Examining the effect of government structure and size on the performance of Mississippi community water systems

By

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Mississippi has an abundant supply of underground aquifers which are utilized by community water systems as their source of drinking water. As the demand for water increases through the increasing population and the influx of industries, there is a need to manage the consumption and distribution of this valuable resource. Since its inception, the Mississippi drinking water industry has spawned new regulations, new management options, and creative ideas to promote a safer more efficient community water system.

The Mississippi State Department of Health-Bureau of Public Water Supply's Capacity Development Assessment is a comprehensive survey completed annually for every community water system in Mississippi. The Capacity Development Assessment will be used to gauge the quality of performance of the specified community water systems based exclusively on size classification, exclusively on government structure classification, and government structure by size classification.

Over the past 15 years, Mississippi has seen several centralization efforts occur, where a municipality, utility district, and/or a rural water association merges with one or multiple adjoining or close proximity community water systems. This results in one of

the three main legal structures of government over community water systems increasing in size in an effort to heighten performance. This research has analyzed the size (population) and government structures of Mississippi community water systems and has determined that economies of scale do exist. Government structure alone does not have an effect on the performance of community water systems but size alone does have an effect on the performance of community water systems. Municipalities and rural water associations reach optimal performance at the medium size classification and utility districts reach optimal performance at the small size classification.

Regardless of the driving force, it is valuable to see that all of the Mississippi consolidating government structures are able to achieve optimal performance. Future state and/or federal legislatures, county governments, city governments, public water supply associations, and business economic drivers can benefit by knowing which structure(s) of community water system governance is the most productive and efficient when the time comes to explore the option of persuasion or mandates to increase viability or heighten performance.

DEDICATION

The first person that comes to mind when I think about dedicating this dissertation is my wife, Dr. Shannon Street Barrett. She has been very patient and forgiving over the past eight years while I worked on my Ph.D. She has been a continual point of encouragement and support every step of the way. My beautiful and loving kids; Joe Benton, Bronwynne Ruth, Betsy Gray, and Hudson David, this is dedicated to you. I love you all so much and I know that I am blessed to have you in my life.

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I would like to thank the Mississippi State Department of Health-Bureau of Public Water Supply for allowing me access to their data.

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CHAPTER I

INTRODUCTION

"Drinking water systems have an enormous impact on public health, and the public health benefits of a well-run system cannot be overstated. Customers rely on their water systems to provide safe water for drinking, bathing, cleaning, and cooking. High quality drinking water is a major contributor to the high standard of living and health enjoyed by Americans." (EPA, 2003) Public health is important in the United States of America (U.S.) because it contributes to a higher quality of living that has become an expectation for most Americans. "The Safe Drinking Water Act was originally passed by Congress in 1974 to protect public health by regulating the nation's public drinking water supply."[1] "The Safe Drinking Water Act (SDWA) is the main federal law that ensures the quality of Americans' drinking water. Under SDWA, the Environmental Protection Agency (EPA) sets standards for drinking water quality and oversees the states, localities, and water suppliers who implement those standards."[2] EPA[3] gives authority to each state to have regulatory authority or primacy over its drinking water quality and public drinking water system management. The Mississippi State Department of Health-Bureau

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[1] Retrieved on March 25, 2014 from http://water.epa.gov/lawsregs/rulesregs/sdwa/index.cfm

[2] Retrieved on March 25, 2014 from http://water.epa.gov/lawsregs/rulesregs/sdwa/index.cfm

[3] The Safe Drinking Water Act authorizes the United States Environmental Protection Agency to set national health-based standards for drinking water to protect against both naturally-occurring and man-made contaminants that may be found in drinking water. http://water.epa.gov/lawsregs/rulesregs/sdwa/index.cfm

of Public Water Supply[4] (MSDH) is the regulatory body over public water systems in Mississippi. There are three types of public water systems; community water system (CWS)[5], non-transient non-community water system (NTNCWS)[6], and transient non-community water system (TNCWS)[7] .

In order to safeguard public health in connection with public water systems, MSDH established an advisory board to design a survey that would evaluate and gauge the performance of public water systems in Mississippi. The survey instrument is known as the Capacity Development Assessment (CDA). This study will focus on CWSs because the institutional performance of CWSs is essential to understanding those functions that contribute to improving the public health of CWSs in Mississippi.

Why this Topic is Important

It is very important to the U.S. to protect public health of its citizens. The performance of CWSs is a vital component to protecting public health. The performance of drinking water systems can be measured by the CDA survey results (or scores). This study is an examination of the impact that government structure independently, size independently, and government structure by size have on the performance of Mississippi

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[4] The Mississippi State Department of Health-Bureau of Public Water Supply is authorized by EPA as the Primacy Agency for Mississippi. Mississippi State Department of Health-Bureau of Public Water Supply is the state regulator for the Safe Drinking Water Act.

[5] A community water system is a public water system that supplies water to the same population year-round. http://water.epa.gov/infrastructure/drinkingwater/pws/factoids.cfm

[6] A non-transient non-community water system is a public water system that regularly supplies water to at least 25 of the same people at least six months per year, but not year-round; schools, factories, office buildings. http://water.epa.gov/infrastructure/drinkingwater/pws/factoids.cfm

[7] A transient non-community water system is a public water system that provides water in a place such as a gas station or campground where people do not remain for long periods of time. http://water.epa.gov/infrastructure/drinkingwater/pws/factoids.cfm

CWSs as measured through the CDA. The study will analyze the CDA scores. The only area of change is how the CDA scores change as a CWS size changes.

While the literature concerning the study of government structures, such as a municipality, for optimal water utility performance is ample (Giles, Gabris, & Krane 1980, Hollman & Boyett 1975, Croxford 1975, Kuranz 1969); the literature on utility district's and rural water association's performance is weak. While the literature concerning the study of community water system size is plentiful (Found 2011, Davis 1983, Rubin 2013, Castillo, Rubin, Keefe, & Raucher 1997, Hansen 2013, NRC 1997); the literature on the size of community water systems in Mississippi for optimal performance is not.

The performance of CWSs in Mississippi is analyzed in this research by government structure independently and analyzed by size independently. This will allow for a better understanding of the effect that government structure and size have on the performance of CWSs. Then each government structure within each size category will be analyzed to determine the optimal performing size of each government structure.

The three government structure examples provided (City of Grenada, Tunica County Utility District, and Black Bayou Water Association) are examples of growth that has occurred to promote a higher level of performance. These examples provide insight should future state and/or a federal government wants to achieve fewer CWSs in Mississippi and/or higher performance levels. Understanding institutional performance can lead to improved overall environmental outcomes. The manner in which the data will be analyzed is to provide results to assist the government entities and/or policy makers as they decide how to achieve their desired outcome(s). If they decide to choose a specific government structure (municipality, utility district, or rural water association), results will show which government entity has higher performance measures and results will show at what size that government structure achieves optimal performance. If they decide to allow the most viable government structure (in a specified region) to take the lead in expansion (this could be any of the government structures), results will show the size at which that government structure has optimal performance. This study will have practical value to policy makers as well as theoretical value to the field of study by connecting theoretical structure with actual outcomes.

CHAPTER II

BACKGROUND

Mississippi has enjoyed a bountiful supply of groundwater as a source of drinking water for many years. The manner in which the citizens of Mississippi derive drinking water has evolved from hand dug wells replenished by the close-by water table and serving just one home site to the construction of drinking water systems.[8] The first loan for a rural water system in Mississippi was made to the Abbeville Water Association in Lafayette County. The loan was approved by the Farmers Home Administration (FHA) on November 7, 1962. (Ginn, 1966)

The Consolidated Farmers Home Act of 1961 was the first major impetus for the construction and improvement of rural water systems in the United States. (Cartee and Williams, 1973) In the latter half of the 1960s, it opened the way for rapid expansion of rural water systems. According to Cartee and Williams, in order for FHA to lend on construction of a water system, a non-profit association (this is what we know today as a rural water association) had to be established. Also, demand had to be demonstrated, and a professional engineer had to prepare the plans and supervise the construction. The

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[8] The construction of drinking water systems is defined as the physical work of building a facility to pump, treat, and distribute water to a customer base. The water system can be legally classified as a water association, municipal water supply, utility district, or private water supply. All forms of governance perform the same technical function but have a different legal makeup. For this research, the phrase 'community water system' will refer to any of these legal forms.

State Public Service Commission (now named the Mississippi Public Service Commission) had to approve the engineer, review the plans, and regulate costs. The State Health Department (now named the Mississippi State Department of Health-Bureau of Public Water Supply) had to review plans and specs.

Mississippi was a leading state in the establishment of rural water systems, second only to Texas. (Ross, Friery, and Peterson, 1973) From 1962 to 1964, 22 Mississippi counties[9] had at least one rural water system. By 1965, 50 Mississippi counties had at least one rural water system and by the end of 1967, 78 Mississippi counties had at least one. (Ross, Friery, and Peterson, 1973) The formal construction of the water systems in the late 1960's and the early 1970's brought along with it the need for a legal formation to govern each water system. The FHA Loan Guarantee program had spent approximately $127 Million by February of 1973 for the construction of 580 water systems in Mississippi. (Cartee and Williams, 1973) The loans and grants of the late 1960s and early 1970s facilitated an increase in housing in rural areas which helped bring in new industries, as well as benefiting the poultry industry, livestock industry, and the dairy industry. (Landry, Cartee, and Williams, 1973) Due to the rural nature and isolation of many Mississippi areas, regions, towns, and villages during this era, approximately 1,500 rural water systems were formed to provide a safe water source. The number of water systems in Mississippi has decreased over the last forty years from

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[9] Mississippi has 82 counties.

its peak of approximately 1,500 to 1,165 in fiscal year (FY) 2013[10]. Much of this decline in numbers is due to consolidation with neighboring or adjoining water systems.

This chapter will characterize the change in the number of community water systems and the change in government structures from 2002 to 2013. Next I will discuss each of the government structures that make up community water system governance in Mississippi and briefly provide an example of each government structure along with its change since the inception of the CDA. With each government structure expansion example, will be a table with demographic date from the earliest CDA in FY 2002 to the most current CDA in FY 2013 and a map color coding of the geographic expansion.

Changes in the Water Industry from 2002 to 2013

In FY 2002, MSDH surveyed two hundred and sixty-one (261) cities and towns (municipalities), twenty-four (24) utility districts, and five hundred and forty-three (543) rural associations for a total of eight hundred and twenty-eight (828) community water systems. For this research, I will only analyze public water system identification numbers that represent a CWS. There are public water system identification numbers given to entities which serve drinking water but are not an actual community with an overseeing government structure, i.e. municipality, utility district, or rural association. The non-community entities are schools, companies, trailer parks, or government buildings. To get an accurate measure of CWSs in Mississippi for FY 2002, there were three hundred and thirty-six (336) public water system identifications removed from the

[10] Fiscal Year 2013 for the Mississippi State Department of Health-Bureau of Public Water Supply is from July 1, 2012 to June 30, 2013. A fiscal year for MSDH is from July 1 till June 30.

city/town, utility district, and rural association numbers based on the fact that these water systems independently supply a school, company, trailer parks, or government buildings. These connections are considered commercial or non-community.

By FY 2013, the number had changed to MSDH surveying two hundred and ninety-two (292) cities and towns, thirty-eight (38) utility districts, and six hundred and forty (640) rural associations for a total of nine hundred and seventy (970) CWSs. For this research, I will only analyze public water system identification numbers that represent a CWS. There are public water system identification numbers given to entities which serve drinking water but are not an actual community with an overseeing government structure, i.e. municipality, utility district, or rural association. The non-community entities are schools, companies, trailer park, or government building. To get an accurate measure of CWSs in Mississippi for FY 2013, there were one hundred and ninety-five (195) public water system identifications removed from the city/town, utility district, and rural association numbers based on the fact that these water systems independently supply a school, company, trailer park, or government building.

The gross number of inspections increased from 1,164 in FY 2002 to 1,285 in FY 2003 and then began to decrease to the lowest number of inspections, 1,080, in FY 2006. FY 2006 is the year that Hurricane Katrina hit the Mississippi gulf coast and prohibited much of the lower six counties from being surveyed. There were 1,210 inspections in FY 2007 and inspections declined to 1,165 by FY 2013.

Mississippi Community Water System Government Structures

All Mississippi CWSs have a managing board. Depending on the legal description of the CWS, the managing board may be a mayor and board of aldermen

(Municipality), county board of supervisors (County/Utility Districts), appointed members of the water system (County/Utility Districts or Municipality), or elected members of the water system (Rural Water Association). Regardless of the makeup of the board, they are all expected to manage the CWS in a similar manner to achieve the performance measures. There is criteria for board management that is set by the EPA and MSDH.

To this point in time in Mississippi, there has not been a catalyst to demand or expect expansion, consolidation, or growth of a CWS. Most if not all expansion, consolidation, or growth has occurred gradually as the market justified. This displays a pattern of natural selection but it may come a point in time where it is necessary for a particular government structure to lead an effort to expand, consolidate, or grow. When that time comes, the examples of a municipality (City of Grenada), utility district (Tunica County Utility District), and rural water association (Black Bayou Water Association) having actually undergone an expansion, consolidation, or growth contributes to the argument that different government structures can achieve performance levels to protect public health.

Municipality

The Municipality will be a board of elected officials which serves a general purpose government who are elected in a general election by the citizens of the Municipality. Cities and towns have formed departments that are solely responsible for the management of the drinking water system. This method has proven popular because the city officials can maintain a high quality of performance for their drinking water system without having to detract from managing other important aspects of the city.

To further understand the municipality in Mississippi, its ability to maintain quality performance of a drinking water system, and potential existence of economies of scale, I am providing an example of a Mississippi city that has taken the lead in expanding its customer base in an effort to achieve greater efficiencies and achieve higher performance measures.

City of Grenada Water System

The City of Grenada Water System (Grenada) was selected because its growth efforts were driven by a municipality from a management need and an asset management perspective. Until the later 1990's, there were twelve certificated areas serving water to residents of Grenada County. Two were United States Army Corps of Engineers, two were rural water associations, one was privately owned, one was the City of Grenada, and the remaining six were operated by the Grenada County Board of Supervisors. Due to a lack of desire by the private system owner and the Grenada County Board of Supervisors and the desire of Grenada to expand its service area, a deal was made for Grenada to purchase the water systems from the Grenada County Board of Supervisors. The Grenada County Board of Supervisors kept one water system under their control and connected that system with the privately owned system. The consolidation efforts in Grenada County resulted in the United States Army Corps of Engineers maintaining their two water systems, the rural water associations maintaining their two systems, the Grenada County Board of Supervisors maintaining their one system (this one system includes the privately owned water system that relinquished its certificated area), and Grenada expanded to include five additional certificated areas that still possess a public water system identification number but are owned and operated by Grenada.

At the time of the first CDA survey, which was FY 2002 (July 1, 2001 to June 30, 2002), there were twelve different certificated areas that served drinking water in Grenada County. The twelve drinking water supplies were; Grenada, Tallahatchie, & Yalobusha Water District Inc., City of Grenada, Grenada-Holcomb, Grenada-Girl Scout, Grenada-Mondy Rd/Elliot, Poor House Water Association #1, Poor House Water Association #2, Grenada Industrial Park & Airport Water, Grenada, Tallahatchie, & Yalobusha Water District Inc.-Scenic Hill, Grenada-Gore Springs, Young's Water/Sewer District #1-Dividing R, and Young's Water/Sewer District #2-Young Sys.

For the CDA survey of FY 2013 (July 1, 2012 to June 30, 2013), there were eleven different certificated areas that served drinking water. The Grenada, Tallahatchie, & Yalobusha Water District Inc.-Scenic Hill has been the only water system to approach the Mississippi Public Service Commission and relinquish their certificated area to the Grenada, Tallahatchie, & Yalobusha Water District Inc. The remaining eleven water systems still have a public water system identification number with the MSDH. The City of Grenada consolidated and has under their board management and operations the Grenada-Holcomb, Grenada-Girl Scout, Grenada-Mondy Rd/Elliot, Grenada Industrial Park & Airport Water, and Grenada-Gore Springs. The historical actions of expansion of Grenada County drinking water systems with the City of Grenada began in 1999.

Table 1 is a compilation of the community water systems that combined with the City of Grenada, their government structure, EPA size classification, and their service population. The water system name 'Total Combined (City of Grenada)" is the most current data of government structure and service population. The Total Combined (City of Grenada) includes the current population of the municipality serving what were once four rural water associations and one utility district. The service population has increased 9.56% (20,498/22,666) from FY 2002 to FY 2013.

Table 1 Demographic Data of City of Grenada Expansion

Water System Name	***Gov't Structure***	***EPA Size Class***	***Population***
Holcomb*	Rural Water Assn	Small	988
Girl Scout*	Rural Water Assn	Small	1,728
Mondy Road/Elliot*	Rural Water Assn	Small	2,998
Industrial Park & Airport Water*	Utility District	Small	684
Gore Springs*	Rural Water Assn	Small	1,350
Grenada*	Municipality	Large	12,750
Total Combined (City of Grenada)**	Municipality	Large	22,666

*Population based on the FY 2002 MSDH CDA
**Population based on the FY 2013 MSDH CDA

Figure 1 is a map detailing the certificated areas in Grenada County to show the physical scale of expansion that has transpired for the City of Grenada. The legend is color coded to delineate the separate CWSs within Grenada County. Light blue represents the City of Grenada and all of the CWSs that have combined with the City of Grenada. Green represents the CWSs that operate within Grenada County but are not under the management of the City of Grenada. These CWSs have their own MSDH identification number and their own managing board. The rose color represents the CWSs from adjacent counties that have a certificated area (and possibly a customer base) that spills over into Grenada County.

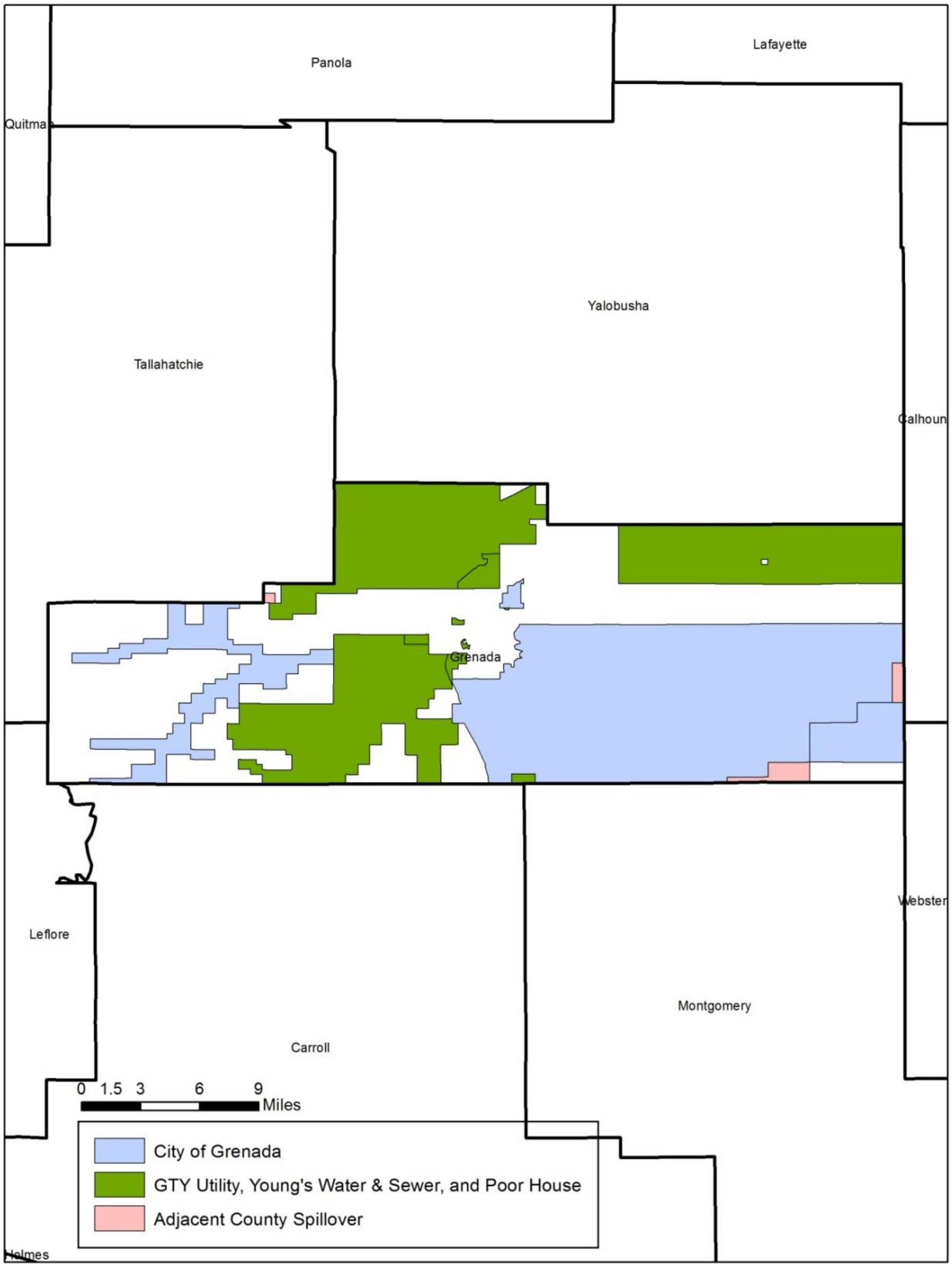

Figure 1 City of Grenada Map of Certificated Areas

Utility District

The Utility Districts are managed by the county board of supervisors or a board that is appointed by the county board of supervisors. Each (county) supervisor is elected by the citizens that live within the county limits, comparable to city officials being elected by the citizens that live within the city limits. Some county boards of supervisors will appoint a managing board consisting of customers of the CWS (county residents that derive water from the utility district). This management system is more adequate than the county board of supervisors managing it themselves. This managing board (not the county board of supervisors) acts very similar to a rural water association.

To further understand the utility district in Mississippi, its ability to maintain quality performance of a drinking water system, and potential existence of economies of scale, I am providing an example of a utility district in Mississippi that has taken the lead in expanding its customer base in an effort to achieve greater efficiencies and achieve higher performance measures.

Tunica County Utility District

Tunica County was selected because its growth efforts were county driven from an economic development perspective. In 1992, the first river boat casino was docked in Tunica County, Mississippi and by 1998 there were eight casinos in Tunica County, Mississippi. The casinos produced massive amounts of new revenue for the county. The expansion of the casino industry brought with it jobs and a desire for people to relocate. The county at this point had an incentive to improve the drinking water infrastructure and resources of the county.

At the time of the first CDA survey, which was FY 2002 (July 1, 2001 to June 30, 2002), there was nine different certificated areas that served drinking water. The nine drinking water supplies were; Town of Tunica, KWP Utility Company, Tunica County Utility District, Tesi-White Oak, NEL-Win Camp, Dundee Water Association, Pride of the Pond, Charlie's Camp Water Association, and Harrah's Tunica. For the CDA survey of FY 2013 (July 1, 2012 to June 30, 2013), there were three different certificated areas that served drinking water. The three drinking water supplies were; Town of Tunica, KWP Utility Company, and Tunica County Utility District. The historical actions of consolidation of Tunica County drinking water systems with the Tunica County Utility District is TESI-White Oak and the Dundee Water Association (FY 2003), NEL-Win Camp (FY 2004), Harrah's Tunica (FY 2005), Charlie's Camp Water Association (FY 2011), and Pride of the Pond (FY 2013).

Table 2 is a compilation of the community water systems that combined with the Tunica County Utility District, their government structure, EPA size classification, and their service population. The water system name 'Total Combined (Tunica County Utility District)" is the most current data of government structure and service population. The Total Combined (Tunica County Utility District) includes the current population of the utility district serving what were once three rural water associations and three private non-community water systems. The service population has increased 15.04% (6,423/7,560) from FY 2002 to FY 2013.

Table 2 Demographic Data of Tunica County Utility District Expansion

Water System Name	***Gov't Structure***	***EPA Size Class***	***Population***
TESI-White Oak*	Rural Water Assn	Small	537
Dundee Water Assn*	Rural Water Assn	Small	1,745
NEL-Win Camp*	Private-TNC	Very Small	375
Harrah's Tunica*	Private-NTNC	Small	1,200
Charlie's Camp Water Assn*	Rural Water Assn	Very Small	99
Pride of the Pond*	Private-NTNC	Very Small	100
Tunica County Utility District*	Utility District	Small	2,367
Total Combined (Tunica County Utility District)**	Utility District	Medium	7,560

*Population based on the FY 2002 MSDH CDA
**Population based on the FY 2013 MSDH CDA

Figure 2 is a map detailing the certificated areas in Tunica County to show the physical scale of expansion that has transpired for the Tunica County Utility District. The legend is color coded to delineate the separate CWSs within Tunica County. Light blue represents the Tunica County Utility District and all of the CWSs that have combined with the Tunica County Utility District. Green represents the CWSs that operate within Tunica County but are not under the management of the Tunica County Utility District. These CWSs have their own MSDH identification number and their own managing board. The rose color represents the CWSs from adjacent counties that have a certificated area (and possibly a customer base) that spills over into Tunica County.

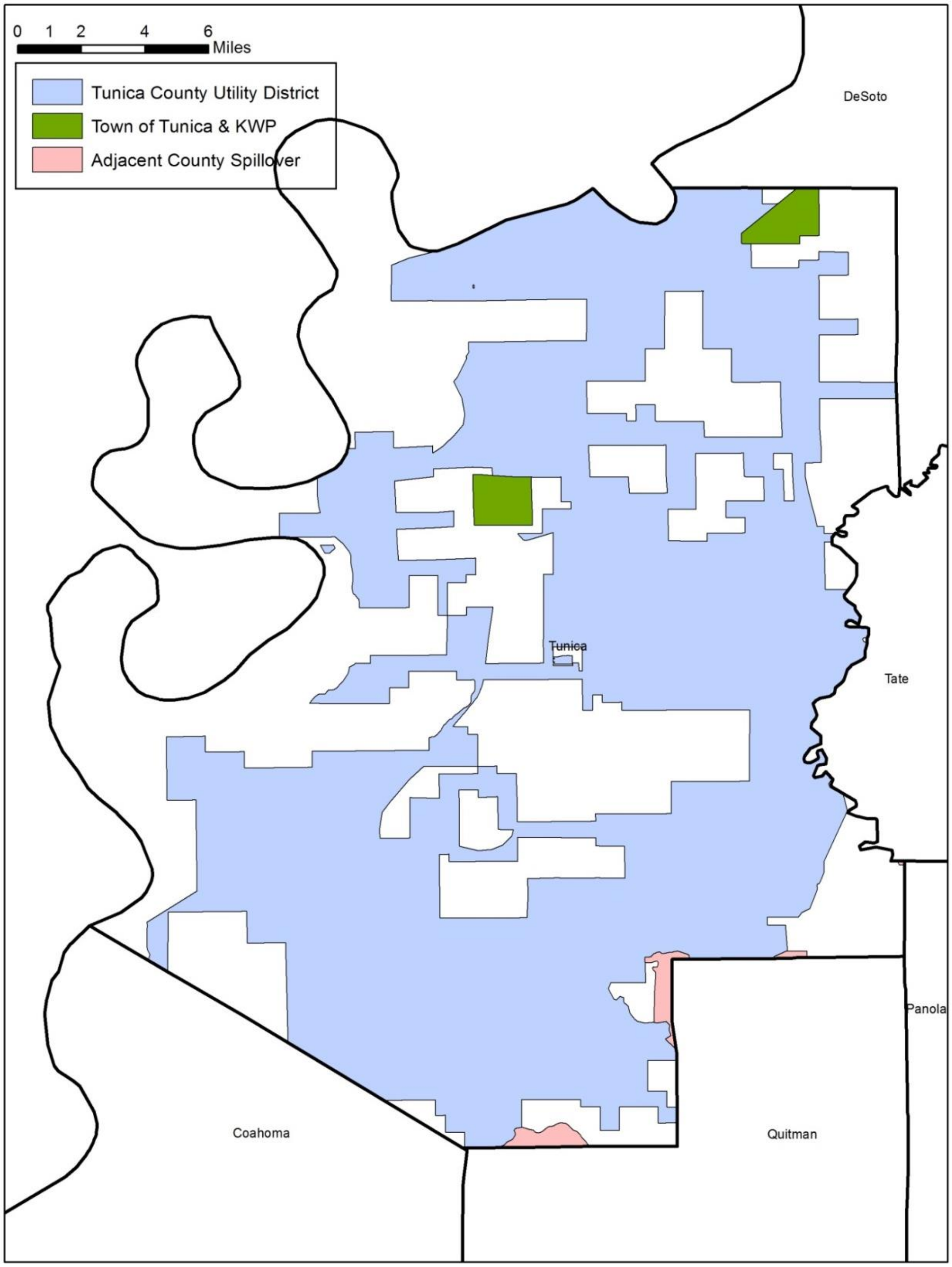

Figure 2 Tunica County Utility District Map of Certificated Areas

Rural Water Association

A rural water association is a not-for-profit entity created solely to manage a CWS for a specific certificated area[11]. This government structure is the most widely used in Mississippi. Rural water association boards will be comprised of five to seven members that are customers of the rural water association. Each customer of a rural water association is an owner of that association. It is very possible for specific areas of Mississippi to have a customer base without the knowledge capacity to manage a water system. There can be situations in which the rural water associations do not perform up to standard because of extenuating circumstances that exceed the capabilities of the managing board.

To further understand a rural water association in Mississippi, its ability to maintain quality performance of a drinking water system, and potential existence of economies of scale, I am providing an example of a rural water association in Mississippi that has taken the lead in expanding its customer base in an effort to achieve greater efficiencies and achieve higher performance measures.

Black Bayou Water Association

The Black Bayou Water Association (Black Bayou) was selected because its growth efforts were driven by a not-for-profit rural water association from a quality of performance perspective. David Koehn, a Mennonite farmer, became the certified water operator for the Black Bayou in Washington County in 1991. Over the next twenty-three

[11] A certificated area is legally called a Certificate of Convenience and Necessity. Mississippi Code 77-3-12 (1) A certificate of public convenience and necessity issued by the Public Service Commission authorizing public utility services to or for the public for compensation in an area grants an exclusive right to the public utility to provide that service in the certificated area.

years, the adjacent water systems to Black Bayou came to value the management quality of Mr. Koehn. As a result, the adjacent water system boards desired to see their water systems consolidate, either through physical connection or management, with Black Bayou. Mr. Koehn has made a valid effort to offer his services to as many adjacent water systems as possible because he realizes the need for quality management in the Mississippi Delta, as well as the economy of scale benefits to Black Bayou as they increase their customer base.

At the time of the first CDA survey which was FY 2002 (July 1, 2001 to June 30, 2002), there were six different certificated areas that served drinking water in four different counties; Washington, Bolivar, Sharkey, and Issaquena. The six drinking water supplies were; Black Bayou (Washington County), Elizabeth Water Association (Washington County), Lake Jackson Water Association (Washington County and Issaquena County), Delta Choctaw Water Association (Bolivar County), Grace Water Association (Issaquena County and Sharkey County), and Darlove-Murphy Water Association (Washington County). For the CDA survey of FY 2013 (July 1, 2012 to June 30, 2013), there were five different certificated areas that served drinking water. The Elizabeth Water Association has been the only water association to approach the Mississippi Public Service Commission and relinquish their certificated area to Black Bayou. The remaining four water associations still have an identification number with the MSDH, but their board management and operations are under Black Bayou. The historical actions of consolidation of Washington, Bolivar, Sharkey, and Issaquena Counties drinking water systems with Black Bayou is Elizabeth Water Association (FY 2006), Delta Choctaw Water Association (FY 2008), Lake Jackson Water Association

(FY 2010), Grace Water Association (FY 2011), and Darlove-Murphy Water Association (FY 2013).

Table 3 is a compilation of the community water systems that combined with the Black Bayou Water Association, their government structure, EPA size classification, and their service population. The water system name ‘Total Combined (Black Bayou Water Association)” is the most current data of government structure and service population. The Total Combined (Black Bayou Water Association) includes the current population of the rural water association serving what were once five rural water associations. The service population has increased 13.59% (4,622/5,349) from FY 2002 to FY 2013.

Table 3 Demographic Data of Black Bayou Water Association Expansion

Water System Name	***Gov't Structure***	***EPA Size Class***	***Population***
Elizabeth Water Assn*	Rural Water Assn	Very Small	269
Lake Jackson Water Assn*	Rural Water Assn	Small	918
Delta Choctaw Water Assn*	Rural Water Assn	Very Small	240
Grace Water Assn*	Rural Water Assn	Very Small	270
Darlove-Murphy Water Assn*	Rural Water Assn	Very Small	480
Black Bayou Water Assn*	Rural Water Assn	Small	2,445
Total Combined (Black Bayou Water Assn)**	Rural Water Assn	Medium	5,349

*Population based on the FY 2002 MSDH CDA
**Population based on the FY 2013 MSDH CDA

Figure 3 is a map detailing specific certificated areas in Washington, Bolivar, Issaquena, and Sharkey Counties to show the physical scale of expansion that has transpired for the Black Bayou Water Association. The legend is color coded to delineate the separate CWSs within Washington County. Several of the CWSs that have combined with the Black Bayou Water Association have certificated areas that cross county lines. The adjacent counties are shown to get an accurate perspective of the physical scale of consolidation. Light blue represents the Black Bayou Water Association and all of the CWSs that have combined with the Black Bayou Water Association. Green represents the CWSs that operate within Washington County but are not under the management of the Black Bayou Water Association. These CWSs have their own MSDH identification number and their own managing board. There is no color to represent adjacent county spillover because several of the CWSs that have combined with the Black Bayou Water Association have the spill over affect.

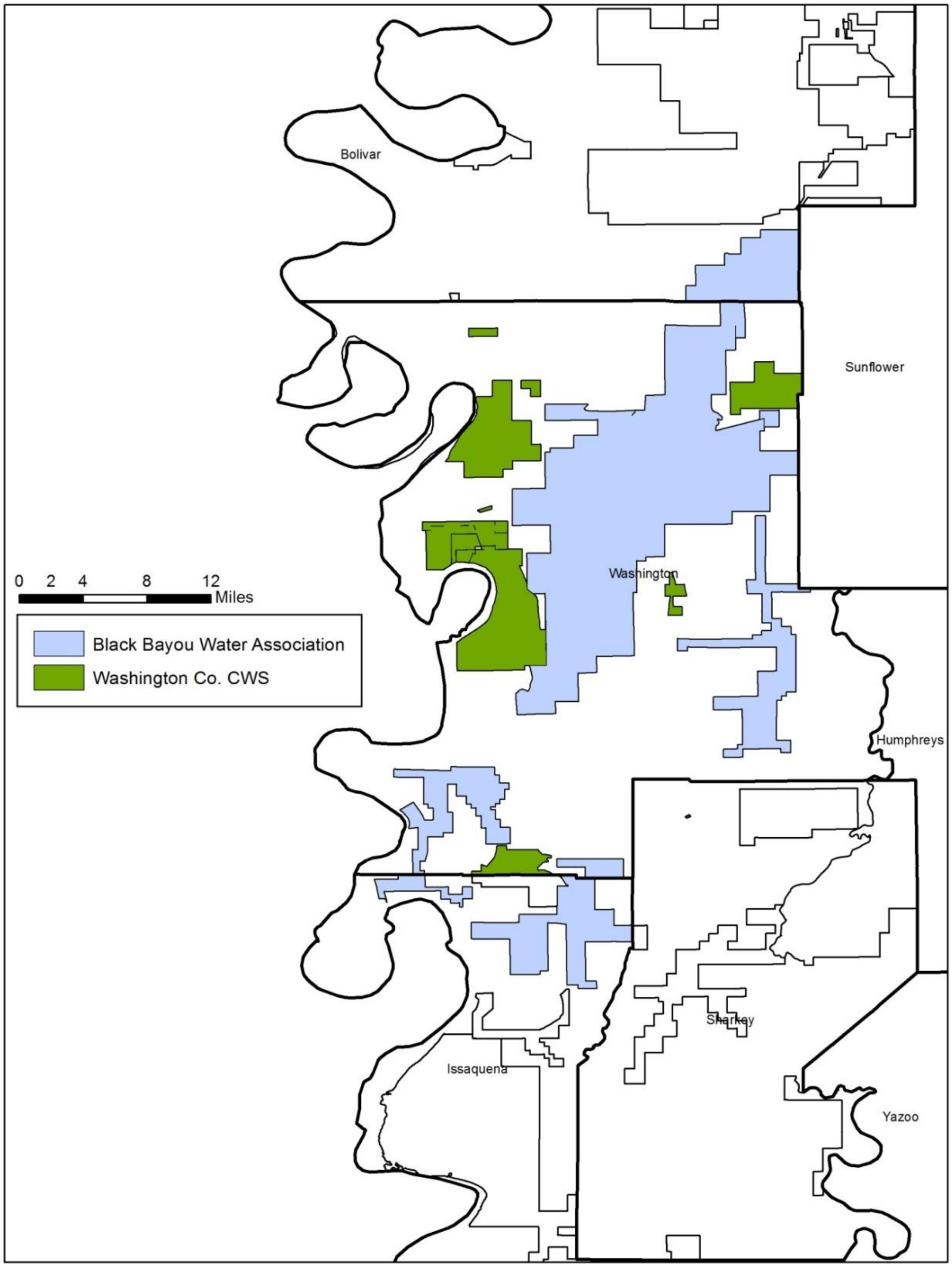

Figure 3 Black Bayou Water Association Map of Certificated Areas

Conclusion

This chapter has detailed the formation of CWSs in Mississippi and the understanding of why CWSs were and are needed. Next, this chapter has explained the change in the industry which is fewer CWSs but now they are larger in physical size, geographical size, and number of people being served. This study is interested in knowing if the size of a CWS actually has an effect on its performance. In MS, there has been a gradual trend of expansion of CWS so I have provided an example of each government structure that has undergone an expansion or consolidation. These examples show that it is very possible for each government structure to be the culprit of growth. This study will determine which of the government structures performs better at the different size categories.

CHAPTER III

LITERATURE REVIEW

This chapter will discuss previous literature that has explored and studied factors associated with the performance of a utility and it explores the previous variables used in determining the quality of performance of CWSs. It is clear to see that the initial expansion in existence of CWSs was an effort to get a safe affordable uninterrupted drinking water supply to people in the state. The diversity of performance of CWSs in Mississippi is a result of multiple factors which may be isolated or a combination of factors. This chapter will identify previous research that has examined factors that may affect the performance of CWSs. It will also cover literature that contributes to the theory that the size of a CWS and the structure of government of a CWS have a correlation with performance.

General Utility Performance

In the "Dynamics in Rural Policy Development", survey data is utilized to suggest that county (rural) governments are managed primarily by elected officials who possess only marginal administrative experience. (Giles, Gabris, Krane, 1980) Local governments (municipal) are more likely to hire professional managers and pursue public-regarding policies which advance the entire community. (Giles, Gabris, Krane, 1980) The authors define the stereotype of rural government structures not possessing the learned knowledge to achieve optimal performance of its government structure. Yet, municipal governments being the most progressive will achieve higher performance levels than their rural counterpart.

It is understood in this article that the county and local governments that are being compared are providing comparable types of services to its citizens. This article would give support for municipalities being the government structure that is more likely to achieve optimal performance. It also concludes with results showing rural county governments having struggles to achieve optimal performance so for this research it would support utility districts and rural water associations being in the same category of a laggard to optimal performance. The CWSs in Mississippi that fall under a municipal government structure may benefit from economies of scope because there are multiple services being provided whereas utility districts and rural water associations are special purpose structures of government with only one service to provide; water.

Size does matter and that size is dependent of the economies of scope associated with Urban and Rural municipalities. (Found, 2011) Found is researching whether or not larger municipalities are more efficient. He is measuring efficiency by dividing the general budget of the municipality by the number of citizens being served by that municipality and creating average cost curves. This measure creates a dollar amount per citizen spent by the municipality to provide a finite set of services so he is determining whether or not larger municipalities are able to achieve lower costs. The finite set of services being studied is general government, fire, police, roads, winter control, waste collection, ambulance, parks, recreational programs, and recreational facilities. Found's study is strictly quantitative because he is not surveying citizens to see if the quality of their services are comparable to other municipalities surveyed. He does divide urban and rural governments to delineate at which population each will achieve optimal efficiency. This publication can be utilized to make the comparison of Municipalities and Utility Districts (Urban) and Rural Water Association (Rural). The efficiency level of the urban structure of government is achieved at a much higher population.

This publication lends itself to this research because it addresses urban versus rural government structures which can be compared to municipalities and utility districts versus rural water associations in respect to economies of scale and of scope. Conclusions from this article would allow someone to promote municipal or utility district expansion over rural water association expansions because optimal performance can be achieved at a higher population level. In areas of Mississippi that have or may see large populations, it is beneficial to know that a municipality is more efficient at that size whereas a rural water association may be in the area of increasing average costs or diminishing returns. Found’s results do show that rural governments can achieve an optimal range of performance at a lower population. These findings do suggest having a rural government in isolated lower population areas.

Giles, Gabris, and Krane and Found all compare urban to rural in the matter of addressing the performance of the government structure except Giles, Gabris, and Krane use survey data to determine the educational levels of the elected officials and Found uses the general budget divided by the number of citizens. Both conclude that municipalities are superior in performance; Giles, Gabris, and Krane say this due to having better educated elected officials and Found says this because the highest performance (most efficient with least dollars per citizen) is at a higher population than a rural government structure.

Water Utility Performance by Size

A typical rural South Dakota system averages about 1,000 farms or ranches and three rural towns and includes some 600-1,200 miles of plastic pipe. (Davis, 1983) This would equate to a CWS servicing more than 4,000 customers which would be a *Medium*[12] sized water system and this would be considered an above average sized water system in Mississippi. In "Organizing and managing South Dakota's rural water systems", Davis gives a historic account of the development of the CWS in South Dakota. The author delves into the theories of economies of scale and scope as to the reasoning for the initial size of the rural systems and the different government structures. Davis does not give an optimal size range nor does he agree to a specific structure of government that is optimal. He notes that canvassing and collecting hook-up fees was a necessity in providing the financial support to build a CWS. This act defines economies of scale because the farmers, ranchers, and town's people realized they needed at least a certain amount of customers before the CWS could be built.

The vastness of South Dakota necessitated the physical size of their CWSs and as a result their economies of scale are a factor in achieving optimal performance. "The measuring stick that will distinguish success from failure is the rural water systems' ability to provide the best possible service for the least possible cost". (Davis, 1983)

[12] Environmental Protection Agency size classification of Medium is defined as 3,301 to 10,000 populations.

Similar to Found's article on optimal size of municipalities, Davis is studying South Dakota in its infancy stage of CWS management and as the CWSs expand and/or merge with other CWSs they should begin to see their average cost of operations per customer decrease. This article lends itself to this research because it details the development of CWSs in South Dakota and that size and/or economy of scale was critical to their formation. This research will study data over a longer period of time rather than simply documenting the formation of CWSs and their performance at that time. Davis lends to the argument that size is a factor in being able to provide optimal performance and that there is a minimum size needed for formation and initial operations.

Rubin uses 2012 data of water system violations to conclude that smaller water systems (*Very Small*[13] *& Small*[14]) are no more likely than larger water systems (*Medium & Large*[15]), except *Very Large*[16] systems, to violate health related Safe Drinking Water Act requirements but smaller CWSs are more likely than larger systems to violate monitoring, reporting, and notification requirements. (Rubin, 2013) Rubin analyzes the size of CWSs and not a government structure. His results show that smaller water systems are violating the elementary reporting requirements which relate to quality of managerial performance. As a water system gets larger, they stop violating the elementary requirements but they are still as likely to violate health requirements. A

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[13] Environmental Protection Agency size classification of Very Small is defined as 25 to 500 populations.

[14] Environmental Protection Agency size classification of Small defined as 501 to 3,300 populations.

[15] Environmental Protection Agency size classification of Large is defined as 10,001 to 100,000 populations.

[16] Environmental Protection Agency size classification of Very Large is defined as greater than 100,000 populations.

water system greatly diminishes is violations as it exceeds 100,000 population (at 2.6 people per connection, approximately 38,500 connections). Conclusions from this study could be utilized to emphasize the need for larger water utilities which will result in better performance (fewer elementary reporting violations and fewer water quality violations). As measured by Rubin, as a CWS gets larger, its performance becomes more optimal.

Rubin's study begins to narrow the size classifications for CWSs to have higher levels of compliance with the Safe Drinking Water Act. The author's results suggests that an optimal size CWSs is 3,300 to 10,000 population and as the population gets closer to 100,000 the water system is no less likely to violate SDWA requirements as the water systems below 3,300 population. This article has a similar thread as the Ontario municipal article in that performance quality plotted is a U Shape or an inverted bell shape curve not a supply curve.

"Researchers, regulators, and utilities are encouraged to undertake further study of these trends at the CWS level to help stakeholders better understand the stresses placed on small CWSs and how systems respond to them." (Rubin, 2013) Rubin performed a nationwide study of CWSs in relation to the change in size and source water. His size categories are in respect to 25-500 (*Very Small)*, 501-3,300 *(Small)*, 3,301-10,000 *(Medium)*, 10,001-100,000 *(Large)*, and 100,001 and greater is *(Very Large)* and source water in respect to groundwater or surface water. Results show a decrease in the total number of CWSs but an increase in population served by the CWS by 12.7%. The number of people served by CWSs increased faster than the overall growth rate in population and the average size of CWSs increased at almost twice the rate of overall population growth. The number of CWSs decreasing can be attributed to consolidation and/or mergers. The population served increase can be attributed to people on private wells or on the edge of a service area connecting to the CWS. Just over 1,400 CWSs changed from groundwater to surface water and just over 600 changed from surface water to groundwater. Rubin's interest is in the effect that size and source water have on the change in regulatory requirements of CWSs.

"The drinking water industry is not static. Systems expand, contract, consolidate, and change water sources." (Rubin, 2013) Rubin's research shows that CWSs are growing and this growth is adding requirements and regulations to the overall operations of a water system. In Mississippi, the CDA is a survey that measures the performance of the CWSs. The CDA does measure how CWSs are performing as well as meeting the Safe Drinking Water Act requirements. This article informs this research because it concludes that size is a factor to be recognized among CWSs and this research will analyze the effect that size has had on the performance.

MacDonald, Zander, and Snoeyink conducted a study for the National Research Council at the request of the United States Environmental Protection Agency to make recommendations on methods to improve the quality of service in small communities. Three strategies came out of the study with one being the need to strengthen small water system financing and management. It is noted that there is a larger extent to which *Small* water systems are at violating Safe Drinking Water Act regulations. (Macdonald, Zander, and Snoeyink, 1997) The authors relate this issue to the lack of economies of scale. The authors do display more accurate population ranges for greater performance and they do not specify any information related to optimal structure of government.

The authors are utilizing Safe Drinking Water Act violations as a litmus test of performance (dependent variable) and are categorizing these according to Environmental Protection Agency population ranges. This research will utilize the CDA as the litmus test for performance. Similar to MacDonald, Zander, and Snoeyink, I will categorize the CDA results by size and I will analyze the structure of government (municipal, utility district, or rural association) and its effect on performance.

Restructuring is considered physically connecting systems together (Castillo, Rubin, Keefe, and Raucher, 1997). The goal to be achieved is providing a solution to the many problems faced by small (*Very Small and Small*) water systems. There are seventeen states from which data is drawn in this article. There are two methods viewed as being achievable by small water systems; one is to physically connect with another water system and the second is allowing a larger system to provide satellite management over a smaller system. The authors use the distance between two systems to judge or calculate effectiveness. They compared costs in rural areas to costs in urban areas considering there is an actual cost associated with distance. The cost in rural areas is less than the cost in urban areas. This allows small systems in rural areas to travel further to connect to a medium or large system than a small system in an urban area. The cost approximated was $40/ft. for interconnections in urban areas and $20/ft. for interconnections in rural areas.

Not every water system will have the capability to physically connect to another water system. One hundred percent (100%) of Mississippi water systems could be under satellite management of a medium system and ninety-nine percent (99%) could be under satellite management of a large system. Castillo, Rubin, Keefe, and Raucher do not consider Mississippi as one of the top five states that has potential for physical connection but they do suggest that consolidation, under their definitions, can happen to Mississippi CWSs.

The goal to achieve state wide efficiency of water systems in relation to water quality and cost can be achieved by using methods such as physical interconnections and satellite management. (Castillo, Rubin, Keefe, and Raucher, 1997) Castillo, Rubin, Keefe, and Raucher realize that in order for CWSs to be viable they need to be of an optimal size. It is concluded from their study that the very small and/or small water systems do not need to exist and they must consolidate with a medium or large water system. Their study examined the ability of CWSs to consolidate to achieve this optimal size. This article lends to this research because the authors have established that a minimum size is truly needed.

In "Estimating stakeholder benefits of community water system regionalization", Hansen examines the economic effects to the consumer as well as the water system as a result of consolidation. "In small rural communities across the United States, managers of water systems deliver their product to customers, which mean distributing relatively large fixed costs over, by definition, a small rate base. Inherent economic and political realities emerge from this process, which jeopardize the efficient and effective management of community water systems." (Hansen, 2013) Hansen is making the argument that size is a factor when it comes to optimal performance of a drinking water system. He is focusing on the financial aspect and the financial aspect is a part of the overall performance. The efficiency that he questions is the fact of having fixed-costs associated with pumping, treating, storing, and distributing safe drinking water. The majority of these costs are consistent across different size water systems. The small water systems will in the end have a higher rate for the same amount of water as another larger system which has more customers to spread the costs over. The idea of costs for similar amounts of water goes into the notion of Consumer Surplus as one set of customers feel they are receiving a greater benefit in the fact of receiving more water for the same amount of money or the same amount of water for less money. The author notes one result of his research is the overconsumption of water by customers that are on the consumed or consolidated system because they are accustomed to paying a specific amount for a general use of water and now that price has been reduced so they are able to use more water and stay within their acceptable financial outlay. The author notes this result as a reason for consolidating water systems to show reluctance at times. They may consume a system that actually taxes the ability of the water system to supply all customers due to the unexpected increase in consumption by customers. This notion makes it incumbent upon the board to fully understand the socioeconomics of their community. Once consolidation has occurred, the rate structure should be adjusted to maintain a consumption level that is realistic to the capacity of the water systems assets. Hansen argues that consolidation is needed to the long run viability of CWSs and at the same time, it is important to understand the price signals being send to customers and how the price signals will make different customers respond differently. This article lends to this research because Hansen concludes that size is a critical factor to the viability of a CWS.

Water Utility Performance by Government Structure and Size

The article "An Empirical Analysis of Water-Price Determinants in Small Municipalities" explored the variable of size of a water system with the hypothesis that economies of scale would exist. (Hollman and Boyet, 1975) Hollman and Boyet are strictly examining small municipalities. This research could be duplicated with the utility districts or rural water associations being interchanged with municipalities. There were six independent variables used in determining the elasticity of price of water amongst residential customers. The independent variables are; number of customers, production and distribution costs, whether or not the source of supply has changed in the last ten years, whether or not the system is subsidized by a government agency, whether or not it is FHA-financed, and whether or not the system has installation charges. The results concluded that size does matter but the size variation or range was not specific. This article contributes to this research of which size of water systems is optimal for management. Hollman and Boyet leave room for further research to study whether other government structures of water system management perform as well as municipalities considering economies of scope does exist with municipalities but not rural water associations that have a single purpose of supplying drinking water.

It was determined that the price of water to residential customers is inelastic so it can be concluded that the price of water has to increase dramatically before customers will actually start to conserve. "Only when water is priced properly is the public welfare best served." (Hollman and Boyet, 1975) The price acceptability of water is subjective to the socioeconomic strata that are valuing the water. Overpricing can stymie growth and underpricing can promote excessive use so it is critical to price water at an optimal point not to obstruct growth and not to promote waste. Larger water systems are able to charge less for water while maintaining quality of performance. This article contributes to this research as it promotes the accurate pricing for drinking water because of the overall benefit to the public and it is a benefit to the public to have an optimal performing CWS. It also leaves room for study into other government structures of CWSs and their water price determinants.

The "Melbourne's Water-Management Approach" article is a case study on the formation and operation of a drinking water system board and the management approaches they implemented. Melbourne's approach recognizes that regionalization is attractive because it is a means of achieving an end with great economies of scale and a great utilization of human and material resources. (Croxford, 1975) They desired to eliminate duplication of services from the beginning. Melbourne realizes the economies of scope by combining services under management of the board as to orchestrate the comprehensive planning and organization to guide development into the area's best suited for community purposes and benefits. They openly see the drinking water system as a community asset rather than a business or business model so the desire to produce excessive amounts of money is trumped by the desire to have a utility to provide for the citizens that is priced attractively.

Melbourne initially set out attempting to accomplish economies of scale and scope to ultimately benefit the community whereas in Mississippi, the community is now interested in increasing performance through whatever measures are acceptable; expansion, consolidation, satellite management, etc. This research is going to analyze the current existence of economies of scale and scope to see if they truly have an effect on optimal performance which will be gauged by the CDA.

"Setting the Stage for Good Management" (Kuranz, 1969) was written as a general consensus of a task force dedicated to determining an operating philosophy for publicly owned and managed water utilities. Kuranz concludes that for cities owning a public water utility and smaller communities such as towns or villages owning a public water utility, the governing board should provide for nonpartisan organization and management; i.e. a board or commission entirely in charge of management of the utility. The task force feels it paramount to have all functions related to the operations and management of a public water utility outside the control of the elected governing board of the city or town. The nonpartisanship is crucial to optimal planning. (Kuranz, 1969)

This article lends to this research because it does conclude that municipalities should be the drivers of water utility management but they should appoint a nonpartisan board. This concept really mirrors the operations undertaken by utility districts in Mississippi because they are an elected governing board and they appoint a nonpartisan commission to oversee the management and operations of the CWS. This article would conceptually agree with Mississippi municipalities and Mississippi utility districts as the CWS structure of government for optimal performance.

"Safe Water From Every Tap: Improving Water Service to Small Communities" is discussing the solution to the problem of providing safe drinking water to small communities and the article lists three elements, each equally important: (1) providing affordable water treatment technologies, (2) creating the institutional structure necessary to ensure the financial stability of water systems, and (3) improving programs to train small system operators in all aspects of water system maintenance and management. (NRC, 1997) Number two explores the options that exist for the long run stability of water systems. This research says that a failing water system has but two options; "improve services on its own or restructure by delegating some or all of its responsibilities to another entity, such as a rural electric utility, regional water authority, local government, or investor-owned utility". (NRC, 1997) All of these options fall under the umbrella of change of management and the National Research Council does not specify which option is the best for any one system. Their results lie in the notion of consolidation to transpire in the most productive manner possible to meet the needs of the small water system.

NRC leaves room for further research to explore which management options have been utilized and have shown positive performance results. NRC is clear in its directive that some drinking water systems need to grow in size in order to maintain viability. In Mississippi, we are able to see that these functions have taken place and we will be able to utilize the CDA to determine performance from an increase in size and change in government structure to assist CWSs.

Economies of Scale

Economies of scale exist when a firm's start-up costs are high, and its average costs fall for each additional unit it produces. (O'Sullivan & Sheffrin, 2007) Economies of scale arise because of the inverse relationship between the quantity produced and per-unit fixed costs; i.e. the greater the quantity of a good produced, the lower the per-unit fixed cost because these costs are shared over a larger number of goods. Economies of scale may also reduce variable costs per unit because of operational efficiencies and synergies. There is a finite upper limit to how large an organization can grow to achieve economies of scale. After reaching a certain size, it becomes increasingly expensive to manage a gigantic organization for a number of reasons, including its complexity, bureaucratic nature and operating inefficiencies. This undesirable phenomenon is referred to as diseconomies of scale[17].

Economies of scale exist when there is a cost advantage achieved by an increase in output. This study of CWSs in Mississippi will relate optimal performance (higher CDA score) to cost advantage and will relate an increase in size to an increase in production.

Increase in Output (Increase in Population) = Cost Advantage (Greater Performance) (1)

Found (2011) concluded that for rural and urban governments there is a point at which diseconomies of scale occurs. This study will use economies of scale theory to test whether optimal performance can be achieved for municipality, utility district, and/or rural water association as size increases.

Lessons Learned from the Literature Review

The literature suggests three primary characteristics towards the performance of CWSs; municipalities are the optimal government structure, performance measures can be achieved by different government structures but at different sizes, and per capita spending and SDWA violations have been the only measures utilized to determine optimal performance. The hypotheses are derived from these characteristics.

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[17] Definition of economies of scale and diseconomies of scale obtained from Investopedia at http://www.investopedia.com/terms/e/economiesofscale.asp

Giles, Gabris, and Krane (1980) say that a municipality is the optimal form of government in Mississippi and Croxford (1975) concludes that a municipality as a general form of government is optimal for water utility performance in Melbourne, Australia. Kuranz (1969) determines that a municipality or a utility district with a non-partisan board is the optimal performing government form for a water utility.

Hollman and Boyett (1975) have results that show a municipality is the most efficient form of government for a community water system and that price does not directly affect consumption so larger population CWSs can afford to charge lower rates for water because they have more customers over which to distribute the costs and Found (2011) says rural and municipal governments can achieve optimal performance but it is at two different population ranges with the rural government being optimal at a smaller population range than a municipality. Davis (1983) concludes that the size of a community water system is important to provide the best possible service at the least possible cost and Hansen (2013) summarizes that size is a factor for effective pricing of water and all customers should be factored when selecting a rate structure.

Rubin (2013) determines that community water systems with minimum Safe Drinking Water Act violations are within the population range of 3,301 to 10,000 (Medium). Rubin (2013) finds that community water systems are increasing in size and decreasing in number. Macdonald, Zander, and Snoeyink (1997) conclude that small (501-3,300) community water systems are the most likely to violate Safe Drinking Water Act requirements.

Castillo, Rubin, Keefe, and Raucher (1997) find that increasing the size of a community water system is needed for optimal performance and Mississippi is a candidate for satellite management (which is a form of consolidation) and NRC (1997) finds that size is critical and some small CWSs need to merge with another government form to remain viable. These articles lend to idea that consolidation and expansion of CWSs is needed and it will benefit the communities.

How this Research adds to the Literature

This dissertation will add to the literature in four ways. The first area will be a better understanding of how different government structures influence the performance of CWSs. Giles, Gabres, and Krane (1980), Croxford (1975), Kuranz (1969), Hollman and Boyett (1975) focus primarily on municipalities so there is a weakness in the literature surrounding the performance of utility districts and rural water associations. The second area will be a better understanding of how water system size can influence performance of CWSs. Found (2011), Davis (1983), and Hansen (2013) all find that size plays a major role in CWS performance and setting the appropriate rate structure yet there is not a repeated size category specified as optimal. The third will be the discussion of the survey instrument known as the CDA which is used to measure CWS performance. Rubin (2013) and Macdonald, Zander, and Snoeyink (1997) use SDWA violations as a measure of performance quality and Found (2011) uses per capita spending as the measure of performance quality. The CDA survey results have not been tested to measure CWS performance. The fourth and final area this dissertation will add to the literature will be testing of economies of scale to explain population's effect on the performance of a CWS.

The next chapter will discuss the methods that will be used to determine which CWS government structure has optimal performance, which size classification of a CWS has optimal performance, and at which size classification does each government structure achieve optimal performance. The chapter will also describe which quantitative method will be used to produce results of the effects that government structure and size have on the performance of CWSs.

CHAPTER IV

METHODS AND DATA COLLECTION

This chapter will first state the research questions which are the basic questions to pursue with this study. The discussion of the data collection and variables will delve into how the data is gathered, who is gathering the data, the variables and how they are operationalized. The Capacity Development Assessment (CDA) needs to be discussed before we can delve into the research questions because the CDA is used to measure quality of performance of community water systems (CWS). After the CDA has been discussed, I will state the hypothesis to be tested along with a model for each hypothesis. Finally, I will review the statistical analysis utilized to test the hypothesis in this study. This will prelude the analysis and discussion of the findings of the data.

Research Questions

1. Does the government structure of a community water system affect its performance?
2. Does the size of a community water system affect its performance?
3. At what size does each community water system government structure perform optimally?

Discussion of Data Collection and Variables

The data used in this study is obtained from the Mississippi State Department of Health-Bureau of Public Water Supply (MSDH), it is secondary data. The CDA survey is performed annually and the data is compiled annually for every CWS in Mississippi. The CDA overall average, the CDA technical score, the CDA managerial score, the CDA financial score, CWS size, and CWS government structure are all gathered by the MSDH regional engineer when they perform the CDA survey.

The performance of CWSs will be the dependent variable. The dependent variable will be operationalized based on responses found in the CDA survey and the score will range from 0 (zero) to 5 (five) with 1/3 intervals. In addition to the dependent variable measuring the overall performance, three component dependent variables will be used that represent the subcategories of the Technical, Managerial, and Financial sections that comprise the CDA. The Technical, Managerial, and Financial sections are each comprised of five (5) questions for a total of fifteen (15) questions for the entire CDA survey. A public water system must have the appropriate documentation and/or correctly demonstrated actions to achieve credit for each specific question. A CWS may achieve from a 0 (zero) to 5 (five) on each section. The CDA overall score can be calculated by adding the scores from each section then dividing that number by three (3).

The independent variables will include the government structure of a CWS and the size of a CWS. The different government structures are municipality, utility district, and rural water association. The subgroups of size[18] are *very small* (15-500 population),

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[18] The size categories listed of very small, small, medium, large, and very large are industry standards set by the United State Environmental Protection Agency.

small (501-3,300 population), *medium* (3,301-10,000 population), *large* (10,001-100,000 population), and *very large* (100,000 and above population). Each of these independent variables can be used in the difference in means test to measure effect on the dependent variable.

Discussion of the Capacity Development Assessment Survey

The United States Environmental Protection Agency (EPA) as a centralized body has allowed each state (there are 10 EPA regions within the United States, Mississippi is in Region 4) to enforce water quality and CWS performance regulations. Each state knows the blend of its scientific, political, social, and economic motivations and aspirations and also knows the best way to implement policies. Sigman said that when the localities have more power, they choose environmental quality levels that correspond to local tastes and costs resulting in greater heterogeneity than under central authority. (Sigman, 2009) This allows Mississippi to establish its regulatory, quality, and performance measures in a manner that best suits its needs.

The 1996 amendments to the Safe Drinking Water Act included a provision for capacity development. "The capacity development provisions of the 1996 Safe Drinking Water Act offer a flexible framework within which states and water systems can work together to ensure that systems acquire and maintain the technical, financial, and managerial capacity needed to consistently achieve the public health protections objectives of the act." (Shanaghan, Kline, Beecher, and Jones, 1998) As a result of this provision, the Mississippi State Department of Health-Bureau of Public Water Supply (MSDH) formed an advisory board to design a survey that would evaluate and gauge the desired capacity assistance needed by Mississippi water systems. This survey became known as the Capacity Development Assessment (CDA) in Mississippi and MSDH began surveying every public water system in FY 2001. The CDA is a comprehensive assessment of a CWS. A CWS that scores well on the CDA is performing at an optimal level by complying with every MSDH required regulation and every suggested best management practice.

MSDH employs regional engineers responsible for completing the CDA survey for every public water system in their region. Mississippi is divided into ten regions which give each regional engineer approximately eight counties or approximately one hundred and eight (108) public water systems to survey on an annual basis. In order to be employed with MSDH as a regional engineer, one must hold an engineering degree from an accredited university. The CDA survey has numerous questions that comprise the regulations, standards, and best management practices that every public water system should operate under. The CDA has three sections; Technical, Managerial, and Financial. Each section of the CDA has five major questions. Each question of the CDA may have multiple parts. Each part to a question must be answered appropriately in order to receive credit for that particular question. No partial credit is given. A public water system can achieve up to a five (5) on each section, and then the three sections are averaged to give the total score. The total score cannot exceed 5.0.

The MSDH Regional Engineer is responsible for completing the survey for each public water system. The MSDH Regional Engineer will contact the certified water operator prior to visiting the public water system to complete the survey and (s)he will provide the certified water operator with the survey prior to the physical visit. By providing the certified water operator with a copy of the survey, the certified water operator can be prepared for the visit with sound mechanical operations and necessary documentation. It is common for the MSDH Regional Engineer to solely meet with the certified water operator for the entire inspection if the certified water operator has gathered all required documentation from other individuals that maintain the documents.

The Technical, Managerial, and Financial sections of the Capacity Development Assessment are the vital and all-encompassing functions of a community water system. A CWS that achieves a 5.0 on the CDA is operating a mechanically sound, regulatory compliant and financially efficient CWS. All sections are critical and every CWS should strive to achieve a 5.0 on the CDA.

Technical Capacity

The technical section of the CDA addresses the actual applied mechanical aspects of a public water system are in place and functioning properly. The certified water works operator is primarily responsible for the tasks measured by the technical section of the CDA. The MSDH Regional Engineer will physically complete the survey with assistance from the certified water operator to make sure the survey is completed accurately. This section pertains to the wells, pumps, treatment process, water storage tanks, water quality tests, water accountability, and back up sources of power. These acts and physical assets are needed to conceptually pump, treat, and distribute a clean safe uninterrupted water supply.

The technical section of the CDA addresses water system significant deficiencies, water treatment process, certified water operator duties, water conservation, and alternatives supply and power in times of emergency. Significant deficiency is defined as a deficiency to the public water system that is critical to maintain the quality of water and/or the quality of management required by MSDH. Items that are labeled as significant deficiencies are source, treatment, distribution system, finished water storage, pumps, pump facilities, controls, monitoring, reporting, data verification, system management and operation, and operator compliance.

A water system must track their water loss which can be 'unaccounted for' water or water that was not sold. 'Unaccounted for' water is best described as water that was pumped, treated, and sent into the distribution system and no one knows where it went from there. Water that was not sold is best described as water that was pumped, treated, and sent into the distribution system and was used to put out a fire, flushed from the lines, discharged at a major leak, etc. Most CWSs are only interested in the 'unaccounted for' water because it is a loss of revenue for the system because they spent money to pump, treat, and send the water into the distribution system but did not get to bill for the water used by a resident or a business.

Tracking water loss can be accomplished by comparing the amount of water pumped during a finite billing cycle to the amount of water billed during that same finite billing cycle. The water system will be able to determine the amount of 'unaccounted for' water by performing this calculation. By determining the 'unaccounted for' water or water loss, a water system will realize the conservation efforts needed in order to reduce expenses and prolong the life of the pumping, treating, and distribution assets of the water system.

A water system must not be overloaded. Overloaded refers to a point in time where the customer demand (or the amount of water being required) exceeds the water supply capacity or the amount of water that can physically be pumped, treated, and distributed throughout the system. The MSDH regional engineers will calculate the service capacity which determines the amount of people that can be serviced from a particular water system. MSDH suggests that a water system stay below 80% of their service capacity. Once a water system exceeds this percentage of service capacity, it is desired that the water system begin planning for increasing service capacity. This can be accomplished by drilling another well and/or replacing an older well with a newer and larger well. If a water system were to get overloaded, the customers could notice a decrease in availability of water and a decrease in pressure during times of high usage.

A water system should have consistent pressure throughout the distribution system. The minimum allowable water pressure is 20 psi and should not exceed 80 psi. This enables each customer to enjoy ample water pressure regardless of their location within the distribution. The causes for fluctuations in water pressure are either natural or man-made. The natural causes for deviations from consistent pressure are elevation changes from the plant site to different customers throughout the distribution, height of the elevated storage tank, and friction as the water moves through the distribution lines. The man-made causes for deviations from consistent pressure are valve quality and location and changes in distribution line quality, diameter, and type.

A water system designed to produce its own water will have pumps installed with a specific design capacity and as the pump ages and depending on the aquifer type[19], the pump capacity will decrease. The design capacity of a well is measured by gallons per

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[19] Different aquifer types have different levels of porosity which exert different levels of strain on the pumps to draw water through the aquifer. This may lead to some pumps having to work harder to draw a comparable amount of water.

minute (gpm). The length of time at which the gpms decrease depends on usage and the quality of the aquifer. A pump test will give an accurate measure of the gpms of the well at that current time and it will allow a water system to know how their pump is maintaining its designed production ability. MSDH requires that a water system perform a pump test every two years and if the water system has a service capacity that exceeds 80%, MSDH requires the water system to perform a pump test every year. A water system can project the life span of a pump by the pump test and will be prepared when (not if) the time comes to replace the pump.

It is recommended that a water system have the ability to provide water during power outages (electricity operating the plant and plant equipment is terminated). At some point in time, there will be a power outage and most (if not all) CWSs need electricity to pump, treat, and distribute safe water to the customers of the water systems. At the point when power is interrupted or out, the water system is unable to perform these tasks. Several scenarios may exist that will prolong a water systems ability to provide water without power, but all powerless scenarios have limitations on treatment, distribution, and time. A back up source of power will allow a water system to be autonomous and give peace of mind to its customers.

Another manner to assist water systems during times of need is to have a physical connection with an adjoining water system. The adjoining water system would need to have the excess service capacity to supply the additional connections should the need arise. Multiple reasons could justify the need to open a connection with the adjoining water system. The connection should be a mutual agreement that is acceptable and physically capable by both parties.

Managerial Capacity

The Managerial section of the CDA surveys the management responsibilities of the public water system to assess whether they are being performed timely and accurately. The board of directors of the public water system (which may be a municipality, utility district, or a rural water association) are responsible for the tasks measured by the Managerial section of the CDA. The MSDH Regional Engineer will physically complete the survey with assistance from the certified water operator to make sure the survey is completed accurately. This section pertains to the Safe Drinking Water Act records, policies and procedures, board meetings, long range plans, and sample site plans. Board actions are needed to maintain regulatory compliance and customer fairness for the CWS.

The Safe Drinking Water Act (SDWA) required records consist of bacteriological sample results for the past five years, water quality analysis for the last ten years, lead and copper results for the last twelve years, inspection reports for the last ten years, annual reports for the last three years, the certified water works operator log books for the last five years, actions taken by the water system to correct violations for the last three years, records concerning a variance or exemption for the last five years, and all other MSDH correspondence for the last three years. The SDWA records provide a historical account of the quality of management and water quality test results. This documentation is very valuable should there be a need for new ownership and/or management of the public water system.

Policies and procedures are the backbone of operations by which a public water system operates. MSDH requires that public water systems have certain policies and procedures in place and that the policies and procedures are followed as they are written. There is a difference in required policies and recommended policies. Some policies may only be needed in certain locations of the state or in certain situations. Each water system should implement policies that best fit the needs of their management. The required policies are by-laws, water user's agreement[20], subdivision and/or line extension policy[21], long-range improvements plan[22], water rate review policy, cut-off policy[23], customer service policy, new customer connection policy, prospective customer having excessive requirements for service, and job descriptions for employees. The recommended policies are emergency or contingency plan, complaint log, line flushing program[24], and a fire hydrant policy. There are numerous policies that may exist for a public water system and they are all in place to produce safe affordable uninterrupted drinking water.

MSDH requires that all rural water association board members and municipality boards with a service population less than 10,000 to attend Board Management Training. House Bill number 1227 (HB-1227) is the state law requiring any public water system board member elected or re-elected after June 30, 1998 to attend an eight hour

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[20] The water user's agreement should consist of at least the connection fee amount, any late charges and what will cause them to go into effect, amount of deposit, and wastewater requirements. The water user's agreement is the tangible binding agreement between the customer and the water system.

[21] The line extension policy should be in place to have a consistent chain of command and action in order to expand the distribution system. The builder or developer must obtain MSDH approval on design before any construction begins.

[22] The long-range improvements plan should be in place to allow the water system to develop a plan for growth and/or upgrade to their water system. If a water system is not growing, they must maintain their assets and plan to update those assets at some point in the future. Long-range planning is not only for growing water systems.

[23] The cut-off policy must be in place and implemented. It is a direct incentive for customers to pay their water bill and it enables the water system to collect needed revenue.

[24] Line flushing is a very useful tool to remove sediment from lines and to move clean treated water throughout the distribution system. A line flushing program must have a schedule and records showing times and flow. This allows for proper accountability of water that is not sold.

management training course which will certify them for life. The board members must complete this course within two years of being elected to the board. MSDH requests that a board member attend within one year of coming onto the board. MSDH will not give a water system credit on the CDA for board members that have not attended within the one year window of time even though state law (HB-1227) allows the board members two years. Board management training topics include laws and regulations, duties and responsibilities, customer service and community relations, rate setting, management and finance, long-range financial planning, operations and maintenance, and emergency preparedness. The drinking water supply business and industry in concept has not changed much since we are still pumping water and sending it through a distribution system, but oversight, regulatory requirements, and legal ramifications have escalated and are continually changing, creating a great need for management training of water system board members.

It is required by MSDH that a water system board meet monthly or if the water system has a full time manager, it is allowed to meet quarterly. Utility districts and municipalities normally meet monthly or bi-monthly because they handle other business, not just the affairs of the water system. Rural water associations have the sole purpose of managing the drinking water system. Monthly board meetings should be held to keep the board members aware of all activities associated with the functions of the water system. This also creates a venue for customers to attend and learn what is transpiring with the water system, as well as ask questions and have complaints heard. The majority of rural water associations in Mississippi are incorporated as not-for-profit corporations. The Mississippi Code of 1972 section 79-11-197 (1) requires that an annual meeting be held at a fixed time and that all member are notified in a timely manner. It can be seen that MSDH and Mississippi Nonprofit Law require board meetings because there is a value to the board and to the customers for this activity to take place.

MSDH has an acceptance window of one year (they ask in the survey if the water system has had any SDWA violations since the last inspection) for SDWA violations even though the survey may not be performed on the exact day from one year to the next. Items that are considered SDWA violations are the Total Coliform Rule, Ground Water Rule, Surface Water Treatment Rule, Inorganic Contaminants, Organic Contaminants, Radionuclide Contaminants, Disinfection By-Products Rule, Lead & Copper Rule, Consumer Confidence Report, and Public Notice. SDWA rules are implemented and recorded by the primacy agency for each state in the United States. A system that completes a calendar year with no SDWA violations has taken the required samples and no contaminants have been found or the contaminants have not exceeded the acceptable level, and the public has been notified about annual sampling results as well as notified about any interference, interruption, or possible contamination of the drinking water.

A long-range improvement plan shows that the public water system management is devoting the necessary resources to either improve the system and/or insure its sustainability. The first step in developing the long-range improvement plan is to facilitate the identification of short run and long run needs and then institute a process through which these needs are prioritized. It is important that the water system take into account the potential growth or decline in population which will affect the service capacity required. Also, a funding stream needs to be identified to accomplish the projects.

The long range improvement plan strategies must be jointly determined by the system operator and the managing board of the water system. Both parties must work together to determine the future plans for the water system. Long-range planning will enable a water system to sustain itself as well as be prepared should opportunities present themselves, such as larger residential or commercial growth than expected or industry demand for water. Since the physical assets related to the pumping, treating, and distribution of safe drinking water all have a finite life, a long-range plan is paramount to the posterity of a drinking water system.

A Cross Connection Control[25] program is needed for every drinking water system regardless if a cross connection exists on the water system at the time of implementation. The existence of a Cross Connection Control program will aid in deterring and preventing any connections that could potentially be or pose a risk to the quality of the drinking water. If there are potential cross connections, a backflow preventer needs to be installed to prevent non-potable water from contaminating the potable water. The water system should keep a record of all backflow preventers.

Annual tests should be performed on every backflow preventer to make sure it is operating properly and records should be kept to log the test results. Ultimately, a cross connection control program can eliminate contaminates being introduced into the drinking water supply from an unwanted source.

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[25] The United States Environmental Protection Agency defines a cross connection as actual or potential connections between a potable and non-potable water supply. Chapter 26 of the Mississippi Safe Drinking Water Act of 1997 defines cross connection as any direct interconnection between a public water system and a non-public water system or other source which may result in the contamination of the drinking water provided by the public water system.

MSDH requires that every public water system take bacteriological samples (it may also be referred to as a bacti sample) on a monthly basis. The size of the public water system will determine the number of bacteriological samples to be taken. Larger public water systems will be required to take more samples and vice versa. MSDH must approve a sample site plan and the certified water operator must abide by the sample site plan when taking the monthly bacteriological samples. The purpose of the sample site plan is to allow for sampling to be representative of the entire distribution system.

Lead and copper samples must be taken every six months to three years depending on the results of the sample. If a presence exists, the six month sampling cycle may be implemented. If minimal or no presence, the three year sampling cycle may be implemented. Similar to bacteriological sampling, MSDH must approve a lead and copper sample site plan that must be adhered to by the certified water operator.

Financial Capacity

Revenue and expenses associated with and generated to maintain public water systems are reviewed in the financial section of the CDA. Public water systems differ in their strategies of who is the actual individual to function in this role. Some public water systems have clerks, assistants, or they may utilize the certified water operator to handle the finances and that individual is responsible for the tasks measured by the financial section of the CDA. The financial section pertains to water rates, rate policies, budgeting, and audit reports. The MSDH Regional Engineer will physically complete the survey with assistance from the certified water operator to make sure the survey is completed accurately. Accurate rates, fair policies, and timely audits are needed for long run sustainability and short run viability of the CWS.

MSDH will request that a CWS increase their rate at least once every five years or prove that the water systems revenue exceeds expenditures by ten percent a year for the past five years. The rate is the dollar amount charged to a customer for a specific amount of water used by that customer. Conceptually, the more water a customer uses, the higher the monthly water bill.

MSDH will take into account expenses that have been one-time expenditures for emergency projects or for major improvements. The need for an increase in water rates is to keep up with inflation, adequately finance depreciation of system assets, and plan for future needs. There will be a point that rates will need to be increased and it will be at a level that is much higher and noticeable to the customers, if a water system does not gradually increase rates over a period of time. It is much easier and understandable to make minimal increases on a regular basis to adequately fund the current and future operations of a public water system.

The autonomy nature of Mississippi CWSs has caused many rural associations and municipalities to not want to increase water rates on the customer base. This attitude seems to persist because different finance options are available when times of need arise. The availability of grants as a financing option is decreasing but there are still multiple options available for low interest loans.

Water systems need to be aware of their revenue and its ability to maintain the water system. It is required that every public water system in Mississippi have a policy requiring the water system to review its rate and rate structure annually to make sure they are adequate to fully fund the current and future operations of the public water system and still produce at least a ten percent profit. The MSDH incentive to review rates annually is an attempt to have all public water system boards aware of what their rate and rate structure is and if it is financially viable.

A cut off policy can be defined as a list, generated at the end of a billing cycle, of customers that have not paid their bill in full. The concept of a cut off policy and following that policy are critical to the continual revenue flow of a public water system. A rural association and a utility district are in more need of enforcing the cut off policy because water bill revenue is their only source of revenue. A municipality is likely to have additional sources of revenue to supplement the gaps in cash flow should they have customers who do not pay their bills or do not pay them on time. A public water system that does not enforce a cut off policy will have an above average amount of customers late on payment or not paying at all. This creates an environment that is unfair to the remaining customers because they will need to pay higher rates to produce the revenue needed to maintain the public water system. No public water system should have to provide free service to any customer.

A public water system may only have one product to sell but it is still a business. There are assets and employees needed in order to function as a viable drinking water system. An annual budget is needed to track revenue and expenses from one year to the next to keep the business operating in the black. If a water system is functioning without a budget, it may encounter times when there is not enough revenue to pay the expenses incurred. An accurate annual budget will greatly assist when reviewing and setting a rate and rate structure. The annual budget will allow the water system to see the amount of revenue that is needed to fully fund the current operations and projected to fully fund future operations. An annual budget can also be utilized to establish funds for major upgrades and expansion of a water system's distribution system. The annual planning will allow the water system to determine a set amount of revenue for reserves for multiple years in order to provide cash for anticipated expenses. A public water system needs to generate an annual budget and they need to update the annual budget to accurately reflect the previous year's revenue and expenses.

Rural water associations, utility districts, and municipalities must all submit an audit report to the Mississippi Office of the State Auditor. Rural water associations that are classified as non-profit public water systems are required to submit the 'Annual Financial Report for Non-Profit Public Water Systems' to the Mississippi Office of the State Auditor. Municipalities, which normally have an accounting firm perform an annual financial audit, will simply submit a copy of the final audit report to the Mississippi Office of the State Auditor. Utility Districts under the control of the county board of supervisors will have an accounting firm perform an annual financial audit and will simply submit a copy of the final audit report to the Mississippi Office of the State Auditor.

Each section of the CDA has a dominant individual or body that presides over it, but it takes all individuals associated with a CWS to make it operate efficiently and effectively. Ultimately the board members are the responsible officials of the water systems. For this research, the overall performance of a CWS will be gauged by the CDA score of that particular water system considering MSDH believes the CDA to be the most comprehensive survey of Mississippi CWSs. It is realized through the detailed nature of each section that the CDA is very thorough and examines every aspect of a CWS.

It is very possible for a CWS to achieve a 5.0 (five) and still have performance areas that need improvement. Even if all of the tasks are completed, reports completed and filed, and all water quality tests are safe, a CWS is still under the management of people who must work together. The CDA is not the pinnacle of performance, but rather an epic benchmark that should be achieved by all Mississippi CWSs.

Hypotheses

H1a: A municipal water system is more likely to be a better performing community water system than a rural water association or a utility district.

H1b: A rural water association is more likely to be a better performing community water system than a utility district.

The overall scope of operation of a general purpose government structure (municipal) expands beyond simply managing a community water system (CWS) as would be with a special purpose government structure (rural water association or utility district). A municipality is an example of a general purpose government structure and it is able to utilize resources (people and equipment) across government enterprises. This allows for the maximum utility of resources by the general purpose government structure which relates to less expenditure to perform comparable services of a special purpose government structure. A model for Hypothesis 1a and Hypothesis 1b is displayed in Figure 4. *General Purpose Government* is representative of a municipal water system and it is more likely to have a *Higher Quality/Performance* as measured by the *Capacity Development Assessment* than a *Special Purpose Government*, which is representative of a rural water association and a utility district.

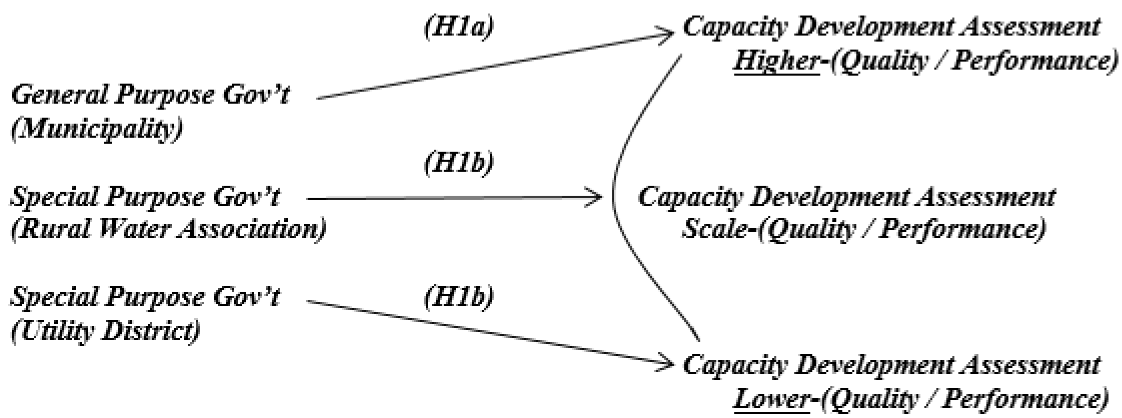

Figure 4 Hypothesis 1a and Hypothesis 1b Model

H2: As the population of a community water system (municipal, utility district, or rural water association structure of government) increases, it will more likely produce a better performing community water system.

Using economies of scale as a theoretical comparison, in the relationship that as each additional unit is produced, the cost of production is decreasing per unit. This means that efficiency is increasing and as a CWS population increases the quality of performance is increasing. Similar to economies of scale, in the relationship that for every additional unit produced that is an extra unit over which the cost of production can be distributed, as a CWS population increases that is an extra customer over which the cost of overall operations can be distributed. A model for Hypothesis 2 is displayed in Figure 5. As a *Community Water System* has an *Increase in Population*, it is more likely to have a higher *Quality/Performance* as measured by the *Capacity Development Assessment*.

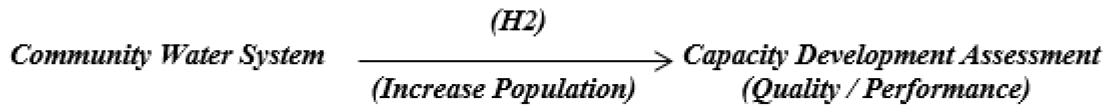

Figure 5 Hypothesis 2 Model

H3: A general purpose government structure is more likely to achieve optimal quality of performance at a smaller population than a special purpose government structure.

A general purpose government structure will have multiple services or enterprises over which to spread costs and they will be able to utilize resources across enterprises. This design allows for less of a financial burden on each individual customer related to a specific enterprise (i.e. water). The general purpose government structure should be able to operate more efficient at a small customer base than its special purpose government structure counterpart. A model for Hypothesis 3 is displayed in Figure 6. As a *Community Water System Government Structure* has an *Increase in Population*, it is more likely to have a higher *Quality/Performance* as measured by the *Capacity Development Assessment*. *General Purpose Government* (municipal water system) is more likely to achieve a higher *Quality/Performance* as measured by the *Capacity Development Assessment,* sooner along the population growth scale as compared to a *Special Purpose Government* (rural water association or utility district).

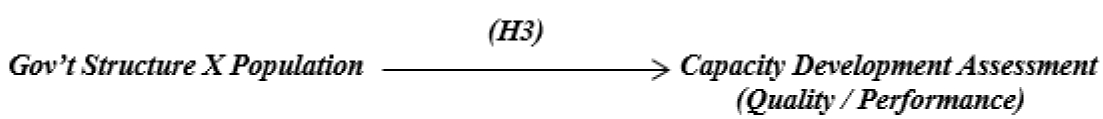

Figure 6 Hypothesis 3 Model

Statistical Analysis

The CDA scores (technical, managerial, financial, and overall average) will be analyzed with a difference in means test to determine if a relationship exists between government structures and the change in CDA scores as well as if a relationship exists between size of a CWS and a change in CDA scores. The statistical method that will be utilized is a t-test for a difference in means to measure the effect that government structure and size have on the performance of CWSs. The statistical software, STATA, will be used to compute the statistical analysis.

CHAPTER V

TESTING THE HYPOTHESIS

The purpose of this chapter is to examine the CDA data to determine the relationship between government structure and size and if there is statistical significance. The t-test for a difference in means will be performed accordingly to test each hypothesis and answer the research questions. The following tables will display the results and an explanation of each table will be provided.

A two sample t-test produces an output that contains a t Stat and a P value. The t Stat will need to be > 2.0 (greater than 2.0) or <-2.0 (less than -2.0) in order to accept the hypothesis. The P value needs to be <=0.1 (less than or equal to 0.1) to produce a statistical significance with 90% (ninety percent) confidence. Prior to each analysis a table displays the CDA average score for that group and the N for each variable.

Data Analysis of Government Structures

Each government structure; municipality, utility district, and rural water association, has been grouped regardless of size and a two sample t-test has been performed in order to determine if government structure alone has an effect on the performance of CWSs. Grouping of government structures has municipalities with 292 surveyed with an average CDA score of 4.42, utility districts with 38 surveyed with an average CDA score of 4.54, and rural water associations with 640 surveyed with an average CDA score of 4.48 (Table 4).

Table 4 Government Structures: Quantity and Capacity Development Assessment

GOVERNMENT STRUCTURE			
	Municipality	***Utility District***	***Rural Water Assn.***
Capacity Development Assessment Average & N	4.42 N = 292	4.54 N = 38	4.48 N = 640

Table 5 displays the results of the two sample t-test that was conducted to examine the relationship between the average CDA scores of the government structures.

Table 5 T-Test Results of CDA Score Comparisons of Government Structures

GOVERNMENT STRUCTURE		
	Utility District	**Rural Water Assn.**
Municipality	-1.1379	-1.5182
Utility District	-	0.5909

* = P < 0.1
** = P < 0.05
*** = P < 0.01

The absence of statistical significance in relationship of any government structure examination suggests that government structure alone does not have an effect on the performance of CWSs (Figure 7).

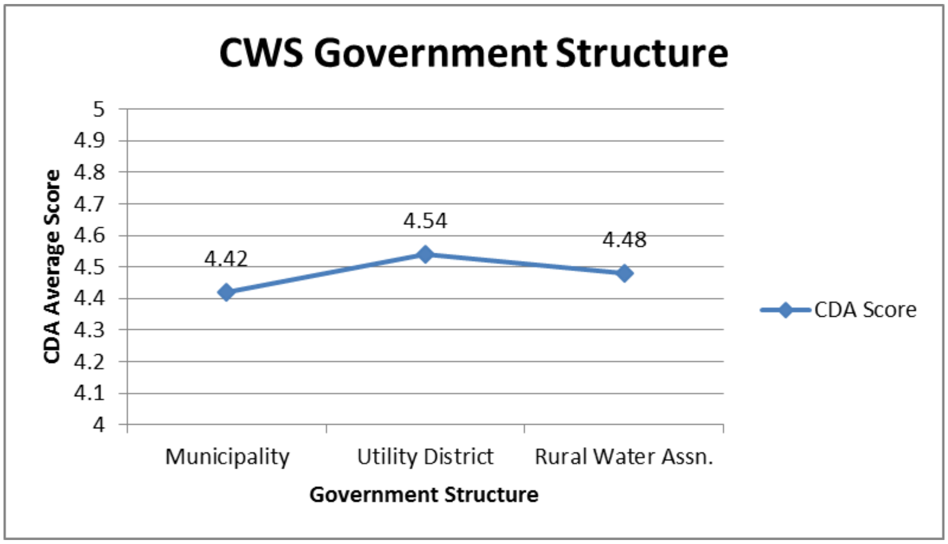

Figure 7 Government Structure Comparisons

Data Analysis of Size Categories

Each size classification; very small, small, medium, and large, has been grouped regardless of government structure and a two sample t-test has been performed in order to determine if size alone has an effect on the performance of CWSs. Grouping of EPA size classification has very small CWSs with 203 surveyed with an average CDA score of 4.16, small with 576 surveyed with an average CDA score of 4.49, medium with 134 surveyed with an average CDA score of 4.72, and large with 57 surveyed with an average CDA score of 4.67 (Table 6).

Table 6 Size: Quantity and Capacity Development Assessment

	SIZE			
	Very Small	**Small**	**Medium**	**Large**
Capacity Development Assessment Average & N	4.16 N = 203	4.49 N = 576	4.72 N = 134	4.67 N = 57

Table 7 displays the results of the two sample t-test that was conducted to examine the relationship between the average CDA scores of the size classifications.

Table 7 T-Test Results of CDA Score Comparisons of Size

SIZE			
	Small	**Medium**	**Large**
Very Small	-6.2928***	-7.0213***	-4.4031***
Small	-	-4.5265***	-2.3610***
Medium	-	-	0.7688

* = P < 0.1
** = P < 0.05
*** = P < 0.01

The results suggest that size alone does have an effect on the performance of CWSs in every relationship except for medium versus large CWSs. These results may be interpreted as CWSs can achieve greater performance as they increase in size from very small to small and from small to medium but there is no performance incentive to increase in population past the 10,000 mark (past the medium size classification) (Figure 8).

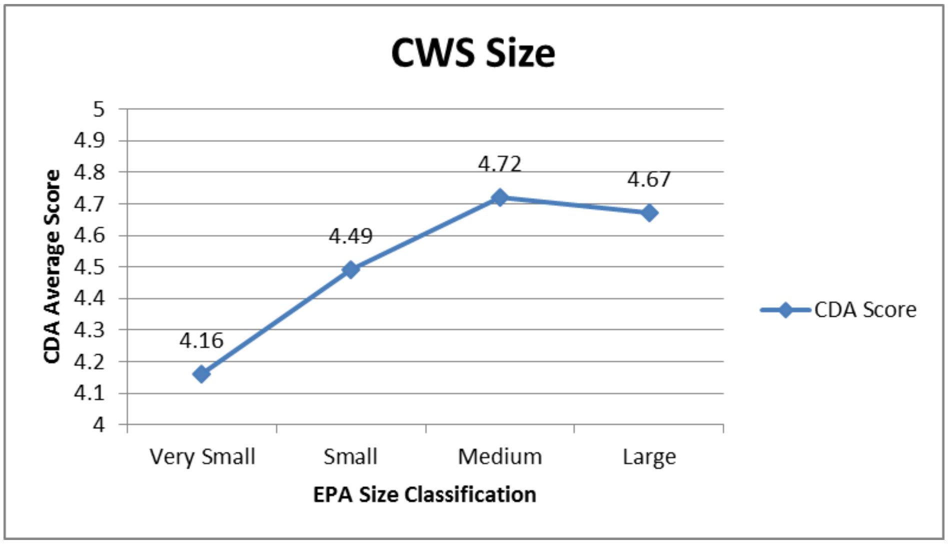

Figure 8 Size Comparisons

Data Analysis of Government Structures by Size

Each government structure; municipality, utility district and rural water association, has been divided into a corresponding size classification; very small, small, medium, and large, and a two sample t-test has been performed in order to determine if government structure by size (Table 9) and if size by government structure (Table 10) have an effect on the performance of CWSs. Dividing municipalities by EPA size classification has very small with 42 surveyed with an average CDA score of 4.27, small with 160 surveyed with an average CDA score of 4.34, medium with 46 surveyed with an average CDA score of 4.58, and large with 44 surveyed with an average CDA score of 4.65. Dividing utility districts by EPA size classification has very small with 11 surveyed with an average CDA score of 4.12, small with 16 surveyed with an average CDA score of 4.75, medium with 6 surveyed with an average CDA score of 4.61, and large with 5 surveyed with an average CDA score of 4.73. Dividing rural water associations by EPA size classification has very small with 150 surveyed with an average CDA score of 4.14, small with 400 surveyed with an average CDA score of 4.54, medium with 82 surveyed with an average CDA score of 4.81, and large with 8 surveyed with an average CDA score of 4.71 (Table 8).

Table 8 Government Structure x Size: Quantity and Capacity Development Assessment

	GOVERNMENT STRUCTURE		
SIZE	**Municipal**	**Utility District**	**Rural Water Assn.**
Very Small – Capacity Development Assessment & N	4.27 N = 42	4.12 N = 11	4.14 N = 150
Small – Capacity Development Assessment & N	4.34 N = 160	4.75 N = 16	4.54 N = 400
Medium – Capacity Development Assessment & N	4.58 N = 46	4.61 N = 6	4.81 N = 82
Large – Capacity Development Assessment & N	4.65 N = 44	4.73 N = 5	4.71 N = 8

Table 9 displays the results of the two sample t-tests conducted to examine the relationship between the average CDA scores of each government structure at each size classification.

Table 9 T-Test Results of CDA Score Comparisons of Government Structure by Sizes

	GOVERNMENT STRUCTURE		
SIZE	**Municipal vs Utility District**	**Municipal vs Rural Water Assn.**	**Utility District vs Rural Water Assn.**
Very Small	0.4	0.9195	-0.0624
Small	-2.4792***	-3.8869***	1.6734*
Medium	-0.1321	-2.6649***	-1.0508
Large	-0.3828	-0.3437	0.1299

* = P < 0.1
** = P < 0.05
*** = P < 0.01

The results suggest that there is no significant difference in performance amongst very small municipalities, utility districts, and rural water associations (Figure 9).

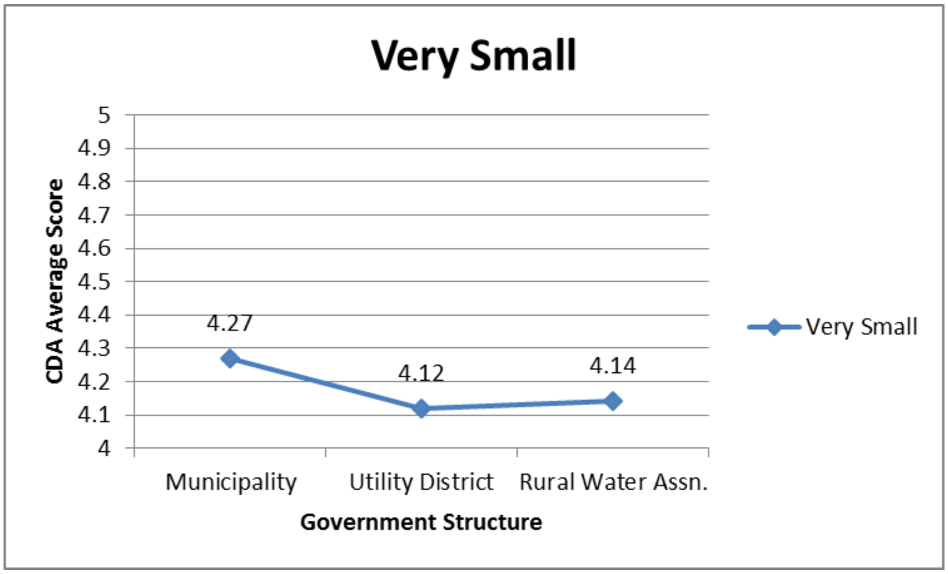

Figure 9 Very Small Government Structures

The results suggest that there is a significant difference in performance among small municipalities, utility districts, and rural water associations. At the small size classification, utility districts outperform rural water associations and municipalities respectively (Figure 10).

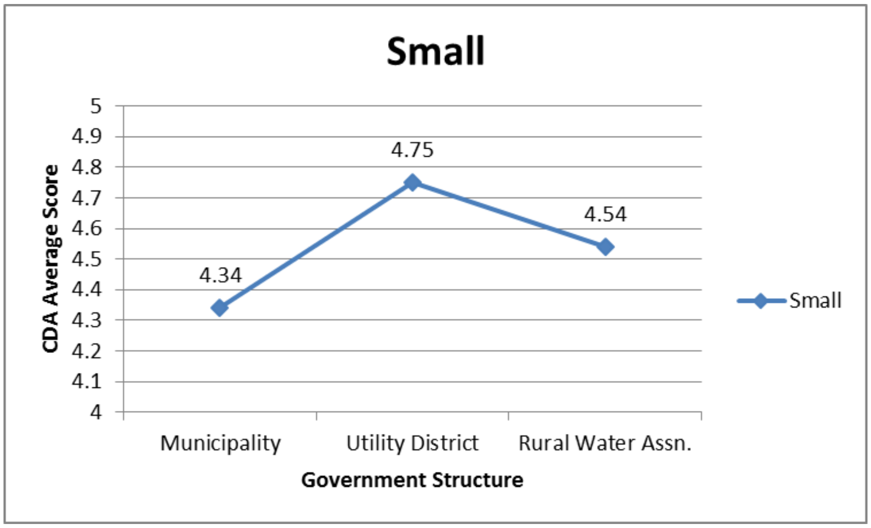

Figure 10 Small Government Structures

The results suggest that there is only a significant difference in performance among medium municipalities and rural water associations with rural water associations having greater performance. At the medium size classification, rural water associations outperform utility districts and municipalities respectively (Figure 11).

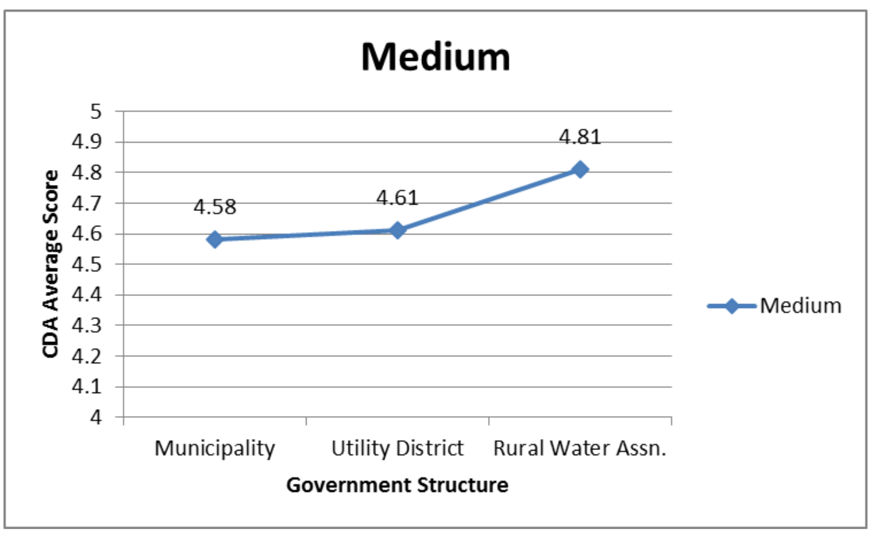

Figure 11 Medium Government Structures

These results suggest that there is no significant difference in performance amongst large municipalities, utility districts, and rural water associations (Figure 12).

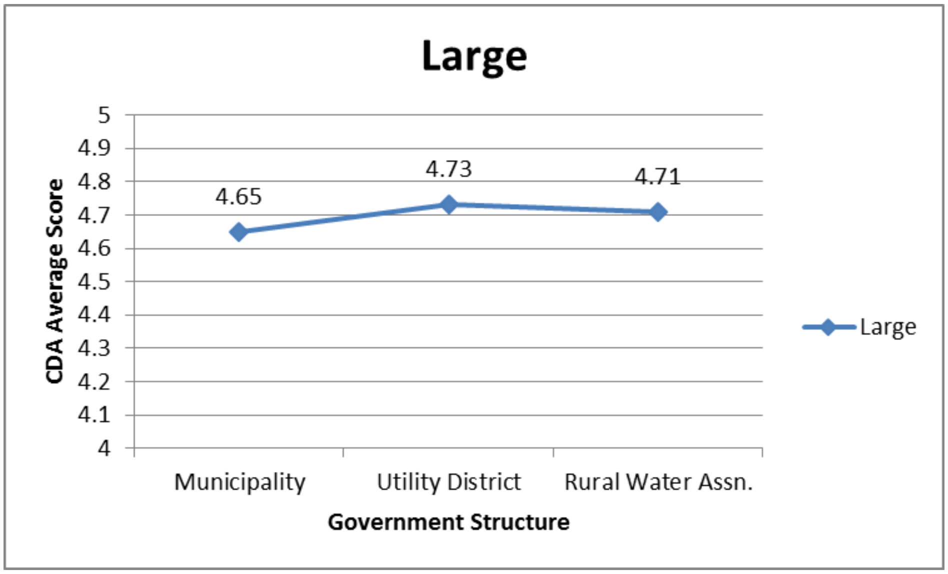

Figure 12 Large Government Structures

The results of the t-tests have analyzed CDA scores at each particular size category by government structure. This is beneficial if size of the CWS is the limiting factor and the need is to know which government structure is the optimal performer at that particular size. Very small CWSs in Mississippi do not see a difference in performance due to the government structure. Small CWSs in Mississippi may achieve the highest performance attainable under a utility district government structure. Medium CWSs in Mississippi may achieve the highest performance attainable under a rural water association government structure. Large CWSs in Mississippi do not see a difference in performance due to the government structure.

Data Analysis of Size by Government Structure

Table 10 displays the results of the two sample t-tests conducted to examine the relationship between the average CDA scores of each size classification by government structure.

Table 10 T-Test Results of CDA Score Comparisons of Size by Government Structure

	GOVERNMENT STRUCTURE		
SIZE	**Municipal**	**Utility District**	**Rural Water Assn.**
Very Small vs Small	-0.6120	-2.0685**	-6.9640***
Small vs Medium	-2.2921**	0.6019	-4.6240***
Medium vs Large	-0.6885	-0.3669	0.6586

* = $P < 0.1$
** = $P < 0.05$
*** = $P < 0.01$

The results suggest that there is an improvement in performance of municipalities as its size increases from very small to large yet the only statistically significant increase is from small to medium (Figure 13).

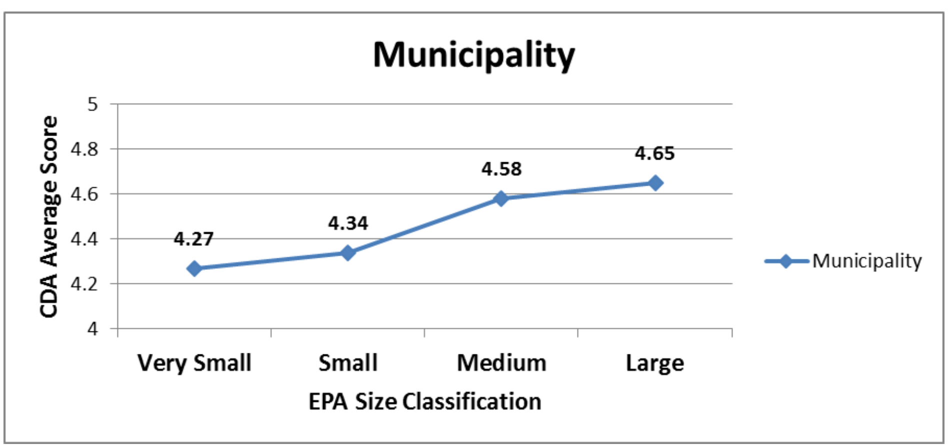

Figure 13 Municipalities

These results suggest that there is an improvement in performance of utility districts as its size increases from very small to small and this is the only statistically significant increase. As a utility district increases in size from small to large its performance is nearly unchanged and there is no statistical significance between the CDA scores (Figure 14).

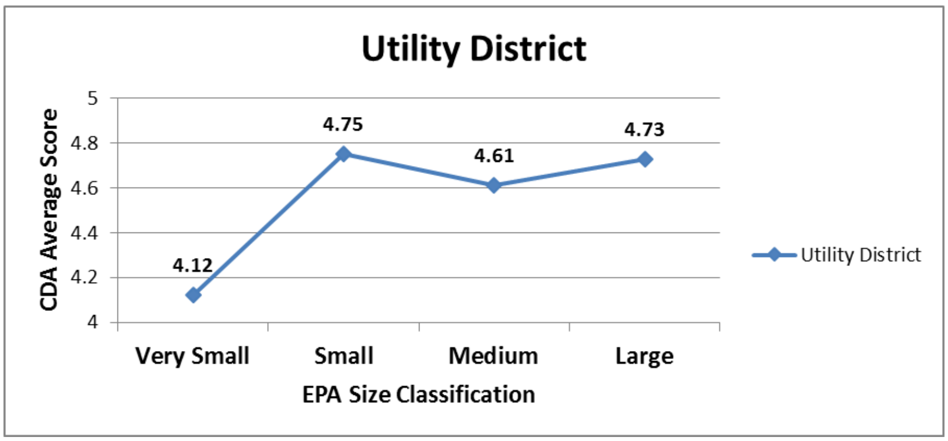

Figure 14 Utility Districts

These results suggest that there is an improvement in performance of rural water associations as its size increases from very small to small and from small to medium and both increases are statistically significant. As rural water associations increases in size from medium to large its performance decreases slightly but there is no statistical significance between the CDA scores (Figure 15).

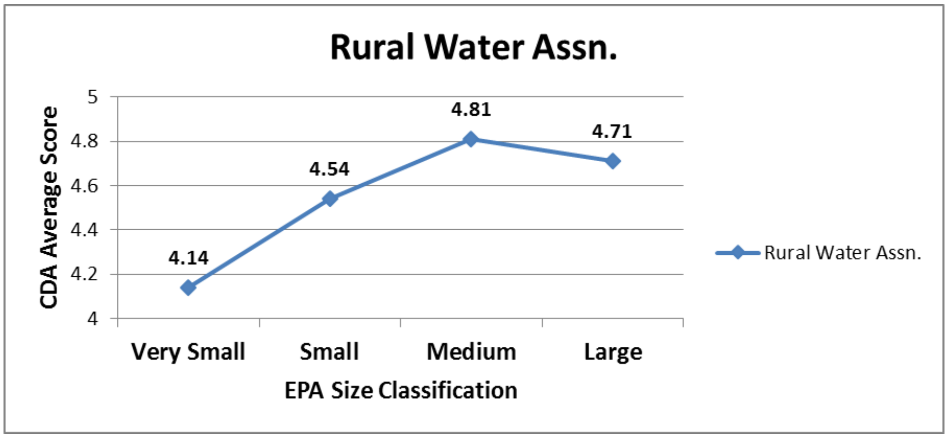

Figure 15 Rural Water Associations

The results of the t-tests have analyzed CDA scores at each particular government structure by size category. This is beneficial if government structure of the CWS is the limiting factor and the need is to know which size produces optimal performance of that particular government structure. Municipal CWSs in Mississippi see an improvement in performance as they increase in size from very small to large. Municipal CWSs in Mississippi achieve their optimal performance at the medium size. Utility district CWSs in Mississippi see an improvement in performance as they increase in size from very small to small. As they increase in size from small to large, performance is unchanged. Utility district CWSs in Mississippi achieve their optimal performance at the small size and maintain that performance level through medium and large size classifications. Rural water association CWSs in Mississippi see an improvement in performance as they increase in size from very small to medium and they reach their optimal performance level at the medium size classification. As they increase in size from medium to large, performance declines but it is not a statistically significant difference.

Data Analysis of Subgroups; Government Structure by Size

Table 11 displays the results of the two sample t-tests conducted to examine the relationship between the Technical CDA scores of each government structure at each size classification.

Table 11 Technical - T-Test Results of CDA Score Comparisons of Government Structure by Sizes

	GOVERNMENT STRUCTURE		
SIZE	**Municipal vs Utility District**	**Municipal vs Rural Water Assn.**	**Utility District vs Rural Water Assn.**
Very Small	-0.4388	0.0244	0.4797
Small	-2.4873***	-2.4435***	1.8181*
Medium	-0.2377	-2.8115***	-1.1140
Large	0.0199	-0.2503	-0.2168

* = $P < 0.1$
** = $P < 0.05$
*** = $P < 0.01$

These results suggest that there is no significant difference in technical performance amongst very small municipalities, utility districts, and rural water associations (Figure 16).

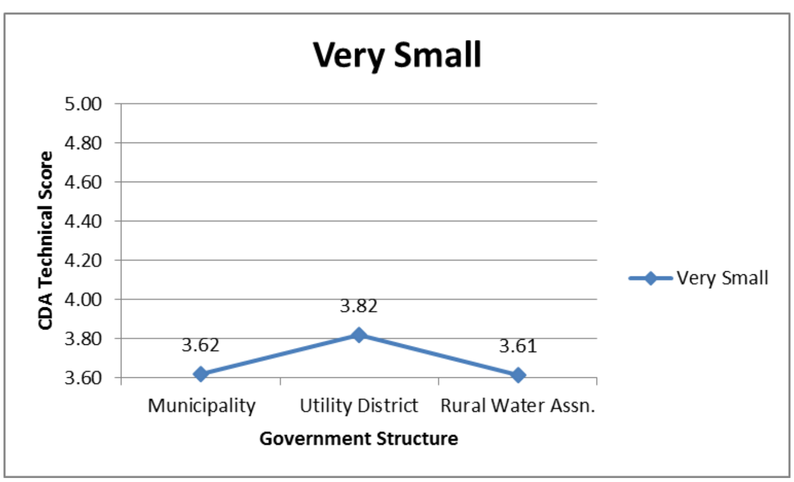

Figure 16 Very Small Government Structures - Technical

These results suggest that there is a significant difference in technical performance among small municipalities, utility districts, and rural water associations. At the small size classification, utility districts outperform rural water associations and municipalities respectively (Figure 17).

