school degree or equivalent
❑ Associate's degree
❑ Bachelor's degree
❑ Graduate or professional degree
❑ Doctorate degree

D5 What is your annual income?

❑ $0 – $19,000
❑ $20,000 – $39,999
❑ $40,000 – $59,999
❑ $60,000 – $79,999
❑ $80,000 – $99,999
❑ $100,000 – $119,999
❑ $120,000 or more

Thank you very much for participating!

For questions, please contact Dr. Deborah McGrath (dmcgrath@sewanee.edu / 931-598-1991).

Questionnaire 2:

Dear board members,

Over the last three years, the Sewanee - UGA Constructed Wetlands Research Group has worked to increase the general level of water literacy in our community. In this context, we also tried to engage community members in the constructed wetland pilot project. [At this point, briefly summarize the results of the first survey]. With this survey, we would like to evaluate our efforts to communicate the progress and outcome of the pilot project and the associated community engagement campaign with you. [If the pilot project is successful, add: We also want to hear your opinions on the prospect of constructing a full-scale wetland to recycle treated, high-quality wastewater back into our reservoirs to mitigate future water shortages in Sewanee.]

Please know that your answers will not be attached to your name or identity in any way. Furthermore, participation in this study is completely optional. You can withdraw from the survey at any point or refuse to answer any of the questions asked.

We kindly thank you for your participation!

A The constructed wetland pilot project

A1 How would you rate the quantity of information provided to you about…

	Too little	About right	Too much
… the constructed wetland pilot project?	❑	❑	❑
... the community engagement campaign?	❑	❑	❑

A2 How would you rate the quality of information provided to you?

	Strongly disagree	Disagree	Agree	Strongly agree	I don't know
It is accessible.	❑	❑	❑	❑	❑
It is comprehensive.	❑	❑	❑	❑	❑
It is trustworthy.	❑	❑	❑	❑	❑
It is interesting.	❑	❑	❑	❑	❑
It is relevant.	❑	❑	❑	❑	❑

A3 How would you rate your ability to ask questions and provide comments?

❑ Very poor ❑ Poor ❑ Fair ❑ Good ❑ Very good

A4 Overall, how can we do a better job of communicating project-related information to you?

Please specify here:

A5 How would you rate the quality of monitoring data we shared with you?

	Strongly disagree	Disagree	Agree	Strongly agree	I don't know
It is accessible.	❑	❑	❑	❑	❑
It is comprehensive.	❑	❑	❑	❑	❑
It is trustworthy.	❑	❑	❑	❑	❑
It is interesting.	❑	❑	❑	❑	❑
It is relevant.	❑	❑	❑	❑	❑

A6 Do you have any concerns about the monitoring program?

❑ Yes ❑ No

If so, please explain your concerns:

A7 How could we improve our ways of sharing monitoring data with you?

Please specify here:

A8 Do you think the water that leaves the pilot constructed wetland is of good quality?

❑ Yes ❑ No ❑ I don't know

A9 Are you confident in using a (full-scale) constructed wetland to treat Sewanee's wastewater?

❑ Yes ❑ No ❑ I don't know

If you selected "no" or "I don't know", please specify what concerns you have:

B Water reuse in Sewanee

[this section should only be included if the pilot project is successful]

B1 How would you rate your knowledge about water reuse in general?

- ❑ Not at all knowledgeable
- ❑ Not very knowledgeable
- ❑ Somewhat knowledgeable
- ❑ Very knowledgeable

B2 In general, how do you feel about using a constructed wetland to treat and introduce municipal wastewater in Sewanee's drinking water supply (assuming the water meets safety regulations)?

❑ Strongly oppose ❑ Oppose ❑ Support ❑ Strongly support ❑ Unsure

B3 Do you believe…

	Yes	No	Unsure
… it is or will be necessary (or at least beneficial) to augment Sewanee's drinking water supplies with treated wastewater?	❑	❑	❑
… constructed wetlands are a safe (effective and reliable) solution to do this?	❑	❑	❑
… constructed wetlands are the most cost-effective solution to do this?	❑	❑	❑
… that most Sewanee community members would support such project?	❑	❑	❑

B4 Over the past three years, has your opinion about using treated wastewater for reservoir recharge in Sewanee changed?

- ❑ No, I am generally opposed (please go to question B6)
- ❑ I have become opposed (please go to question B6)
- ❑ No, I am generally supportive (please go to question B6)
- ❑ I have become supportive

B5 What has changed your mind? Check all that apply.

Knowing that all water constantly undergoes recycling	❑
Learning about case studies on safe reuse practices	❑
Increased knowledge about water reuse in general	❑
Water quality data that demonstrates the cleanliness of treated wastewater	❑
Knowing that the water meets reuse guidelines and safety standards	❑
Knowing that water reuse can benefit the environment and downstream users	❑
Knowing that it can mitigate future water scarcity and shortages	❑
Knowing that it can address expected (student) population growth	❑
A possible increase in drinking water quality	❑
Trust in the research team	❑
Knowing that the community supports such project [only include this option if this is the case]	❑
Other: _____	❑

B6 Do you have any concerns with using a constructed wetland to augment our drinking water reservoirs with treated wastewater?

❑ Yes ❑ No

If so, please list and explain your concerns: