MANAGING INFRASTRUCTURE SYSTEMS:

WHO'S HEARD IN THE DECISION MAKING PROCESS?

A Dissertation

by

SHERI LASHEL SMITH

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2002

Major Subject: Urban and Regional Science

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Approved as to style and content by:

Andrew D. Seidel (Chair of Committee)	Timothy J. Lomax (Member)
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ABSTRACT

Managing Infrastructure Systems:

Who's Heard in the Decision Making Process? (May 2002)

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Chair of Advisory Committee: Dr. Andrew D. Seidel

Citizen participation includes those activities by citizens who are not public officials that are more or less intended to influence the actions taken by government (Verba & Nie, 1972). Citizen initiated contacts are one such form of participation. In 1999, the volume of complaint and service related calls received by the Department of Public Works and Engineering equaled almost 20 percent of the city's population. Via Houston's Customer Response Center, these contacts are logged in, directed to the appropriate department and incorporated into the department's infrastructure management system (IMS).

The goal of the IMS is to provide a systems approach to making cost-effective decisions about the design, rehabilitation, construction, retrofitting, maintenance or abandonment of the city's infrastructure (Grigg, 1988). To date, the effectiveness of this program is perceived as less than ideal and the public is critical of the results (Graves, 2002). Residents express concerns that infrastructure projects are targeted towards business and industrial areas while neighborhood needs are being ignored. Politicians are concerned that projects are not equally distributed among the districts. Meanwhile, public works' staff are concerned because there isn't enough money to address citizen calls, business and industrial needs and political concerns in addition to the problems they have identified.

The purpose of this research is twofold: to determine if citizen initiated contacts have been a significant factor in the selection of water and sewer projects and, to identify other factors that may play a role in the decision making process.

This study is longitudinal in nature, covering the time period between 1992 and 1999. Univariate, bivariate and multivariate analysis were applied to the various data sets provided by the City of Houston. The results of the analysis supports the following:

- Citizen contacts have been significant in determining the allocation of water and sewer CIP projects; however, that has not been consistent through the years.
- Factors such as race, class, line type, material, size, age and location also factor into the decision making process.

ACKNOWLEDGEMENTS

This dissertation reflects the efforts of many people. First and foremost I would like to thank my parents. They supported my decision to return to school and have listened and encouraged me throughout the highs and lows of this process. I have other family members and friends in Kansas City, Missouri who have either directly helped or wished me well. The list of names would be long but I want them to know that I appreciate their proof reads, cards, food, visits and phone calls.

I would like to thank Dr. Andrew Seidel who was willing to advise a project on a subject that didn't fall within the traditional fields of planning. Through this process I believe that we have progressed from a student advisor relationship to a friendship that will last long after graduation. I would also like to thank my committee who assisted me in finding a research project that served as the basis for this research and helped me finance my education.

The various statistical analysis that are discussed in the upcoming chapters would not have been possible without the advice, direction and patience of Drs. Margaret Slater, Sherry Bame, Cliff Spiegleman and Eun Sug Park. Each made contributions that resulted in my having a better understanding of the "world of statistics."

Finally, my special thanks to my friends, Theresa Good and Mary McGehee. Everyone should have friends who have gone through the process before them and are willing to reach back and help you along. These women have listened, laughed and given advice at critical times. It would have been lonely without them.

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CHAPTER I

INTRODUCTION

Since the 1970's, if not before, there have been growing concerns about the decaying conditions of our nations' infrastructure. These concerns have not been focused solely on older cities such as Boston, New York or Chicago. Infrastructure related problems have plagued cities young and old, large and small, east and west, rural and urban. Articles have appeared in magazines, professional journals, books and reports attempting to identify contributing causes. Some of the reasons cited include a decrease in capital spending (Crihfield & McGuire, 1997; Seely, 1993), redirection of spending from rehabilitation to new construction (Koehn et al., 1985), consumer demand exceeding capacity (Haughwout, 1995) and poor decision making and management practices (Sanders, 1973). Regardless of the reasons, in the face of limited resources, aging infrastructure and competing demands, government agencies did not have well developed methods to determine how much money should be spent nor where the funds should be directed (Crihfield & McGuire, 1997). The result was a piecemeal approach to infrastructure management, the continued decay of infrastructure systems and the increased frustration among citizens who could not see the impact their tax dollars had on their city.

The style and format for this study follow that of the *Urban Affairs Review*.

Infrastructure is vital to all cities. It is the physical framework that supports and sustains all economic activity and produces services central to the quality of life (Grigg, 1994; Cain, 1997). It is important to understand that a city's infrastructure is not a single element or facility but a combination of several elements. Though authors differ on the categories, most agree that the following are included: roads and bridges, buildings and outdoor sports areas, transportation services, water and sewer, waste management, energy production and distribution and communication (Grigg, 1988; Federal Public Works, 1993).

The Infrastructure Management System

In the past two decades, efforts have been made to better manage infrastructure elements. Relying on common sense, experience, manual records and memories of long-time employees to identify potential problems was proving ineffective and cities were tiring of reactionary planning or crisis management (Snodgrass, Kiengle & Labriola, 1996). At the same time, growth in the urban areas was causing an increase in service demand and technology was creating a more sophisticated consumer (Snodgrass, Kiengle & Labriola, 1996). It was evident that most city and county agencies were ill equipped to manage the mountains of information being generated daily (Snodgrass, Kiengle & Labriola, 1996). Public works staff realized that when asked to justify budget requests, they could not account for the exact number of publicly owned bridges and streets, nor could they identify the location and condition of water and sewer lines. Staff was also unable to estimate funding needs or show the impacts of funding changes (Thornton & Ulrich, 1993).

As a result of the situation identified, Houston and many other cities adopted and/or modernized their Infrastructure Management System (IMS). The IMS was designed to provide a holistic or systems approach to making cost-effective decisions about design, rehabilitation, construction, retrofitting, maintenance or abandonment of an infrastructure element (Grigg, 1988). The IMS process is a multi-step endeavor that entails the following (Lytton, 1991):

- an inventory of what is being managed,
- a condition assessment of existing elements,
- determination of fund needs,
- identification and prioritization of candidate projects when funds are constrained,
- method to determine the impact of funding decisions on the future condition and funding, needs and
- a feedback process.

A key step in this process is condition assessment. It is in this step that data is collected to identify type and severity of deterioration, structural integrity, functional adequacy and safety of the infrastructure element (Grigg, 1986; Habibian, 1994). The information is then used to determine future maintenance, rehabilitation or replacement needs.

Collecting data to determine the condition of an infrastructure element is not a simple task. For elements that are visible such as streets, buildings and bridges, visual assessments are valuable indicators in ascertaining current conditions. However, visual indicators are of little or no assistance when attempting to assess the condition of water distribution and sewer collection lines. Because the lines are buried and rarely uncovered or exposed, a comprehensive and systematic routine checking procedure cannot be carried out without spending large sums of money.

One solution that is available to all municipalities is to incorporate citizen input into the condition assessment process. The citizen is the end user. He or she would be the first to notice loss of water pressure, water discoloration, a sewer leak or backup. These are some of the primary indicators of water and sewer system problems. When citizen contacts are combined with in-house records and monitored over time, engineers should be able to identify deteriorating lines (Goodwin & Peterson, 1983, 1984).

Incorporating Citizen Input

Citizen interaction with government agencies is not a new concept. Citizens have expressed their views and exerted their influence on a variety of topics in a number of ways since before the United States Constitution made provisions for a representative form of government in 1787 (So et al., 1979; King, Feltey & Susel, 1998). According to Sherry Arnstein (1969), “the principle of citizen participation of the governed in their government is the cornerstone of democracy.” Over time, the enthusiasm and intensity surrounding this principle has surged and waned. In the 1960's, participation hit a new high as citizens responded to the war on poverty, racial discrimination and the Model Cities Program. The results of their participation were policy changes that have had lasting effects (So et al., 1979; King, Feltey & Susel, 1998; Creighton, 1999). Currently, almost every piece of legislation contains requirements for public participation, though some are more prescriptive than others (Creighton, 1999).

As defined by Verba and Nie (1972), citizen participation includes those activities by private citizens that are more or less directly aimed at influencing the selection of government personnel and/or the actions they take. In their book *Participation in America*, Verba and Nie identified four modes of participation: citizen initiated contacts, voting, campaign activity and cooperative activity (1972). Of the modes identified, citizen initiated contacts are the least discussed (Sharp, 1986; Jones et al., 1977). They have also been the most difficult to explain (Hirlinger, 1992; Thomas, 1982).

Citizen initiated contacts are characterized by one-on-one interactions between an individual and a government agency on an issue that is highly salient to the individual (Jones et al., 1977). It is estimated that between one-fifth to three-fifths of a municipality's population will initiate contact with a city agency to register a complaint or request a service (Sharp, 1986; Thomas & Melkers, 1999). This makes citizen contacts the highest volume of all forms of participation, including voting (Thomas, 1982). To capture these calls, many cities have in place a central contact point where citizens may report utility problems or request services. The data these contacts provide may have the potential to increase the effectiveness of a city's infrastructure management process by providing important information pertaining to the condition of underground water and sewer lines.

Yet, we still don't know if the citizen's potentially valuable information is being incorporated into the condition assessment step and ultimately into the infrastructure management process. The reason for this ambiguity may lie in the fact that citizen contacts are potentially one of many factors that could be incorporated into the decision making process. It may be naive to believe that a citizen's call will directly translate into the expenditure of dollars in a CIP project. However, what other factors are considered and to what degree each has an influence is yet to be determined.

Research Setting

The City of Houston is situated in southeast Texas and, according to the Census Bureau, is the fourth largest city in the nation. Houston is typical of many cites in that it is responsible for the provision of water and sewer services to its 2.5 million residents. Like other cities, Houston has more water and sewer lines in need of repair than it has funds to repair them (Barrett & Green, 2000). The Department of Public Works and Engineering (PW&E) estimates that their Utilities Maintenance Division is responsible for approximately 7,000 miles of water distribution and 6,000 miles of sewer collection lines that run throughout the city. Of those lines, PW&E staff estimates that at least 55 percent are in need of some level of repair or upgrade with an estimated cost exceeding 750 million dollars.

Efforts to systematically address this situation are progressing. Prior to 1985, all maintenance and historical information were manually maintained on cards. In 1985, a computerized work order tracking system (WOTS) was developed and maintained by the city to assist with the maintenance of water and sewer systems. Ten years later, in 1995, Houston brought on-line a Geographic Information Management System (GIMS) that generates a visual map of the city's water and sewer systems. During the summer of 1999, WOTS was replaced with an infrastructure management system (IMS). This system also tracks work orders. However, unlike its predecessor, it is fully integrated with GIMS which allows the IMS to visually link service requests and complaints to systems data maintained in GIMS. In its first year, the IMS tracked 341,364 incoming calls. Eighty eight percent were directed to PW&E. Figure 1.1 shows how citizen calls were distributed within PW&E in 1999. Sixty-five percent or 154,000 calls were sewer and water service requests and complaints. That number has increased over the past years and it is anticipated that it will continue to do so.

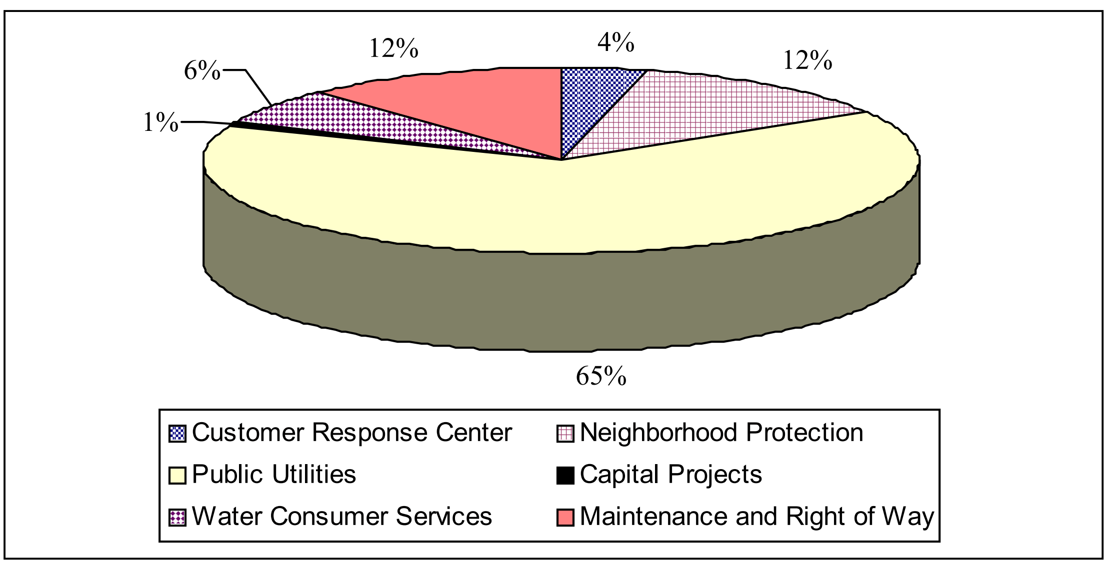

Figure 1.1: Distribution of 1999 PW&E Citizen Calls

Problem and Research Objective

Implementation of new technology has not alleviated criticisms (Schwartz, 2000; Garcia, 2000; Graves, 2002). Individual residents state that the city is still not responding to their service requests and complaints. They believe that rehabilitation and replacement projects are targeted toward business and industrial areas and that neighborhood needs are being ignored. Politicians, in an effort to make their constituency happy and become re-elected, want to ensure that projects are equally distributed among council districts. Meanwhile, PW&E staff assert that they are incorporating citizen requests and complaints into the planning process, but there is not enough money to satisfy citizen demands and political requests in addition to the problems that they have identified.

The objective of this study is twofold: First, to ascertain if citizen initiated contacts are incorporated into recommendations from Houston's infrastructure management process for water and sewer lines. Secondly, to identify other factors that may be considered in the infrastructure management process. Achieving both objectives entails identifying the players and understanding the process. More importantly, it involves measuring the outcome or output of that process to determine the effect, if any, of citizen contacts or other factors.

The Decision Making Structure and Process

It is important to understand the organizational structure and process under which the rehabilitation process operates. During the last few years, the Department of Public

Works and Engineering reorganized several times. What will be discussed is based on the organizational structure and process followed at the time of this study, 1999-2000.

Operational Structure of Public Works and Engineering Utilities Division

The Public Works and Engineering Department is responsible for the design, construction and maintenance of the City of Houston's infrastructure including water, sewers, streets, storm drainage, ditches, sidewalks and traffic control. Within the department is the Public Utilities Division which is responsible for the city's public water supply and sewer system. The city's water system is divided into two phases: each phase is the responsibility of a different section.

Water Collection transports water from its source i.e. surface water or aquifer to a treatment facility. The Water Production Section oversees this process and is responsible for the pipes, valves, pump stations, wells, water towers and treatment facilities that make up the collection system. Once the water has been treated, it enters into the second phase, water distribution. This is the phase where water is delivered to homes, businesses and industry. The Utility Maintenance Section manages this phase and is responsible for the lines (mains and laterals) and pump stations that comprise the water system.

The sanitary sewer system is divided in much the same way. In the collection phase, sewage is transported from households, businesses and industry to a sewer treatment facility. The process is overseen by the Utility Maintenance Section which is also responsible for the maintenance of all pipes, valves and lift stations that lead to the sewer treatment plant. In the distribution phase, sewage is treated and the effluent or treated water is transported to a water source i.e. water, lake, river, etc. This process, including the sewer treatment facility, falls under the auspices of the Sewer Operations Section.

Utility Division Maintenance Process

The Public Utilities Division has two ways that it funds the repair and replacement of its water supply and sewer systems: the operations budget funds routine or daily maintenance and a special water and sewer enterprise fund finances capital improvement projects (CIP). In addition to the source of funding, what differentiates the two is the degree of the work involved and the decision making process.

Routine maintenance includes activities such as cleaning lines, repairing cracks, painting fire hydrants, repairing manholes, mowing right-of-ways, etc. It also covers emergency repairs due to accidents or other unplanned events.

The Public Utilities Division receives complaints from a variety of sources. Typically, water and sewer related complaints are received through the Customer Request Center (CRC) where it is transferred to Central Operations as shown in Figure 1.2. Central Operations enters the information into the IMS system and sends out an investigator. If the problem is found to be the responsibility of the city, a work order is created and either the Central Operations work crews or staff from the appropriate section performs the necessary work. If the problem is larger than these two groups can handle, the repair is contracted out. Once the repair has been made, resolution of the problem is entered into the IMS system and the project is closed out. Currently, the city claims that it sends out an inspector within 24 hours after receiving the call.

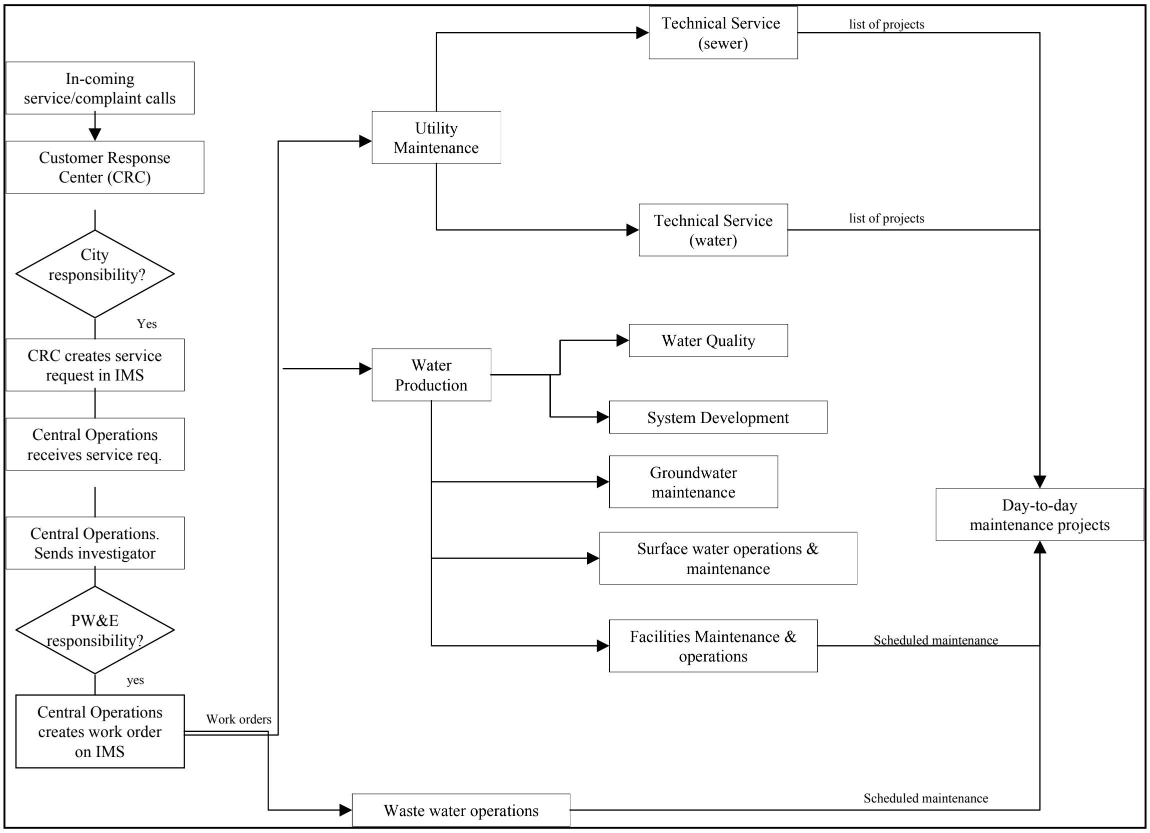

Figure 1.2: Routine Maintenance Summary

CIP Process

While the focus of maintenance is on prevention and immediate fixes, capital improvement projects (CIP) are typically major, infrequent expenditures, such as the construction or rehabilitation of a new facility (Bowyer, 1993). The CIP projects are based on priorities, based on the needs or desires for such improvements and according the city's present and anticipated financial situation (American Society of Planning Officials, 1951; So, 1962).

The CIP is planned with a five-year horizon but is generally reconsidered and readopted each year to permit a re-evaluation of anticipated expenditures, technology costs, material, and manpower availability (Bowyer, 1993).

Beginning in late fall or early winter, each section in the Public Utilities Division gathers data to identify what projects (with related costs) will be submitted for CIP consideration. As shown in Figure 1.3, the sections meet as one group with the Planning and Operations Section. This section is involved in overall systems modeling and operations. They are also aware of new regulations and overall system shortcomings that may exist. Together these four sections discuss project priorities knowing that the available funds are limited to a set annual amount of 270 million dollars (dollar amount set in 1997). The final list is then presented to the CIP Committee who shepherd it through Finance and Administration, Mayoral and Council reviews. The CIP must be adopted before the fiscal year begins on July 1st.

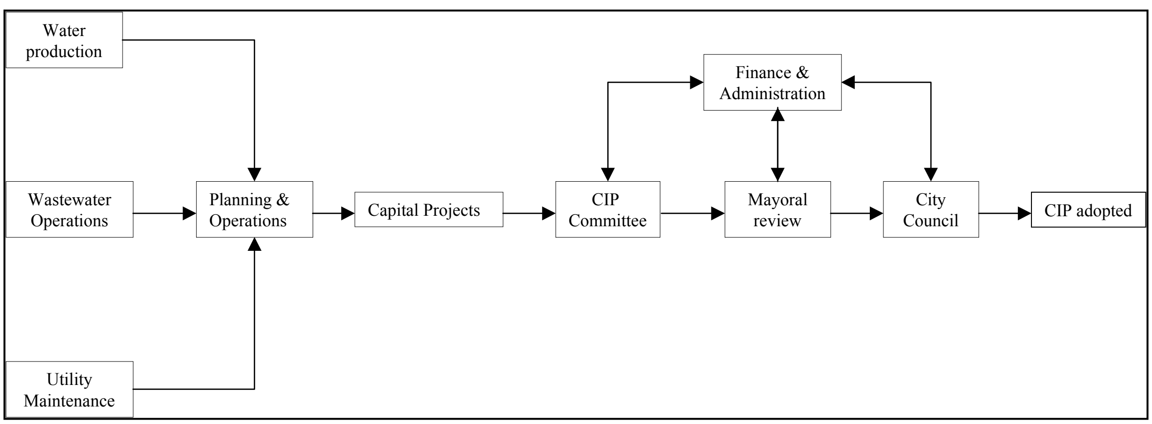

Figure 1.3: Summary of Houston's CIP Process

In the following chapters, information is presented and discussed that addresses the criticisms directed at the city and its infrastructure management efforts. As was shown in the previous sections, there is much to consider. The process is not simple, the players are many and the desired results are individualized.

Chapter II outlines research that has been documented on citizen contacts, its definition, who makes contact and more importantly, how government has responded to those contacts. The chapter concludes with a review of the literature on urban service delivery. This review will identify potential variables and other research issues to be considered in meeting this study's second objective. Chapter III describes the research design, selected variables and the data sets used. It also defines the hypotheses to be tested and explains the statistical methods applied to the data. Chapters IV and V guide the reader through the three levels of data analysis. The final chapter discusses the results of the analysis chapters, relates the results to previous research and provides recommendations for future action or research.

CHAPTER II

LITERATURE REVIEW

Scholars in several disciplines have examined the extent to which decisions made by agents in public bureaucracies reflect the preferences of elected officials, interest groups and private citizens (Balla, 2000). Because this research is focused on citizen initiated contacts and their potential effects on the selection of water and sewer rehabilitation and replacement projects, it is important to have a working knowledge of citizen contacts, its importance, explanatory theories and the resulting government response. In light of the possibility that there may be other factors that affect the selection or distribution of resources in addition to or instead of citizen contacts, this chapter includes research on public service distribution.

Defining Citizen Initiated Contacts: Their Uniqueness and Importance

Citizen contacts are defined as solitary acts where the individual asks a government official to act on an issue or problem in which the individual, their family or community has a perceived stake (Eisinger, 1972, Greene, 1982; Zuckerman & West, 1985; Hirlinger, 1992). The contact may occur in many forms; writing, phone call, personal visit, day to day interactions or via the Internet (Lehnen, 1976; Bimber, 1999; Lando, 1999).

In their book *Participation in America*, Sidney Verba and Norma Nie delved deeply into the subject of citizen participation in an effort to identify and describe its various components. They claimed that a valid form of participation " will emphasize the processes of influencing governmental policies, be a flow of influence upward from the masses and be a part of a process by which the national interests are created." In their book, they identified four modes of participation, campaigning, cooperative activities, voting and citizen contacts. Of these modes, citizen contacts have been the least discussed and the most difficult to explain (Jones et al., 1977; Thomas, 1982; Sharp, 1986; Hirlinger, 1992).

Citizen contacts are participatory acts that sharply differ from other forms of participation (Verba & Nie, 1972; Zuckerman & West, 1985). There are several aspects of citizen contacts that makes them unique. The first is individuality and control. Unlike voting, cooperative activity and campaigning, the individual usually acts alone. Contact is made solely by the individual, at their initiative and they alone determine the time contact will be made and the topic to be discussed (Verba & Nie, 1972; Coulter, 1992; Traut & Emmert, 1993). The person who makes contact with a government official knows what they want and is therefore making contact for a specific reason and is expecting a specific response in the near future (Sharp, 1984; Thomas, 1982). This makes citizen contacts more instrumental in nature than other forms of participation and it makes it the only form of participatory activity where is it possible that only one person may benefit (Vedlitz & Veblen, 1980; Thomas, 1982; Brown, 1982). Unfortunately, the degree of pressure on the politician or administrator to act is lower and response to the contact may be slower because only one person is involved (Verba & Nie 1972; Coulter, 1992).

The second aspect is cost. Citizen contact requires a low degree of maintenance on the part of both the individual and government official. It does not involve the formation and maintenance of groups, the selection of office holders nor does it include public demonstrations of political strength. Contacts do not require and hardly ever seek resources for groups larger than neighborhoods (Zuckerman & West, 1985; Verba & Nie, 1972). A final aspect of citizen contact that makes it unique is its non partisanship (Coulter, 1992). The individual usually does not face political opposition, there is seldom a public issue and there are no parties or affiliations from which to choose.

In addition to being unique, citizen contacts are an important form of participation. In fact, these individual and isolated activities on the part of citizens can have as much cumulative impact on urban policy as the more commonly studied forms of political participation such as voting and campaigning (Traut & Emmert, 1993). Contacts are the communication link between the public and elected officials, especially during non-electoral periods (Vedlitz & Veblen, 1980). By making contact, individual citizens have the opportunity to provide input into the political system. For government, contacts are a means to communicate informally with community residents and public officials, provide information, influence public behavior and otherwise implement policy (Lehnen, 1976). Thus citizen contacts may be the key to maintaining government responsiveness and the distribution of municipal services (Jones et al., 1977; Mladenka, 1977).

The potential influence that contacts have over government comes largely from the numbers that are involved. Research on citizen contacts report that between 1/3 to 3/5 of the sample populations reported making at least one contact to a government agency. In many cases these numbers are twice that of usual voter turnout in a local council election (Sharp, 1986). Because contacts represent such a high volume of citizen participation with local government, they should exert a substantial influence over the distribution of local services (Thomas & Melkers, 1999).

Who Makes Contact

The majority of research on citizen contacts have explored the demographics of who makes contact, where they live and why contact was made. However, a definitive profile of the potential or typical citizen who makes contact has yet to be established (Traut & Emmert, 1993; Thomas & Melkers, 1999). Since citizen contacts became a singular research issue about twenty five years ago, variables such as age, race, education, awareness, social well being, need or combinations of the above have been suggested as determining factors. There has also been a few popular, more comprehensive models. These include the Standard Socioeconomic Model that contends that factors such as income and education predispose an individual to make contact because higher socioeconomic status brings the greater economic and psychological resources that facilitate participation (Verba & Nie, 1972; Thomas, 1982, Coulter, 1988). A second model, the Parabolic or Need-Awareness Model, states the propensity to contact is a function of both the individual's need for services and their awareness of the government agency designed to provide the service. This model proposes that an individual's needs are inversely related to their social well being while awareness is directly related to well being (Jones et al., 1977). A third model is the Political Involvement Model. It states that ones' propensity to contact is based on how connected one is to the existing political structure which may include civic organizations (Verba & Nie, 1972; Coulter, 1988).

Peter Eisinger (1972) was one of the first to study citizen contacts. He surveyed 554 Milwaukee adults to discover who made contact, how they differed from those who do not and to identify the various dimensions of contacts. His results supported the socioeconomic model. He found that whites, even when one controlled for level of education, were much more likely to contact city officials than their black counterparts. An important aspect of Eisinger's work is in his differentiation between two forms of contacts, *request* and *opinion*. Request contact occurs in three ways. Either the citizen is complaining of some unjust or inadequate service, seeking help or a favor or, is calling to request that someone do something about a problem. Opinion contact can occur in two ways. Either someone is calling to exert influence or they are commenting on an existing state of affairs.

As part of his exploratory study on the distribution of government services, Herbert Jacob also studied the nature of citizen contacts in Milwaukee (Jacob, 1972). Using the independent variables of income and race and arranging his findings by service category i.e. health, law enforcement and regulatory agencies, Jacob found that blacks had fewer total contacts with government agencies than whites but those differences were not great. He also found that contact with government officials and public programs is never uniform throughout a population. This is primarily because many government agencies are designed for special populations and those populations tend to geographically cluster together.

Verba and Nie's work on citizen contacts distinguished between two types of referents, the entity on whose behalf a contact is made. In *particular referents*, the citizen is concerned with an issue that is salient to themselves and/or the immediate family. The subsequent response would presumably have little or no direct impact on others in society. *Broad referents* are more public in nature. Government actions would affect a significant segment of the population, if not the entire community or society. Verba & Nie concluded that those who made broad referent contact fit the standard socioeconomic model. They felt it was virtually impossible to explain particularized contact (Verba & Nie, 1972).

Robert Lehnen, a strong supporter of citizen contacts as a viable form of participation, attempted to determine which of three variables affected contact; sex, race or age (Lehnen, 1976). His results illustrated that when controlling for socioeconomic status, a persons' sex only made a slight difference. Race showed more of a differential. Whites contacted more than blacks and the disparity of the rate of contact between the races increased as socioeconomic status increased. With regards to age, regardless of socioeconomics, the highest propensity to contact government staff or officials was for those between the ages 30 to 49. After age 49, the rates of contact decreased.

In an attempt to answer the question who contacts and why, Bryan Jones and colleagues structured their research somewhat differently from earlier studies (Jones et al., 1977). Whereas previous research used the individual as the unit of analysis Jones et al. (1977) studied agency records and aggregated their analysis by census tracts. Their research also differed in how the independent variables were operationalized. Social well-being was measured by the distance from city's center and awareness was the citizen's recognitions of government's to deal with problems. With these variables they included educational levels. Their research showed that a citizen's propensity to contact is low in neighborhoods of low social well-being. The propensity to contact increased with social well-being until it reached a maximum middle level, then it declined (parabolic model). The relationship between contact and awareness was positively related with the propensity to contact increasing as awareness increased. When social-well being was removed from the equation they found that the number of black and white contacts were almost equal which contradicted the socioeconomic model.

In 1978, Jones and colleagues again tested the parabolic model by studying the distribution of local government services in three Detroit Bureaucracies (Jones et al., 1978). Using the same variables and aggregating the data as in his previous study, they found that though citizen contacts came from all over the city, they were disproportionately concentrated in neighborhoods at the middle ranges of the social well being scale. This further supported the earlier proposed parabolic needs/awareness model.

Houston, Texas was the site for Kenneth Mladenka's research on citizen contacts. Testing the applicability of the socioeconomic model, Mladenka hypothesized that black and other low income neighborhoods were less likely to contact government agencies (Mladenka, 1977). By studying individual contacts pulled from government records, he found no evidence to support that race or income were factors contributing to who contacted. Instead, he found very low levels of contact across all neighborhoods with no variation based on socioeconomic characteristics.

Vedlitz, Dyer and Durand tested the parabolic needs/awareness model by applying it to Dallas and Houston in the mid 1970's. They too studied governmental records and like both of the Jones et al. (1977 & 1978) studies, they aggregated their results at the census tract level. Where their study differed from Jones is how they operationalized social well-being. Their definitions included age of housing, average value of rent and median household income (Vedlitz, Dyer & Durand, 1980). Their results provided no evidence supporting the parabolic needs/awareness model. However, they were unable to completely rule out the model's potential validity. They suggested that the model may be more appropriate at aggregate levels but it could not be universally applied to all cities. Vedlitz et al. suggested to more appropriately test the model and increase its external validity, the operational variables should include age of housing, average value of rent and median household income and, the number of cities tested should increase (Vedlitz, Dyer & Durand, 1980). Also in the mid 80's, Arnold Vedlitz, with the assistance of Eric Veblen, studied citizen initiated contacts in the upper income neighborhood of Garland, Texas. Using the socioeconomic variables of education and interest in city government they too could not find support for the parabolic relationship. Their results provided some evidence of socioeconomic influence. However, it was not very strong.

John Thomas tested the applicability of both the socioeconomic and the parabolic need/awareness model in Cincinnati (Thomas, 1982). Using income and educational levels as variables for social well being and analyzing individual response records, he discovered that the data rejected the parabolic needs/awareness model. The socioeconomic model was a better fit though it was not a good fit because it was valid only as a secondary influence. Only when you control for need for services did citizen contacts increase with socioeconomics. Thomas then introduced an alternative model of citizen-contact, clientele-participation. The underlying premise of clientele participation is the distinction between *objective needs*, "what an objective observer would describe as a particular individual's needs and *perceived needs*, what people feel they need." Thomas concluded that an individual becomes part of an agency's clientele because of perceived needs that might be met or reduced by the agency's actions.

In the early 1980's, Steven Brown realized that the research on citizen contacts were inconclusive. In Kitchener, Ontario, he surveyed 500 residents to determine which model of citizen contacts were best described by the data. The models tested were the socioeconomic, need/awareness and social involvement models. His independent measures included educational level, political efficacy, awareness of government, sense of civic duty, a psychological involvement in government, the number of memberships in organizations and willingness to pay for a variety of services (need). Brown concluded that the need/awareness model was not a good predictor of contact because the impact of awareness on contacts were largely conditional on the presence of some but not an excessive degree of need. The socioeconomic model was an imperfect explanation of citizen contact though there was a moderately strong relationship between contacts and education, the variable for social well being. What Brown concluded was that when need arose, citizens tended to be those who possessed the resources, the skills, and the facilitating political attitudes (Brown, 1982).

In her studies on citizen contacts, Elaine Sharp adapted the Jones parabolic needs/awareness model to individual contacts in Wichita, Kansas (Sharp, 1982). She used education and income levels as measures of socioeconomic status. For measures of awareness and efficacy, she used citizen recognition of a channel for contact. Her conclusions were that the likelihood of making contact does increase with socioeconomic status. In her study, awareness was positively related to socioeconomics and need negatively related, which was in support of the need-awareness model. But, socioeconomics, need, awareness and contact variables do not all work together as the parabolic need-awareness model suggested, because there was a strong positive association between socioeconomics and contacts when need and awareness are controlled.

In 1984, Sharp tested the significance of socioeconomic variables such as income and education as predictors of contacts in 24 Kansas City neighborhoods. Her results mirrored those of Thomas' 1982 study in that she found that if one controls for need, contact is associated with income and education. When perceived need is high, the contact propensity across socioeconomics is negligible (Sharp, 1984).

Where previous studies of citizen contacts had been at either the local or national level, Alan Zuckerman and Darrell West looked at the propensity to contact across several countries (Zuckerman & West, 1985). Using the independent variables of income and education as a measure for socioeconomic status and political activities as a measure of political ties, they concluded that contacts are not the results of socioeconomics, efficacy or need. Those persons with political ties to those who can help and with the political obligation to help others were most likely to make contacts.

In 1986, Rodney Hero made his contribution to the research on citizen contacts by looking at the independent variables of age, ethnic/racial status, perceived need, efficacy and awareness. He analyzed the relationships among the variables by using a bivariate and multi-variable analysis (Hero, 1986). For his dependent variables, he differentiated between two types of contacts, calls to complain and calls to seek information or services. When using his bivariate analysis, he found no clear relationship between income, efficacy or race. He did find that age and perceived need had a statistically significant relationship to citizen contacts. When he used a multivariate analysis, age was the only variable to remain statistically significant. He concluded that perceived need was significant when using bivariate analysis because other intervening factors had not been controlled for.

Also in 1986, Steven Peterson attempted to identify what factors helped to determine citizen contact. He altered his research from other studies by specifically looking at older Americans in a rural setting (Peterson, 1986 & 1988). Peterson believed that some of the contradicting studies on citizen contacts were due to a lack of specification of the dependent variable, contacts. In his research, he differentiated between *input* and *out take* contacts. Input contacts are the effort to get an agency to respond to a particular problem. In out take contacts, the individual extracts from the political system. Out takers are clients of the programs and/or are ongoing recipients of services. Peterson felt this important to distinguish because different types of contacts are separate process at work. He found that the best predictors of input contacts were education, efficacy, interest, need (inversely) and group consciousness. The best predictors of out-take contacts were need, efficacy and group consciousness.

Philip Coulter, in his book *Political Voice*, provided a more in-depth analysis of citizen contacts by looking at its importance, uniqueness and types (Coulter, 1992). As part of his study, he tried to understand why previous research produced a variety of results. He asserted that the variations were due to three reasons: differences in cities, differences in methodologies and misspecifications of explanatory equations. Coulter's study, conducted in Birmingham, Alabama, looked at aggregated responses at the census tract level and tested the effects of social well being and median family income (as a measure of socioeconomics). In his estimation, the predominant theories on contacts i.e. socioeconomic and need-awareness, were inadequate to explain patterns of citizen contact in Birmingham. He found some evidence, albeit spurious, that race may have an effect on citizen contacts. The need awareness model provided some significant results but the relationship was opposite of Jones' original model. In Birmingham, Coulter proposed that there were two kinds of need that best explained his observations: substantial need which caused those of the lower income groups to contact public agencies and significant need, which resulted in those from the higher income brackets to contact government agencies.

In the 90's, citizen contacts were receiving growing attention as an integral part of political participation. The objective of Michael Hirlinger's research on contacts was to determine whether different patterns of contact behavior in urban settings were indeed subject to different explanatory models. Surveying 332 adults in a mid-size southwestern city and differentiating between *particularized contacts* (calling on behalf of one's self) and *general contacts* (calling on behalf of a group) Hirlinger tested six independent variables commonly tested in previous research: perceived need, socioeconomics, political ties, perceived efficacy, age and race. He found that particularized contacts appeared to be best explained by age and a perceived-need political ties model; generalized contacts were best explained by perceived efficacy (Hirlinger, 1992).

The socioeconomic and need-awareness model was revisited by Carol Ann Traut and Craig Emmert in 1993. Surveying 1449 residents in three Florida towns, they analyzed the effects of both models by developing a multi-variate model that included components of both (Traut & Emmert, 1993). Separating particularized from social or broad referents, Traut and Emmert concluded that the socioeconomic model was a good predictor of social referent (on whose behalf the contact is made) contact. Need, as measured by service evaluation and awareness, was a better predictor of particularistic contact. However, to achieve an understanding of general contacts it was necessary to analyze the interaction of the socioeconomic and need-awareness models.

Thomas and Melkers's (1999) research in Atlanta is the most recent attempt at providing an explanation of citizen initiated contacts. Studying only particularized contacts, they found that need, especially in the light of stake holding, emerged as the most consistent predictor of the different municipal contacts. The next best predictor was other forms of local civic and neighborhood involvement. Thomas and Melkers felt that based on the volume of contacts, some substantial influence on locals services should be exerted. Their conclusions emphasized that future research should be about the consequences of citizen contacts and what impact, if any, these contacts have on the problems local governments choose to address.

So what does this review of who makes contact tell us? It says that after many studies there is still a lack of consensus on who makes contact and why. What can be ascertained is that there are several aspects of citizen contacts that must be considered, if not controlled for, to allow researchers to better interpret their results. These issues are:

- analyzing aggregate records vs. individual response
- using multi-variate vs. bivariate analysis
- selecting consistent independent variables
- accurately measuring the independent variable(s)
- distinguishing between broad referents vs. particular referents
- determining objective vs. subjective needs
- differentiating between types of services studied

Government Response to Contacts

The literature on local governments' response to contact is much smaller than the body of literature previously discussed. Kenneth Mladenka's research looked at how well a variety of Houston municipal services responded to citizen initiated contacts and if these responses varied based on the socioeconomic characteristics of the neighborhood. His results found very low levels of contacts and because of those low levels, governmental responses were low (Mladenka, 1977). Lack of contact and response showed no variation based on the socioeconomic characteristics of the neighborhood. The reasons given by government officials were that "low levels of demand-making precluded the possibility of any sanctions for municipality unresponsiveness." Therefore citizen contacts were not effective because contacts played an insignificant role in the decision-making and resource allocation process. Mladenka concluded that citizen contacts could affect government policy "only if public decision makers were constrained to pay more than passing attention to this mode of participatory activity."

Bryan Jones reached more conclusive results when he studied government response records in Detroit (Jones et al., 1977). Their research identified three factors that governed the effectiveness of citizen-initiated contacts: nature of the political system, content of the citizen contact and characteristics of the individual. Their conclusions indicated that contact effectiveness, the ability to generate government response, was inversely related to the number of contacts made from an area. Large numbers inevitably put a strain on resources and resulted in lower response rates. However, they did not determine the optimal number of contacts to generate government response or if government response rates would improve if the analysis allowed for response rates over a longer time period.

Kenneth Mladenka followed up his 1977 study by expanding his research to include the City of Chicago, thereby allowing for different types of political systems (Mladenka, 1981). The results from his study indicated that the effectiveness of citizen contacts were not based on political influences, class or race. In both cities there was evidence that bureaucratic decision rules may have been a determining factor. However, like Jones and in his previous study, Mladenka focused on immediate or short-term responses.

Kenneth Greene believed that government records weren't enough to evaluate the response to citizen contacts. Records didn't convey why administrators did or did not respond to contacts (Greene, 1982). Therefore Greene questioned 164 administrators within the state of New Jersey. In his study he was able to identify two types of administrators, the *expert* and the *mediator*. The expert administrator is not receptive to contacts and feels that responding to them reduces his agencies' efficiency and will not endeavor to address them. The mediator administrator is more receptive to contact demands, consider them part of the daily workload and will develop rules to satisfy those demands.

Vedlitz and Dyer tested the factors of politics, socioeconomic and bureaucratic decision rules as determinants of government response to citizen contacts (Vedlitz & Dyer, 1984). Their findings supported earlier studies that politics and socioeconomic factors do not determine the effectiveness of citizen contacts. They were able to provide some evidence that supported the theory that bureaucratic decision rules may be a factor however, their study was based on short-term responses.

Table 2.1 summarizes the research presented on government's response to citizen contacts. In the few studies that address this issue, note the two-common elements. All studies address immediate or short-term results (short-term is not defined). And, the effectiveness of the citizen contact, measured as the ability to generate a response, is evaluated in the context of other variables or settings.

TABLE 2.1: Summary of Government Response to Citizen Contacts Literature

Author	*Response Time*	*Variables*	*Conditions of Effectiveness*
Mladenka (1977)	Immediate	Socioeconomic	Unsure, not enough calls to number of calls determine
Jones et al. (1977)	Immediate	Political systems Contact content Citizen characteristics	Inversely related to number of contacts made from area
Mladenka (1981)	Immediate	Race, class Political systems Decision rules	Internal agency rules
Greene (1982)	Immediate	Type of administrator	Mediator administrator
Vedlitz & Dyer (1984)	Short-term	Politics Socioeconomic	Internal agency rules

Theories of Urban Service Delivery or Resource Allocation

It would seem that the effectiveness of government's response to citizen-initiated contacts may be better understood by reviewing the literature on service delivery. This area of research is broader and adds more depth to understanding the factors that influence government's decisions with regards to the allocation of services. Research in this area may fall under one of two categories; economical or political (Jones et al., 1978; Viteritti, 1982). The emphasis of this research will be on the political approach. This approach centers on the distribution of services to identifiable demographic groups, and asks who gains and who loses as a consequences of delivery practices (Viteritti, 1982).

It is generally agreed that resource allocation patterns are virtually never distributed equally across a municipality Mladenka & Hill, 1978; Jones, 1980; Baer, 1985). Researcher's attempts to explain these distributional patterns resulted in three predominant theories; bureaucratic decision rules, underclass or class bias and political influence. These theories have subsequently guided investigations into urban service delivery as researchers test the applicability of these theories with a variety of different public services areas in a multitude of cities.

Class Bias Theory

The underclass or class bias theory was one of the first theories to be proposed (Lee, 1994). It states that the distribution of urban services discriminates against either minority or lower-class neighborhoods and favors those neighborhoods dominated by the upper-class or non-minorities (Lee, 1994; Cingranelli, 1981).

In 1981, David Cingranelli studied the distribution of police and fire protection in Boston. He concluded that it was difficult to select a single or set of variables when attempting to explain the distribution of services. However, he believed that given a "need for services" and when studying comparable neighborhoods, race or the underclass theory was best supported (Cingranelli, 1981).

David Cingranelli, this time in collaboration with Frederick Bolton, revisited the underclass hypothesis. They proposed that earlier studies were flawed in three areas: the use of inappropriate measures of neighborhood need, analyzing a limited number of variables and failure to study comparable neighborhoods (Bolotin & Cingranelli, 1983). By incorporating these modifications into their study of the distribution of police services in Boston, they found evidence to support the underclass hypothesis.

Richard Feiock's research took a slightly different approach. He criticized earlier works for not measuring provision of services in relation to the tax burden (Feiock, 1986). His study looked at elementary education in Erie, Pennsylvania. His objective, to test the application of the underclass hypothesis by examining the distribution of service benefits and tax burdens resulting from the provision of an urban service. His findings revealed a regressive relationship in the provision of services. The net incidence of education was related to the socioeconomic status of neighborhoods which further supported the underclass hypothesis.

In 1989, Mladenka was not satisfied with the research, his included, on urban service distribution. Among his criticisms were that previous studies did not look at distributional patterns over time, failed to use multiple-indicators, did not take into account demographic shifts and failed to define or elaborate on decision rules to see if the rules were truly racially or economically neutral (Mladenka, 1989). For this study, Mladenka studied parks and recreation facilities programs and expenditures between 1962 –1983. He used multiple indicators of recreational resources and services, aggregated his data by wards and supplemented the data with interviews. He concluded that race was a factor but only in the early 60's. After 1967, changing demographics and other social changes altered the distributional patterns. His study showed that after 1967, home-ownership was the factor governing service distribution.

Emily Talen (1997), in a more recent study, applied exploratory spatial data analysis techniques (ESDA) to the issue of service distribution patterns. She measured accessibility (in distance) to park facilities in Macon, Georgia and Pueblo, Colorado. Her goal, "to determine whether political or other factors account for a distributional inequities." The results of her research added a physical or spatial dimension to the ongoing research in this area. It also provided support for the class bias theory.

Table 2.2 summarizes the research supporting the Class Bias theory.

TABLE 2.2: Summary of Class Bias Literature

Author	*Services Studied*	*Location*	*Measures to Consider*
Cingranelli (1981)	Police	Boston, MA	➢ Need for services
Bolotin and Cingranelli (1983)	Police	Boston, MA	➢ Need for services ➢ Comparable neighborhoods ➢ Multiple variables
Feiock (1986)	Elementary education	Erie, PA	➢ Distribution of service benefits ➢ Tax burden ➢ Education
Mladenka (1989)	Parks and recreation	Chicago, IL	➢ Long-term response of distributional patterns ➢ Multiple indicators ➢ Account for demographic shifts ➢ Define decision rules ➢ Aggregated data ➢ Added interviews
Talen (1997)	Parks	Macon, GA Pueblo, CO	➢ Accessibility

Bureaucratic Decision Rules

According to the bureaucratic decision rules theory, the distribution of services are based on a set of professional criteria that bureaucracies use to determine who gets what. These criteria should be immune to political, socioeconomic or other external factors (Jones et al., 1977; Mladenka & Hill, 1978; Lee, 1994).

In *Urban Outcomes*, the authors concentrated their research on the government's distribution of goods and services to the citizens of Oakland, California (Levy, Meltsner & Wildavsky, 1974). One of the studies' objectives was to determine why and how schools, libraries and street reconstruction were allocated among groups in the city. The authors found that there were several professional criteria that were involved in the allocation of street reconstruction projects. Reconstruction projects were under the control of the street department and the decision rules that they follow. Though there was some political influence, it only resulted in shifting priority schedules. For libraries, a set of internal rules also governed the location and amount of resources allocated. These rules were based on usership. However, the results were a distributional pattern that favored the well-to-do areas, particularly those with scholarly interest who used special collections. With regards to schools, when comparing the areas of class size, teacher salaries, experience and salary dollars per student, the rules guiding their allocation resulted in a distributional pattern where neighborhoods at the upper and lower end of the income brackets received the greatest benefits.

In 1977, George Antunes studied the quality of streets in Houston. His results revealed no evidence that racial or socioeconomic factors accounted for the unequal distribution of paved streets. Instead, the basis for allocating street repairs were a set of internal rules that governed the agency, although not entirely (Antunes & Plumlee, 1977). There existed an equity rule that required council members to receive their proper allocations, by districts, of all capital improvement money that was spent in the city. So if there were inequalities, they were due to unknown factors.

Bureaucratic decision rule was also the supported theory in Mladenka and Hill's study of the distribution of police services in Houston. Their research confirmed what other studies had shown, that different neighborhoods receive different levels of services (Mladenka, & Hill, 1978). Socioeconomic status nor race accounted for the variation in police responsiveness. Rather, responsiveness was based on the severity of the offense. This way of prioritizing was based on an internal rule, not other considerations. But, the authors acknowledged that one could not assume that the consequences of these rules would be neutral.

Kenneth Mladenka, in 1978, decided to reexamine the role of organizational rules in decision making and their impact on the distribution of urban public services; namely parks and libraries (Mladenka, 1978). This study included six cities in Virginia and information was aggregated at the census tract level. Mladenka discovered that there were no clear cumulative inequalities in either service. Instead, there existed a set of operational rules that had distributional consequences. These rules, merely simplified the choice among alternative solutions, reduced uncertainty, made for easy application and reliable performance, limited discretion and relied on existing agency records and information. He noted that the reason he focused on the impacts of services rather than facilities was because he recognized that neighborhoods change easier than physical facilities. Therefore, the current neighborhood may not resemble the neighborhood that existed when these services were built.

Bryan Jones and colleagues attempted to show that the distribution of services had political consequences even though the internal decision making process was governed by a set of agency rules. Their study of three agencies in the City of Detroit revealed that the decision rules that were followed did have distributional or political consequences. However, the nature of the impact and the characteristics of the resulting distributional patterns varied from agency to agency. They concluded that to better understand the distributional patterns of a given agency, one should study the internal structures and processes of that agency (Jones et al., 1978).

Boston was the site of Pietro Nivola's (1978) study of housing inspection services. He was concerned that the conventional views of service distribution i.e. underclass and politics needed to be reconsidered. He concluded that the distributional patterns had little to do with authoritative policies or political influence. Instead, housing inspection service patterns were dictated by internal imperatives of the administrative process. Unfortunately, these distributional patterns reflected a system of initiatives which were continually rationed and limited activity.

Mladenka further explored the distribution of urban services in 1980. This time, he looked at the distribution of parks & recreation, fire, refuse collection and education in the City of Chicago. Again, he found little evidence that supported the influence of political or socioeconomic factors. He determined that the pattern of service delivery was more a function of past decisions, population shifts, technological change, reliance on technical-rational criteria and professional values (Mladenka, 1980). He did acknowledge that the determinants of distributional outcomes vary across types of bureaucracies. The government agencies he selected for his study allowed little room for discretion and in that case, organizational rules were a better explanation of who gets what.

Mary Sanger analyzed the determinants of New York City's service distributions for fire, police and sanitation in 1969-1970. Neither the underclass nor a need based ecological hypothesis satisfactorily explained the distributional patterns she observed (Sanger, 1982). The bureaucratic decision rules hypothesis provided a more consistent and useful explanation of how services were distributed. However, she pointed out that while other theories explained outcomes, the decision rules theory really only explained the process by which outcomes come about. This then makes the decision rules just a *residual* theory because very seldom is the content of the rules themselves known. In fact, these rules could embody principles suggested by the other theories.

Table 2.3 summarizes the literature supporting the Decision Rules theory of urban service delivery.

TABLE 2.3: Summary of Decision Rules Literature

Author	*Services Studied*	*Location*	*Measures to Consider*
Levy, Meltsner & Wildavsky (1974)	Schools Libraries Streets	Oakland, CA	➢Internal rules ➢Public usage ➢Professional criteria
Antunes & Plumlee (1977)	Streets	Houston, TX	➢Internal rules and equity among council districts
Mladenka & Hill (1978)	Police	Houston, TX	➢Severity of offense
Mladenka (1978)	Parks and libraries	6 cities in Virginia	➢Operational rules
Jones et al. (1978)	Three agencies	Detroit, MI	➢Study the internal process and structure of agency
Nivola (1978)	Housing inspection services	Boston, MA	➢Internal imperatives of the administrative process
Mladenka (1980)	Parks and recreation Fire, refuse collection, education	Chicago, IL	➢Past decisions ➢Population shifts ➢Technological changes ➢Technical-rational criteria ➢Professional values
Sanger (1982)	Fire Police Sanitation	New York	➢Knowledge of the agencies internal rules

Political Influence

The Political Influence theory supports the contention that the distribution of services reflects the electoral considerations of politicians (Lee, 1994). These considerations are influenced by external forces that can include civic pressures or re-election issues (Meier, Stewart & England, 1991).

Bryan Jones analyzed the role of intermediary groups in delivery of urban public services. For his study, Jones chose to focus on Chicago's Department of Buildings. His objective was to determine whether citizens were linked in any way to the service bureaucracy through mediating structures and whether these linkages affected the distribution of services. His results revealed the influence of political party structure at all stages of the service delivery process. He attributed this to three factors: the nature of Chicago's political culture, the agencies penetrability or openness to political influence and the nature of the agencies service product (Jones, 1981).

Previous studies had not convinced Glen Abney and Thomas Lauth that politics did not play a role in the distribution of services. In 1982 they conducted a survey of department heads in US cities with populations of 50,000 or more. The respondents were asked to indicate those factors affecting their decision about service delivery and rule enforcement. Their results showed that the political culture of the environment dictated whether political influences would affect the administrative decision making process (Abney & Lauth, 1982).

Support for political influence in the distribution of services was provided by Koehler and Wrightson in their reanalysis of Mladenka's 1980 study of park services in Chicago. They changed Mladenka's study design by adding the two exogenous factors of population mobility and the short-term mobility of facilities. They found that politics did have an influence in the distribution of services (Koehler & Wrightson, 1987). They concluded that population mobility coupled with the immobility of certain park facilities had led to an underestimate of the impact of politics in the allocation of park facilities.

Kenneth Meier also believed that politics played a role in the distribution of services. One of his major criticisms of previous research on service distribution was that it focused on only a few cities and a few policy areas. He believed that it would be better to analyze one city over a long period of time or incorporate several cities into one study (Meier, 1991). His research looked at educational access in 140 school districts across the US. He chose education because he believed it would be most likely controlled by bureaucratic decision rules and least by electoral politics. He found that bureaucratic decision rules did not over ride the impact of political forces or social class biases. In cases where bureaucratic decision rules had been established, thus preventing bureaucrats from adjusting services to meet either political or social ends, decision rules determined policy. However, where there was room for discretion, political forces clearly an exerted influence.

The objective of Rowan and Tunyavong's study was to reexamine the role of distributional politics (Rowan & Tunyavong, 1994). In the City of Chicago, they analyzed the distribution of Community Development Block Grant funds (CDBG) over a 15-year period and Capital Improvement Projects (CIP) over a 6-year period. Their findings were in support of political influences in service distribution. They concluded that who rules really does matter. The use of a particular program for political purposes can occur over short periods of time. Elected officials can be selective by choosing certain programs for political purposes. Only when it is not to their benefit to do so they allow bureaucratic decision rules to reign.

Table 2.4 is a summary of the political influence literature.

Additional Studies

In addition to the studies just discussed, there are a number of studies that propose alternative theories or address service distribution issues.

TABLE 2.4: Summary of Political Influence Literature

Author	*Services Studied*	*Location*	*Measures to Consider*
Jones (1981)	Department of buildings	Chicago, IL	➢ Political culture ➢ Agency penetrability ➢ Type of product
Abney and Lauth (1982)	Government Department heads	Nationwide	➢ Political culture
Koehler & Wrightson (1987)	Park services	Chicago, IL	➢ Population mobility ➢ Short-term mobility of facilities
Meier (1991)	Schools	Nationwide	➢ One city over time or several cities in one study
Rowan & Tunyavong (1994)	CDBG program CIP	Chicago, IL	➢ Long-term analysis

San Antonio, Texas was the site of Robert Lineberry's 1975 study of public services. His study attempted to conjoin the issues of public service distribution and equity. Using as case studies fire and public parks, Lineberry found little or no support for the Class Bias theory. What he discovered were inequalities but they were unpatterned inequalities. He concluded that service delivery would probably vary from city to city and from service to service (Lineberry, 1975).

James Boyle and David Jacobs critiques of earlier service distributional studies were that equity had not really been defined, the range of service outcomes were limited and only a simple bivariate correlation was used. Therefore, they decided that in their study of New York City, in 1970, they would apply a multiple regression model to a cross sectional analysis of sixty-two community planning districts and cover six different services (Boyle & Jacobs, 1982). What they found was a definite difference in types of services and distributional explanations. The distributional patterns of property related services like fire, sanitation and police were best explained by the contributory hypothesis. This hypothesis states that "municipal services will be distributed in proportion to tax contributions." Distribution patterns for social services like health, welfare and education services were best explained by the compensatory hypothesis. This states that "municipal services are distributed on the basis of need." Boyle and Jacobs further commented that those studies that found no clear distributional pattern and attributed this to decision rules possibly overlooked or omitted important explanatory or external variables. They stated that it is not realistic to believe that there are no external influences in service distribution.

The purpose of Peter Nardulli and Jeffery Stonecash's research was to provide the theoretical framework for posing or evaluating any theory of service distribution (Nardulli & Stonecash, 1982). They believed that previous research had neglected very important logical questions about possible influences upon distribution. Therefore, they posed a series of five questions they believed must be considered if a general theory or an expectation for a specific city is to be formed. The questions, in suggested order, are as follows:

1. What is the nature of services (can the service be unequally distributed)?
2. What is the nature of the bureaucracy (it is susceptible to political influence and/or does a bureaucratic policy exist.)
3. What are the rules of allocation the organization uses?
4. If the bureaucracy is susceptible to external influences, whit kind of political linkages exits?
5. What are the distributional patterns desired by the bureaucracy?

Nardulli and Stonecash believed that it was too simplistic to dichotomize the influences on distributions. The rules governing service distribution may be varied, therefore the felt that more care must be taken in interpreting their meaning.

William Baer attempted to clarify why various studies were supporting different outcomes. In his research, he differentiated between *labor-intensive* services and *capital intensive* services (Baer, 1985). Labor intensive services such as police, fire and trash collection are typically routine, repetitive, and recurrent; of short duration and revisable or even reversible if change is desired. The sources of funding for these type of activities usually come from a city's operating budget. Capital intensive projects such as land acquisition, street construction and water line replacement are infrequent, continual, long-lived and non reversible. Such projects are often funded from special funds. Baer's contention is that those studies that supported bureaucratic decision rules as a basis for distribution patterns were really looking at labor intensive services. Decisions for capital intensive projects reflect more political influence because they are often made in consultation with politicians, the public and other bureaucrats. And, funding for such projects require well-articulated and publicized justifications of distributive decisions.

Another attempt to resolve the conflict between the three theories was made by Seung Jong Lee (1994). Using data on service distribution of several agencies in New York City in 1980, Lee devised a service typology that categorized services by type and function. His study concluded that for administrative services, bureaucratic rules governed. For mixed services either the political or class bias model would be more appropriate. Political services, which are highly susceptible to external influence favor high income or politically active communities. However, objective criteria, service needs and conditions proved to be more important determinates of service distribution, regardless of the service type.

Table 2.5 summarizes the findings of the additional studies.

TABLE 2.5: Summary of Additional Studies

Author	*Services Studied*	*Location*	*Findings*
Lineberry (1975)	Parks Fire	San Antonio, TX	Unpatterned inequalities that vary from city to city and from service to service
Boyle & Jacobs (1982)	Variety	New York City	Different in types of services and distributional patterns; patterns depending on nature of service
Nardulli & Stonecash (1982)			Not dichotomize the influences or distributions
Baer (1985)	Variety		Type of services: capital intensive vs. labor intensive, dictated type influence
Lee (1994)	Variety	New York City	Service type, objective criteria service needs and conditions dictate influence

Contributions of Current Research

A majority of the research on citizen contacts identifies who makes contact, why they make contact and the bureaucracy's immediate response. The effects of citizen initiated contacts, on public policy have received little attention (Rosener, 1978; Potter & Norville, 1983; Thomas & Melkers, 1999). This study intends to extend what is known about government's response to citizen initiated contacts by determining if these contacts effect long-range policy.

This research will also contribute to the body of knowledge on service distribution. Though there a number of studies on service distribution patterns, their research suggest gaps that should be address. Those gaps which are addressed in this study include: reviewing the internal structure and process of the agency as part of evaluating the distribution of services (Jones et al., 1978); taking a closer look at the rules embodied within the agency (Sanger, 1982); studying the same city and services over time in order to detect changes in distributional patterns and the use of multiple indicators (Mladenka, 1989).

In addition to research on service distribution, this study attempts to understand the decision making process with regards to infrastructure repair/replacement allocation and the Public Works Department. It is accepted that infrastructure decision making models can no longer be solely a technical issue (Rittel & Webber, 1973). However, it is unclear how non-technical issues are being incorporated into the current decision making process. This research will determine if and how non-technical issues are being integrated into the infrastructure policy-making process.

CHAPTER III

METHODOLOGY

In Houston, the repair and maintenance of water and sewer elements are managed by different branches within the Public Utilities Division. However, Capital Improvement Projects for both infrastructure elements are funded from the same source and follow virtually the same decision making process. For those reasons, both are part of this study.

This chapter will state the research and null hypotheses, outline the study design, define the variables and explain the statistical procedures to be used.

Research Hypotheses

To achieve the objectives of determining the statistical significance of citizen contacts on the selection of water and sewer capital improvement projects, this study will test five null hypotheses. Each of the null hypotheses tests the significance of citizen contacts on the selection of water and sewer capital improvement projects singularly and in the presence of other variables.

Direct Relationship Between Work Orders and Project Selection

Hypothesis 1a. Citizen initiated contacts have had a significant effect on the selection of water related capital improvement projects between 1992 and 1999.

Null Hypothesis 1a. Citizen initiated contacts have had no significant effect on the selection of water related capital improvement projects between 1992 and 1999.

Hypothesis 1b. Citizen initiated contacts have had a significant effect on the selection of sewer related capital improvement projects between 1992 and 1999.

Null Hypothesis 1b. Citizen initiated contacts have had no significant effect on the selection of sewer related capital improvement projects between 1992 and 1999.

Hypotheses Representing the Class Bias Theory

Hypothesis 2a. Citizen initiated contacts, when taken in consideration with sociodemographic variables, have had a significant effect on the selection of water related capital improvement projects between 1992 and 1999.

Null Hypothesis 2a. Citizen initiated contacts, when taken in consideration with sociodemographic variables, have had no significant effect on the selection of water related capital improvement projects between 1992 and 1999.

Hypothesis 2b. Citizen initiated contacts, when taken in consideration with sociodemographic variables, have had a significant effect on the selection of sewer related capital improvement projects between 1992 and 1999.

Null Hypothesis 2b. Citizen initiated contacts, when taken in consideration with sociodemographic variables, have had no significant effect on the selection of sewer *related capital improvement projects between 1992 and 1999.*

Hypotheses Representing Decision Rule Theory

Hypothesis 3a. Citizen initiated contacts, when taken in consideration with technical factors, have had a significant effect on the selection of water related capital improvement projects between 1992 and 1999.

Null Hypothesis 3a. Citizen initiated contacts, when taken in consideration with technical factors, have had no significant effect on the selection of water related capital improvement projects between 1992 and 1999.

Hypothesis 3b. Citizen initiated contacts, when taken in consideration with technical factors, have had a significant effect on the selection of sewer related capital improvement projects between 1992 and 1999.

Null Hypothesis 3b. Citizen initiated contacts, when taken in consideration with technical factors, have had no significant effect on the selection of sewer related capital improvement projects between 1992 and 1999.

Hypotheses Representing Political Theory

Hypothesis 4a. Citizen initiated contacts, when taken in consideration with political factors, have had a significant effect on the selection of water related capital improvement projects between 1992 and 1999.

Null Hypothesis 4a. Citizen initiated contacts, when taken in consideration with political factors, have had no significant effect on the selection of water related capital improvement projects between 1992 and 1999.

Hypothesis 4b. Citizen initiated contacts, when taken in consideration with political factors, have had a significant effect on the selection of sewer related capital improvement projects between 1992 and 1999.

Null Hypothesis 4b. Citizen initiated contacts, when taken in consideration with political factors, have had no significant effect on the selection of sewer related capital improvement projects between 1992 and 1999.

Hypotheses Incorporating All Variables

Hypothesis 5a. Citizen initiated contacts, when taken in consideration with all other factors, have had a significant effect on the selection of water related capital improvement projects between 1992 and 1999.

Null Hypothesis 5a. Citizen initiated contacts, when taken in consideration with all other factors, have had no significant effect on the selection of water related capital improvement projects between 1992 and 1999.

Hypothesis 5b. Citizen initiated contacts, when taken in consideration with all other factors, have had a significant effect on the selection of sewer related capital improvement projects between 1992 and 1999.

Null Hypothesis 5b. Citizen initiated contacts, when taken in consideration with all other factors, have had no significant effect on the selection of sewer related capital improvement projects between 1992 and 1999.

Research Design

This research is a quantitatively analyzed case study designed with the purpose of describing and diagnosing the factors considered in the selection of sewer and water projects for Houston's Capital Improvement Plan. The study is longitudinal in nature; covering the time period beginning in 1992 (the year the city's maintenance system became computerized) through 1999. A longitudinal study was chosen because it will allow for technological, administrative and political changes that may occur over time.

The target population is the City of Houston, Texas. Houston was chosen for two reasons. First, when the research began, the Department of Public Works and Engineering was in the process of upgrading their GIS and Infrastructure Management System. Secondly, the city was working with Texas A&M University on an infrastructure project funded by the National Science Foundation. This research is an extension of that project.

The city has various levels of analysis that could be studied: census tracts, zip codes, Key Maps, Inc., neighborhood, super neighborhoods and voting districts. Census tracts were chosen for this research because of the availability of demographic data; the existence of concrete, non-subjective boundaries; and the constancy of the boundaries during the study period.

Of the 481 census tracts in Houston, only those tracts that had at least one-third of its land mass within the city's boundaries were considered. Seven tracts were omitted from the study because they were commercial areas (downtown and the Galleria) that have ongoing projects and thus are not subjected the same annual CIP selection process. In total, 375 census tracts were studied.

Dependent Variables

Two dependent variables will be measured. Water related projects (WCIP) and sewer related projects (SCIP) are capital improvement projects approved by City Council 1992-1999. The dependent variable will only include work on underground lines and valves. Treatment plants, towers, lift and pump stations, etc. will not be studied because they are visible features of the water system and this study focuses on underground, non-visible elements. Also, towers and treatment plants have little if no interaction with the public. Citizen complaints address local problems, not global problems. Major rehabilitation or replacement projects are driven by capacity or regulatory issues although these issues can cause local problems.

The dependent variable will be dichotomous in nature, taking on the values of either (0) no project allocated that year or (1) project(s) allocated that year.

Independent Variables

Citizen initiated contacts may not be the only factor that contributes to the selection of water and sewer replacement projects. Therefore, this study includes other variables that may be considered by the Department of Public Works and those who affect the selection of CIP projects. The independent variables have been identified in the literature and via formal and informal interviews with PW&E staff and City Council members.

- Citizen calls will be represented by work orders. During the study period, all citizen complaints or requests for utilities determined to be the city's responsibility, resulted in either water work orders (WWO) or sewer work orders (SWO). Between 1992 and 1995, PW&E began gathering and summarizing data in the spring prior to June 30th (end of fiscal year). In 1996, their planning process began earlier and data was summarized the previous winter. Therefore, the number of calls will be calculated March to February for years 1992 through 1995 and on a calendar year 1997 through 1999. Year 1996 will capture work orders beginning March 1995 through December 1995.

Variables Representing the Class Bias Theory

- Racial composition is the percent non-white population as of the 1990 census (NONWHITE). This percent is calculated as the number of non-white persons divided by the total population.
- Median household income according to the 1990 census (INC).
- Percent home owner in 1990 (OWN). This number is calculated as the number of owner-occupied housing divided by the number of occupied housing units.

- Median cost of housing (COST). This number is an index that combines the 1990 median value of owner-occupied housing with the 1990 median gross rent of renter-occupied housing units paying cash rent.

Variables Representing Objective Criteria (Bureaucratic Decision Rules)

- Line type (TYPE) describes how the water/sewer line is used i.e., main line, fire line, collector, etc.
- Line material (MAT) describes the material used to construct the line.
- Line diameter (DIAM) is a measure of line size.
- The age of the line (AGE) is the year the line was originally installed. When that information is unavailable, age will be based on the median year that housing structures were built in that tract.
- Service date (SERV) is the most recent date the original line was replaced. When data for both AGE and SERV are available, the most recent date will be used.
- Location is based on the census tract's relationship to I-610, i.e. inside or outside of I-610 (LOOP610). I-610 is an inner beltway that, in some cases, helps identify several other demographic and political variables.

Variables Representing Political Influence

- City Council tenure is the number of years the council member has been in office (TEN). City statutes are such that council members will be elected or re-elected for a two-year term. The maximum number of terms that can be served is three.

- Electoral influence is described by the variable percent registered to vote (VOTE). It is the number of registered voters divided by census tract population.
- Stable (STABLE) indicates if a precinct has been redistricted during the study period
- Percent of the population that is active (ACTIVE) is the number of citizen calls divided by census tract population.
- Districts (DIST) represent the nine council districts in Houston.

Data Sources

The data used is archival, originally collected by various city departments and organizations. This section describes the characteristics of each database provided by source.

- The Planning and Development Department provides an Arcview database, COHGIS, release five. COHGIS contains a variety of layers that will be used in this study. These layers include: city limits, council districts, counties, neighborhood to standard areas, super neighborhoods and capital improvement projects. The strength of this database is the amount of information that it contains and the fact that it is in tabular and graphical formats. The weakness is that the layers are updated at different times.

Therefore, before comparisons are made, it is necessary to update the older layers to correspond with the most recent.

- Harris County Tax Assessor's office offers a computerized precinct map and a list of all registered voters by precinct, by year. A weakness of the voter database is that it may be current but not necessarily accurate.
- The Department of Public Works and Engineering maintains
    1. A GIMS database that describes water and sewer lines. A weakness of this database is that not all the fields have information. The method for collecting, entering and updating information is unclear. Therefore, one does not know how recent the information is. A second weakness is that historical information is lost when a line segment is replaced. The strength of the database lies in that it provides relatively accurate location and description of water and sewer lines.
    2. An IMS database that contains citizen contact and work order records for 1992 through June, 1999. The strength of the database is that it is fairly complete, provides location of call, date and time; it also tracks work orders until work is completed. Most importantly, it ties service requests to work orders so that service request and work order numbers can be coordinated. The weakness of IMS stems from changes in record keeping throughout the study period. Work orders were initially maintained by separate offices with jurisdiction over city quadrants and were transferred to a central location in the mid 1990's. There may be a possible loss of

records and changes in the way data was recorded. Also, the level of completeness varies from work order record to record.

3. The CIP documents which describe the individual projects. The weakness of this source is that there are instances where the approved CIP project is substituted by another. This may happen at the design phase and therefore would not be included within the document nor would the substitution show in subsequent years.

- The Bureau of the Census has 1990 demographic information on the census tracts that are part of the city of Houston. The demographics selected contain racial composition, median household income, percent homeownership, average cost of housing and median housing age. The strength of this database is that its numbers and percentages are commonly recognized and used.
- The Houston Chronicle newspaper supplied political information relating to council districts, tenure, election years and redistricting. All archived editions are accessed on-line.

In addition to the data collected, formal and informal interviews were held with persons from the various divisions within the Department of Public Works and Engineering and select council members. The purpose of the interviews were to have a better understanding of how the data was used and to identify the players in the decision making process. When permitted, interviews were tape recorded for accuracy.

Data Analysis

Three levels of analysis were performed: descriptive univariate analysis, comparative bivariate analysis, and explanatory multivariate analysis.

Descriptive Univariate Analysis

A univariate analysis is useful for three reasons (Hatcher & Stepanski, 1994). It screens the data, helping to identify data keyed in incorrectly and to ensure that data can be read and manipulated by the computer. Secondly, it reveals the shape of the data. This will help to determine if the data is normally distributed or if transformations need to be made. Finally, the analysis will provide a basic description of the data i.e. minimum, maximum, mean, frequency and measures of central tendency.

Bivariate Analysis of Variable Relationships

A bivariate analysis was used to determine the strength and direction of the relationships among the independent variables and between the dependent and independent variables (Healey, 1984). Because the variables are measured differently, several measures were used. The chi-square test of independence was used to test the relationship between two categorical variables. While the chi-square test statistic tests the significance of the relationship, there are two chi-square based statistics that assess the strength of the relationship. The Phi θ coefficient is used for 2 x 2 tables, the Cramer's V statistic is applied to larger tables (Healey, 1984). Where appropriate, either of these statistics will be calculated. Pearson's rho measured the relationship between integer variables. Kendall's Tau-b was used for measuring the association between two ordinal variables and between ordinal and integer variables. A t-test measured the relationship between categorical and integer variables and a Kruskal-Wallis test was used on ordinal and categorical variables.

Multivariate Analysis

A multivariate logistic regression analysis was used to determine the importance of the independent variables on the selection of CIP projects. Logistic regression was chosen because it is specifically designed for modeling the relationship between a discrete, dichotomous dependent variable and one or more independent variables (Hosemer & Lemeshow, 2000).

For both water and sewer, five separate logistic regression models were run. As shown in the example below, the first model tests for a direct relationship between work orders and the dependent variable.

$$\textit{Simple model:}\ (\ (x)\ (\textit{water project allocation}) = \frac{e^{B(0) + B(1)\,x(1)}}{1 + e^{B(0) + B(1)\,x(1)}}$$

$$\textit{where}\ \ x(1) = WWO \textit{ or } SWO$$

Three of the five models are theory based and will test the individual and interactive effects of the independent variables on CIP project selection and the fit of the model in predicting the dependent variable, CIP. The example below is the logistic regression for the Class Bias Model.

Class Bias Model: $((x)$ *(water project allocation) =*

$$\frac{e^{B(0) + B(1)x(1) + B(2)\,x(2) + B(3)\,x(3) + B(4)x(4) + B(5)\,x(5)}}{1 + e^{B(0) + B(1)x(1) + B(2)\,x(2) + B(3)\,x(3) + B(4)x(4) + B(5)\,x(5)}}$$

where x_1 = *WWO or SWO*
x_2 = *NONWHITE*
x_3 = *INC*
x_4 = *OWN*
x_5 = *COST*

The fifth model is a full model examining the contribution of all the independent variables on the dependent variable irrespective of theoretical considerations.

Full Model: $((x)$ *(water project allocation) =*

$$\frac{e^{B(0) + B(1)x(1) + B(2)\,x(2) + B(3)\,x(3) + B(4)x(4) + B(5)\,x(5) + B(6)x(6) + B(7)x(7) + \ldots\ B(\ )x(\ )}}{1 + e^{B(0) + B(1)x(1) + B(2)\,x(2) + B(3)\,x(3) + B(4)x(4) + B(5)\,x(5) + B(6)x(6) + B(7)x(7) + \ldots\ B(\ )x(\ )}}$$

Two statistics were used to determine the independent variable(s) relationship with the dependent variable. The first is the Wald chi-Square statistic. This statistic functions like the chi-square in a Least Squares regression. The significance level is set for .05. The second, and more reliable statistic, is the Odds Ratio and related 95 percent confidence interval. The Odds Ratio describes the magnitude of the relationship (Dawson-Saunders & Trapp, 1990). It expresses the likelihood of an occurrence i.e. census tract receiving a CIP project, relative to the likelihood of a non-occurrence. The ratio ranges from negative infinity to positive infinity. The stronger the relationship between the independent and dependent variable is in the distance the ratio is from 1.000. A value of 1.000 indicates no relationship.

To assess model fit, the -2 Log Likelihood, Likelihood Ratio and Score statistics were used. Lower values of the 2-Log Likelihood statistic indicate a more desirable model. The Likelihood Ratio and Score statistics have a chi-square distribution with a p-value for the statistic.

CHAPTER IV

THEORETICAL MODEL ANALYSIS

Introduction

The three theories of urban service delivery provide the framework used to analyze the data. By the single variable work order and then by theory, this chapter will first provide a univariate analysis of the variables. The analysis will briefly describe the data and discuss what, if any, transformations were needed to present the data in a manageable, quantitative form without losing too much of the information provided in the raw data. Next, the bivariate relationships will be examined between work orders and the theory based independent variables, among the theory-based variables and between the independent and dependent variables. Finally, the results of the multivariate analysis will be discussed.

Simple Model

Univariate analysis

A total of 330,046 water related and 253,226 sewer related citizen calls were logged in the selected census tracts during the eight-year study period. Though there were fluctuations throughout the years, the volume of calls have been increased from approximately 17,000 water and 10,800 sewer in 1992 to 56,316 water and 38,343 sewer calls in 1999. These calls represent an average of, respectively, 150 and 105 calls per calendar day.

Figure 4.1 summarizes the annual work orders for both water and sewer. Between the second and third years, the number of water work orders almost doubled. After 1994, the number of calls began to decrease until 1997. After a 23 percent decrease in water related calls in 1998, the number of calls reached its maximum of 56,316 in 1999.

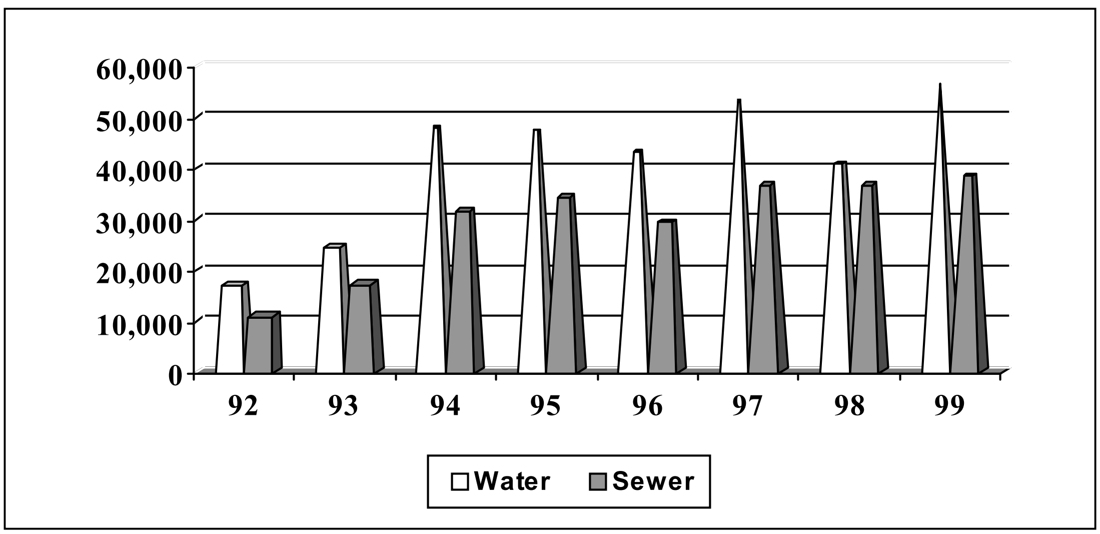

Figure 4.1: Water and Sewer Related Complaints

The number of sewer work orders increased by 60 percent between 1992 and 1993 and by 80 percent between 1993 and 1994. After 1995, the number of calls dropped from 34,308 to 29, 434. The number of calls increased the following year and reached its peak of 38,343 in 1999.

Water and sewer work orders were aggregated by census tracts. The description data is presented in Table 4.1. When aggregated, work orders were not normally distributed nor did they meet the condition of independence from year to year. Calls are carried over to the next year if no corresponding capital improvement project had been allocated. Therefore, to facilitate further analysis, both water and sewer work orders were divided into quartiles based on the median. A description of all the independent variables after the transformations are in Appendix A.

TABLE 4.1: Number of Water and Sewer Work Orders by Census Tract

Variable	*Min*	*Max*	*Mean*	*Median*	*Std. Dev*
Water					
WWO92	0	163	45.24	33.014	38.00
WWO93	0	396	97.53	64.33	89.00
WWO94	0	859	218.63	138.61	192.00
WWO95	0	1316	310.30	212.82	280.00
WWO96	0	1786	369.229	260.267	315.00
WWO97	2.0	2420	472.610	330.24	404.00
WWO98	7.	2897	499.730	396.24	417.00
WWO99	11.0	2608	593.674	430.288	491.00
Sewer					
SWO92	0	203	28.74	29.54	20.00
SWO93	0	551	70.22	68.51	52.00
SWO94	0	1007	147.62	136.63	107.00
SWO95	0	1499	225.07	200.64	165.00
SWO96	0	1919	284.46	216.0	257.65
SWO97	0	2377	358.79	277.0	330.15
SWO98	0	2811	396.58	287.0	298.00
SWO99	0	3278	467.49	334.0	469.56

Multivariate Analysis

The results of the regression model are presented in Table 4.2. The p-values of the multivariate analysis indicate that for five years during the eight-year period (1992, 1993, 1997, 1998 and 1999) water work orders significantly predicted the likelihood that a capital improvement project would be selected in a given census tract. The Odds Ratio indicates that the strongest relationships between water work orders and capital improvement projects are in 1992. In that year, the odds that a census tract with a work order received a capital improvement project is 2.026, or twice as likely than for a census tract without a work order. The corresponding confidence interval contains the value of the true ratio. Since the interval does not contain 1.000 (an indication of no relationship) we can be 95 percent confident that the relationship is indeed significant. After 1992, the ability of work orders to predict a water capital improvement project decreases. In 1993, there is only a 47 percent likelihood that a census tract with a work order was allocated a capital improvement project versus one with no work orders. In 1997, there was a 38 percent likelihood. The likelihood increases in 1998 to 55 percent and increases again in 1999 to 70 percent. In none of these years do the corresponding confidence intervals encompass 1.000. Therefore, we are 95 percent confident of the strength of those relationships. Since water work orders has had a significant influence on the prediction of capital improvement projects 62 percent of the time, we can reject the null hypothesis 1a.

TABLE 4.2: Effects of Citizen Contact on CIP Projects (n=375)

Year	*Estimate*	*(p-value)*	*Odds Ratio*	*Confidence Interval*
Water				
WWO92	.7060	.0001*	2.026	(1554, 2.641)
WWO93	.3872	.0275*	1.473	(1.044, 2.078)
WWO94	.1066	.4591	1.112	(.839, 1.475)
WWO95	.2045	.1244	1.227	(.945, 1.592)
WWO96	.2273	.1735	1.255	(.905, 1.741)
WWO97	.3237	.0159*	1.382	(1.063, 1.798)
WWO98	.4434	.0121*	1.558	(1.102, 2.203)
WWO99	.5359	.0069*	1.709	(1.159, 2.521)
Sewer				
SWO92	.2166	.1079	1.242	(.954, 1.617)
SWO93	.0651	.6661	1.067	(.794, 1.435)
SWO94	.4609	.0269*	1.585	(1.054, 2.384)
SWO95	.1605	.3615	1.174	(.832, 1.657)
SWO96	.0785	.6565	1.079	(.772, 1.507)
SWO97	.4201	.0025*	1.522	(1.159, 2.000)
SWO98	.2745	.1259	1.316	(.926, 1.870)
SWO99	.5268	.0078*	1.649	(1.148, 2.497)

**Significant at the .05 level*

Sewer work orders significantly predict the likelihood of selecting a capital improvement projects in years 1994, 1997 and 1999. Unlike water, the strength or magnitude of the significant relationships of sewer work orders with the dependent variable were relatively consistent. As reflected in the Odds Ratios, census tracts with work orders had a 58 percent likelihood of receiving a capital improvement project, in 1994, versus those tracts with no work orders. In 1997 there was a 52 percent chance and in 1999 a 64 percent chance of a census tract receiving a capital improvement project if there had been a work order. The number of years where work orders had a significant effect on project allocation, was a low 37 percent (3/8) of the time. Still we can reject null hypothesis 1b for sewer work orders has proven to be a significant predictor for three of the study years.

Model Fit

A review of the water model fit shown in Table 4.3 reveals that when compared with the intercept only, the model where water work orders is statistically significant is a better fit 37 percent of the time. The values of the –2 Log Likelihood are shown with the intercept only and with the inclusion of the covariates. A decrease in value signifies a model improvement. The Likelihood Ratio chi-square measures the difference between the two. According to that value, there is a model improvement by adding water work orders. The improvement ranges from .55 in 1994 to 31.71 in 1992. But, is the improvement significant? The p-values associated with the Likelihood Ratio and the Score value indicate that the model improvement is significant in every year except 1994, 1995 and 1996. These coincide with the years where no significant variables were identified.

The inclusion of sewer work orders has also been a model improvement for every year. In 1993, the improvement was a low .18. In 1999, the model improvement was by 8 points. However, the model improvement was significant for only the three years, 1994, 1997 and 1998 where there were significant variables. This conclusion is supported by the chi-square significance of the Likelihood Ratio and Score values.

The results of the multivariate analysis indicate that work orders do not account for all CIP projects. Fortunately, this is not where the analysis ends. The next step is to incorporate the previously discussed models to determine potential group and individual effects.

TABLE 4.3: Simple Model Fit Comparisons (n=375*)*

	-2 Log Likelihood		*Likelihood Ratio*		*Score Value*	
	Intercept Only	*With covariates*	*chi-square*	*p-value*	*chi-square*	*p-value*
Water						
1992	363.941	332.224	31.7173	.0001	30.1832	.0001
1993	232.637	227.552	5.0850	.0241	5.0100	.0252
1994	290.739	290.189	.5501	.4583	.5493	.4586
1995	309.119	306.724	2.3955	.1217	2.3848	.1225
1996	218.704	216.811	1.8938	.1688	1.8772	.1707
1997	316.163	310.125	6.0386	.0140	5.9567	.0147
1998	209.077	202.221	6.8556	.0088	6.6573	.0099
1999	194.086	185.930	8.1568	.0043	7.8526	.0051
Sewer						
1992	275.194	272.559	2.6348	.1045	2.6202	.1055
1993	232.637	232.451	.1866	.6658	.1864	.6659
1994	172.965	167.600	5.3656	.0205	5.1883	.0227
1995	199.160	198.317	.8430	.3585	.8386	.3598
1996	199.160	198.961	.1984	.6560	.1982	.6562
1997	294.506	284.760	9.7463	.0018	9.5296	.0020
1998	183.698	181.261	2.4366	.1185	2.400	.1213
1999	183.698	175.639	8.0581	.0045	7.6989	.0078

**Significant at the .05 value*

Class Bias Theory

Univariate Analysis

The four variables representing the class bias model are: percent nonwhite (NONWHITE), percent ownership (OWN), median household income (INC) and median housing cost (COST). As shown in Table 4.4, percent nonwhite ranges in value from 0 to 100. Slightly less than half (48 percent) of the census tracts are at least 39 percent nonwhite and 30 percent of the census tracts are over 50 percent non-white. The values for income, range from 0 to 350,131. But, over 90 percent of the census tracts had average incomes less than $50,000. Since neither of these variables fit a normal distribution they were divided into categories. Percent nonwhite was divided into quartiles with values based on the median. Income was trichotomized, with the category values also based on the median. Appendix A describes the class bias variables after the transformations.

TABLE 4.4: Description of Class Bias Variables (n=375)

Variable	*Min*	*Max*	*Mean*	*Median*	*Std. Dev*
NONWHITE	0	100	43.989	39.00	30.093
INC	0	350,131	29,986	25,644	23,619
OWN	0	100	45.0533	46.00	22.9719
COST	5.594	10.50	5.594	5.500	1.7581

The values for percent ownership ranged from 0 to 100 percent. The median values revealed that almost 50 percent of the population were homeowners. Housing cost is the combined average of median rent and median housing values. Both median rent and median housing values were scaled from 1 to 11. The values were then added together and divided by 2. The result is the variable housing cost (COST) with values ranging from 0 to 10.5 with a median value of 5.5 resulting in a normal distribution throughout the census tracts.

Bivariate Relationships

Relationships between work orders and class bias variables. The relationships between water work orders (WWO) and the independent variables are described in Table 4.5. Percent nonwhite and water work orders had a significant relationship between 1994 and 1998 however, that relationship was weak. The nature or direction of the relationship indicates that the two variables are negatively related; therefore, we can conclude that in every year, larger numbers of work orders are associated with a smaller percent of nonwhites.

TABLE 4.5: Bivariate Relationship among Class Bias Variables

Variable	*Percent non-white*	*Median income*	*Percent ownership*	*Housing cost*
WWO92	B= -.0809 (.0611)	B= .0727 (.1113)	P= -.0351 (.4970)	P= .0876 (.0900)
WWO93	B= -.0623 (.1498)	B= .0272 (.5511)	P= -.0729 (.1586)	P= .0730 (.1581)
WWO94	B= -.1157 (.0075)	B= .0744 (.1038)	P= -.0124 (.8102)	P= .1098 (.0334)
WWO95	B= -.1595 (.0002)	B= .1056 (.0209)	P= -.0173 (.7384)	P= .1393 (.0069)
WWO96	B= -.1670 (.0001)	B= .0778 (.0891)	P= -.0333 (.5202)	P= .1521 (.0031)
WWO97	B= -.1315 (.0024)	B= .0604 (.1863)	P= .0033 (.9481)	P= .0696 (.1783)
WWO98	B= -.0911 (.0351)	B= .0306 (.5029)	P= -.0148 (.7749)	P= .0318 (.5389)
WWO99	B= -.0727 (.0927)	B= -.0170 (.7098)	P= -.0098 (.8496)	P= -.0033 (.9484)
NONWHITE		B= -.6320 (.0001)	P= -.2250 (.0001)	P= -.6353 (.0001)
INC			P= .3839 (.0001)	P= .7255 (.0001)
OWN				P= .2528 (.0001)
COST				
WCIP92	L= -.0544 (.6290)	L= .3362 (.1415)	L= -.0015 (.7925)	L= .0858 (.2496)
WCIP93	L= .3959 (.0134)	L= -.4578 (.1403)	L= 0.0013 (.8596)	L= -.2570 (.0214)
WCIP94	L= .4722 (.0009)	L= -.5217 (.0528)	L= .0006 (.9181)	L= -.2158 (.0299)
WCIP95	L= .1204 (.9132)	L= -.0318 (.9000)	L= .0019 (.7675)	L= -.0330 (.6977)
WCIP96	L= .1546 (.3309)	L-.0640 (.8405)	L= -.0060 (.4558)	L= .1299 (.2063)
WCIP97	L= -.0217 (.8608)	L= .0533 (.8309)	L= -.0050 (.4231)	L= .0253 (.7589)
WCIP98	L= -.3203 (.0599)	L= 1.258 (.0003)	L= .0018 (.8266)	L= .3379 (.0013)
WCIP99	L= .0237 (.8894)	L= .5633 (.1036)	L-.0049 (.5684)	L= .0317 (.7797)
SWO92	B= -.1058 (.0146)	B= .0652 (.1550)	P= -.0496 (.3373)	P= .0791 (.1261)
SWO93	B= -.1176 (.0066)	B= .0629 (.1689)	P= -.0406 (.4328)	P= .0566 (.0977)
SWO94	B= -.1020 (.0186)	B= .3772 (.4105)	P= -.0351 (.4976)	P= .0819 (.1131)
SWO95	B= -.1081 (.0125)	B= .0539 (.2395)	P= -.0181 (.7257)	P= .0611 (.2375)
SWO96	B= -.1173 (.0067)	B= .0591 (.1961)	P= -.0276 (.5934)	P= .0812 (.1161)
SWO97	B= -.1004 (.0202)	B= .0507 (.2674)	P= .0132 (.7976)	P= .0410 (.4285)
SWO98	B= -.0105 (.8187)	B= -.0105 (.8187)	P= -.0457 (.3771)	P= -.0275 (.6001)
SWO99	B= -.0392 (.3918)	B= -.0392 (.3918)	P= -.0196 (.7039)	P= -.0836 (.1058)
SCIP92	L= -.0855 (.5298)	L= .5995 (.0315)	L= -.0020 (.7690)	L= .2094 (.0180)
SCIP93	L= .3959 (.0139)	L= -.4578 (.1403)	L= -.0013 (.8596)	L=-.2570 (.0214)
SCIP94	L= .2718 (.1506)	L= -.0551 (.1449)	L= -.0013 (.8864)	L= -.1049 (.4110)
SCIP95	L= .2654 (.1234)	L= -.3544 (.2996)	L= .0019 (.8205)	L= -.1272 (.2783)
SCIP96	L= .0925 (.5818)	L= .1062 (.7535)	L= -.0100 (.2478)	L= .1564 (.1499)
SCIP97	L= .1568 (.2314)	L= .3987 (.1305)	L= -.0005 (.9332)	L= .1492 (.0793)
SCIP98	L= -.3271 (.0782)	L= 1.092 (.0032)	L= -.0018 (.8403)	L= .3245 (.0042)
SCIP99	L= .0270 (.8784)	L= .5617 (.1183)	L= .0063 (.4841)	L= .0159 (.8931)

[shaded] = Indicates significance at p=<.05

B=Kendall's Tau-b
P=Pearson's rho
L=Logistic regression

The relationship between water work orders and income is positively significant in 1995. Housing cost and water work orders have a positively significant, albeit weak, relationship between 1994 and 1996.

Percent nonwhite was the only class bias variable to have a significant relationship with sewer work orders (SWO). This occurred between 1992 and 1997. The relationship between the two variables is negative and the value of the correlation coefficient indicates that the relationship is weak.

Associations among class bias variables. All the relationships among the class bias variables are significant. However, they vary on the strength of the correlation and the direction of the relationship. A moderately strong negative relationship exists between percent nonwhite and income and between percent nonwhite and housing cost. As might be expected, lower incomes and lower housing costs are associated with higher percentages of non-whites. The correlation between percent nonwhite and percent ownership is negative and not as strong. The strongest correlation among the class bias variables is the positive relationship between income and housing cost. The relationship between percent ownership and housing cost is also positive but not nearly as strong.

Associations between class bias and dependent variables. The relationships between work orders and the dependent variable were discussed in the first section of this chapter. The relationship between the class bias and dependent variables, also shown in Table 4.5, vary from year to year. In 1992, between 1995 and 1997 and 1999, there were no significant relationships between water capital improvement projects (WCIP) and any of the class bias variables. In 1993 and 1994, percent nonwhite and housing cost were significant and the direction of those relationships are positive. In

1998, water capital improvement projects had a positive significant relationship with both income and housing cost.

For sewer, the only significant relationship in 1992 is the positive relationship between housing cost and sewer capital improvement projects. In 1993, the significant relationships were the positive relationship with percent nonwhite and the negative relationship with housing cost. In 1994 through 1997 and again in 1999, there were no significant relationships. In 1998, sewer capital improvement projects had a positive significant relationship with both income and housing cost.

Multivariate Analysis

From the results of the bivariate analysis, we can conclude that the variable percent ownership, because it has no significant relationship with the dependent variables, could be omitted from further analysis. A series of logistic regressions confirms this.[1] Table 4.6 shows the outcome of regression models run for each year. For brevity, only significant variables are displayed. A detailed output of all variables along with the model fit statistics can be found in Appendix B.

Beginning with water, even with the addition of other variables and with little effect on the strength of the Odds Ratio, water work orders remained positively significant in the same years as in the simple model.

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[1]Stepwise, backward and full model regressions were run to determine the largest number of significant variables. The model fit statistics were based on the model chosen.

TABLE 4.6: Class Bias Model Multivariate Analysis (n=375*)*

Variable	*Coefficients*	*(p-value)*	*Odds Ratio*	*Confidence Intervals*
Water				
1992				
WWO	.7060	.0001	2.026	(1.554, 2,641)
1993				
WWO	.4236	.0163	1.527	(1.081, 2.158)
NONWHITE	.4309	.0084	1.539	(1.117, 2.120)
1994				
NONWHITE	.4722	.0009	1.603	(1.215, 2.116)
1995				
1996				
NONWHITE	.5194	.0186	1.681	(1.091, 2.591)
COST	.3633	.0124	1.438	(1.082, 1.912)
1997				
WWO	.6243	.0025	1.867	(1.246, 2.796)
NONWHITE	.4417	.0497	1.555	(1.001, 2.418)
INC	1.2381	.0095	3.449	(1.334, 8.787)
1998				
WWO	.4603	.0110	1.585	(1.111, 2.260)
INC	1.3041	.0003	3.684	(1.818, 7.466)
1999				
WWO	.5359	.0069	1.709	(1.159, 2.521)
Sewer				
1992				
COST	.2094	.0180	1.233	(1.037, 1.467)
1993				
NONWHITE	.3939	.0139	1.486	(1.084, 2.036)
1994				
SWO	.4609	.0269	1.585	(1.054, 2.384)
1995				
1996				
NONWHITE	.4564	.0499	1.578	(1.000, 2.491)
COST	.3605	.0182	1.434	(1.063, 1.934)
1997				
SWO	.4201	.0025	1.522	(1.159, 2.000)
1998				
INC	1.0927	.0032	2.982	(1.443, 6.162)
1999				
SWO	.5775	.0047	1.782	(1.193, 2.660)
INC	1.4746	.0206	4.369	(1.254, 15.220)

Of the four class bias variables, only housing cost (1996), percent nonwhite (1993, 1994, 1996 and 1999) and income (1997 and 1998) have had a significant effect on capital improvement projects. All of those relationships were positive. Note that in no year do you see the same combination of significant variables. The corresponding Odds Ratios indicate that income in 1997 and 1998 and water work orders in 1992 have the strongest predicting power among all of the variables. The weakest contributor is housing cost. The confidence intervals suggest that we can be 95 percent assured that all the significant variables have some effect on the dependent model (i.e., the interval does not encompass 1.000). Because water work orders is included among the significant variables, we can reject null hypothesis 2a. Water work orders, when tested with class bias variables, have had a significant effect on the selection of capital improvement projects.

As was the case with water, the addition of the class bias variables did not affect the years that sewer work orders is positively significant. In 1992 the regression model indicates a positive significant relationship between housing cost and capital improvement projects selection. In 1998 and again in 1999, the significant variable is income. The variables housing cost and percent nonwhite are individually and positive significant in 1992 and 1993 and are of combined significance in 1996. The Odds Ratios for the significant variables ranged in strength between .23 to 4.3. None of the confidence intervals include 1.000 so we can be 95 percent confident of the variables' predictability. Therefore, we can reject null hypothesis 2b. Sewer work order, when tested with class bias variables, have had a significant effect on the selection of capital improvement projects even though this occurs only 37 percent of the time.

As we progress towards the full model, we see that the following variables have proven to be significant at some point during the research period (Table 4.7). Others have dropped out. This list will be added to as we proceed through this chapter. It is anticipated that the final list will mirror those variables found to be significant in the full model.

TABLE 4.7: Cumulative List of Significant Variables

Significant Variables:	*Water*	*Sewer*
	Water works orders(WWO)	Sewer work orders (SWO)
Theory: Class Bias	Percent nonwhite (NONWHITE)	Cost of housing (COST)
	Percent income (INC)	Percent nonwhite (NONWHITE)
	Cost of housing (COST)	Percent income (INC)

Model Fit

In seven of the eight years, the class bias model is an improvement over the intercept only model. As presented in Appendix B, the –2 Log Likelihood values decrease each year except 1995. The amount of the improvement varies with a high of 31 in 1992 and a low of 6 in 1997. Though the values range, the corresponding p-values indicate that adding the covariates significantly improves the model. In 1995, there were no significant variables thus no model improvements.

The addition of the class bias model is an improvement over the simple model in 1993, 1994, 1996, 1998 and 1999. In 1992 and 1997, there is no improvement since the results of the model were the same.

For sewer, the addition of the class bias variables also resulted in an improvement from the intercept only model for every year except 1995. The degree of model improvement ranged between 5 and 9. As was the case with water in 1995, no significant variables were found. A review of Likelihood Ratio and Score values show that the model improvement were significant. In year 1999, the Score and Likelihood Ratios disagree.

The addition of the class bias variables are an improvement over the sewer simple model in three of the eight years. In the remaining years, either no significant variables were found or the results of the class bias and simple model were the same.

Decision Rules Theory

Univariate Analysis

The five variables representing the decision rules theory are line type (TYPE), material (MAT), size (Diam), AGE (age of line) and location (loop610). The descriptive statistics, summarized in Table 4.8, are prior to any transformations. (See Appendix A for transformations).

The age of the line is estimated by either the average year housing was built or the year the line was replaced, whichever is most recent. The year was then subtracted from the base year 1990. The result is a range of ages between 0, a relatively new line, to 90, a line that was placed in the early 1900's. A frequency count and a median age of 20 indicate that 50 percent of the lines included in this study are at least 20 years old. Two percent of the lines are over 50 years old.

TABLE 4.8: Description of Decision Rule Variables (n=375)

*Variable name **(VARIABLE)***	*Freq*	*Min*	*Max*	*Mean*	*Median*	*Std. Dev*
Water						
Age of line (AGE)		0	90	21.5976	20.0	14.1362
Loop610 (LOOP610)	30.40	0	1	.3040	0	.4605
Type						
Main (MAIN)	49.6	25	2696	558.04	501.00	330.25
Well collection (WCL)	13.87	0	34.00	.9893	0	3.819
Collector (COLL)	3.73	0	225.00	.6640	0	11.621
Hydrant (HYDL)	49.87	1.0	1612.00	237.95	210.00	151.2422
Fire line (FIRE)	45.33	0	41.00	2.722	1.000	4.6403
Casing (CASE)	37.33	0	47.00	2.084	1.000	3.9735
Transmission (TRANS)	3.73	0	21	.3200	0	1.8626
Material						
Asbestos (AB)	49.87	0	1471.00	132.96	85.00	159.59
Cast iron (CI)	49.87	0	630	140.41	113.00	117.44
Concrete (CONC)	8.27	0	49	.5946	0	3.4827
Copper (COP)	22.64	0	28	1.066	0	3.2602
Ductile iron (DI)	29.60	0	222	4.616	0	15.088
Galvanized iron (GALV)	37.87	0	234	15.240	0	34.526
Prestressed concrete (PCPE)	3.20	0	15	.2106	0	1.423
Prestressed concrete lined (PCPL)	1.33	0	11.00	.0800	0	.7835
Polyvinyl (PVC)	49.33	0	2100	99.885	42.00	56.826
Steel cylinder (SRC)	7.73	0	36	.6400	0	3.477
Steel (STL)	85.33	0	64	6.984	4	8.5179
Diameter in inches						
>=2.5 (DIAM1)	49.87	0	354	54.144	31.00	65.109
2.5<>6 (DIAM2)	49.87	24	2931	365.07	321	238.93
8<>12 (DIAM3)	49.87	13	2205	335.75	290	208.127
12<>24 (DIAM4)	48.80	0	470	34.296	22	44.091
>24 (DIAM5)	40.27	0	97.00	7.018	0	14.834
Sewer						
Age of line (AGE)		4	90	25.88	20.0	13.0467
Loop610 (LOOP610)	30.40	0	1	.3040	0	.4605
Type						
Casing (CASE)	16.27	0	30	.3813	0	1.784
Collector (COLL)	49.87	0	3129	354.77	299.00	257.012
Force main (FM)	41.87	0	31	2.504	1.00	4.1366
Lateral (LATL)	42.67	0	1063	32.800	1.00	99.083
Overflow (OF)	29.95	0	10.0	.5267	0	1.1095
Siphon (SIPH)	16.53	0	12	.4933	0	1.4101
Sludge (SLDG)	7.47	0	12	.301	0	1.345
Stub (STUB)	49.87	0	2283	166.42	84	233.666
Material						
Acrylonitrile butadiniene styrene (ABS)	45.87	0	1342.00	26.104	1.00	94.2647
Asbestos cement (AC)	2	0	2.0	.0053	0	.1032
Corrugated metal pipe (CGMP)	9.33	0	31.00	.24	0	1.723
Cast iron (CI)	48.0	0	144.0	15.872	9	19.832
Vitrified clay pipe (CLAY)	24	0	38	.7386	0	2.723
Concrete (CONC)	49.60	0	218	18.333	6	31.479
Ductile iron (DI)	47.47	0	358.00	11.168	3.0	31.479
Extra strength clay pipe (ESC)	2.93	0	840	8.173	0	68.0180
Extra strength concrete pipe (ESP)	49.60	0	651	63.957	22	101.495
Monolithic reinforced concrete (MRC)	41.60	0	57	4.9653	0	8.570
Polyvinyl chloride (PVC)	49.33	0	1025	10.458	0	58.612
Reinforced concrete pipe (RCP)	49.33	0	107	10.650	4	15.8628
Steel (STL)	17.87	0	31	.4400	0	1.876
Diameter (in inches)						
0<>4 (DIAM1)	33.60	0	67.00	1.245	0	4.99
6<>8 (DIAM2)	49.60	0	2671	354.373	268.00	310.208
10<>20 (DIAM3)	49.33	0	654.00	87.312	68.00	69.4031
>20 (DIAM4)	48.53	0	130.00	29.170	23.00	26.1106

The variable for location, loop610, indicates whether the line, or the census tracts that contains the lines, lie inside Interstate Highway 610. Less than 40 percent of the census tracts/lines fall within the loop. Census tracts within loop610 are considered older neighborhoods and typically have a higher density. Public work’s staff have assigned those areas a higher priority.

Houston maintains seven types of water lines. By frequencies, the largest numbers are hydrant leads and main lines. The least frequent are transmission and collector lines. This makes sense given that transmission and collector lines carry water to and from its source. Main and hydrant lines distribute water throughout the city. Individual frequency counts indicated that several line types had numbers so small that the information was lost or the frequencies were too small to be captured when aggregating at the census tract level. Therefore, several types were combined. The combinations were based on similarities in usage. For water, well collection and collector lines were combined to form collection. The line type casing was dropped.

Line material varied as much as line type. Eleven materials were used for Houston’s water lines. The most popular water line material is steel with a frequency of 85.33. The least common materials are prestressed concrete lined, and prestressed concrete. Due to low frequency counts and based on their similarities, several materials were combined. For water, prestressed concrete and prestressed concrete lined were combined to form prestressed concrete. As with type, the subtypes under the variable material were dichotomized given the value of 0 or 1.

Diameter is the final variable in the Decision Rules Model. For water, line diameter was divided into five sizes. The sizes were based on perceived use and priorities as stated by public work's staff. All lines less than 2.5" were considered undersized and had the highest priority (Diam1). The size of the lines then increased from residential (Diam2), commercial (Diam3) to the largest lines designed for either industry (Diam4) and transmission of water from its source i.e., aquifer or surface water (Diam5).

There are eight types of sewer lines that run throughout the city. Collector are those lines that collect sewage from homes and businesses. They represent the highest frequency. Sludge lines were the least frequent. Line types were dichotomized to values 0 or 1. The decision to dichotomize was based on the lack of normality and lack of independence of the data.

For sewer, the most popular materials were concrete, polyvinyl and reinforced concrete pipe. The least, acrylonitrile butadiniene styrene. Due to low frequency counts and based on their similarities, several materials were combined. For sewer, extra strength clay pipe was combined with clay, extra strength concrete pipe was combined with concrete, CISCO was combined with cast iron, and polyethylene pipe were combined with corrugated metal pipe. As with type, the subtypes under the variable material were dichotomized and given the value of 0 or 1.

The sewer variable Diameter was divided into four categories. Again, the smaller lines were designed for residential use (Diam1), the larger lines are for commercial (Diam2), industrial (Diam3) and service to and from the treatment plant (Diam4). Diameter was then dichotomized with the values of 0 and 1.

Bivariate Analysis

Relationships were measured between water work orders and decision rules variables, between the decision rules variables and between the independent and dependent variables. As was done with the class bias theory, different tests were run based on the variable types.

Associations between work orders and decision rules variables. The relationships between water work orders and the decision rules variables are shown in Table 4.9. A Kruskal-Wallis test was run on work orders and line types, material and the variable loop610. Kendall's tau-b analyzed the relationship between water work orders and age of line. Among the line types, water work orders exhibited a significant positive relationship with mains and hydrant leads. These relationships were significant for all eight years. This may not be surprising if you recall that main lines and hydrant leads mainly service residential areas and water work orders are primarily generated by residents.

Among materials, asbestos cement and cast iron were positively significant for all years. Copper had a positively significant relationship between 1993 and 1995. Galvanized iron was positively significant between 1992 and 1997 and polyvinyl was positively related to work orders between 1992 and 1995 and again in 1997.

Line sizes Diam1, Diam2 and Diam3 exhibited a positive significant relationship with work orders during the entire study period. Again, this may not be surprising given that the smaller lines provide relatively direct service to residential neighborhoods.

Loop610 was positively related to work orders in 1992, 1995 and 1996. Age of line was significantly related to water work orders in 1996, 1998 and 1999. The nature of these relationships was positive.

TABLE 4.9. Water Decision Rules Bivariate Analysis

	WWO 92	*WWO 93*	*WWO 94*	*WWO 95*	*WWO 96*	*WWO 97*	*WWO 98*	*WWO 99*
T_MAIN	K=73.55 (.0001)	K=61.85 (.0001)	K=88.39 (.0001)	K=90.97 (.0001)	K=54.97 (.0001)	K=63.24 (.0001)	K=42.36 (.0001)	K=52.75 (.0001)
T_COLL	K=3.300 (.3476)	K=6.333 (.0965)	K=2.195 (.5329)	K=2.866 (.4127)	K=3.198 (.3624)	K=2.014 (.5695)	K=.9014 (.8251)	K=4.126 (.2481)
T_HYDL	K=37.37 (.0001)	K=43.94 (.0001)	K=59.64 (.0001)	K=44.24 (.0001)	K=35.23 (.0001)	K=43.52 (.0001)	K=34.05 (.0001)	K=37.51 (.0001)
T_FIRE	K=5.020 (.1703)	K=3.926 (.2695)	K=.9994 (.8014)	K=3.064 (.3817)	K=5.314 (.1501)	K=4.712 (.1941)	K=7.265 (.0639)	K=4.597 (.2037)
T_TRANS	K=1.209 (.7508)	K=1.450 (.6937)	K=1.020 (.7962)	K=2.048 (.5625)	K=.6717 (.8798)	K=2.641 (.4503)	K=.9972 (.8019)	K=1.964 (.5797)
M_AC	K=12.76 (.0052)	K=32.96 (.0001)	K=36.36 (.0001)	K=34.78 (.0001)	K=41.28 (.0001)	K=42.34 (.0001)	K=25.52 (.0001)	K=25.51 (.0001)
M_CI	K=31.83 (.0001)	K=37.11 (.0001)	K=38.27 (.0001)	K=29.06 (.0001)	K=30.75 (.0001)	K=17.38 (.0001)	K=16.59 (.0009)	K=15.47 (.0015)
M_CONC	K=3.267 (.3523)	K=2.960 (.3977)	K=2.079 (.5562)	K=2.381 (.4971)	K=1.494 (.6835)	K=5.858 (.1187)	K=1.232 (.7453)	K=.5447 (.9090)
M_COP	K=6.172 (.1035)	K=9.602 (.0223)	12.148 (.0069)	K=8.326 (.0397)	K=6.656 (.0837)	K=4.215 (.2391)	K=4.479 (.2142)	K=4.544 (.2084)
M_DI	K=3.825 (.2810)	K=7.649 (.0538)	K=3.085 (.3786)	K=4.527 (.2099)	K=2.980 (.3946)	K=3.072 (.3806)	K=1.721 (.6321)	K=1.234 (.7446)
M_GALV	K=40.86 (.0001)	K=26.41 (.0001)	K=27.71 (.0001)	K=20.84 (.0001)	K=12.91 (.0048)	K=15.30 (.0016)	K=7.185 (.0662)	K=6.620 (.0850)
M_PC	K=5.297 (.1512)	K=5.409 (.1442)	K=2.635 (.4512)	K=4.578 (.2054)	K=2.945 (.4001)	K=1.123 (.7714)	K=1.860 (.6018)	K=2.994 (.3925)
M_PVC	K=34.04 (.0001)	K=14.995 (.0019)	K=23.88 (.0001)	K=12.64 (.0055)	K=2.075 (.5569)	K=14.87 (.0019)	K=5.885 (.1173)	K=5.642 (.1304)
M_SRC	K=3.307 (.3467)	K=.9554 (.8121)	K=2.003 (.5717)	K=1.689 (.6394)	K=1.256 (.7396)	K=.3134 (.9575)	K=.6007 (.8963)	K=.8355 (.8409)
M_STL	K=2.992 (.3927)	K=1.194 (.7543)	K=3.529 (.3169)	K=3.197 (.3622)	K=3.932 (.2688)	K=2.796 (.4241)	K=3.357 (.3397)	K=4.445 (.2172)
DIAM1	K=56.91 (.0001)	K=51.31 (.0001)	K=49.23 (.0001)	K=46.99 (.0001)	K=23.15 (.0001)	K=21.86 (.0001)	K=7.265 (.0001)	K=9.906 (.0001)
DIAM2	K=58.76 (.0001)	K=58.27 (.0001)	K=76.62 (.0001)	K=54.22 (.0001)	K=38.85 (.0001)	K=46.12 (.0001)	K=46.33 (.0001)	K=53.88 (.0001)
DIAM3	K=59.13 (.0001)	K=43.55 (.0001)	K=68.20 (.0001)	K=60.68 (.0001)	K=42.42 (.0001)	K=48.28 (.0001)	K=35.64 (.0001)	K=37.15 (.0001)
DIAM4	K=1.075 (.7831)	K=2.447 (.4848)	K=.4658 (.9263)	K=1.6414 (.6500)	K=1.745 (.6269)	K=4.452 (.2166)	K=2.676 (.4443)	K=8.863 (.0312)
DIAM5	K=2.936 (.4016)	K=1.512 (.6794)	K=2.879 (.4105)	K=4.659 (.1985)	K=.2854 (.9628)	K=1.960 (.5807)	5.3882 (.1455)	K=8.700 (.0336)
LOOP 610	K=14.34 (.0002)	K=3.280 (.0701)	K=3.350 (.0672)	K=5.560 (.0156)	K=4.223 (.0399)	K=1.130 (.2878)	K=3.089 (.0788)	K=1.654 (.1983)
AGE	B=-.012 (.7542)	B=.0399 (.3133)	B=.0292 (.4603)	B=.0545 (.1682)	B=.1150 (.0037)	B=0638 (.1065)	B=.0985 (.0128)	B=.1098 (.0055)

[shaded box] = Indicates significance at p=<.05

K=Kruskal Wallis
B=Kendall's Tau-b

As was done with water, the relationship between sewer work orders (SWO) and line types, material, size and loop610 were examined with a Kruskal-Wallis test. Kendall tau-b evaluated the relationship between sewer work orders and age of line. The results of the tests are in Table 4.10. Among the line types, collector, overflow and stub were the only types that had a positive significant relationship with work orders for every year. Force mains and lateral line types were positively significant for years 1998 and 1999 only. Line type siphon was positively significant in 1993.

The relationship between sewer work orders and line materials reveals that only four of the ten materials have a significant relationship with sewer work orders. Concrete was positively significant for six years. Materials ductile iron and monolithic reinforced concrete were only positively significant in 1994-1995 and 1995, 1996, respectively. Corrugated metal pipe was positively significant in 1997.

The relationship between line size and sewer work orders were simple. The variable Diam2 was positively significant for the entire eight years. Diam4 was positively significant for seven of the eight. The significance of Diam4 is counter intuitive because the larger line size does not typically run through residential areas.

Loop610 was positively significant with sewer work orders in 1996 and 1999. Age of line, unlike what we saw with water, was only significant in 1999.

TABLE 4.10: Sewer Decision Rules Bivariate Analysis

	SWO 92	*SWO 93*	*SWO 94*	*SWO 95*	*SWO 96*	*SWO 97*	*SWO 98*	*SWO 99*
T_CASE	K=3.792 (.2848)	K=.1849 (.9800)	K=2.929 (.4026)	K=5.677 (.1284)	K=2.019 (.5684)	K=4.768 (.1895)	K=.5139 (.9158)	K=.8049 (.8483)
T_COLL	K=32.61 (.0001)	K=47.23 (.0001)	K=45.85 (.0001)	K=35.63 (.0001)	K=39.87 (.0001)	K=44.14 (.0001)	K=39.70 (.0001)	K=36.46 (.0001)
T_FM	K=.5207 (.9143)	K=1.991 (.5741)	K=1.576 (.6646)	K=3.801 (.2838)	K=2.908 (.4059)	K=3.027 (.3874)	K=10.77 (.0130)	K=10.96 (.0119)
T_LATL	K=4.500 (.2123)	K=4.889 (.1800)	K=4.273 (.2334)	K=2.611 (.4555)	K=3.616 (.3059)	K=2.601 (.4573)	K=11.71 (.0084)	K=10.40 (.0154)
T_OF	K=17.79 (.0005)	K=14.73 (.0021)	K=8.321 (.0398)	K=8.084 (.0443)	K=9.499 (.0233)	K=10.29 (.0162)	K=9.371 (.0241)	K=10.46 (.0150)
T_SIPH	K=5.806 (.1214)	K=11.13 (.0110)	K=5.323 (.1496)	K=6.988 (.0723)	K=5.401 (.1447)	K=2.117 (.5484)	K=6.622 (.0849)	K=7.420 (.0596)
T_SLDG	K=1.837 (.6068)	K=2.115 (.5487)	K=2.100 (.5518)	K=2.750 (.4317)	K=4.204 (.2403)	K=2.821 (.4199)	K=4.381 (.2231)	K=4.520 (.2104)
T_STUB	K=11.47 (.0094)	K=8.661 (.0341)	K=8.867 (.0311)	K=9.355 (.0249)	K=10.00 (.0185)	K=8.853 (.0313)	K=8.743 (.0329)	K=13.53 (.0036)
M_ABS	K=1.284 (.7329)	K=.4938 (.9202)	K=3.431 (.3298)	K=1.007 (.7994)	K=1.049 (.7894)	K=3.809 (.2828)	K=2.549 (.4665)	K=3.882 (.2745)
M_CGMP	K=3.364 (.3388)	K=4.208 (.2398)	K=7.219 (.0652)	K=6.718 (.0814)	K=6.634 (.0845)	K=11.04 (.0115)	K=1.950 (.5828)	K=1.729 (.6305)
M_CI	K=2.497 (.4757)	K=.6389 (.8875)	K=.4355 (.9328)	K=1.883 (.5969)	K=1.368 (.7129)	K=.7113 (.8705)	K=.6009 (.8962)	K=2.626 (.4529)
M_CLAY	K=6.026 (.1103)	K=.8431 (.8391)	K=.7023 (.8727)	K=1.062 (.7861)	K=.9865 (.8045)	K=.2629 (.9668)	K=1.059 (.7868)	K=.0740 (.9948)
M_CONC	K=10.92 (.0122)	K=6.402 (.0936)	K=10.32 (.0160)	K=6.363 (.0952)	K=11.00 (.0117)	K=9.989 (.0187)	K=9.942 (.0191)	K=9.635 (.0219)
M_DI	K=4.068 (.2541)	K=4.810 (.1862)	K=12.51 (.0058)	K=7.845 (.0493)	K=5.414 (.1438)	K=6.271 (.0991)	K=4.110 (.2498)	K=4.667 (.1979)
M_MRC	K=4.555 (.2074)	K=8.156 (.0429)	K=11.92 (.0077)	K=6.673 (.0831)	K=7.050 (.0703)	K=5.867 (.1182)	K=2.522 (.4713)	K=.6022 (.8959)
M_PVC	K=1.795 (.6158)	K=1.676 (.6421)	K=6.220 (.1013)	K=3.063 (.3819)	K=3.171 (.3660)	K=3.478 (.3236)	K=3.867 (.2761)	K=4.310 (.2298)
M_RCP	K=.5772 (.9016)	K=2.336 (.5056)	K=.2380 (.9712)	K=4.757 (.1905)	K=3.734 (.2917)	K=1.285 (.7325)	K=2.319 (.5088)	K=.1.525 (.6764)
M_STL	K=2.298 (.5127)	K=.4946 (.9201)	K=1.771 (.6211)	K=3.217 (.3592)	K=1.142 (.7667)	K=1.456 (.6923)	K=.8867 (.8286)	K=1.636 (.6511)
DIAM1	K=2.085 (.5549)	K=3.216 (.3595)	K=.7173 (.8691)	K=.7102 (.8708)	K=.1679 (.9826)	K=.7599 (.8590)	K=1.468 (.6896)	K=.9215 (.8202)
DIAM2	K=35.23 (.0001)	K=39.13 (.0001)	K=34.49 (.0001)	K=36.20 (.0001)	K=31.87 (.0001)	K=36.53 (.0001)	K=37.55 (.0001)	K=36.67 (.0001)
DIAM3	K=7.676 (.0532)	K=4.939 (.1763)	K=6.246 (.1002)	K=5.400 (.1414)	K=3.617 (.3058)	K=2.442 (.4857)	K=6.171 (.1035)	K=6.394 (.0939)
DIAM4	K=6.546 (.0878)	K=8.039 (.0452)	K=9.276 (.0258)	K=9.665 (.0216)	K=18.36 (.0004)	K=11.24 (.0105)	K=16.10 (.0011)	K=15.47 (.0015)
LOOP610	K=1.478 (.2240)	K=2.814 (.0934)	K=2.402 (.1212)	K=3.129 (.0769)	K=6.469 (.0110)	K=2.687 (.1011)	K=2.147 (.1428)	K=5.404 (.020)
AGE	B=-.0329 (.4016)	B=-0258 (.5187)	B=.0083 (.8324)	B=-.0068 (.8604)	B=-.0045 (.9075)	B=.0104 (.7903)	B=.0609 (.1204)	B=.0889 (.0233)

[shaded] = Indicates significance at p=<.05
K=Kruskal-Wallis
B=Kendall's Tau b

<u>Associations among water decision rules variables</u>. The relationships between line types, materials, diameter, loop610 and age of line were tested with a chi-square statistic. The results are in Appendix C. The findings were that line type main had a strong positive significant relationship with 10 of the 12 materials, which indicates that main lines are not composed of any one type of material. Collector lines are primarily made out of materials steel cylinder and prestressed concrete. Hydrant lines are composed of four typical materials; ductile iron, galvanized iron, polyvinyl or steel. Fire lines are primarily ductile iron and steel and transmission lines are composed of primarily cast iron, prestressed concrete or polyvinyl.

The relationships between line types and diameter is clearer. Main lines span the range of sizes which is why it had a positive significant relationship with each of the line size categories. Collector lines range in size between Diam3 and Diam4 while hydrant leads range in size between Diam2 and Diam4. Fire lines span between Diam2 and Diam5 and transmission lines, which we expect to be the largest lines, are significant only at Diam5.

The relationship between line types and loop610 shows a positive relationship with main, collector, hydrant and transmission. The relationship with line types and age of line were tested with a t-test, none of the relationships proved to be significant.

The relationship between material and size varied. The material cast iron was positively significant with line sizes Diam1, Diam2, Diam4 and Diam5. Line material concrete and sizes Diam1 and Diam5 were positively significant. Copper was positively significant with Diam1 and Diam5. Ductile iron and Diam2-Diam4 were positively significant. Galvanized iron is primarily used on the largest size lines while polyvinyl materials are used on all line sizes except the largest size. Steel cylinder is used for line sizes Diam4 and Diam5. Steel is used on all line sizes except the largest.

Four of the line materials had a significant positive relationship with loop610; cast iron, copper, galvanized iron and polyvinyl. Between line material and age of line, there were also four significant relationships. The relationship between age of line and cast iron and age of line and steel were negative. Age of line and prestressed concrete was positive.

The relationship between line size and loop610 indicate that a significant number of the smaller lines are located inside loop610. Between line size and age of line, only Diam2 and Diam5 are positively significant. Finally, there is a negative significant relationship between loop610 and age of line.

Associations among sewer decision rules variables. The relationship between sewer line types and materials were also tested with a chi-square statistic. Collector lines were shown to have a significant positive relationship with every material type. Force main and stub followed, being positively significant with seven and eight of the materials respectively. Line type casing was positively significant with all materials except acrylonitrile butadiniene styrene concrete, monolithic reinforced concrete and polyvinyl. Line type overflow was primarily made from acrylonitrile butadiniene styrene, cast iron and reinforced concrete pipe. Type sludge is positively significant with materials clay, concrete and steel. The relationship between line type and size were significant for almost every pairing. Lateral lines were the only exception. However, lateral lines were the only line type to have a positive significant relationship with loop610. There were no significant relationships between line types and age of line.

Among the materials, acrylonitrile butadiniene styrene, ductile iron and cast iron exhibited a positively significant relationship with each of the line sizes. Corrugated metal pipe is used primarily for the smaller pipes and monolithic reinforced concrete is for the larger pipes. Clay and polyvinyl and steel are mainly used on all pipes except the larger sizes. Concrete and reinforced concrete pipe are mainly used on all sizes except the smaller sizes. Only the material polyvinyl was positively significant with age of line.

Diam3 was the only line size primarily located within loop610. There were no significant relationships between any of the diameters and age of line. As we saw with water, the relationship between age of line and loop610 was positively significant.

<u>Associations between decision rules variables and dependent variables</u>. Table 4.11 shows the relationships between the water decision rules and the dependent variables. The relationships were tested with a logistic regression. Among line types, only main was positively significant. This occurred in 1992 and 1995. Different materials were significant in different years. The relationship between water capital improvement projects and galvanized iron was significant for five of the eight years which indicate that this material gets repaired the most. Polyvinyl followed, being significant in four years. Note that the direction of the relationship between polyvinyl and water capital improvement projects is negative in 1996. The reasons for that are unclear. The materials cast iron and concrete were significant for two years. Copper was positively significant in 1992.

The variable Diam1 had a positive significant relationship with water capital improvement projects between 1992 and 1998 supporting Public Works' contention that smaller lines receive higher priority. The variables Diam3 and Diam5 were positively significant in 1992. Diam2 was positively significant in 1994.

TABLE 4.11: Water Decision Rules and Dependent Variable

	CIP 92	*CIP 93*	*CIP 94*	*CIP 95*	*CIP 96*	*CIP 97*	*CIP 98*	*CIP 99*
T_MAIN	L= 1.160 (.0001)	L=.3347 (.3503)	L=.2539 (.4095)	L=.6366 (.0357)	L=.4319 (.2504)	L=.1028 (.7229)	L=.3088 (.4211)	L=.5881 (.1542)
T_COLL	L=-.7466 (.0785)	L=.0059 (.9899)	L=-.0611 (.8826)	L=-.5677 (.2138)	L=-.3948 (.4753)	L=-.2449 (.5496)	L=-0307 (.9520)	L=.3567 (.4619)
T_HYDL	L=.0413 (.8754)	L=.0689 (.8461)	L=.3368 (.2761)	L=.3546 (.2325)	L=.1427 (.7001)	L=.0062 (.9827)	L=.7569 (.0597)	L=-.3976 (.3275)
T_FIRE	L=.4759 (.0727)	L=.3963 (.2661)	L=.5468 (.0773)	L=.1322 (.6535)	L=.6197 (.0993)	L=.2203 (.4475)	L=.0584 (.8785)	L=.7732 (.0611)
T_TRANS	L=.5626 (.3539)	L=-13.19 (.9824)	L=13.26 (.9794)	L=-.8050 (.4425)	L=-.1998 (.8498)	L=.4605 (.4906)	L=-12.17 (.9751)	L=.8067 (.3080)
M_AC	L=-.1674 (.5263)	L=.7212 (.0527)	L=-.2293 (.4563)	L=-.4307 (.1492)	L=.0058 (.9874)	L=.1745 (.5480)	L=.4459 (.2503)	L=-.2346 (.5593)
M_CI	L=.7548 (.0058)	L=.5849 (.1103)	L=.5304 (.0906)	L=-.1671 (.5709)	L= 1.025 (.0119)	L=.3441 (.2392)	L=.2972 (.4387)	L=.5766 (.1624)
M_CONC	L=-2.306 (.0470)	L=.0437 (.9452)	L=-.3645 (.5614)	L=1.000 (.0191)	L=.5140 (.3679)	L=-.1840 (.7409)	L=-.2504 (.7408)	L=.3567 (.5793)
M_COP	L=.7101 (.0140)	L=.4993 (.1971)	L=.5911 (.0763)	L=.0922 (.7895)	L=.4850 (.2289)	L=.1521 (.6513)	L=-.1722 (.7164)	L=-.5564 (.3173)
M_DI	L=.0812 (.7763)	L=-.5669 (.1913)	L=.3750 (.2423)	L=.0016 (.9959)	L=-.8817 (.0782)	L=.3308 (.2784)	L=.0209 (.9600)	L=.5336 (.1923)
M_GALV	L= 1.539 (.0001)	L= 1.132 (.0021)	L= 1.307 (.0001)	L=.5829 (.0489)	L=.2673 (.4741)	L=.8431 (.0041)	L=-.0558 (.8877)	L=.7771 (.0538)
M_PC	L=-.0125 (.9848)	L=.8581 (.1981)	L=-13.27 (.9779)	L=-.9544 (.3603)	L=.4490 (.5647)	L=1.009 (.0714)	L=-12.18 (.9734)	L=-.1580 (.8807
M_PVC	L=.7068 (.0093)	C-.0336 (.9246)	L= 1.076 (.0013)	L=1.136 (.0004)	L=-.9907 (.0151)	L=.3692 (.2066)	L=.3204 (.4038)	L=.5996 (.1463)
M_SRC	L=-.1235 (.8088)	L=.1242 (.8455)	L=-.2841 (.6520)	L=-.8702 (.2447)	L=-1.012 (.3276)	L=1.666 (.1051)	L=.3104 (.6286)	L=.8098 (.1628)
M_STL	L=.9548 (.0508)	L=.0336 (.9472)	L=.2372 (.6081)	L=.8591 (.1127)	L=.5466 (.3817)	L=.2149 (.6199)	L=-.1655 (.7470)	L=-.3038 (.5578)
DIAM1	L= 1.231 (.0001)	L= 1.010 (.0095)	L=.7308 (.0224)	L=.8117 (.0087)	L=.8643 (.0292)	L= 1.175 (.0003)	L=.2972 (.4387)	L=.7506 (.0754)
DIAM2	L=.3913 (.1416)	L=.3230 (.3675)	L=.6269 (.0466)	L=.3546 (.2325)	L=-.1310 (.7236)	L=-.2465 (.3974)	L=.0597 (.0597)	L=.2461 (.5402)
DIAM3	L=.9072 (.0011)	L=.0689 (.8461)	L=.3368 (.2761)	L=.4432 (.1378)	L=.5633 (.1391)	L=-.1619 (.5772)	L=.5987 (.1285)	L=.7506 (.0754)
DIAM4	L=-.1148 (.6640)	L=.4997 (.1672)	L=.3859 (.2121)	L=-.2044 (.4894)	L=.0525 (.8871)	L=.0564 (.8456)	L=-.0929 (.8075)	L=.1316 (.7421)
DIAM5	L=.5954 (.0249)	L=.4995 (.1606)	L=-.1713 (.5890)	L=.3757 (.2034)	L=.7081 (.0578)	L=.0393 (.8938)	L=.2841 (.4573)	L=.5060 (.2064)
LOOP610	L= 1.774 (.0001)	L=.9900 (.0058)	L=.8261 (.0080)	L=-.0425 (.8948)	L=.9163 (.0141)	L=-.1031 (.7471)	L=.1473 (.7159)	L=.8202 (.0418)
AGE	L= -.0060 (.5356)	L= .0249 (.0198)	L=-.0137 (.2535)	L=-.0451 (.0011)	L= .0086 (.4806)	L=-.0102 (.3547)	L=-.0184 (.2349)	L=-.0164 (.3065)

[shaded box] = Indicates significance at p=<.05
L=Logistic Regression

For five years, loop610 had a positive significant relationship with the dependent variable. Age of line was positively significant in 1993 but negatively related in 1995.

The relationship between the sewer independent variables and the dependent variable in Table 4.12 shows that in any given year, very few variables had a significant effect on the dependent variable. In 1992 and 1993 lateral lines were positively significant. No other line types demonstrated a significant relationship with sewer capital improvement projects until collector in 1998. The nature of that relationship was positive.

The material acrylonitrile butadiniene styrene was significant in four of the eight years. The direction of the relationship was negative in all four years. Concrete had a positive significant effect in 1993 and 1994. The only other material to have a significant relationship with sewer capital improvement projects was corrugated metal pipe in 1998 and monolithic reinforced concrete in 1997. Both of those relationships were positive. The smaller line size (Diam1) had a positive significant relationship with sewer capital improvement projects. The relationship between water capital improvement projects and loop610 was positive and significant in 1992 and 1993.

Multivariate Analysis

The summarized results of water and sewer multivariate analysis are in Table 4.13. The complete results can be found in Appendix D. The variables transmission and collector were omitted from the water multivariate analysis. A combination of low frequencies and concentrated locations compromised the validity of parameters and model fit estimates.