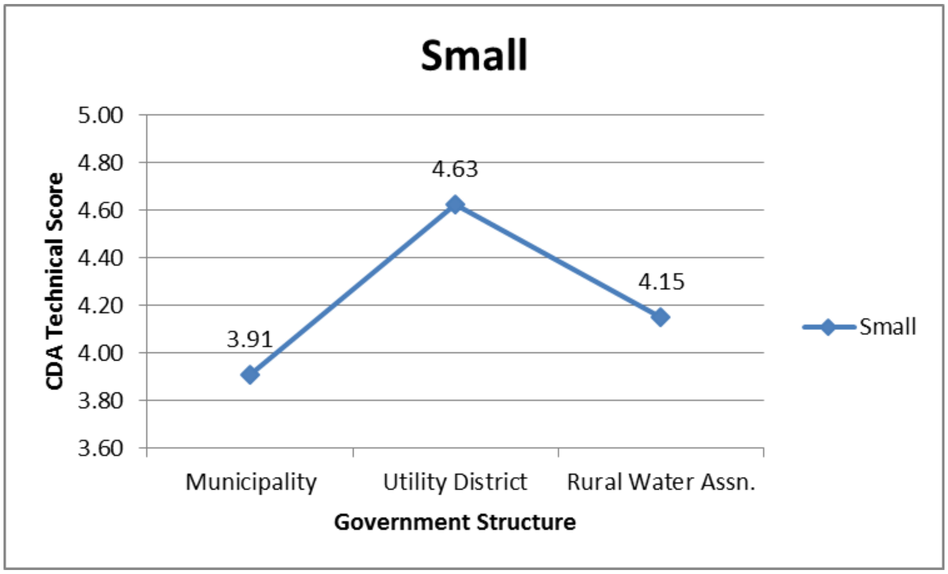

Figure 17 Small Government Structures - Technical

These results suggest that there is only a significant difference in technical performance among medium municipalities and rural water associations with rural water associations having greater performance. At the medium size classification, rural water associations outperform utility districts and municipalities respectively (Figure 18).

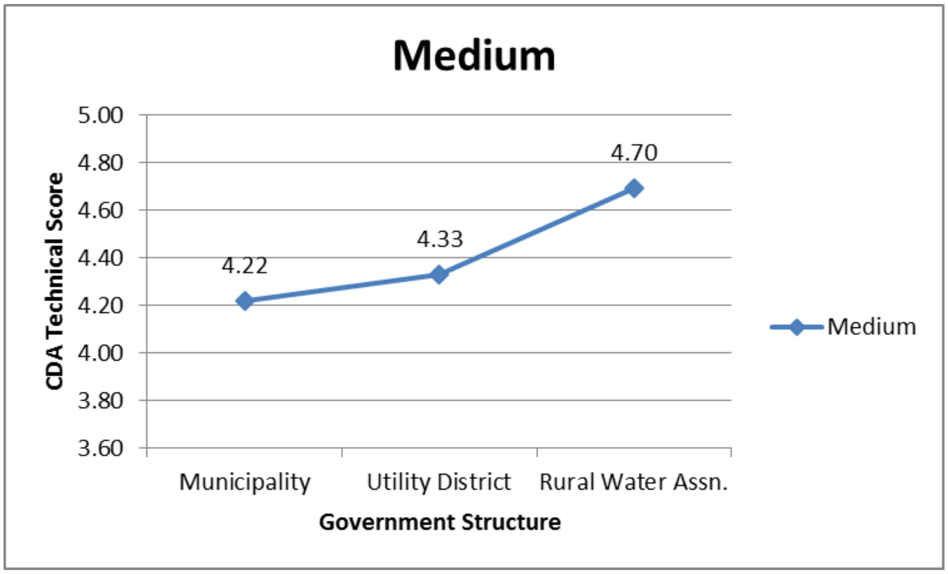

Figure 18 Medium Government Structures – Technical

These results suggest that there is no significant difference in technical performance amongst large municipalities, utility districts, and rural water associations (Figure 19).

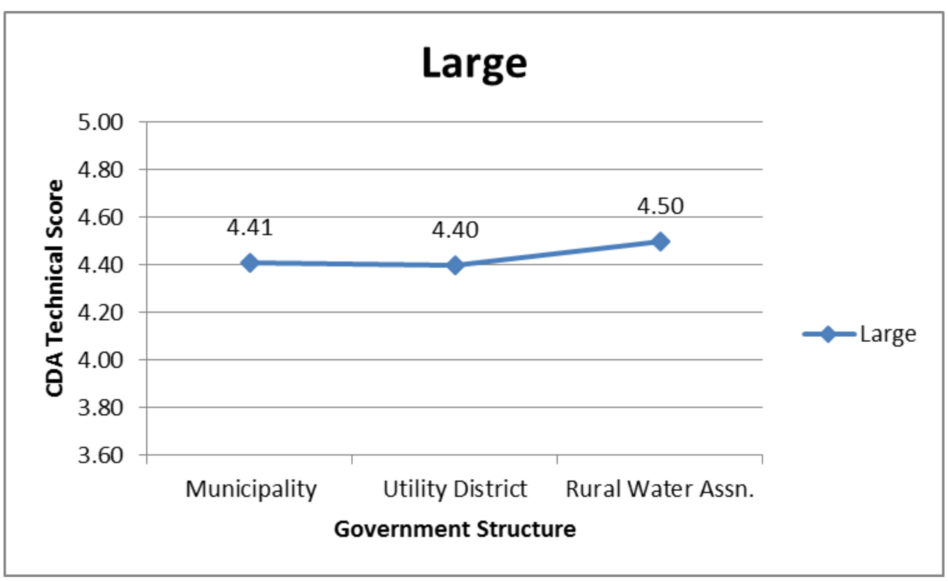

Figure 19 Large Government Structures – Technical

Table 12 displays the results of the two sample t-tests conducted to examine the relationship between the managerial CDA scores of each government structure at each size classification.

Table 12 Managerial - T-Test Results of CDA Score Comparisons of Government Structure by Sizes

	GOVERNMENT STRUCTURE		
SIZE	**Municipal vs Utility District**	**Municipal vs Rural Water Assn.**	**Utility District vs Rural Water Assn.**
Very Small	0.5894	1.7701*	0.3453
Small	-1.8609*	-4.1034***	0.7626
Medium	0.1143	-2.1582**	-1.1547
Large	-1.2096	0.5300	1.5933

* = $P < 0.1$
** = $P < 0.05$
*** = $P < 0.01$

These results suggest that the only significant difference in managerial performance is between very small municipalities and very small rural water associations with municipalities having greater performance (Figure 20).

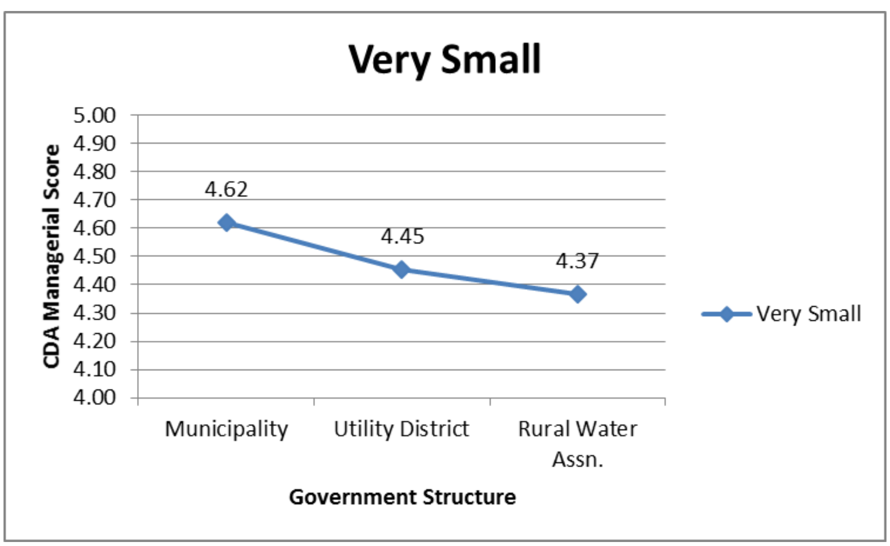

Figure 20 Very Small Government Structures – Managerial

These results suggest that there is a significant difference in managerial performance among small municipalities, utility districts, and rural water associations but no significant difference between utility districts and rural water associations. At the small size classification, utility districts outperform rural water associations and municipalities respectively (Figure 21).

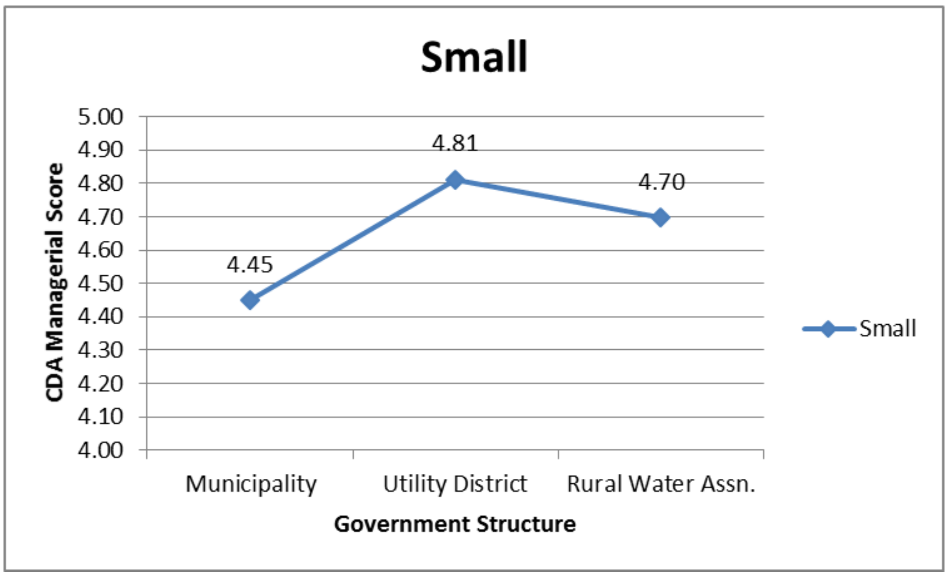

Figure 21 Small Government Structures - Managerial

These results suggest that there is only a significant difference in managerial performance among medium municipalities and rural water associations with rural water associations having greater performance. At the medium size classification, rural water associations outperform municipalities and utility districts respectively (Figure 23).

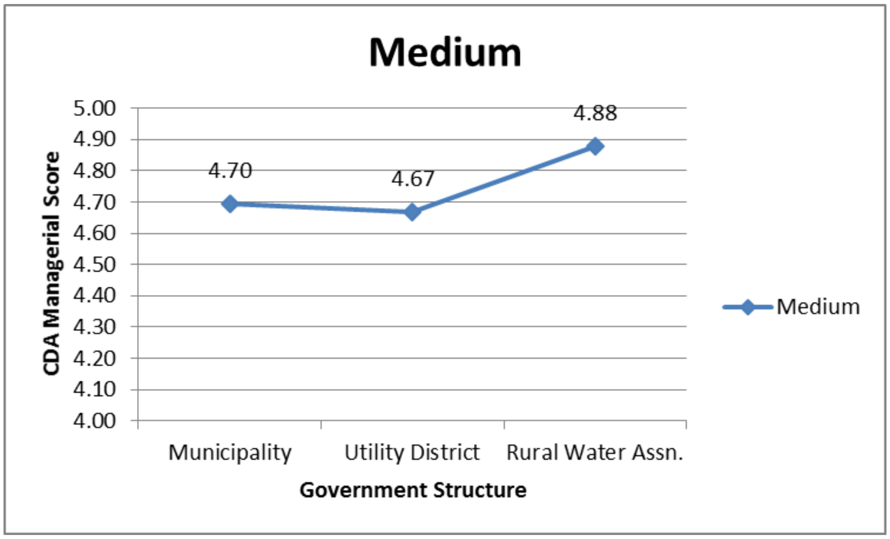

Figure 22 Medium Government Structures – Managerial

These results suggest that there is not a statistically significant difference in managerial performance among large CWSs. Utility districts outperform municipalities and rural water associations respectively (Figure 23).

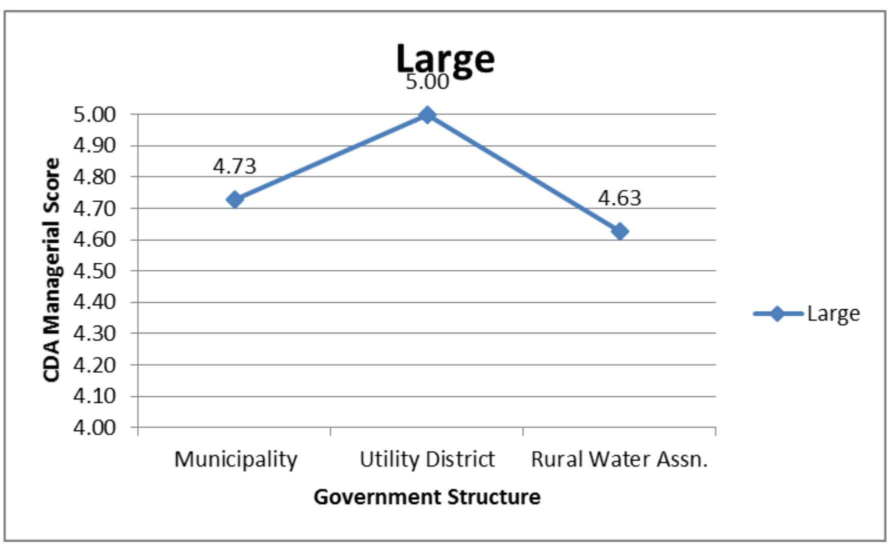

Figure 23 Large Government Structures - Managerial

Table 13 displays the results of the two sample t-tests conducted to examine the relationship between the financial CDA scores of each government structure at each size classification.

Table 13 Financial - T-Test Results of CDA Score Comparisons of Government Structure by Sizes

	GOVERNMENT STRUCTURE		
SIZE	**Municipal vs Utility District**	**Municipal vs Rural Water Assn.**	**Utility District vs Rural Water Assn.**
Very Small	1.5416*	0.8147	-1.0610
Small	-0.8414	-1.9043**	0.3215
Medium	-0.0349	-0.4569	-0.1664
Large	0.0975	-1.3074	-1.3009

* = P < 0.1
** = P < 0.05
*** = P < 0.01

The results suggest that there is a statistically significant difference in financial performance between very small municipalities and utility districts with municipalities having greater performance (Figure 24).

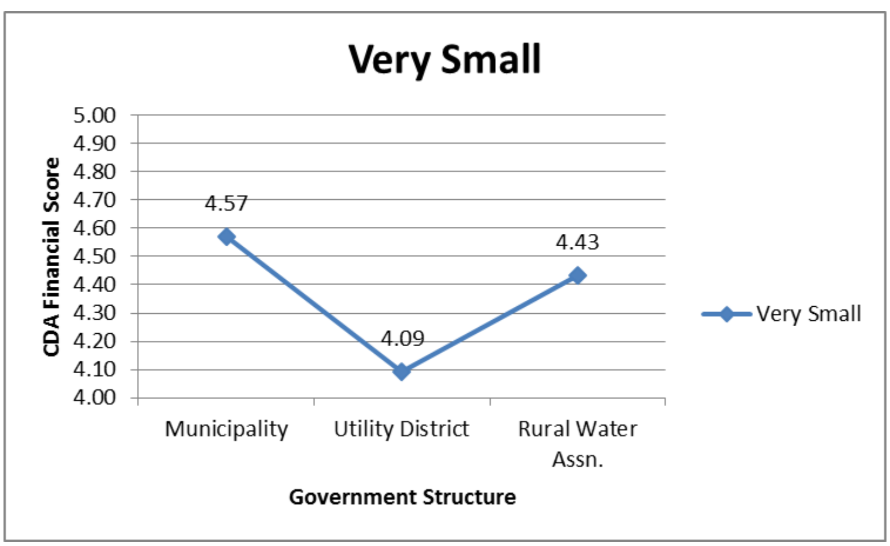

Figure 24 Very Small Government Structures - Financial

The results suggest that there is a statistically significant difference in financial performance among small municipalities and rural water associations with rural water associations having greater performance. At the small size classification, utility districts outperform rural water associations and municipalities respectively (Figure 25).

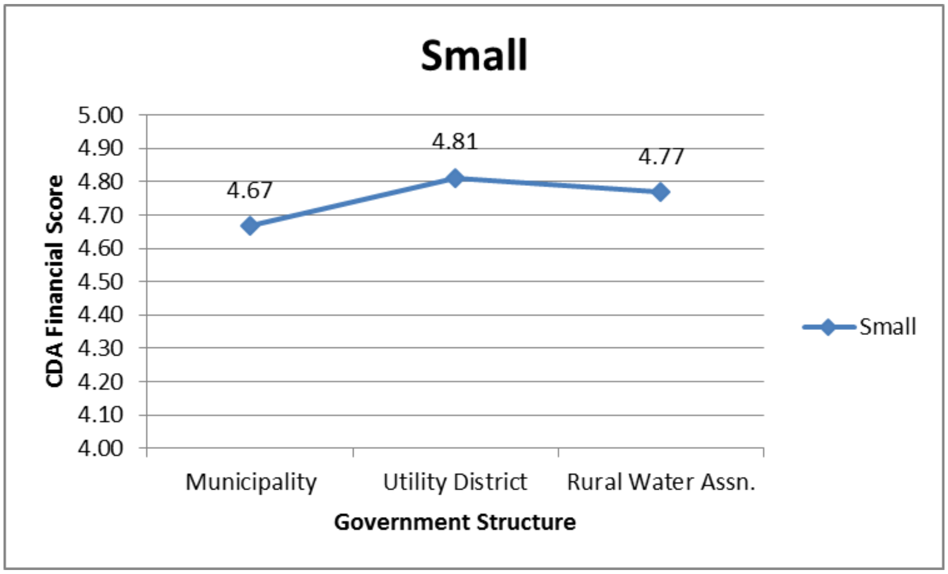

Figure 25 Small Government Structures - Financial

These results suggest that there is not a statistically significant difference in financial performance among medium municipalities, utility districts, and rural water associations. At the medium size classification, rural water associations outperform utility districts and municipalities respectively (Figure 26).

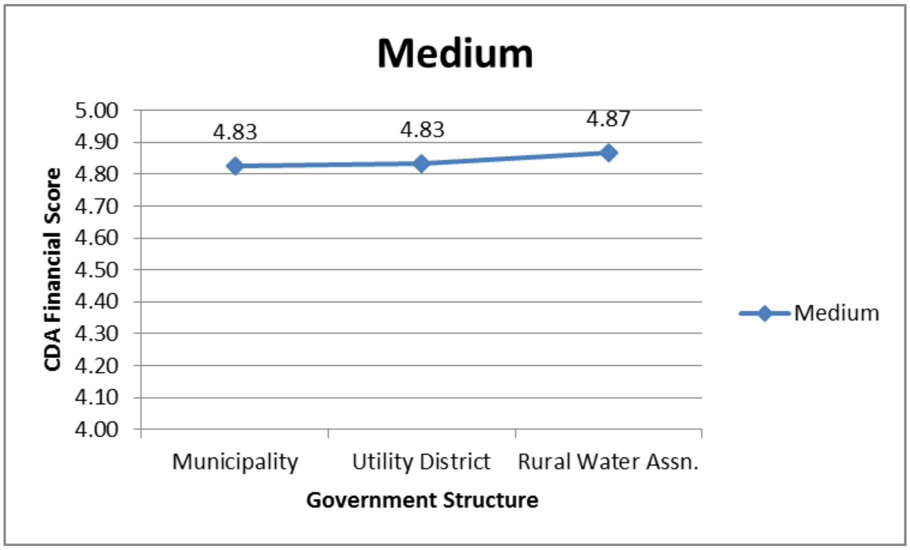

Figure 26 Medium Government Structures – Financial

These results suggest that there is not a statistically significant difference in financial performance amongst large municipalities, utility districts, and rural water associations (Figure 27).

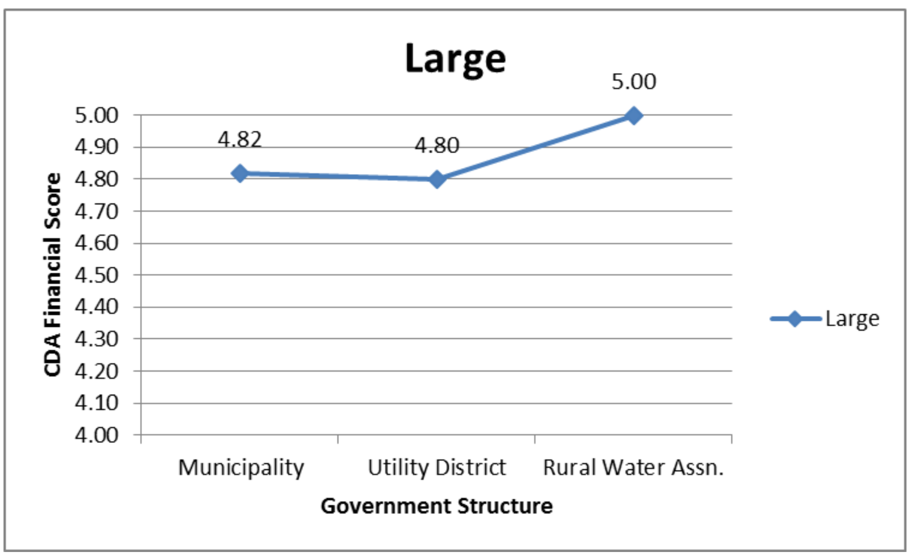

Figure 27 Large Government Structures - Financial

Data Analysis of Subgroups; Size by Government Structure

Table 14 displays the results of the two sample t-tests conducted to examine the relationship between the technical CDA scores of each size classification by government structure.

Table 14 Technical - T-Test Results of CDA Score Comparisons of Size by Government Structure

	GOVERNMENT STRUCTURE		
SIZE	**Municipal**	**Utility District**	**Rural Water Assn.**
Very Small vs Small	-1.4166	-1.9000*	-4.9504***
Small vs Medium	-1.6305*	0.9041	-4.5139***
Medium vs Large	-0.8508	-0.1292	0.6894

* = P < 0.1
** = P < 0.05
*** = P < 0.01

These results suggest that there is an improvement in technical performance of municipalities as its size increases from very small to large yet the only statistically significant increase is from small to medium (Figure 28).

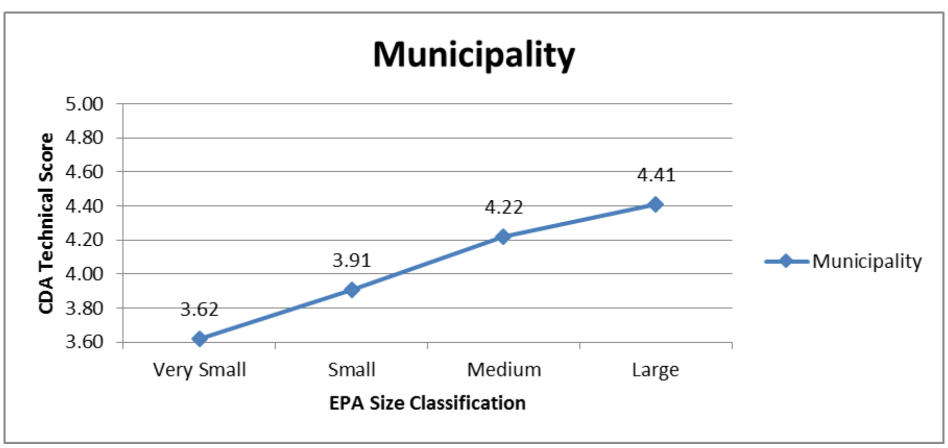

Figure 28 Municipalities - Technical

These results suggest that there is an improvement in technical performance of utility districts as its size increases from very small to small and this is the only statistically significant increase. As a utility district increases in size from small to large its technical performance is nearly unchanged and there is no statistical significance between the CDA scores (Figure 29).

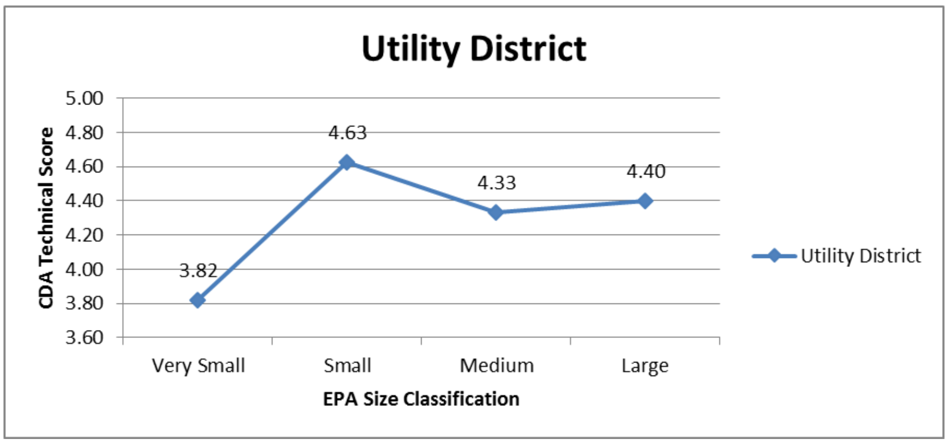

Figure 29 Utility Districts - Technical

These results suggest that there is an improvement in technical performance of rural water associations as its size increases from very small to small and from small to medium and both increases are statistically significant. A rural water association's technical performance decreases slightly as its size increases from medium to large but there is no statistical significance between the CDA scores (Figure 30).

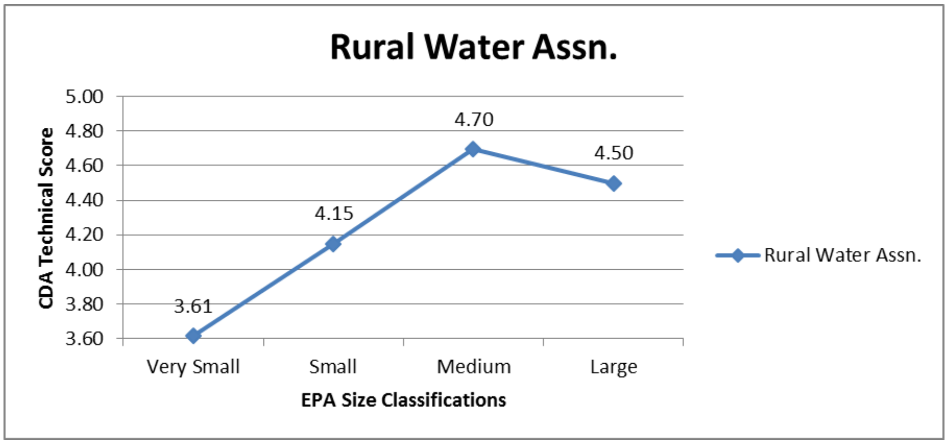

Figure 30 Rural Water Associations - Technical

Table 15 displays the results of the two sample t-tests conducted to examine the relationship between the managerial CDA scores of each size classification by government structure.

Table 15 Managerial - T-Test Results of CDA Score Comparisons of Size by Government Structure

	GOVERNMENT STRUCTURE		
SIZE	**Municipal**	**Utility District**	**Rural Water Assn.**
Very Small vs Small	1.2614	-1.3676	-5.2298***
Small vs Medium	-2.0434**	0.4887	-2.6365***
Medium vs Large	-0.2844	-0.9045	1.6741*

* = P < 0.1
** = P < 0.05
*** = P < 0.01

These results suggest that there is an improvement in managerial performance of municipalities as its size increases from very small to large yet the only statistically significant increase is from small to medium (Figure 31).

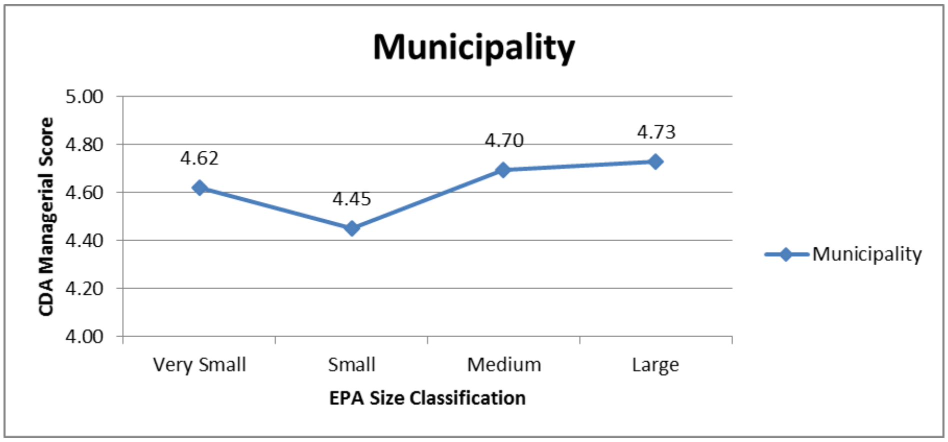

Figure 31 Municipalities - Managerial

These results suggest that there is an improvement in managerial performance of utility districts as its size increases from very small to small and from medium to large and overall from very small to large. As a utility district increases in size from very small to large its managerial performance has no statistical significance between the CDA scores (Figure 32).

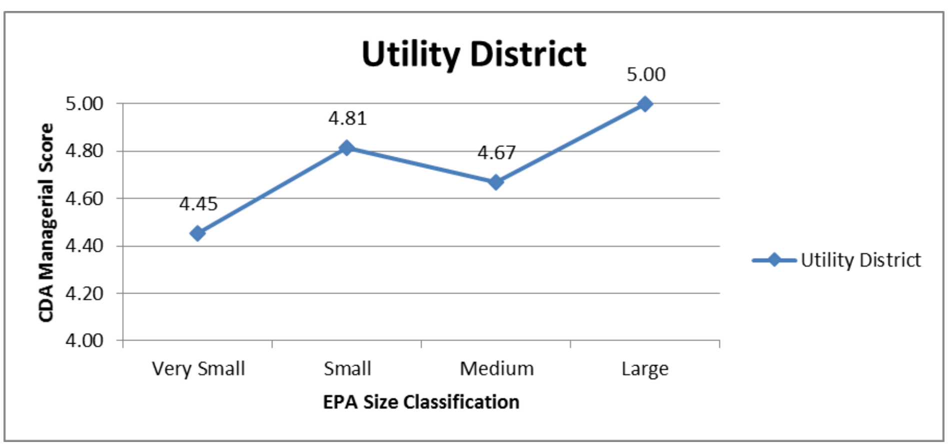

Figure 32 Utility Districts - Managerial

These results suggest that there is an improvement in managerial performance of rural water associations as its size increases from very small to small and from small to medium and both increases are statistically significant. As rural water associations increase in size from medium to large its managerial performance decreases and there is statistical significance between the CDA scores (Figure 33).

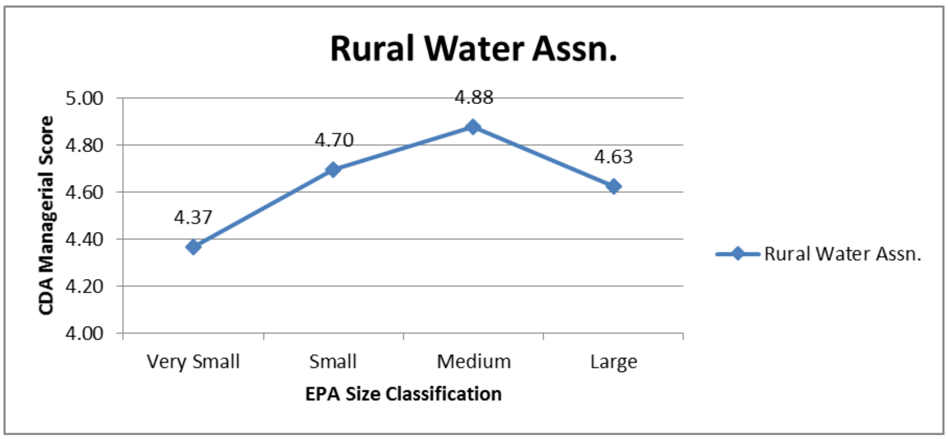

Figure 33 Rural Water Associations - Managerial

Table 16 displays the results of the two sample t-tests conducted to examine the relationship between the financial CDA scores of each size classification by government structure.

Table 16 Financial - T-Test Results of CDA Score Comparisons of Size by Government Structure

	GOVERNMENT STRUCTURE		
SIZE	**Municipal**	**Utility District**	**Rural Water Assn.**
Very Small vs Small	-0.8030	-2.0943**	-5.0887***
Small vs Medium	-1.4829*	-0.1076	-1.5411*
Medium vs Large	0.0849	0.1292	-0.8116

* = P < 0.1
** = P < 0.05
*** = P < 0.01

These results suggest that there is an improvement in financial performance of municipalities as its size increases from very small to large yet the only statistically significant increase is from small to medium (Figure 34).

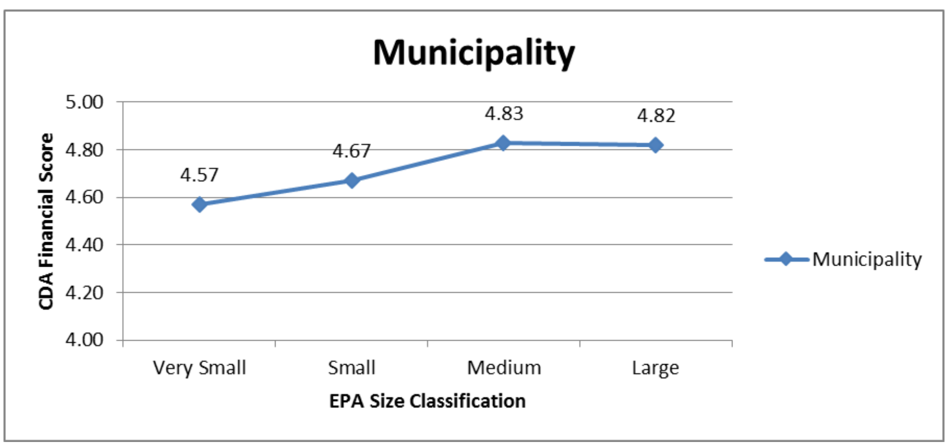

Figure 34 Municipalities - Financial

These results suggest that there is an improvement in financial performance of utility districts as its size increases from very small to small and this is the only statistically significant increase. As a utility district increases in size from small to large its financial performance is nearly unchanged and there is no statistical significance between the CDA scores (Figure 35).

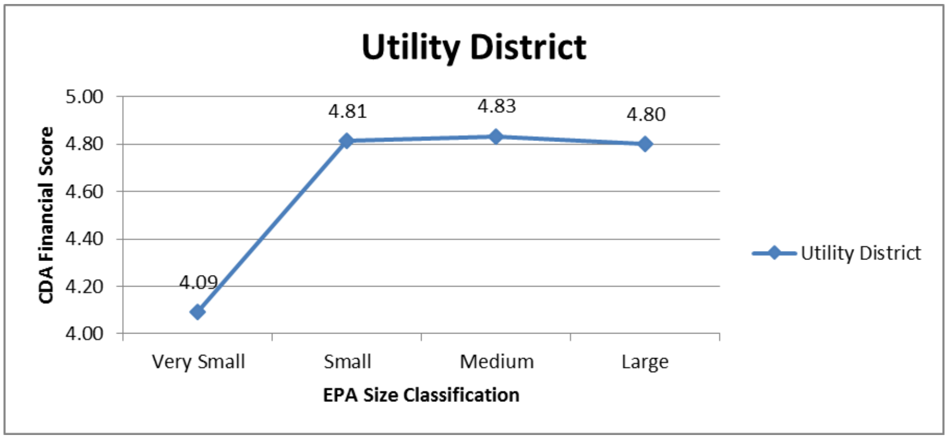

Figure 35 Utility Districts - Financial

These results suggest that there is an improvement in financial performance of rural water associations as its size increases from very small to small and from small to medium and both increases are statistically significant. As rural water associations increases in size from medium to large its financial performance increases but there is no statistical significance between the CDA scores (Figure 36).

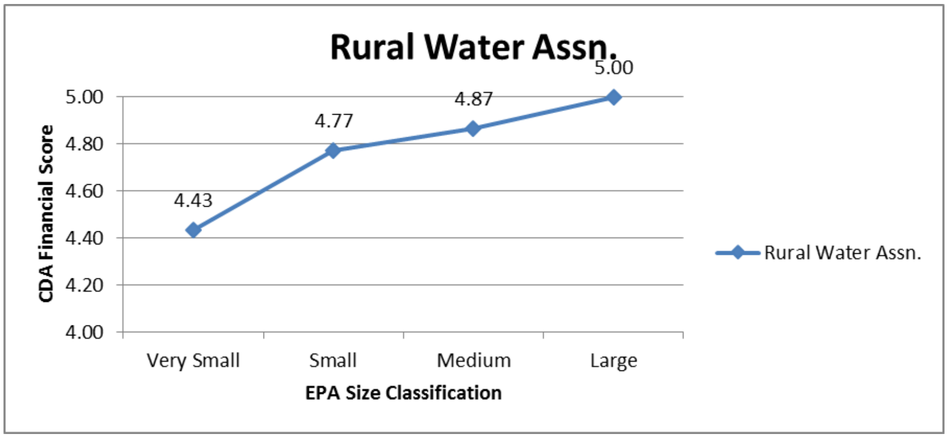

Figure 36 Rural Water Associations - Financial

Subgroups and Overall Average CDA Comparisons

The previous tables (Table 9 – Table 15) have displayed the t Stat and P Value of t-tests performed to determine if there is a statistical significance between the variables. The previous figures (Figure 9 – Figure 36) have given a visual representation of the CDA scores (subgroups and overall average). Each figure displayed and discussed the statistical significance of just one variable.

I will display three figures below that will represent each government structure across all size classifications. Each figure will display the technical, managerial, financial, and overall CDA average for each government structure. The importance of these figures is to visualize which variables give weight to the overall CDA average and at which size does each government structure perform optimally.

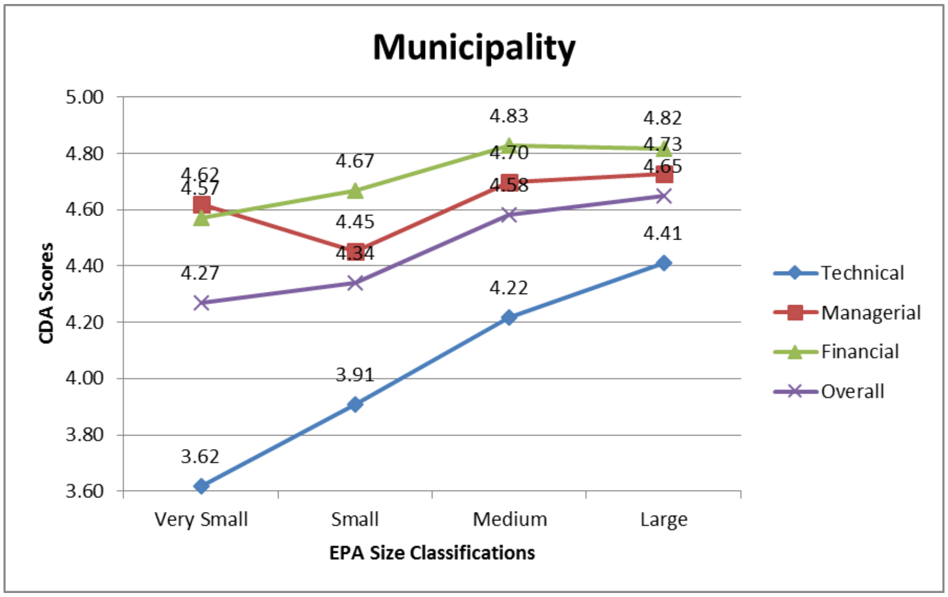

Figure 37 Municipal – Subgroups and Overall CDA Average

Figure 37 shows that as a municipal CWS increases in size, it performs at a higher level. Managerial performance decreases from very small to small but the change is not statistically significant. The statistical significance of municipalities performance occurs when size increases from small to medium; technical performance is significant at the 0.1 level ($P<0.1$), managerial performance is significant at the 0.05 level ($P<0.05$), financial performance is significant at the 0.1 level ($P<0.1$), and overall performance is significant at the 0.05 level ($P<0.05$). Graphically it is clear that technical performance weighs down the overall performance of municipalities.

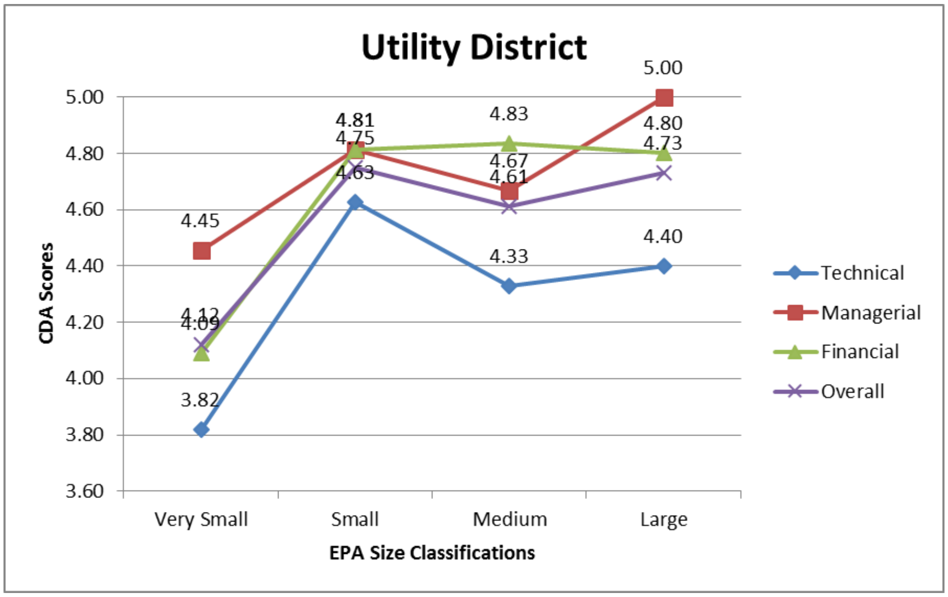

Figure 38 Utility District – Subgroups and Overall CDA Average

Figure 38 shows that as a utility district CWS increases in size from very small to small, it performs at a higher level and from small to large there is no statistical significant difference in performance. Technical and managerial performance decreases from small to medium but the change is not statistically significant. Financial performance decreases from medium to large but the change is not statistically significant. The statistical significance of utility districts performance occurs when size increases from very small to small; technical performance is significant at the 0.1 level ($P<0.1$), financial performance is significant at the 0.05 level ($P<0.05$), and overall performance is significant at the 0.05 level ($P<0.05$). Managerial performance is greater than technical and financial at the very small size classification and there is no statistical significance as its performance increases as size increase from very small to small.

Graphically it is clear that technical performance weighs down the overall performance of utility districts.

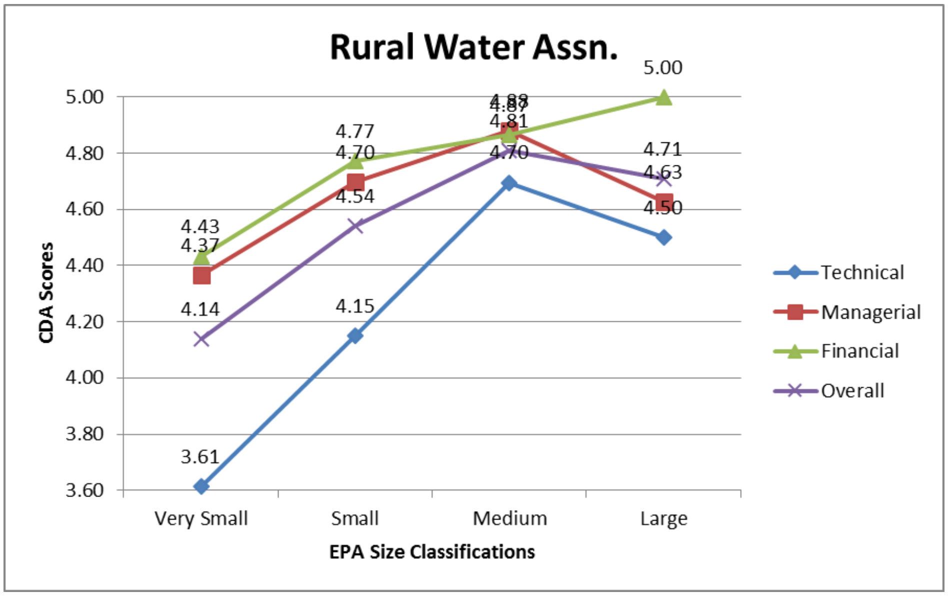

Figure 39 Rural Water Association – Subgroups and Overall CDA Average

Figure 39 shows that as a rural water association CWS increases in size from very small to medium, it performs at a higher level and it is statistically significant. From medium to large, its performance decreases but there is no statistical significance. Technical and managerial performance decrease from medium to large but the change is not statistically significant. The statistical significance of rural water association performance occurs when size increases from very small to small; technical performance is significant at the 0.01 level ($P<0.01$), managerial performance is significant at the 0.01 level ($P<0.01$), financial performance is significant at the 0.01 level ($P<0.01$), and overall performance is significant at the 0.01 level ($P<0.01$) and when size increases from small to medium; technical performance is significant at the 0.01 level ($P<0.01$), managerial performance is significant at the 0.01 level ($P<0.01$), financial performance is significant at the 0.1 level ($P<0.1$), and overall performance is significant at the 0.01 level ($P<0.01$). Graphically it is clear that technical performance weighs down the overall performance of rural water associations.