TABLE 4.12: Sewer Decision Rules Relationship with Dependent Variable

	CIP 92	*CIP 93*	*CIP 94*	*CIP 95*	*CIP 96*	*CIP 97*	*CIP 98*	*CIP 99*
T_CASE	L=.2903 (.4704)	L=-.1681 (.7391)	L=.6450 (.1944)	L=.5926 (.1985)	L=.1219 (.8127)	L=.2952 (.4433)	L=-.3761 (.5518)	L=-.8464 (.2596)
T_COLL	L=.3621 (.2597)	L=.0689 (.8461)	L=-.2737 (.5282)	L=-.3050 (.4420)	L=-.1489 (.7055)	L=.0061 (.9838)	L= 1.761 (.0015)	L=-.2572 (.5446)
T_FM	L=-.2769 (.4026)	L=.3239 (.3626)	L=-.0976 (.8248)	L=-.2562 (.5312)	L=.2241 (.5699)	L=-.2589 (.4116)	L=-.2408 (.5759)	L=-.4310 (.3297)
T_LATL	L= 1.238 (.0003)	L= 1.339 (.0006)	L=.5949 (.1707)	L=.1648 (.6759)	L=.3197 (.4162	L=.2491 (.4135)	L=-.1178 (.7803)	L=.4029 (.3313)
T_OF	L=.2963 (.3752)	L=.3638 (.3250)	L=.0289 (.9508)	L=-.0676 (.8763)	L=-.0676 (.8763)	L=.1156 (.7234)	L=-.3187 (.5089)	L=.2994 (.4891)
T_SIPH	L=-.0822 (.8507)	L=.6283 (.1297)	L=-.2942 (.6433)	L=-.1857 (.7396)	L=.9663 (.0251)	L=-.2241 (.6052)	L=.7352 (.1170)	L=.5056 (.3027)
T_SLDG	L=.5119 (.3261)	L=.5300 (.3541)	L=-12.18 (.9690)	L=-.0516 (.9460)	L=.8080 (.1636)	L=-.2664 (.6727)	L=.0803 (.9164)	L=.9506 (.1042)
T_STUB	L=.3621 (.2597)	L=-.4407 (.2231)	L=-.2737 (.5282)	L=-.1489 (.7055)	L=.4757 (.2362)	L=.0985 (.7459)	L=-.2526 (.5446)	L=.2640 (.5265)
M_ABS	L=-.9510 (.0073)	L=-.0067 (.9848)	L=-1.467 (.0088)	L=-.1317 (.7399)	L=.3339 (.3967)	L=-.6737 (.0369)	L=.7934 (.0652)	L=-1.294 (.0113)
M_CGMP	L=.6866 (.1324)	L=-1.329 (.1972)	L=.7795 (.1800)	L=.5300 (.3541)	L=-.3116 (.6803)	L=.0886 (.8618)	L=1.251 (.0135)	L=.6730 (.2435)
M_CI	L=-.0608 (.8486)	L=-.2288 (.5231)	L=-.7926 (.0887)	L=.0865 (.8257)	L=-.0681 (.8627)	L=-.3746 (.2257)	L=.5199 (.2180)	L=-.5296 (.2182)
M_CLAY	L=.0277 (.9404)	L=-.0702 (.8680)	L=.3492 (.4577)	L=.2568 (.5567)	L=-.4004 (.4315)	L=.1237 (.7222)	L=-.2491 (.6288)	L=.2240 (.6284)
M_CONC	L=-.1335 (.6750)	L=.7330 (.0490)	L=.2964 (.4945)	L=-.1373 (.7273)	L=-.4526 (.2597)	L=.0185 (.9515)	L=.0129 (.8039)	L=-.4168 (.3233)
M_DI	L=-.1382 (.6653)	L=-.3348 (.3546)	L=.0154 (.9716)	L=-.3603 (.3696)	L=.2643 (.5023)	L=-.1611 (.5982)	L=.0229 (.9559)	L=-.6966 (.1149)
M_MRC	L=-.4000 (.2328)	L=-.3422 (.3585)	L=-.3076 (.4951)	L=.3673 (.3505)	L=.0557 (.8884)	L=.6723 (.0284)	L=.6229 (.1356)	L=.4499 (.2781)
M_PVC	L=.1820 (.5676)	L=-.2877 (.4221)	L=-.6400 (.1555)	L=-.1258 (.7494)	L=.1835 (.6414)	L=-.5326 (.0876)	L=-.0572 (.8902)	L=.4626 (.2730)
M_RCP	L=.3864 (.2291)	L=-.2877 (.4221)	L=-.4418 (.3157)	L=-.4410 (.2721)	L=.1835 (.6414)	L=-.2473 (.4186)	L=.2869 (.4913)	L=.2869 (.4913)
M_STL	L=.1591 (.6907)	L=-.2910 (.5628)	L=.7558 (.1114)	L=.2460 (.6096)	L=-.2857 (.6085)	L=.0105 (.9789)	L=-.4953 (.4323)	L=-.1419 (.8011)
DIAM1	C=-.1289 (.7065)	C=-.1090 (.7753)	C=.2556 (.5630)	C=-.4484 (.3200)	C=-.2532 (.5591)	C=-.0836 (.7970)	C=-.0777 (.8609)	C=.8207 (.0487)
DIAM2	C=.0687 (.8289)	C=-.0454 (.8983)	C=-.4532 (.3034)	C=.0173 (.9649)	C=-.1373 (.7273)	C=.1108 (.7155)	C=.6325 (.1415)	C=.1029 (.8039)
DIAM3	C=.2838 (.3746)	C=-.1601 (.6531)	C=-.0643 (.8814)	C=.4987 (.2143)	C=.4987 (.2143)	C=-.5326 (.0876)	C=.2869 (.4913)	C=-.5868 (.1725)
DIAM4	C=-.1172 (.7124)	C=-.2524 (.4813)	C=-.6059 (.1787)	C=-.5705 (.1628)	C=-.0912 (.8169)	C=.2527 (.4069)	C=.3212 (.4410)	C=-.0029 (.9560)
LOOP610	P= 1.541 (.0001)	P=.9900 (.0058)	P=.4136 (.3503)	P=-.0949 (.8270)	P=.7471 (.0598)	P=.1914 (.5526)	P=-.3456 (.4737)	P=.6335 (.1311)
AGE	T=-.010 (.4030)	T=.0203 (.0888)	T= .0132 (.3748)	T= .0012 (.9350)	T=-.0029 (.8488)	T=-.0133 (.2940)	T=-.0334 (.0829)	T=-.0242 (.1898)

[shaded] = Indicates significance at p=<.05

L=logistic regression

TABLE 4.13: Decision Rules Model Multivariate Analysis

Year	*Coefficients*	*(p-value)*	*Odds Ratio*	*Confidence Intervals*
Water				
1992				
WWO	.6750	.0001	1.964	(1.478, 2.609)
M-CONC	-2.9636	.0057	.052	(.006, .423)
M_STL	1.2530	.0246	3.501	(1.174, 10.438)
DIAM5	.7096	.0202	2.033	(1.117, 3.700)
LOOP610	1.7694	.0001	5.867	(3.207, 10.735)
1993				
M_AC	.7579	.0472	2.134	(1.010, 4.510)
M_GALV	1.2185	.0012	3.382	(1.621, 7.058)
AGE	.0263	.0192	1.027	(1.004, 1.049)
1994				
T_MAIN	-1.1083	.0142	.330	(.136, .801)
M_GALV	1.5074	.0001	4.515	(2.269, 8.982)
M_PVC	.9634	.0075	2.621	(1.294, 5.307)
DIAM2	1.2877	.0041	3.624	(1.503, 8.738)
1995				
M_CONC	.9053	.0496	2.473	(1.002, 6.104)
M-PVC	.9059	.0092	2.474	(1.251, 4.892)
DIAM1	1.0398	.0035	2.829	(1.407, 5.687)
LOOP610	-.7714	.0382	.462	(.223, .959)
AGE	-.0446	.0018	.956	(.930, .984)
1996				
M_GALV	-1.5123	.0248	.220	(.059, 825)
M_PVC	-1.6432	.0004	.193	(.078, 478)
DIAM3	1.0867	.0101	2.964	(1.295, 6.785)
LOOP610	1.1514	.0037	3.163	(1.455, 6.875)
1997				
M_GALV	.8288	.0308	2.290	(1.080, 4.859)
DIAM1	1.1752	.0003	3.239	(1.723, 6.088)
LOOP610	-1.0229	.0093	.360	(.166, .777)
1998				
WWO	.4434	.0121	1.558	(1.102, 2.203)
1999				
WWO	.8026	.0007	2.231	(1.400, 3.555)
T_HYDL	-2.1817	.0002	.119	(.036, .354)
T_FIRE	1.0970	.0193	2.995	(1.195, 7.508)
M_COP	-1.5383	.0181	.215	(.060, .769)
DIAM3	1.4137	.0136	4.111	(1.337, 12.640)
Sewer				
1992				
M_ABS	-1.1281	.0048	.324	(1.48, 7.08)
DIAM3	.9365	.0110	2.551	(1.239, 5.252)
LOOP610	1.5040	.0001	4.499	(2.296, 8.818)
1993				
T_LATL	1.3690	.0005	3.931	(1.810, 8.536)
M_CONC	.7649	.0454	2.149	(1.016, 4.545)
AGE	.0253	.0425	1.026	(1.001, 1.051)
1994				
SWO	.4465	.0357	1.563	(1.030, 2.371)
M_ABS	-1.4312	.0110	.239	(.079, .720)
1995				
1996				
T_SIPH	1.0304	.0184	2.802	(1.190, 6.597)
LOOP610	.8086	.0445	2.245	(1.020, 4.939)

TABLE 4.13: continued

Year	*Coefficients*	*(p-value)*	*Odds Ratio*	*Confidence Intervals*
1997				
SWO	.4362	.0023	1.547	(1.168, 2.048)
M_MRC	.6565	.0361	1.928	(1.043, 3.563)
DIAM3	-.6618	.0391	.516	(.275, .967)
1998				
T_COLL	1.6887	.0025	5.413	(1.810, 16.186)
M_CGMP	1.0592	.0417	2.884	(1.041, 7.993)
1999				
SWO	.5063	.0129	1.659	(1.113, 2.472)
M_ABS	-1.4385	.0062	.237	(.085, .664)
DIAM1	1.0053	.0206	2.733	(1.167, 6.401)

Water

Significant for five years in the simple model, with the addition of the decision rules variables water work orders is only positively significant for three (1992, 1998 & 1999). A look at the results shows that in 1992, water work orders, two types of material, larger size lines and lines inside of loop610 significantly predict the likelihood of a capital improvement project. All variables but concrete were positive. The strongest variables, as indicated by the Odds Ratio, are loop610 and steel. The weakest variable is the material concrete. Concrete also contributes inversely to the model. In 1993, galvanized iron, age of line and asbestos cement are the best predictors. Three variables were positively significant in 1994; galvanized iron and polyvinyl and Diam2 The fourth variable, main, was negatively significant. Galvanized iron was the strongest predictor followed by Diam2, polyvinyl and main. In 1995, the variable Diam1 has the strongest power, loop610 and age of line are the weakest. Loop610 and age of line contributed negatively to the model. In fact, according to the confidence intervals, these two variables, along with concrete, get close to making no significant contribution to the model. In the following year, we see the materials polyvinyl and loop610 are again significant, although polyvinyl has a negative relationship and loop610 is positive. These variables are accompanied by galvanized iron and Diam3. In 1997, the variables Diam3, galvanized iron and loop610 reappear. Water work orders were again positively significant in 1998 and 1999. In 1999, water work orders was joined by hydrant, fire line, copper and Diam3.

Although water work orders have not been significant in every year, they have been significant 37 percent of the time, therefore, we can reject the null hypothesis 3a. Water work orders have had a significant effect on predicting the likelihood of a capital improvement project when taken into consideration with technical factors.

Sewer

Sewer work orders remained significant in the same three years (1994, 1997 and 1999) that they were in the simple model. A review of the years shows the significant variables. In 1992, Diam3 and loop610 are all positively significant with the variable loop610 having the strongest degree of predictability. The variable acrylonitrile butadiniene styrene is also significant but its relationship is negative, and, according to the Odds Ratio, its contribution to the model is the weakest. In 1993, lateral, concrete and age of line were able to predict the likelihood of a capital improvement project.

The year 1994 is the first year we see the significance of sewer work orders, it is joined by the variable acrylonitrile butadiniene styrene. No variables were significant in 1995. In 1996, the predicting variables were siphon and loop610. Two new variables joined sewer work orders in predicting the likelihood of a capital improvement project in 1997. The following year we see that collector and corrugated metal pipe are significant. In 1998, sewer work orders and acrylonitrile butadiniene styrene are joined by Diam1.

Because sewer work orders was also significant at least 37 percent of the time, we reject null hypothesis 3b. When taken in consideration with technical factors, sewer work orders had a significant effect on the selection of sewer related capital improvement projects.

Adding the significant decision rules variables to the variables found to be significant in the previous models results in the following (Table 4.14):

TABLE 4.14: Cumulative List of Significant Variables with Decision Rules

Significant Variables:	*Water*	*Sewer*
	Water work orders (WWO)	Sewer work orders (SWO)
Theory: Class Bias	Percent nonwhite (NONWHITE)	Cost of housing (COST)
	Percent income (INC)	Percent nonwhite (NONWHITE)
	Cost of housing (COST)	Percent income (INC)
Theory: Decision Rules		
Significant Variables:		
	Main (MAIN)	Lateral (LATL)
	Hydrant (HYDL)	Siphon (SIPH)
	Fire line (FIRE)	Collector (COLL)
	Concrete (CONC)	Corrugated metal (CGMP)
	Steel (STL)	Asbestos cement (AC)
	Acrylonitrile (ABS)	Concrete (CONC)
	Galvanized (GALV)	Monolithic reinforced pipe (MRC)
	Polyvinyl (PVC)	Diam1 (DIAM1)
	Copper (COP)	Diam3 (DIAM3)
	Diam1 (DIAM1)	Loop610 (LOOP610)
	Diam2 (DIAM2)	Age of line (AGE)
	Diam3 (DIAM3)	
	Diam5 (DIAM5)	
	Loop610 (LOOP610)	
	Age of line (AGE)	

Model Fit

The addition of the water decision rules variables is a better fit over the intercept only model for every year (see Appendix D). As calculated by the Likelihood Ratio, the range of improvement is between 6.8 in 1998 and 85.9 in 1992. In every year but 1998, the Likelihood Ratio and Score values indicate that the model significantly improved by adding decision rules variables. In all but one year, 1998, the Decision Rules model is an improvement over the simple model. In that year, the results of the two multivariate analysis are the same.

The addition of the decision rules variables to the sewer model resulted in a decrease in the –2 Log Likelihood values in seven of the eight years. The range of improvements were a low of 8.4 in 1996 to a high of 33.5 in 1992. In these years, the improvements were shown to be significant. In 1995, no variables were significant thus no change in the –2 Log L. A comparison of this model to the simple model show that the Decision Rules Model seems to be a better in every year except 1995.

Political Influence

Univariate Analysis

Analyzing the political influence model differed from the previous models. Political data was only available by precincts. Few census tracts and voter precinct share the same boundaries. Seventeen percent (17 percent) of the census tracts were perfectly aligned with precinct borders, the remaining precincts were divided between tracts.

Adjustments were made and the number of census tracts studied for this model is 64. That number represents those precinct boundaries that closely match census boundaries.

There are five variables representing the political model, stable (STABLE), percent vote (VOTE), percent active (ACTIVE), tenure (TEN), and DIST. The descriptive statistics are shown in Table 4.15.

Percent active is the number of work orders per census population. The range of values for this variable is 0 to 13.04. In general, less than 13 percent of the census tract population contacts the city to complain. Note that the maximum increases steadily over the eight-year period. This may be due to an increasing awareness of the Customer Response Center. The values of percent active were dichotomized based on the median value.

Percent vote represents the number of registered voters per census tract population. Notice that the yearly maximum often exceeds the population. This is due to the nature of raw data and characteristics of voters. The records are updated every two years. Oftentimes, the voter has moved but has yet to notify Harris County. Also, the number of voters increase but the denominator is based on census information that is static as of 1990. To accommodate this, the values for percent vote were dichotomized based on the median value.

Tenure is the number of years the council member has been in office. The range is 1 to 6. Prior to 1993, there were no term limits so years served over six were classified as six. In 1992, of the eight council members, six (or 75 percent) had served six or more years. In DistE, the council member was serving his 28^{th} year. As expected, the mean years in office decreased with 64 percent serving their first year. Tenure then increased each year only to drop in 1998 when 54 percent of the council members were replaced.

TABLE 4.15: Description of Political Bias Variables *(*n=64*)*

Variable	*N*	*Min*	*Max*	*Mean*	*Median*	*Std. Dev*
DIST A	375	0	1.00	.1146	0	.3190
DIST B	375	0	1.00	.1253	0	.3315
DIST C	375	0	1.00	.1066	0	.3091
DIST D	375	0	1.00	.1386	0	.3460
DIST E	375	0	1.00	.0960	0	.2949
DIST F	375	0	1.00	.0613	0	.2402
DIST G	375	0	1.00	.1040	0	.3056
DIST H	375	0	1.00	.1466	0	.3542
DIST I	375	0	1.00	.1066	0	.3091
ACTIVE 92	375	0	5.19	1.057	.8700	.0651
ACTIVE 93	375	0	8.82	1.645	1.445	1.542
ACTIVE 94	375	0	9.05	2.789	2.535	2.117
ACTIVE 95	375	0	8.14	2.888	2.815	2.093
ACTIVE 96	375	0	9.08	2.763	2.475	2.017
ACTIVE 97	375	.0100	13.04	3.331	3.100	2.624
ACTIVE 98	375	.0400	11.08	2.452	2.225	1.958
ACTIVE 99	375	.1900	.19	3.687	3.250	2.692
TEN 92	375	2.0	6.0	4.986	6.00	1.742
TEN 93	375	1.0	6.0	2.040	1.0	1.614
TEN 94	375	2.0	6.0	3.040	2.0	1.614
TEN 95	375	1.0	5.0	2.578	3.0	1.284
TEN 96	375	2.0	6.0	3.578	4.0	1.284
TEN 97	375	1.0	5.0	3.858	5.0	1.284
TEN 98	375	2.0	6.0	4.858	6.0	1.379
TEN 99	375	1.0	6.0	2.594	1.0	1.840
STABLE	64	0	2.00	.3906	0	.7478
VOTE 92	64	1.39	142.22	27.13	20.235	26.873
VOTE 93	64	1.48	157.64	31.019	23.135	30.577
VOTE 94	64	1.50	169.75	32.466	24.690	32.083
VOTE 95	64	1.53	190.43	34.420	26.07	34.215
VOTE 96	64	1.57	210.380	37.528	28.610	37.073
VOTE 97	64	1.70	236.13	41.55	31.185	40.400
VOTE 98	64	1.68	156.34	43.905	32.590	42.886
VOTE 99	64	1.63	238.160	41.177	31.095	40.401

Houston is divided into nine council districts (A-I). DistH is comprised of the most census tracts (15 percent) while DistE is comprised of the least (10 percent).

The variable stable represents those precincts that had not been redistricted during the study period. Less than 25 percent of the precincts had not been redistricted. The values associated with stable range from 0 to 3. The value 0 indicates there have been changes, 1 represents a stable tract, 2 indicates that the census tract is comprised of two or more precincts where at least one of them is stable. See Appendix A for description of the political influence variables after adjustments were made.

Bivariate Analysis

Associations between work orders and political bias independent variables. Table 4.16 shows the results of the relationship between work orders and the independent variables. Because it is calculated using work orders in the denominator, the relationship between percent active and water work orders is always significant. The Cramer's V statistic indicates that the relationship is stronger in the early years and decreases over time.

Among the districts, DistA was positively significant in 1994 while DistI was positively significant in 1992. DistE displayed the longest significant relationship with water work orders. It was positively related in 1992 through 1994. DistF and DistG were each positively significantly related to work orders in 1999 and 1998, respectively. The final district to have a significant relationship with work orders was DistI in 1992 and 1993.

TABLE 4.16: Bivariate Political and Water Work Orders

	WWO 92	*WWO 93*	*WWO 94*	*WWO 95*	*WWO 96*	*WWO 97*	*WWO 98*	*WWO 99*
Water								
ACTIVE	C=.6157 (.0001)	C=.5871 (.0001)	C=.5990 (.0001)	C=.4979 (.0001)	C=.4377 (.0001)	C=.3782 (.0001)	C=.2592 (.0001)	C=.3993 (.0001)
TEN	B=-.0082 (.8616)	B=.1175 (.0101)	B=.1197 (.0088)	B=-.113 (.0125)	B=-.058 (.2012)	B=-.011 (.8066)	B=.0644 (.1567)	B=-.0222 (.6249)
DISTA	K=6.8006 (.0785)	K=2.3061 (.5114)	K=7.9712 (.0466)	K=6.4922 (.0900)	K=7.3396 (.0618)	K=1.9384 (.5853)	K=4.0546 (.2556)	K=3.6670 (.2957)
DISTB	K=13.0481 (.0045)	K=4.8547 (.1828)	K=6.0409 (.1096)	K=1.8308 (.6082)	K=7.6188 (.0546)	K=5.2373 (.1552)	K=2.3765 (.4980)	K=2.3448 (.5040)
DISTC	K=3.0525 (.3836)	K=3.1869 (.3637)	K=4.5393 (.2088)	K=1.7436 (.6273)	K=1.6679 (.6441)	K=2.8821 (.4102)	K=1.9345 (.5861)	K=1.0250 (.7952)
DISTD	K=2.6368 (.4511)	K=2.2020 (.5315)	K=7.3228 (.0623)	K=4.9224 (.1776)	K=6.3231 (.0969)	K=3.0312 (.3868)	K=.3275 (.9548)	K=3.2489 (.3548)
DISTE	K=18.5267 (.0003)	K=22.7197 (.0001)	K=17.3540 (.0006)	K=7.7642 (.0511)	K=7.3457 (.0617)	K=2.4980 (.4757)	K=4.7653 (.1898)	K=4.1657 (.2441)
DISTF	K=3.9855 (.2630)	K=1.5153 (.6787)	K=.5556 (.9065)	K=.4069 (.9388)	K=.2234 (.9737)	K=3.1583 (.3679)	K=3.7472 (.2901)	K=8.8421 .0315
DISTG	K=.9272 (.8189)	K=3.4714 (.3245)	K=5.2042 (.1574)	K=5.4956 (.1389)	K=1.4430 (.6955)	K=1.7211 (.6323)	K=8.0301 (.0454)	K=6.9645 (.0730)
DISTH	K=1.3307 (.7218)	K=3.2934 (.3486)	K=2.7317 (.4349)	K=3.1976 (.3622)	K=1.9043 (.5925)	K=3.7196 (.2934)	K=5.6255 (.1313)	K=1.7428 (.6275)
DISTI	K=13.2895 (.0041)	K=7.9893 (.0462)	K=5.5561 (.1353)	K=6.1014 (.1068)	K=3.3315 (.3433)	K=4.1173 (.2491)	K=1.2125 (.7500)	K=1.0997 (.7771)
STABLE	B=.1093 (.0201)	B=.0926 (.0491)	B=.0865 (.0660)	B=.1077 (.0220)	B=.0231 (.6234)	B=.0913 (.0524)	B=.0943 (.0449)	B=.0160 (.0242)
VOTE	B= .1401 (.183)	B=.1422 (.1770)	B=.1336 (.2044)	B=.1985 (.0591)	B=.2141 (.0426)	B=.2058 (.0522)	B=.1526 (.1493)	B=.1477 (.1617)
	SWO92	*SWO93*	*SWO94*	*SWO95*	*SWO96*	*SWO97*	*SWO98*	*SWO99*
Sewer								
ACTIVE	C=.6671 (.0001)	C=.6581 (.0001)	C=.5926 (.0001)	C=.5550 (.0001)	C=.5686 (.0001)	C=.5463 (.0001)	C=.5308 (.0001)	C=.5674 (.0001)
TEN	.B=-.154 (0001)	B=.255 (.0001)	B=.229 (.0001)	B=-.220 (.0001)	B=-.219 (.0001)	B=-.135 (.0028)	B=-.055 (.2225)	B=.1409 (.0020)
DISTA	K=5.6833 (.1281)	K=8.6662 (.0341)	K=9.0566 (.0285)	K=4.3088 (.2300)	K=4.2972 (.2311)	K=4.0669 (.2543)	K=2.1913 (.5337)	K=.7469 (.8621)
DISTB	K=5.7823 (.1227)	K=8.5150 (.0365)	K=7.8517 (.0492)	K=3.2065 (.3609)	K=8.5268 (.0363)	K=2.7603 (.4301)	K=.6707 (.8801)	K=.7878 (.8524)
DISTC	K=.5735 (.9025)	K=2.0383 (.5645)	K=4.0250 (.2588)	K=3.9772 (.2639)	K=4.5099 (.2114)		K=7.0617 (.0700)	K=5.8154 (.1209)
DISTD	K=20.9128 (.0001)	K=23.3849 (.0001)	K=29.3743 (.0001)	K=26.6685 (.0001)	K=28.862 (.0001)	K=30.6584 (.0001)	K=9.7985 (.0204)	K=13.4837 (.0031)
DISTE	K=16.854 (.0008)	K=8.9789 (.0300)	K=15.4399 (.0015)	K=13.3732 (.0039	K=13.551 (.0036)	K=7.9746 (.0465)	K=12.182 (.0068)	K=13.0641 (.0045)
DISTF	K=2.6177 (.4544)	K=2.9144 (.4050)	K=.8046 (.8484)	K=1.2244 (.7471)	K=1.4258 (.6995)	K=.3825 (.9438)	K=3.5927 (.3089)	K=3.9893 (.2626)
DISTG	K=12.0359 (.0073)	K=14.2730 (.0026)	K=15.1450 (.0017)	K=15.6708 (.0013)	K=19.277 (.0002)	K=15.1732 (.0017)	K=8.8459 (.0314)	K=8.6916 (.0337)
DISTH	K=14.5430 (.0023)	K=10.6147 (.0140)	K=23.0609 (.0001)	K=17.4725 (.0006)	K=7.2005 (.0658)	K=8.2579 (.0410)	K=7.3887 (.0605)	K=6.4751 (.0906)
DISTI	K=13.6512 (.0034)	K=21.3347 (.0001)	K=14.9056 (.0019)	K=17.3568 (.0006)	K=10.908 (.0122)	K=15.9283 (.0012)	K=8.8842 (.0309)	K=5.4420 (.1422)
STABLE	B=.1229 (.0092)	B=.1167 (.0132)	B=.1315 (.0053)	B=.1441 (.0022)	B=.0955 (.0424)	B=.1195 (.0110)	B=.1535 (.0011)	B=.1225 (.0093)
VOTE	B=.0293 (.7821)	B=.0994 (.3487)	B=.0339 (.7490)	B=.0722 (.4947)	B=.2169 (.0402)	B=1731 (.1024)	B=1400 (.1896)	B=.1836 (.0844)

= Indicates significance at p=<.05

C=chi-square/Cramer's V
B=Kendall tau b
K=Kruska-Wallis

Tenure has a significant, albeit weak, relationship with water work orders between 1993 and 1995. In 1993 the relationship is positive, in 1995 the relationship is negative. The variables stable and water work orders exhibit a significant relationship in five of the eight years. These relationships are not strong but are consistently positive. Percent vote was only significantly positive in 1996.

The level of association between sewer work orders (SWO) and percent active is significant in every year. The relationship between tenure and sewer work orders is significant for seven of the eight years studied. The direction of the relationship varies between years. In 1992 and between 1995 and 1997, the relationship was negative in 1993, 1994 and 1999 the relationship was positive. The reason for the change in signs is unclear.

The variable stable has a significant relationship with sewer work orders during the entire study period. During each of the years, the relationship was positive. As was the case with water, the variable percent vote was only significant in 1996. The relationship was positive. Surprisingly, DistD and DistE and DistG were positively significant with sewer work orders for all eight years. DistI was positively significant six of the eight years, DistH for five. It seems that sewer work orders are more evenly distributed across the districts over the years than water work orders.

Associations among political variables. The results of the analysis among the political variables can be found in Appendix E. Beginning with water, tenure was positively significantly related with all districts in every year. Tenure was also positive and significant related with percent active in 1998. The variables percent active and percent vote were positive and significantly related every year except 1996-1998. Percent active and DistH displayed a significant relationship in 1995, 1996-1998. The only other significant relationship with percent active was the positive relationship with DistD in 1997 and the positive relationships with DistD, DistE and DistH in 1998. Percent vote was only significant with DistH. This positive relationship occurred in 1997 and 1998.

Among the sewer variables, the results were similar. Tenure was significantly and positively related to every district. Tenure was also significantly related to percent active. In 1992, the relationship was negative; in 1992 and 1993 it was positive. The variables percent active and percent vote were significant four of the eight years. In each of the significant years, the relationship is positive. Percent active and stable were significantly and positively related in 1998 and 1999. Only two districts were significantly related to percent active. DistD was positive in 1992, 1993 and 1995. DistG was positive in 1995 and 1997 through 1999.

Associations between political variables and dependent variables. As reflected in Table 4.17, few of the political variables have a significant relationship with the dependent variable. Beginning with water, the results of the chi-square analysis indicated that there is a significantly positive relationship between percent active and capital improvement project in 1992, 1995 and 1998. The Cramer's V value indicates that the relationship is relatively weak. Stable was significant and positive in 1992 and 1995. The years 1992, 1994 and 1997 were the only years where council districts were significantly related to water capital improvement projects. In 1992, DistA, DistB and DistH were most likely to receive a capital improvement project. In 1994, it was DistA, DistB, DistC and DistH. By 1997, only DistG was significantly, albeit negatively, related to the dependent variable.

TABLE 4.17: Bivariate Political Independent and Dependent Variable

	CIP 92	*CIP 93*	*CIP 94*	*CIP 95*	*CIP 96*	*CIP 97*	*CIP 98*	*CIP 99*
Water								
ACTIVE	L=.7200 (.0081)	L=.5967 (.1033)	L=.5427 (.0834)	L=.6366 (.0357)	L=.3038 (.4146)	L=.3692 (.2066)	L=.9459 (.0219)	L=-.3861 (.3417)
TEN	L=.0470 (.5475)	L=-.0173 (.8775)	L=-.0274 (.7785)	L=-.0164 (.8864)	L=.0717 (.6161)	L=-.2284 (.0216)	L=.1719 (.2579)	L=-.1121 (.3276)
DISTA	L=-1.233 (.0444)	L=-.0041 (.9941)	L=.8227 (.0393)	L=-.2744 (.5834)	L=.3963 (.4428)	L=.6334 (.1082)	L=-1.391 (.1769)	L=-1.272 (.2178)
DISTB	L=-.1475 (.7207)	L=.4113 (.3899)	L=-2.064 (.0435)	L=.5565 (.1552)	L=-.8175 (.2742)	L=-.2062 (.6563)	L=-.7419 (.3220)	L=.7606 (.1220)
DISTC	L=-1.595 (.0307)	L=.3732 (.4686)	L=-1.131 (.1274)	L=-.4568 (.4053)	L=-.6253 (.4046)	L= -.2287 (.6485)	L=-.0780 (.9019)	L=-.4267 (.5718)
DISTD	L= .4211 (.2310)	L=-1.791 (.0807)	L=-.6639 (.2228)	L=-1.118 (.0684)	L=-.4769 (.4460)	L= .2063 (.6052)	L=-.0493 (.9298)	L= .0834 (.8824)
DISTE	L=-.1707 (.7153)	L=-.6061 (.4192)	L=-.5464 (.3809)	L=-.0465 (.9268)	L=-.5011 (.5054)	L=-.0934 (.8533)	L=-.4256 (.5724)	L=-1.067 (.3022)
DISTF	L=.4436 (.3695)	L=-.8551 (.4101)	L=-1.245 (.2286)	L=.5410 (.3060)	L=.8907 (.1274)	L=.1944 (.7331)	L=.9712 (.0978)	L=.7179 (.2725)
DISTG	L=-.7790 (.1530)	L=-.7005 (.3495)	L=-1.845 (.0717)	L=-.1492 (.7668)	L=-.1253 (.8427)	L=-2.005 (.0500)	L= .6040 (.2474)	L=-1.159 (.2620)
DISTH	L= 1.103 (.0005)	L= .7941 (.0575)	L=2.095 (.0001)	L=.0138 (.9734)	L=.3258 (.4948)	L=-.2149 (.6199)	L=-.1200 (.8297)	L=.5559 (.2546)
DISTI	L=.2456 (.5431)	L=.3732 (.4686)	L=-.3336 (.5447)	L= .6265 (.1276)	L=.4884 (.3463)	L=.5761 (.1600)	L=.5718 (.2727)	L=.0494 (.9381)
STABLE	L=.7051 (.0238)	L=-10.29 (.9650)	L=-.3175 (.5734)	L=.8024 (.0111)	L=-10.28 (.9665)	L=-.1459 (.7555)	L=.2593 (.5791)	L=-.3613 (.6442)
VOTE	L=.1755 (.5779)	L=.1632 (.6380)	L=-.2484 (.6123)	L=-.4806 (.1306)	L=-.5788 (.3276)	L=-.1323 (.7537)	L=-.0410 (.9273)	L=-.1094 (.7575)
Sewer								
ACTIVE	L=.0162 (.9594)	L=-.0101 (.9773)	L=.6968 (.1220)	L=.2065 (.6000)	L=.3511 (.3761)	L=.0431 (.8872)	L=-.2297 (.5816)	L=.1143 (.7826)
TEN	L=.0135 (.8838)	L=-.0173 (.8775)	L=.0983 (.4191)	L=.1802 (.2344)	L=-.0047 (.9753)	L=-.2150 (.0388)	L= .2167 (.2043)	L=-.1327 (.2702)
DISTA	L=-1.858 (.0697)	L=-.0041 (.9941)	L= 1.100 (.0296)	L= .5697 (.2756)	L=-.0823 (.8967)	L=.4563 (.2832)	L=-1.185 (.2514)	L=-1.185 (.2514)
DISTB	L=.2895 (.5148)	L=.4113 (.3899)	L=-12.24 (.9597)	L= .7108 (.1466)	L=-.6612 (.3787)	L=-.8972 (.1460)	L=-.5287 (.4737)	L=.8673 (.0809)
DISTC	L=-1.028 (.1666)	L=.3732 (.4686)	L=-1.007 (.3308)	L=.0054 (.9932)	L=-.4692 (.5336)	L=-.3589 (.5143)	L=.1429 (.8232)	L=-1.101 (.2869)
DISTD	L= .6725 (.0885)	L=-1.791 (.0807)	L=.2880 (.6143)	L=-1.537 (.1354)	L=-.3146 (.6176)	L=.3648 (.3652)	L=-.1771 (.7801)	L=-.1771 (.7801)
DISTE	L=-.4418 (.4797)	L=-.6061 (.4192)	L=.3716 (.5649)	L=-.3444 (.6485)	L=-.3444 (.6485)	L=-.2278 (.6806)	L=-.2129 (.7791)	L=-.9802 (.3440)
DISTF	L= .7732 (.1466)	L=-.8551 (.4101)	L=-.3830 (.7142)	L=-.6030 (.5627)	L= 1.056 (.0729)	L=.3372 (.5557)	L=1.1995 (.0436)	L= .8112 (.2170)
DISTG	L=-13.33 (.9667)	L=-.7005 (.3495)	L=-.9786 (.3451)	L=.0364 (.9543)	L=.0364 (.9543)	L=-1.869 (.0681)	L=.8433 (.1126)	L=-1.072 (.3000)
DISTH	L= .5931 (.1311)	L= .7641 (.0575)	L=.5175 (.3271)	L=-.3845 (.5411)	L=.2558 (.6204)	L=.1193 (.7748)	L=-.7189 (.3392)	L=.6626 (.1789)
DISTI	L= .5055 (.2617)	L=.3732 (.4686)	L=-.2394 (.7526)	L=.3645 (.5211)	L=.3645 (.5211)	L=.7333 (.0763)	L=.1429 (.8232)	L=.1429 (.8232)
STABLE	L= .6073 (.0753)	L=-10.29 (.9650)	L=-10.23 (.9715)	L=.7951 (.0284)	L=-10.26 (.9686)	L=-11.37 (.9723)	L=.3731 (.4257)	L=-.3128 (.6887)
VOTE	L=.0000 (.1735)	L=-.0001 (.6587)	L=-.0005 (.7518)	L=-.0009 (.2295)	L=-.0007 (.3802)	L=-.0006 (.4846)	L=.0001 (.7560)	L=-.0002 (.5982)

[shaded] = Indicates significance at p=<.05

L=Logistic Regression

For sewer, the variable stable is significant and positive in 1995. Tenure had a negatively significant relationship with sewer capital improvement projects in 1997. Only two of the nine districts were likely to receive a sewer capital improvement project. DistA and DistE were significantly and positively related for one year; DistA in 1994 and DistF in 1998.

Multivariate Analysis

The results of the multivariate analysis are shown in Table 4.18. The decision was made to omit percent active and percent vote from the multivariate analysis. Percent active was omitted from the multivariate analysis due to its strong relationship with work orders. Because percent active is calculated using work orders, the presence of both variables in the model would be repetitive.

Percent vote's presence in the model compromised the validity of parameters and model fit estimates. This occurred because the variable is not present for every census tract. Recall that there are 64 tracts that contain values for the variable percent vote. That is less than a fifth of the study population. Therefore, the final multivariate analysis for the political model includes the nine districts, tenure, work orders and stable.

Water work orders from DistH significantly predicted the likelihood of a capital improvement project in 1992. The Odds Ratio for those variables indicate that DistH is the stronger predictor. The next year with a significant variable is 1994 with the variables DistH and DistA. In 1995, stable is the significant variable. In 1997, work orders is again significant. DistG has a negative effect on capital improvement project selection. In the final two years of the study, water work orders is the only variable that significantly predicts the likelihood of a capital improvement project. In those two years, the strength of the variable is similar.

Based on the results of the multivariate analysis, we can reject null hypothesis 4a. Water work orders, when analyzed with political variables has significantly affected the selection of capital improvement projects. However, we have to acknowledge that water work orders was significant only 50 percent of the time.

TABLE 4.18: Political Model Multivariate Analysis

	Estimate	*(p-value)*	*Odds Ratio*	*Confidence Intervals*
Water				
1992				
WWO	.7216	.0001	2.058	(1.567, 2.702)
DISTH	1.1526	.0007	3.166	(1.626, 6.165)
1993				
1994				
DISTA	1.5980	.0003	4.943	(2.073, 11.789)
DISTH	2.4617	.0001	11.725	(5.616, 24.497)
1995				
STABLE	.8024	.0111	2.231	(1.201, 4.143)
1996				
1997				
WWO	.3434	.0116	1.410	(1.080, 1.841)
DISTG	-2.0769	.0429	.125	(.017, .936)
1998				
WWO	.4434	.0121	1.558	(1.102, 2.203)
1999				
WWO	.5359	.0069	1.709	(1.159, 2.521)
Sewer				
1992				
1993				
1994				
SWO	.5190	.0178	1.680	(1.094, 2.581)
DISTA	1.2523	.0160	3.498	(1.263, 9.693)
1995				
STABLE	.7951	.0284	2.215	(1.088, 4.509)
1996				
1997				
SWO	.4201	.0025	1.522	(1.159, 2.000)
1998				
DISTF	1.1995	.0436	3.318	(1.035, 10.638)
1999				
SWO	.5268	.0078	1.694	(1.148, 2.497)

For sewer work orders, the results are simple. There were only three years when variables significantly predicted the likelihood of a capital improvement project (1994, 1997 and 1998). The strength of the relationship between sewer work orders and the dependent variable is relatively consistent. There is less than a .15 difference in the Odds Ratios with the strongest relationship in 1999 and the weakest in 1997. In 1994, sewer work orders is accompanied by the stronger Predictor DistA. In 1995, the significant variable is stable. In 1998, the variable is DistF.

In addition to sewer work orders, in 1994 DistA contributed to the prediction of the dependent variable. As calculated by the Odds Ratio, its contribution is three times stronger than sewer work orders. In 1998, DistF is the significant predictor. Based on the results of the multivariate analysis, we can reject the null hypothesis 4b. Sewer work orders, when analyzed with political variables has significantly affected the selection of capital improvement projects.

Adding the significant variables that represent the Political Influence theory to the other variables produces the following list of variables we may expect to see in the full model (Table 4.19).

TABLE 4.19: Cumulative List of Significant Variables with Political Influence

Significant Variables:	*Water*	*Sewer*
	Water work orders (WWO)	Sewer work orders (SWO)
Theory: Class Bias	Percent nonwhite (NONWHITE)	Cost of housing (COST)
	Percent income (INC)	Percent nonwhite (NONWHITE)
	Cost of housing (COST)	Percent income (INC)
Theory: Decision Rules		
Significant Variables:	Main (MAIN)	Lateral (LATL)
	Hydrant (HYDL)	Siphon (SIPH)
	Fire line (FIRE)	Collector (COLL)
	Concrete (CONC)	Corrugated metal (CGMP)
	Steel (STL)	Asbestos cement (AC)
	Acrylonitrile (ABS)	Concrete (CONC)
	Galvanized (GALV)	Monolithic reinforced pipe (MRC)
	Polyvinyl (PVC)	Diam1 (DIAM1)
	Copper (COP)	Diam3 (DIAM3)
	Diam1 (DIAM1)	Loop610 (LOOP610)
	Diam2 (DIAM2)	Age of line (AGE)
	Diam3 (DIAM3)	
	Diam5 (DIAM5)	
	Loop610 (LOOP610)	
	Age of line (AGE)	
Theory: Political Influence		
Significant Variables:	DistA (DISTA)	DistA (DISTA)
	DistG (DISTG)	DistE (DISTE)
	DistH (DISTH)	Stable (STABLE)
	Stable (STABLE)	

Model Fit

The addition of the political influence variables to the water model proved to be an improvement. A look at the Likelihood Ratios and Score values, in Table 4.20, indicate that in the years that we saw significant variables, we also experienced a significant model fit. Comparing the fit of the political model with the simple model, we see that the political bias model is an improvement. However, in 1993, the improvement is by a mere 5.377 and in 1996, there is no improvement. Given this small difference, it is correct to expect that there isn't a significant difference in each year. In fact, the years where the political model is a significantly better fit is in 1992, 1997, 1998 and 1999. Is the political model an improvement over the simple model? Yes, in some years, specifically in 1992, 1994, 1995 and 1997. The –2 Log Likelihood values were the same in 1998 and 1999 where the multivariate results were the same. In the remaining years, there were no significant variables for the Political model.

TABLE 4.20: Political Model Fit Comparisons (n=375)

	2-Log Likelihood		*Likelihood Ratio*		*Score Value*	
	Intercept Only	*With Covariates*	*chi-Square*	*p-value*	*chi-Square*	*p-value*
Water						
1992	363.941	321.284	42.656	.0001	41.3119	.0001
1993	232.637	227.259	5.377	.0204	3.9175	.0478
1994	290.739	243.712	47.027	.0001	56.9163	.0001
1995	309.119	303.457	5.6618	.0173	7.6683	.0056
1996	218.704					
1997	316.163	302.218	13.9454	.0009	11.6181	.0030
1998	209.077	202.221	6.8556	.0088	6.6573	.0099
1999	194.086	185.930	8.1568	.0043	7.8526	.0051
Sewer						
1992	275.194					
1993	232.637					
1994	172.965	162.643	10.322	.0057	10.8384	.0044
1995	199.160	195.376	3.7839	.0517	5.7063	.0169
1996	199.160					
1997	294.605	284.760	9.746	.0018	9.5296	.0020
1998	183.698	180.378	3.3198	.0685	4.5294	.0333
1999	183.698	175.639	8.0581	.0045	7.6989	.0055

Sewer results resemble water. There is a model improvement when we add the political variables to the intercept-only model in five of the eight years. The range in difference is a low of 3.31 in 1998 and a high of 10.3 in 1994. In the remaining years, no significant variables were detected. A comparison with the simple work order model reveals that the political influence is a better fit but only in 1994.

The simple and three theory-based models indicate that for both water and sewer, work orders retained some power of predictability. However, the years and the degree varied. The next step, to be addressed, in Chapter V, is to determine if work orders, when taken into consideration with all the variables discussed in this chapter, have a significant effect on the selection of capital improvement projects. A discussion of the findings from this chapter and Chapter V will be in Chapter VI.

CHAPTER V

FULL MODEL ANALYSIS

Introduction

This chapter will discuss the interaction between variables outside of their theoretical boundaries. It will then present the results of the bivariate and multivariate analysis; determining which variables, if any, have a significant effect on the selection of capital improvement projects. This chapter concludes by evaluating the model fit and discussing which model best fits the data.

Bivariate Analysis

Water

As was done with the previous bivariate analysis, different tests were run based on the variable types. The results of the analysis are in Appendix F.

Decision rules and class bias variables. Because the decision rules variables are comprised primarily of technically oriented variables, one would not expect there to be many statistically significant relationships between decision rules and class bias variables. For the most part, that expectation holds true. Only the material concrete was positive and significantly related to percent ownership. Line size showed a few more significant interactions. The variable Diam3 was significantly yet negatively related with housing cost. Diam5 is positive and significantly related to percent nonwhite. The variable loop610 was shown to be significantly related to housing cost (negative) and INC (positive). According to the p-values and direction of the relationship, it would seem that higher income, lower cost census tracts are located within the central city. The variable age of line was significantly related to percent nonwhite, housing cost and income. This indicates that tracts with older lines are comprised of higher percentages of non-whites. Via the direction of the relationship with housing cost and income, higher housing costs and people with higher incomes are associated with those tracts with newer or newly replaced lines.

Class bias and political variables. Few statistically significant relationships existed between class bias and political variables. In two years, 1995 and 1997, percent active had a positive relationship with percent nonwhite. In those two years, which are election years, higher percentages of nonwhites are associated with higher percentages of phone calls.

In 1993, 1994 and again in 1999 tenure and percent nonwhite were significantly and negatively related. The remainder of the time, the significant relationships between the variables were positive. Housing cost and tenure were also significant in every year except in 1997 and 1998. The nature of the relationships vary between the years. While it is positive a majority of the time, the relationship is negative in 1995 and 1996. Reasons for these sign changes are unclear. The relationships between income and tenure almost mirror the relationship between housing cost and tenure, except in 1994.

There were many statistically significant relationships between council districts and the class bias variables. Council DistA had a positive relationship with housing cost and DistB was significant with high percentages of percent nonwhite in high housing cost, high income census tracts. DistD was negatively significant with housing cost while DistF was significant with percent nonwhite and percent ownership. Both DistG and DistI were significantly related with percent nonwhite but in low cost, high income census tracts. DistH was significantly related to housing cost.

Political and decision rules variables. Stable was significant and positively related with type main lines, materials concrete and ductile iron and sizes Diam1 and Diam2. These are the primary lines, materials and sizes in the 64 census tracts where the variable was measured.

Percent vote was significant with a number of variables throughout the study period though the reasons are unclear. Percent vote showed a positive, significant relationship with line type hydrant and material galvanized iron. Those relationships were significant for each year. Material cast iron was positively significant in every year except 1996. Line sizes, Diam2 and percent vote were positive and significantly related in all eight years. Diam4 was significant for every year except 1999. That relationship was positive for all seven years. Age of line and percent vote are only significant in 1992. That relationship is negative indicating that low voter registration occurs in the older neighborhoods. Percent vote's significant and consistently positive relationship with loop610 during the entire study period can be attributed to the fact that more than half of the study areas is located within the loop.

The variable percent active was significantly related in all eight years to line types main and hydrant; materials cast iron, polyvinyl; and sizes Diam1, Diam2 and Diam3. In each of those years, the relationships were positive except for the relationship between hydrant and percent active in 1999. The materials copper (1993-1995, 1997 and 1998), and prestressed concrete (1998) were significant and positively related. The material steel and percent active were significant but negatively related in 1993 and 1998.

There weren't many significant relationships between tenure and the decision rules variables. Only line type main was positively significant in 1999. Tenure was significantly related to the materials cast iron between 1992 and 1994; ductile iron in 1995 and 1996; galvanized iron between 1993 and 1996; prestressed concrete in 1995 and 1996 and polyvinyl in 1995, 1996 and 1999. Each of those relationships were positive. The smallest lines size (Diam1) was significant and positively related to tenure in 1993 and 1994. The largest line size (Diam5) was significantly related to tenure in 1992 and 1996. The relationships were positive.

In evaluating the relationship with the council districts, no two districts were alike. Among the significant relationships, DistA was positively related with line types collector, line material cast iron and age of line. The remaining relationships, main, galvanized iron, Diam5 and loop610 were negative. DistB had a negative relationship with material polyvinyl and sizes Diam2 and Diam3. The only positive relationship with DistB was with Diam5. All significant relationships between DistC and the decision rules variables were negative: cast iron, galvanized iron and Diam1. DistD had a negative relationship with line type fire and a positive relationship with both loop610 and age of line.

DistE had the largest number of significant variables. Positive relationships existed with line types main and hydrant, Diam2, loop610 and age of line. Negative relationships were with materials cast iron, copper, galvanized iron and Diam1. The positive relationships with DistF include line type fire line, material steel cylinder and Diam5. The negative relationships were with materials copper, galvanized iron, Diam1 and loop610. Except for the positive relationship with age of line, all other variables significantly related to DistG were negative. This includes the materials concrete and galvanized iron and sizes Diam1 and Diam5. Conversely, all the relationships with DistH were positive except for the relationship with hydrant lines. All the significant relationships with DistI were positive. This included materials galvanized iron and polyvinyl, sizes Diam, Diam3 and Diam5, loop610 and age of line.

Sewer

The sewer bivariate discussion will compare the decision rules variables with the class bias and political variables. The results of the bivariate analysis are in Appendix G.

<u>Decision rules with class bias variables</u>. An analysis of the relationship between the variables representing these two theories shows that among line types, collector is significantly related to lower housing cost and higher percentages of nonwhites. Lateral lines are in lower cost, higher income census tracts and FM and stub lines have an inverse significant relationship with percent ownership.

Five types of line materials were found to be significant and positively related to percent nonwhite: acrylonitrile butadiniene styrene, cast iron, concrete, ductile iron and polyvinyl. Among the variables significantly associated with housing cost, all demonstrated a negative relationship. The variable income was significant and positively associated with materials acrylonitrile butadiniene styrene, cast iron, concrete and polyvinyl.

Among the line sizes, Diam1 was found to be significant and positively related to income and negatively related to housing cost. Diam3 was significant and positively related to percent nonwhite. The largest line size (Diam4) was significantly related to all class bias variables except percent ownership. The relationship was negative with housing cost and positive with percent nonwhite and income.

The variables loop610 and age of line exhibited a significant relationship with the same variables. The significant relationships were positive between loop610 and percent nonwhite and between loop610 and income. The negative relationships were between loop610, age of line and housing cost and between age of line and income.

<u>Class bias and political variables</u>. Class and political variables are not water/sewer specific. Therefore, the bivariate results are the same that were discussed in water. The exception is the political variable percent active. The only significant relationship we see between percent active and the class bias variables is with housing cost in 1993 through 1999. These relationships are negative which may indicate that lower cost neighborhoods make more calls as a percentage of the population.

<u>Political and decision rules variables</u>. The variable stable exhibited a positive significant relationship with line types casing and overflow. Among the remaining variables, only the material ductile iron and line size Diam4 were significant and positive. The variable percent vote was significant and positively related to two line types; sludge in 1996 and 1997 and stub in 1992, 1994-1995 and 1998-1999. Corrugated metal pipe is the only significantly related line material with percent vote.

This relationship was significant and positive for all eight years. Only two other decision rules variables were shown to be significant and positively related to percent vote; Diam2 and loop610 between 1992 and 1999.

Percent active was significantly related with types collector and stub, line sizes Diam2, Diam4 and age of line for every year. Each of these relationships were positive. The remaining significant relationships were with line type overflow which was positive between 1992 and 1994 and siphon which was positive in 1992 and again in 1996 and 1997. With the materials, percent active was significant and positive with ductile iron in 1995 and again between 1997 and 1999 and with monolithic reinforced concrete in 1996. Age of line and percent active were significantly related between 1993 and 1999. That relationship was negative.

At some points in the study period, tenure has been significantly related with seven of the eight line types. All the relationships were positive. Casing, collector and force main lines were significant in 1999. Lateral lines were significant in 1993 through 1996. Overflow and siphon lines were significant in 1995 and 1996. Sludge lines were significant in 1993 and 1994.

Two materials were found to be significant and positively related to tenure, monolithic reinforced concrete in 1992 and Clay in 1995, 1996 and 1999. Diam3 in 1997 and 1998 was the only line size to be significantly related to tenure. The relationship was positive for both years. Loop610 and tenure were significant and positive between 1993 and 1996. Age of line was significant in 1995, 1996 and 1999. The relationship was positive in 1995 and 1996 but negative in 1999.

Among the districts, five line types were significant; the positive relationship between casing with DistB and DistE; the negative relationships between collector and Force main with DistH; the negative relationships between lateral with DistA, DistB and DistF and the positive relationship with DistH and DistI. Line type overflow had a negative relationship with DistB and a positive relationship with DistI. Stub was negatively associated with DistC.

Significant relationships with the line materials were the negative relationship between acrylonitrile butadiniene styrene and DistB; DistH and Dist and the positive relationship between acrylonitrile butadiniene styrene and Dist C and DistG. Cast iron and DistC and DistH had a negative relationship; cast iron and DistF and DistG had a positive relationship; clay and DistE; concrete and DistG had a positive relationship. The relationship between ductile iron and DistE, DistG was positive while the relationship between ductile iron and DistH was negative; material monolithic reinforced concrete and DistB were negatively related; monolithic reinforced concrete and DistD were positively related. Material polyvinyl was negatively related to DistH and positively related to DistG. Material reinforced concrete pipe was significant with DistF, DistG and DistH. The relationship with DistH was negative. Finally, steel was positively related to DistE and negatively related to DistC.