This chapter has displayed the results of data analysis and graphical comparisons. The data analysis determines the significance of government structure and size (independently and combined) on the performance of Mississippi CWSs. The figures provide a visual confirmation to the statistical measures employed to determine significance.

CHAPTER VI

FINDINGS AND INTERPRETATIONS

This chapter will revisit the hypotheses and discuss how the results lend to accepting or rejecting each hypothesis. This chapter will also delve into the interpretations of the findings that lend to additional findings resulting from the data analysis.

H1a: A municipal water system is more likely to be a better performing community water system than a rural water association or a utility district.

The results of the t test that examined the relationship between the average CDA scores of each government structure, regardless of size, produced no statistical significance to support this hypothesis. Municipal CWSs actually had a lower average CDA than the utility district CWSs and the rural water association CWSs.

H1b: A rural water association is more likely to be a better performing community water system than a utility district.

The results of the t tests that examined the relationship between the average CDA scores of each government structure, regardless of size, produced no statistical significance to support this hypothesis. Rural water association CWSs had a lower average CDA than the utility district CWSs.

There was no statistical significance in the difference of the average CDA scores of the three government structures even though utility district CWSs outperformed rural water association CWSs and municipal CWSs respectively. The results suggest that government structure alone has no effect on the difference in performance of Mississippi CWSs.

H2: As the population of a community water system (municipal, utility district, or rural water association structure of government) increases, it will more likely produce a better performing community water system.

The results of the t tests that examined the relationship between the average CDA scores of each EPA size classification, regardless of government structure, produced statistical significance to support this hypothesis. Performance of CWSs increased with statistical significance as size increased from very small to small and from small to medium. The size increase from medium to large did not have a statistical significance even though the large average CDA was lower than the medium average CDA. This suggests that performance of medium and large CWSs is statistically the same. The results imply that size alone has an effect on the difference in performance of Mississippi CWSs.

H3: A general purpose government structure is more likely to achieve optimal quality of performance at a smaller population than a special purpose government structure.

The results of the t tests, that examined the relationship between the average CDA scores of each government structure by different size classifications as well as each size classification by each government structure, produced no statistical significance to support this hypothesis. I will use the statistical significance in the difference of the average CDA scores to discuss the different performance levels of each government structure.

Very small and small municipal CWSs do not have a statistical significance in the difference of their average CDA scores. There is no statistical significance in the difference of the average CDA scores of medium and large municipal CWSs. The lack of significance between these size classifications for municipalities generates a plateau affect in which very small and small are on the same plateau and medium and large are on the same plateau. There is a statistically significant difference in the average CDA scores of small and medium municipality CWSs. This suggests that municipal CWSs perform at two levels; very small and small are the lowest plateau and medium and large are the highest plateau. There is a threshold of quality of performance and it exists where municipalities move from one plateau to the other. Mississippi municipal CWSs reach their highest performance at the medium size classification.

There is a statistically significant difference in the average CDA scores of very small and small utility district CWSs. Small, medium, and large utility district CWSs do not have a statistical significance in the difference of their average CDA scores. The lack of significance between these size classifications for utility districts generates a plateau affect in which very small is on one plateau and small, medium, and large are on the same plateau. This suggests that utility district CWSs perform at two levels; very small is the lowest plateau and small, medium, and large are the highest plateau. There is a threshold of quality of performance and it exists where utility districts move from one plateau to the other. Mississippi utility district CWSs reach their highest performance at the small size classification.

There is a statistically significant difference in the average CDA scores of very small and small rural water association CWSs. There is a statistically significant difference in the average CDA scores of small and medium rural water association CWSs. There is no statistical significance in the difference of the average CDA scores of medium and large rural water association CWSs. The significance between these size classifications for rural water associations generates a plateau affect in which very small is on one plateau and small is on one plateau and medium and large are on the same plateau. This suggests that rural water association CWSs perform at three levels; very small is the lowest plateau, small is the intermediate plateau, and medium and large are the highest plateau. Mississippi rural water association CWSs reach their highest performance at the medium size classification.

The general purpose government structure (municipality) for a CWS in Mississippi achieves optimal performance at the same size classification (medium) as one of the special purpose government structure (rural water association) CWSs but behind the other special purpose government structure (utility district) CWSs as it achieves optimal performance at the small size classification. The results suggest that a general purpose government structure does not achieve an optimal quality of performance at a smaller population level than the special purpose government structures.

By revisiting each hypothesis and discussing the findings that relate to each hypothesis does not fully display the findings of the data analysis. I will expose other findings that were produced as a result of testing to accept or reject the initially stated hypothesis.

The data analysis by subgroup showed which of the subgroups skewed or weighed the overall average. First, I analyzed subgroups at government structure by size while using Table 9 as the reference point. The technical scores carried statistical significance at the exact same comparisons as the overall CDA average (Table 11). The managerial scores deviated from the overall CDA average by dropping the significance at small utility districts compared to small rural water associations and adding significance at very small municipalities compared to very small rural water associations (Table 12). This should be interpreted as the governing boards of special purpose government structure (utility district and rural water association) CWSs perform statistically no different at the small size classification. The addition of significance at the very small size classification should be interpreted as the governing board of a general purpose government structure (municipality) CWS significantly outperforms a special purposed government structure (rural water association) CWS and outperforms the other special purpose government structure (utility district) CWS but with no significance. The financial scores deviate from the overall CDA average by dropping significance at small municipalities compared to small utility districts, small utility districts compared to small rural water associations, and medium municipalities compared to medium rural water associations (Table 13). Significance is added at very small municipalities compared to very small utility districts. The lack of statistical significance in difference of the financial scores across size classifications of the CWS government structures should be interpreted as all government structures are performing similarly across their size classification. The addition of significance at the very small size classification should be interpreted as a general purpose government structure (municipality) CWS significantly outperforms a special purposed government structure (utility district) CWS and outperforms the other special purpose government structure (rural water association) CWS but with no significance.

Second, I analyzed subgroups at size by government structure while using Table 10 as the reference point. The technical scores carried statistical significance at the exact same comparisons as the overall CDA average (Table 14). The managerial scores deviated from the overall CDA average by dropping the significance as a utility district increases in size from very small to small even though the CDA score increases from very small to small (Table 15). This should be interpreted as the governing boards of all sizes of utility district CWSs perform similarly. The financial scores carried statistical significance at the exact same comparisons as the overall CDA average (Table 16).

The graphic conclusion to the data analysis displays each government structure with results of the technical, managerial, financial, and overall CDA average scores at each size classification. Visually, not necessarily statistically significant, across all size classifications, the financial scores are higher than the managerial and technical, respectively. The overall CDA average is between the managerial and the technical. Technical scores are the laggard across each government structure at each size classification. This should be interpreted as the financial requirements of the CDA are the easiest to achieve of the three subgroups. The managerial requirements of the CDA are in the middle with the technical requirements of the CDA being the hardest overall to achieve.

CHAPTER VII

FUTURE RESEARCH AND CONCLUSION

This chapter will lay out areas of future research that can build on the current literature as well as build on this research. Also, conclusions from this research will be drawn and potential policies will be discussed along with the implications those policies may play on the CWS environment in Mississippi

There are several points of future research that should be addressed in order to build upon this study's findings and further validate this study's findings. In order to build upon this study's findings, the same methodology followed for Mississippi should be implemented with another state. The state used to replace Mississippi should be one in which the primacy agency has developed a capacity development mechanism such as the Mississippi CDA. If similar results are found related to the performance of very small CWSs, there may need to be a federal and/or state regulatory push to eliminate the very small community water systems by forcing them to merge or consolidate with larger CWSs. If similar results are found related to the deficiency of technical capacity, there may need to be resources made available for CWSs to increase the technical capacity or added emphasis on technical areas with water operator certification.

In order to further validate this study's findings, previous survey data such as SDWA violations that were utilized to make comparisons among CWSs in the United States could be used for the Mississippi CWSs. Rubin's study looked at the United States but a future study could look solely at Mississippi to determine if SDWA violations and CDA scores are in line with determining the performance of CWSs.

To draw on final conclusions of this research is to confidently state items that should be addressed in order to have optimal performance of all CWSs in Mississippi. The MSDH is the primacy agency for all public water systems in Mississippi and they provide the financial resources to implement technical assistance to the public water systems of Mississippi. The efforts thus far have been fruitful but this research produces results that show that technical CDA scores for all government structures at all size classifications are the laggard. MSDH should take one of two approaches or take both approaches. The first approach is to incorporate more emphasis on the technical aspects of the CDA into current public water system assistance programs. The second approach is to create a public water system assistance program that solely focuses on the technical aspects of the CDA. It is more likely to see MSDH accept approach number one considering it could be implemented without increased expenditure from the primacy agency. Approach number two would take additional funds unless MSDH substituted the new public water system assistance program for an older public water system assistance program that may not be achieving desired results or meeting expectations.

The literature review produced support for municipalities to be the optimal governing structure for CWSs. This research produced results that show utility districts performing optimally at the small size classification which also outperforms municipalities at this level. This research also produced results that show rural water association CWSs and utility district CWSs performing as well as and better (in some cases) than municipality CWSs at each of the size classifications. The special purpose government structures, utility district and rural water association, of CWSs are a very viable option as the government structure in Mississippi and should be given equal respect as a governing entity for CWSs in Mississippi.

Very small CWSs make up 20.9% of the CWSs in Mississippi. This is a result of the sparse population of Mississippi and the remoteness of some communities in their area. The initial service to provide citizens of Mississippi with a clean, uninterrupted, and safe source of drinking water was achieved in the late 1960's and early 1970's but one result of that initiative is the large number of very small CWSs. These CWSs do not perform well with any government structure or at any subgroup of the CDA. It is a disservice to the Mississippi citizens that live on a very small CWS because it costs the system more per customer to operate and any financial assistance they may receive from a state or federal agency cannot be realistically paid back in a timely or fair manner. Very small CWSs should not exist in Mississippi. All efforts (financial and/or political) should be focused to combine the very small CWSs with larger (small, medium, or large) CWSs.

Final Thoughts

The CWSs of Mississippi have served a great purpose for many Mississippians for decades. The function of providing a safe, clean, uninterrupted supply of drinking water has been accomplished and it has been accomplished at a very low cost to the customer. Mississippi is blessed with an abundance of ground water that we should all appreciate and look to conserve moving forward. The efforts we make today will benefit generations to come. Water is a true necessity. We should realize its value as consumers and we should value those that provide it for us.

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APPENDIX A

FISCAL YEAR 2013 CAPACITY DEVELOPMENT ASSESSMENT

Mississippi State Department of Health Bureau of Public Water Supply

Capacity Development Rating Form Assessment Criteria

01 July 2012 - 30 June 2013

Technical Capacity

T1 Does the water system have any significant deficiencies?

T2 (1) Was the water treatment process functioning properly? Corrosion control plants: within +/- 0.5 of target pH (approximately 8.4, Langlier Index, or 7.2-7.8 if adding phosphate for corrosion AND minimum phosphate residual of 0.5 mg/L as P or 1.5 mg/L as PO4 (most test kits)), Iron removal plants: finished water Fe < 0.3 mg/l, Chlorine: Adequate at plant to provide free residual throughout system, spot checked on system, Systems adjusting Fluoride: 0.7 - 1.3 mg/l

T2 (2) Was needed water system equipment in place and functioning properly at the time of survey?
Adequate security: locked fence around wells/treatment plant/tank (6' or 5' + barbed wire at top), locked hatches on water storage tanks (operator verifies), Security Vulnerability Self-Assessment and Emergency Response Plan, both updated annually. Required equipment in place (i.e., phosphate and/or fluoride feeders on all wells if required), major components sized correctly if affects water quality or quantity, major components working at time of inspection unless provisions for repairs made. Must be noted on inspection report.

T2 (3) Were records available to the regional engineer clearly showing that all water storage tanks have been inspected and cleaned or painted (if needed) within the past 5 years? Maintenance and painting contracts, tank inspection reports, operator can inspect own tank if he/she writes a report and/or takes pictures, painted if needed.

T3 (1) Was the certified waterworks operator or his/her authorized representative present for survey?
Operator or representative must be present unless emergency; operator of record shouldn't miss two in a row.

T3 (2) Was log book up to date and properly maintained and did it show that MSDH Minimum JOB Guidelines for W. W. Operators were being met? Log book: Cl2 recorded as required, pH, Fe, Fluoride, and phosphate where applicable, major events recorded (fix major leaks, replace chlorine cylinder, equipment repairs, etc.) Part time operator must make required entries in log book to show MSDH MINIMUM JOB GUIDELINES are met. Major events can be recorded separately (work orders).

T3 (3) Was the water system properly maintained at the time of survey? Grass cut, packing not leaking excessively, plant presentable, etc.

T3 (4) Did the operator satisfactorily demonstrate to the regional engineer that he/she could fully perform all water quality tests required to properly operate this water system? Must have appropriate test kits, fresh reagents, and able to perform tests (where applicable: chlorine, pH, iron, fluoride, phosphate). Regional engineer may perform tests to verify operator's results. Chlorine test must be performed by operator at all inspections.

T4 (1) Does water system routinely track water loss and were acceptable water loss records available for review by the regional engineer? Requires metered connections and master meter or annual pump test with run time. Must show calculating water loss at least quarterly.

T4 (2) Is the water system overloaded? Cannot exceed MSDH design capacity, consecutive systems overloaded if supplier overloaded or based on hydraulic calculations or pressure recording.

T4 (3) Was there any indication that the water system is/has been experiencing low pressure in any part(s) of the distribution system? Documented by hydraulics or pressure recording, or verified by operator. Must be documented on inspection report

T4 (4) Are well pumping tests performed routinely? Must have pump tests at least every two years on all wells that are greater than three (3) years old, OR pump tests every year on wells at systems with design capacity exceeding 80%.

T5 (1) Does the water system have the ability to provide water during power outages? Credit given for generators, can give credit for emergency tie-ins w/ system w/ generator if hydraulics work, credit given for right angle drive if motor attached during survey, may be required to operate during inspection. Credit given for generator on trailer if quick-connect, systems with elevated storage may share generator on trailer, must have prior agreement.

T5 (2) Does the water system have a usable backup source of water?

Managerial Capacity

M1 Were all SDWA required records maintained in logical and orderly manner and available for review? In one location, sample results, MSDH correspondence, copy of CCR report, etc.

M2 (1) Have acceptable written policies and procedures for operating this water system been formally adopted and available for review? Must have water users agreement (connection fees, late charges, deposits, wastewater requirements) and subdivision/line extension policy (written procedure requiring developer/system obtain MSDH approval before construction begins) and either By-laws or Job Description for Employees (employee handbook), plus at least two of the following: Emergency or contingency plan (chain of command, phone numbers, etc.), Flushing program (flushing schedule w/ records), Fire hydrant policy (maintenance schedule, flow tests, agreement w/ fire dept.), or Updated distribution map (can be updated by operator).

M2 (2) Have all Board Members (in office more than 12 months) completed Board Member Training? Must have certificate (or copy) available for review. This does not apply to Municipalities with population over 10,000.

M2 (3) Does Board meet monthly and were minutes of Board meetings available for review? Allow quarterly meetings with full time manager. Manager must be appointed by the board and documentation of appointment provided.

M3 Has the water system had any SDWA violations since the last Capacity Assessment? System and Regional Engineer's records

M4 Has the water system developed a long range improvement plan and was this plan available for review? Hydraulic analysis, engineering report, completed State

Needs Survey Form or list of goals prepared by operator and adopted by board, can give credit for major improvement project within past 5 years. Plan in use should indicate progress towards improvements.

M5(1) **Does the water system have an effective cross connection program in compliance with MSDH regulations?** Shall include the following: Cross connection policy, records of backflow preventers installed on the system, current test results for each backflow preventer on system.

M5(2) **Was a copy of** the **MSDH approved bacti sample site plan and lead and copper sample site plan available for review and bacti results show site plan is followed?** Copy of sampling site plans available and bacti results show plan is being followed.

Financial Capacity

F1 **Has the water system raised water rates in the past 5 years?** Credit also allowed if revenue exceeds expenditures (excluding out of pocket for major improvements and depreciation) by 10% for past five years.

F2 **Does the water system have an official policy requiring rates routinely reviewed and adjusted if necessary?** Must be in minutes showing adopted

F3 **Is the water system following an official cut off policy?** Must be published (in minutes or on bills), must follow policy (cut off customers who by policy should be cut off)

F4 **Was a copy of system's adopted annual budget available for review and does financial accounting system clearly and accurately track receipts and expenditures?** Must provide copy of budget and balance sheet (income statement) for review.

F5 **Is the municipality current in submitting audit reports to State Auditor? Was audit report (Municipal) available for review? Were water and sewer fund accounts separate from other accounts?** List of violators, copy in records, can accept CPA audit report

F5 1) **Has the water system filed financial report with State Auditor and copy available (Rural) for review?** List of violators, copy in records, can accept CPA audit report **2**) **Does the latest report show that receipts exceed expenditures?** Excluding out of pocket for major improvements

APPENDIX B

SIGNIFICANT DEFICIENCIES

Source

Well near source of fecal contamination (ex. Septic systems, sewer lines)
Well in flood zone (100 year)
Improperly constructed well (ex. not properly grouted)
Spring boxes that are poorly constructed and/or are subject to flooding

Treatment

Inadequate application of treatment chemicals (Health related MCLs)
Lack of redundant mechanical components where treatment is required (one well)
Unprotected cross-connections with treatment systems
Inadequate monitoring (Health related MCLs)

Distribution system

Negative pressure that could result in contamination
Inadequate disinfectant residual monitoring (when required)
Unprotected cross-connections

Finished water storage

Inadequate internal cleaning/maintenance of storage tanks
Improper screening of overflow pipes, drains, or vents
Necessary repairs of storage tank roofs or covers

Pumps, pump facilities, and controls

Inadequate pump capacity
Inadequate maintenance
Inadequate/inoperable control system

Monitoring, reporting, and data verification

Not monitoring according to site sampling plan or monitoring plan
Not meeting reporting requirements
Improper recordkeeping

System management and operation

Failure to meet water supply demands (overloaded)
No approved emergency response plan or vulnerability analysis (updated)
Inadequate follow-up on previous deficiencies
Inadequate security measures

Operator compliance

Operator is not qualified
Lack of required operator training

APPENDIX C

MISSISSIPPI STATE DEPARTMENT OF HEALTH RECOMMENDED POLICIES

Standard Operating Procedures for the system

Long-Range Improvements Plan

Policy requiring water rates to be routinely reviewed and adjusted when appropriate

Cut-Off Policy (may need cut-off list)

Cross Connection Policy

Bylaws

Job Description of Employees

Water Users Agreement

Emergency or Contingency Plan

Subdivision Policy

Flushing Program

Fire Hydrant Policies

Safety Policy

Complaint Log

Customer Service Policy (policy for dealing with customer disputes etc.)

Policy for connecting new customers

Policy for prospective customers having excessive requirements for service

APPENDIX D

MISSISSIPPI HOUSE BILL 1227

To: Municipalities; Conservation and Water Resources
MISSISSIPPI LEGISLATURE REGULAR SESSION 2007
By: Representative Robinson (63rd)

HOUSE BILL NO. 1227

AN ACT TO AMEND SECTION 41-26-101, MISSISSIPPI CODE OF 1972, TO REVISE THE MUNICIPAL POPULATION REQUIREMENT FOR CERTAIN MUNICIPALITIES THAT ALLOWS COMMUNITY PUBLIC WATER SYSTEM BOARD MEMBERS TO BE EXEMPT FROM CERTAIN MANAGEMENT TRAINING; AND FOR RELATED PURPOSES.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF MISSISSIPPI:

SECTION 1. Section 41-26-101, Mississippi Code of 1972, is amended as follows:

41-26-101. (1) Each member elected or reelected after June 30, 1998, to serve on a governing board of any community public water system, except systems operated by municipalities with a population greater than ten thousand (10,000), shall attend a minimum of eight (8) hours of management training within two (2) years following the election of that board member. Any member failing to complete the management training within two (2) years after his election shall be subject to removal from the board by the remaining members. If a board member has undergone training and is reelected to the board, that board member shall not be required to attend training as provided by this subsection.

(2) The management training shall be organized by the State Department of Health, in cooperation with the Mississippi Rural Water Association and other organizations. The management training shall include information on water system management and financing, rate setting and structures, operations and maintenance, applicable laws and regulations, ethics, the duties and responsibilities of a board member and other information deemed necessary by the department after consultation with the association and other organizations. The department shall develop and provide all training materials. The department may charge a fee not to exceed Seventy-five Dollars ($75.00) per member to defray the actual costs of providing the materials and training. These costs shall be reimbursed to the board member as an expense of the community public water system.

(3) To avoid board members having to interfere with their jobs or employment, management training sessions may be divided into segments and, to the greatest extent possible, shall be scheduled for evening sessions. The department shall conduct management training on a regional basis and shall use community college or other public facilities for the convenience of board members.
(4) The department may make exceptions to and grant exemptions and variances to the requirements of this section for good cause shown.

SECTION 2. This act shall take effect and be in force from and after July 1, 2007