The line size Diam2 was only negatively significant with DistC. Diam3 and DistB and DistH were negatively related. Diam3 and DistF and DistG were positive. Diam4 was significant and positively related to DistF; loop610 was significant with every district except DistB and DistC. Age of line and the districts were significant for DistD, DistE, DistG and DistI. Each of those relationships were significant.

Multivariate Analysis

Water

A review of Table 5.1 reveals no obvious patterns of prediction. In the first year, census tracts that had generated work orders, were within loop610 and had large numbers of steel lines had a strong likelihood of receiving a capital improvement project. The Odds Ratios show that of those significant variables, the negative effects of concrete contributed the least to the model. Loop610 was the strongest contributor followed by the material steel.

The year 1993 told a different story. Lines made out of galvanized iron that were in less expensive neighborhoods predicted the likelihood of a capital improvement project.

In 1994, we see the longest list of significant contributing variables. This time, older lines with diameters between 2.5” and 6” made from galvanized iron or polyvinyl in percent nonwhite census tracts located in either DistA or DistH were likely to receive a capital improvement project. The strongest contributors to the model, according to the Odds Ratio, were DistA and DistA accompanied by Diam2. Line type main was negatively significant.

In the following year, 1995, there are four significant variables. The variable polyvinyl and age of line retain their significance from 1994 and are joined by undersized lines (Diam1). DistD contributes negatively to the model.

TABLE 5.1: Multivariate Analysis of Water Variables

	Estimate	*p-value*	*Odds Ratio*	*Confidence Interval*
1992				
STABL	.8877	.0156	5.225	(1.183, 4.988)
DIAM5	.7817	.0123	2.430	(1.185, 4.029)
LOOP610	1.6534	.0001	5.225	(2.765, 9.873)
M_CONC	-3.3875	.0028	.034	(.004, .313)
M_STL	1.2634	.0282	3.537	(1.145, 10.932)
WWO	.6803	.0001	1.975	(1.472, 2.648)
DISTH	.7882	.0443	2.199	(1.028, 4.741)
1993				
M_GALV	1.2402	.0010	3.456	(1.656, 7.212)
COST	-.3014	.0099	.740	(.588, .930)
1994				
AGE	.0434	.0001	1.044	(1.011, 1.079)
DIAM2	1.7275	.0081	5.626	(2.118, 14.949)
M_GALV	1.499	.0005	3.158	(1.361, 7.329)
M_PVC	1.2604	.0074	3.527	(1.488, 8.361)
T_MAIN	-1.4394	.0047	.237	(.087, .643)
NONWHITE	.4566	.0079	1.579	(1.127, 2.211)
DISTA	2.4691	.0001	11.811	(4.048, 34.462)
DISTH	2.4724	.0001	11.851	(4.636, 30.293)
1995				
M_PVC	.9059	.0092	2.474	(1.251, 4.892)
AGE	.0446	.0018	1.046	(1.017, 1.075)
DIAM1	1.0398	.0035	2.829	(1.407, 5.687)
DISTD	-1.4729	.0194	.229	(.067, .788)
1996				
DIAM3	1.0867	.0101	2.964	(1.295, 6.785)
LOOP610	1.1514	.0037	3.163	(1.455, 9.876)
M_PVC	-1.6432	.0004	.193	(.078, .478)
1997				
DIAM1	1.1787	.0003	3.250	(1.722, 6.135)
TEN	-.2328	.0237	.792	(.648, .969)
1998				
WWO	.4603	.0110	1.585	(1.111, 2.260)
INC	1.304	.0003	3.684	(1.818, 7.466)
1999				
T_FIRE	1.2118	.0070	3.360	(1.393, 8.100)
T_HYDL	-1.2144	.0088	.297	(.120, .736)
WWO	.7733	.0005	2.167	(1.403, 3.346)

In 1996 the material polyvinyl is again significant, only this time the relationship is negative. The variable loop610 is also significant and is the strongest contributor to the model. Polyvinyl and loop610 are joined by the variable Diam3.

The political variable tenure and undersized lines (Diam1) were significant predictors in 1997. Tenure has a negative relationship and, as shown by the Odds Ratio, is the weakest among the two variables. Water work orders were again significant in 1998. It accompanied income which was a three times stronger predictor. In the final year of analysis, water work orders remained significant and with a stronger predicting power. Fire line and to a lesser extent, hydrant were also significant predictors.

There are certain expectations one may have when combining all the variables into one model. Based on the interviews with public works staff and the final list of significant variables compiled at the end of Chapter IV, one would expect to see more frequency in the significance of undersized lines (Diam1), older lines or lines in older census tracts (age of line) and lines within loop610. Tenure should also have been significant in greater frequency. This was not the case, at least not consistently

In the final analysis of water work orders and the full model, we do not see the same significant variables that were compiled at the end of Chapter IV. We lost DistG, material age of line and copper. We gain the political variable tenure. The results for water work orders differed from what was in the simple model, class bias and political model. In those models, water work orders were significant 50 percent of the time and in the same years. The results of the full model are what we found in the Decision Rules Model. Water work orders were significant in three years, 1992, 1998 and 1999. Though this represents only 37 percent of the time, we are able to reject the null hypothesis 5a. Water work orders, when taken into consideration with all variables, has had a significant effect on the selection of water related capital improvement projects.

Sewer

As shown in Table 5.2, in the results of the sewer multivariate analysis, no two years look alike. In 1992 lines between 10" and 20" (Diam3) made from materials other than acrylonitrile butadiniene styrene that were inside loop610, were most likely to determine the likelihood of a capital improvement projects. The Odds Ratio for that year shows that loop610 was the strongest predictor, followed by Diam3 and acrylonitrile butadiniene styrene. In the following year, it was lateral lines made from concrete in lower housing cost census tracts. In 1994, sewer work orders and acrylonitrile butadiniene styrene were significant contributors to capital improvement project selection. By 1996, loop610 is again significant. This time, it is joined by line type siphon. Sewer work orders are significant in 1997. Also, significant in that year are line sizes between 10" and 20" (Diam3) made from monolithic reinforced concrete. The year 1998 has the longest list of significant variables. In that year, collector lines made from corrugated metal pipe in high income tracts were most likely to predict the selection of capital improvement projects. Forced mains inversely contributed to the model. In the final year, sewer work orders was joined by line size Diam1 and material acrylonitrile butadiniene styrene.

TABLE 5.2: Multivariate Analysis of Sewer Variables

	Estimate	*p-value*	*Odds Ratio*	*Confidence Interval*
1992				
DIAM3	.8967	.0168	2.452	(1.175, 5.113)
LOOP610	1.7684	.0001	5.862	(2.800, 12.272)
M_ABS	-1.2322	.0028	.292	(.130, .654)
DISTF	1.7721	.0036	5.883	(1.784, 19.402)
1993				
T_LATL	1.538	.0002	4.659	(2.098, 10.348)
M_CONC	.7843	.0418	2.191	(1.030, 4.662)
COST	-.3688	.0027	.692	(.543, .880)
1994				
M_ABS	-1.4856	.0089	.226	(.074, .689)
SWO	.5003	.0256	1.649	(1.063, 2.559)
DISTA	1.3434	.0119	3.832	(1.346, 10.912)
1995				
STABLE	.7951	.0284	2.215	(1.088, -4.509)
1996				
LOOP610	1.0121	.0187	2.751	(1.184, 6.395)
T_SIPH	.9286	.0370	2.531	(1.057, 6.058)
DISTF	1.2909	.0452	3.636	(1.028, 12.860)
1997				
DIAM3	-.6618	.0391	.516	(.275, .967)
M_MRC	.6565	.0361	1.928	(1.043, 3.563)
SWO	.4362	.0023	1.547	(1.168, 2.048)
1998				
T_COLL	1.8774	.0012	6.537	(2.093, 20.420)
T_FM	-1.0106	.0371	.364	(.141, .941)
M_CGMP	1.3709	.0143	3.939	(1.316, 11.762)
INC	1.1047	.0050	3.018	(1.396, 6.524)
1999				
DIAM1	1.0488	.0166	2.854	(1.210, 6.734)
M_ABS	-1.5705	.0034	.208	(.073, .596)
SWO	.5577	.0077	1.747	(1.159, 2.632)
DISTF	1.5713	.0318	4.813	(1.146, 20.206)

After all the addition and subtraction of variables, our final list of variables differs from the list in the previous chapter. The full model loses the variables percent nonwhite and age of line. It gains line type force main. Overall, variables from the Decision Rules theory seem to be the strongest but in reality, not many of the same variables are repeated throughout the study period. Sewer work orders were significant in the same three years 1994, 1997 and 1999 in the full model that it was in the simple and theory based models. Because sewer work orders is significant 37 percent of the time, we can reject the null hypothesis 5b. When taken in consideration with all other factors, sewer work orders generated by citizen contacts have had a significant effect on the selection on capital improvement projects.

Model Fit Analysis

The incorporation of all the variables previously discussed does not necessarily ensure that the full model will be a better fit. Table 5.3 illustrates the changes in the model fit statistics of the multivariate regression. For the water model, the addition of the covariates does result in an improvement in the –2 Log Likelihood statistic. As was the case with the previous models, the level or degree of improvement varies from year to year. The largest change in the –2 Log Likelihood occurred in 1992, the smallest, in 1993. In each year, the improvements in the –2 Log Likelihood resulted in a significant fit of the model. P-values of both the Likelihood Ratios and Score statistic are within the .05 limit.

TABLE 5.3: Full Model Fit Comparisons

	-2 Log Likelihood		*Likelihood Ratio*		*Score Value*	
	Intercept Only	*With Covariates*	*chi-Square*	*p-value*	*chi-Square*	*p-value*
Water						
1992	363.941	268.317	95.6245	.0001	84.9090	.0001
1993	232.637	215.496	16.7677	.0002	15.462	.0004
1994	290.739	200.817	89.9225	.0001	90.9566	.0001
1995	309.119	272.923	36.1958	.0001	33.8093	.0001
1996	218.704	196.992	21.712	.0001	20.6813	.0001
1997	316.163	296.321	19.8427	.0001	19.3153	.0001
1998	209.077	188.131	20.9464	.0001	19.8020	.0001
1999	194.086	174.219	19.867	.0002	18.7608	.0007
Sewer						
1992	275.194	240.592	34.6013	.0001	34.8374	.0001
1993	232.637	205.783	26.8540	.0001	25.7427	.0001
1994	172.965	153.936	19.0294	.0003	18.5366	.0030
1995	199.160	195.376	3.7839	.0517	5.7063	.0169
1996	199.160	187.326	11.8337	.0080	13.2368	.0042
1997	294.506	276.046	18.1679	.0004	17.506	.0006
1998	183.698	154.111	29.5863	.0001	29.1714	.0001
1999	183.698	159.253	20.2155	.0001	22.8692	.0001

The scenario is slightly different for sewer. In 1995, no variables were found to be significant therefore there was no model improvement (or value) in the –2 Log Likelihood score. The remaining years experience significant changes between the intercept only and the full model. The greatest change was 33 points in 1992. The lowest was eight in 1996.

Model Comparisons

Having reviewed all the model fit analysis, is it valid to assume that the full model is consistently the better fit over the previous four? Not necessarily. It is not statistically valid to compare the changing values of the –2 Log Likelihood scores between the models because they do not test the same variables. The best way to assess which model fits best is to compare the value of the full model to the class bias, decision rules, political and simple models and determine if the –2 Log Likelihood statistic is improved upon by the additional variables. For example, as shown in Table 5.4, the 1992 water Decision Rules model has the lowest –2 Log Likelihood value of 277.990. The addition of the remaining variables in the full model does not improve upon that value. Therefore, in 1992 the Decision Rules model is a better fit. The full model is an equal improvement but it utilizes more variables. In 1993-1995, 1997 and 1999, the –2 Log Likelihood suggests that the full model is a better fit. However, the Decision Rules model is a better fit in 1996 and the Class Bias model fits best in 1998.

TABLE 5.4: Comparison of Model Fit

	-2 Log Likelihood Values				
	Simple	*Class*	*Rules*	*Political*	*Full*
Water					
1992	332.224	332.224	277.990	321.284	268.317*
1993	227.552	220.126	212.940*		215.496*
1994	290.189	278.671	255.880	243.712	200.817*
1995	306.724		272.291*	303.457	272.923
1996	216.811	211.354	174.885*		196.992
1997	310.125	310.125	293.460*	302.218	296.321
1998	202.221	188.131*	202.221	202.221	188.131
1999	185.930	178.745	163.690*	185.930	174.219
Sewer					
1992	272.559	269.648	241.840		240.592*
1993	232.451	226.193	211.981		205.783*
1994	167.600	167.600	159.378	162.643	153.936*
1995	198.317				195.376*
1996	198.961	196.160	190.734		187.326*
1997	284.760	284.760	276.338	284.760	216.046*
1998	181.261	174.636	166.476	180.378	154.111*
1999	175.639	168.774	162.985	175.639	159.253*

* indicates better fitting model

For sewer, the full model is a better fit in every year. But, in 1992, the difference between the decision rules and the full model is slightly more than one point.

CHAPTER VI

CONCLUSIONS AND DISCUSSION

What does the analysis presented in Chapters IV and V mean? How does it satisfy the research objectives? The purpose of this chapter is to summarize the results of the multivariate model fit analysis and relate them to the research objectives: to determine if work orders had an effect on CIP project selection and to identify if other factors are considered in the CIP decision making process. The chapter will conclude with a discussion on the implications of this study for the City of Houston, future research and the field of planning.

Summary of Multivariate Analysis

In answer to the first objective, we know that alone, and in consideration with additional variables, both water and sewer work orders have significantly contributed or have had a significant effect on the selection of CIP projects. Unfortunately, the significance of work orders in the CIP process was not consistent throughout the study period. Critics of Houston's infrastructure management system, or more specifically the CIP process, would focus on the fact that work orders significantly contributed to the decision making process less than 40 percent of the of the time. What they would overlook or misinterpret is in those years when work orders weren't statistically significant it doesn't mean that citizen contacts were completely disregarded or overlooked. A review of the full model in Appendix H would reveal that in every year, work orders have had some degree of influence, however slight. Also, the Department of Public Works & Engineering acknowledges that it can't address all CIP issues or requests in a single year. In those areas that don't receive a CIP project, the number and location of calls are held over and added to the next year's calls. This additive measure of need is then incorporated into the CIP process. That process is continued until a project is allocated in that area.

What has not been asked or answered here is what degree of influence should one expect work orders to have. As was shown in the analysis of the theory models, work orders are not the only factor to be considered. Should they override other issues such as government regulations? And, how can everyone be satisfied when funds are limited.

For the second objective, the urban service delivery literature identified a variety of potential variables. That list was refined by information gathered in the interviews with members of PW&E and the City Council. Through the analysis of each theory, a list of significant variables were compiled. The full model multivariate analysis resulted in the list of variables in Table 6.1. These variables, in addition to work orders, significantly influenced the selection of water and sewer CIP projects between 1992 and 1999. In each year the result was a different set of variables.

TABLE 6.1: Final List of Significant Variables

Water				
Diam5	Stable	DistH	Galvanized	Tenure
Loop610	Concrete	Cost of housing	Fire line	Percent income
Steel	Water work orders	Diam2	Percent nonwhite	Age of line
DistA		Polyvinyl	DistD	
Diam3	Diam1			
	Hydrant			
Sewer				
Diam3	Loop610	Asbestos cement	DistI	DistF
Lateral	Concrete	Cost of housing	DistA	Percent income
Stable	Siphon	DistF	Diam3	Diam1
Monolithic reinforced concrete	Collector		Fire line	
			Corrugated metal	

Based on this list, politicians could and have complained that the distribution of water and sewer CIP projects are not equally allocated across districts. Indeed, DISTA, DISTD, DISTF and DISTH have been repeatedly significant where others have not. Critics could raise concerns that there were years where high income or more expensive census tracts were more likely to receive a project. Conversely, critics could say that areas with higher percentages of nonwhites factored significantly. In any one year, any of the criticisms could be true. However, the results of the full analysis over the eight years show no patterns.

Viewed for its positive aspects, the lack of patterns or consistency reveals no clear bias to any one or set of variables. Nor does it seem that the input of one person or group of individuals dominates, manipulates or exploits the decision making process, at least not consistently.

Results of the full analysis shows evidence that the city is addressing the issues or technical concerns that were identified as funding priorities in the interviews. Lines within LOOP610, undersized lines (DIAM1) and older lines (AGE) are a priority. These variables have been significant throughout the study period. But again, this is not the case in every year. And, because the results for water and sewer were not the same, we could make the assumptions that for the different systems there are different needs at different times and, most importantly, different individuals forming the prioritized lists.

Most importantly, keep in mind that the multivariate results reflect decisions made solely for the allocation of underground lines. Decision makers are allocating funds for the entire system. That includes pumps, lines, treatment facilities, etc. Each player at the table is advocating for his/her section. Therefore, the decision makers are operating within a larger context, the details of which were not shared with this researcher. One issue is a funding cap. We do not know what potential projects were denied due to limited funding. We also don't know what role federal or state regulations played in determining project selection.

So, in sum, we know that work orders have been significant. We know what other variables are factored into the decision making process. Prior to determining the value, if any, of that list, critics must understand that the study of the decision making process is not an exact science. The results are based on information that is available and the methods used.

Summary of Model Fit Findings

The results of the model fit analysis help tie the results of multivariate analysis to the literature on citizen contacts and urban service delivery.

The bivariate and simple model tested the direct relationship between citizen contacts, i.e., work orders and project allocation or government response. When the simple model was compared to the theory models, the –2 Log Likelihood indicated that work orders are not the sole factor in the decision making process. If that were the case, the results of the simple and full model for water and sewer would have been the same i.e. work orders would have been the only significant variable. Therefore, government response to citizen contacts cannot be accurately evaluated with a single variable model. One must consider the bigger picture or context of those contacts. Part of evaluating the strength of the urban service delivery models lies in the variables selected.

The class bias model tested four variables; percent ownership, median household income, percent non-white and average housing cost. Implementing the suggestions of Bolotin and Cingranelli (1983) and Mladenka (1989), I looked for distributional patterns over time. Still, the final results showed little support for this theory. Only in 1998 was the class bias the dominate model. In most years, the addition of the class bias variables resulted in a slight improvement over the simple model. In a few years there was no improvement.

The decision rules literature suggested that the internal rules and/or professional criteria be more thoroughly explored (Jones et al., 1978; Sanger, 1982) . Following those suggestions, the interviews with PW&E suggested five variables that were part of the agencies internal rules: age of the line, line location, diameter, type and material. Among the model fit analysis, the decision rules water model was the better fit in 62 percent of the years. That was not the case for sewer. In no year did the decision rules model prove to be a better fit. However, the value difference between the decision rules and full model was small. The decision rules model proved to be a subset of the full model.

Consider the conclusions of Mladenka (1978) and Sanger (1982); that the Decision Rules theory really only explained the decision making process, not the resulting distributional patterns. Given this we should expect the variables representing the decision rules model to be predominate, and they are.

Research on the Political Influence model suggested a variety of factors to consider. Many of the concepts were difficult to quantify or, the information was not available or, it was not explicitly used by those involved in the decision making process.

Following Meier's (1991) and Rowan and Tunyavong's (1994) suggestion of studying one city over time resulted in no support for the Political Influence theory.

Not only was it never the dominate model, but in several years, 1993 and 1996 for water in 1992, 1993, 1995 and 1996 for sewer, the addition of the political variables was not a model improvement over the intercept only model.

The results of the full model tells us that each of the models, to varying degrees, contributes something to the selection of CIP projects. Though that contribution is not the same each year. What we have learned from the full model is the importance of long-term study. The conclusions reached by many of the urban service delivery studies captured a picture in time. If we look at the water study, say in 1998, the results support the Class Bias theory, in other years, the results would support the Decision Rules. The same range of results can be said, although to a lesser degree, for sewer.

Implications

Implications for City of Houston

The city is doing an admirable job of providing the community with information. It has created a multitude of avenues where the public can request information, submit complaints or make suggestions. However, problems continue to plague PW&E. During the writing of this dissertation, the Houston's PW&E was restructured at least once. In late January of 2002, the department head resigned and the department was harshly criticized as the department of "burst pipes and mangled streets" (Graves, 2002). It would help the situation if the public had a better understanding of how the infrastructure decision making process works, what factors are considered and what are the goals that the process is designed to achieve. That goal(s) may need to be shared among all the decision makers. At this time, different groups are operating attempting to satisfy many objectives.

City planners should be included in the decision making process. The decisions made have distributional consequences/effects. Engineers involved in the process acknowledge the need for a planner's knowledge at the decision making table. While engineers look at systems issues, no one within their department is looking at the current or future, demographic effects or trends. To that end, it would be helpful if the decision makers determined if their goal or objective was process or effect driven, i.e. equitable process or equitable outcome. It is possible these goals will be contradictory. This will make it somewhat easier to measure the results and defend the decisions made. Also, now that the city has an updated GIS system, it should be possible to conduct an impact analysis and graphically depict the location of proposed projects prior to the final decision such that all parties are aware of potential impacts and can discuss or modify them.

Finally, to the extent possible, the city should complete the inventory of the water and sewer system. A systematic method of updating the system inventory and condition assessment should also be considered. The method should include a way of retaining historical information of replaced lines. Historical information will prove useful in analyzing line life spans, etc.

Implications for Future Research

During the data collection and writing of this dissertation, several issues presented themselves as needing further research.

Methodology. For this research, the decision making process was tested using a logistic regression. Other, non-statistical methods can be applied. These methods may be able to capture nuances not incorporated in a statistical model. A tree structured non-parametric data analysis such as a classification and regression tree (CART) is designed so that statistical concerns such as normality are not an issue. The results of various methodologies may be different. A comparison of results may prove interesting.

Cost, regulatory factors, and environmental considerations were not incorporated into the model. If this information could be captured and manipulated, the results may be different. In addition, all elements of a given system, be it water or sewer should be evaluated together since they all compete for the same funds under the same funding cap.

There is a wealth of information contained in the bivariate analyses. Future research may evaluate these relationships to their fullest extent and discuss possible implications on citizen contacts or on the priorities/criteria to be followed when selecting capital improvement projects.

Contributions to Literature. There is a growing body of literature on the output of urban service distribution. Issues of equity or unpatterned inequalities still exists. This study focused on the decision making process of urban services. It did not evaluate the distributional effects or patterns of project allocation. Mladenka and Hill (1978) argue that the decision rules employed in the decision making process were not necessarily neutral in their effects. The effects may be random or unanticipated (Antunes & Plumlee, 1977). A future study may incorporate the use of GIS to spatially analyze the distributional patterns over time and in consideration with population shifts, tenure, etc. The objective would be to determine if biases exist in the CIP program and if so, what are they.

When evaluating the distributional patterns, it will be important to incorporate the lessons learned in the literature review presented in Chapter II.

- Evaluate distributional patterns over time to capture political and socioeconomic changes.
- Distinguish between capital and programs.
- Distinguish between emergency, short-term or long-term programs/responses.
- Use a variety of indicators.

The data that is maintained by Houston's Customer Response Center is extensive. The data set contains call location, time and date of call, reason for call, department referred to, date and time of department response, etc. That information, if aggregated or otherwise modified (to provide anonymity) and studied would contribute to the literature on citizen-initiated contacts and government's immediate response. This information is available not just for sewer and water but for all city services to which the Customer Response Center provides support.

Implications for Planning

In 1986, Arthur Nelson wrote an article entitled *Teaching planners about infrastructure: a call to civil engineers.* In that article he stated that, "more than 40 percent of the more than 20,000 planners in the United States influence the manner in which water, sewer, drainage, streets, and other kinds of physical infrastructure are planned and used." His concern was to what extent planners are educated about infrastructure. Transportation planning is a specialization within planning but it does not cover the other infrastructure elements. At the time of his study, only 10 percent of the universities that offered planning included infrastructure as a course in their curriculum (either offered within their department or cross-listed with engineering). The extent to which that number has increased or decreased and the benefits of such an infrastructure course in the planning curriculum is a topic for future research.

There are many opportunities for planners to collaborate with engineers, public administrators, etc. It is clear that each discipline brings valuable information to the discussion. Between planners and engineers specifically, a better relationship could be fostered if planners were involved in more steps of the CIP progress.

Proactive vs reactive. This is a long-time discussion among the planning profession. The benefits and disadvantages to both as well as when either action would be appropriate is a point for discussion.

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APPENDIX A

DESCRIPTIVE STATISTICS	N	Min	Max	Mean	Median	Std. Dev.		Freq	Cum Freq
Water work orders									
Water work orders 1992	375	1	4	2.53	2	1.136	1	91	91
							2	98	189
							3	82	271
							4	104	375
Water work orders 1993	375	1	4	2.533	2	1.058	1	75	75
							2	113	188
							3	99	287
							4	88	375
Water work orders 1994	375	1	4	2.568	2	1.069	1	71	71
							2	117	188
							3	90	278
							4	97	375
Water work orders 1995	375	1	4	2.541	2	1.122	1	85	85
							2	106	191
							3	80	271
							4	104	375
Water work orders 1996	375	1	4	2.581	2	1.134	1	82	82
							2	106	188
							3	74	262
							4	113	375
Water work orders 1997	375	1	4	2.573	2	1.123	1	81	81
							2	107	188
							3	78	266
							4	109	375
Water work orders 1998	375	1	4	2.536	2	1.176	1	99	99
							2	89	188
							3	74	262
							4	113	375
Water work orders 1999	375	1	4	2.562	2	1.128	1	84	84
							2	104	188
							3	79	267
							4	108	375

Sewer work orders

Sewer work orders 1992	375	1	4	2.528	2	1.203	1	103	103
							2	92	195
							3	59	254
							4	121	375
Sewer work orders 1993	375	1	4	2.5466	2	1.18	1	97	97
							2	93	190
							3	68	258
							4	117	375
Sewer work orders 1994	375	1	4	2.608	2	1.136	1	78	78
							2	110	188
							3	68	256
							4	119	375
Sewer work orders 1995	375	1	4	2.5973	2	1.133	1	79	79
							2	109	188
							3	71	259
							4	116	375
Sewer work orders 1996	375	1	4	2.549	2	1.1572	1	92	92
							2	97	189
							3	74	263
							4	112	375
Sewer work orders 1997	375	1	4	2.525	2	1.169	1	99	99
							2	90	189
							3	76	265
							4	110	375
Sewer work orders 1998	375	1	4	2.56	2	1.204	1	101	101
							2	87	188
							3	63	251
							4	124	375
Sewer work orders 1999	375	1	4	2.56	2	1.195	1	99	99
							2	89	188
							3	65	253
							4	122	375

Demographic Model

	N	Min	Max	Mean	Median	Std. Dev.		Freq	Cum Freq
Percent nonwhite	375	1	4	2.525	2	1.174	1	97	97
							2	98	195
							3	66	261
							4	114	375
Median hh income	375	0	3	1.824	2	0.5813	1	102	102
							2	237	339
							3	36	375
Percent ownership	375	0	100	45.0533	46	22.971904			
Median Hsng Cst (index of below)	375	0	10.5	5.5946	5.5	1.7481001			
Median house value	375	0	1060300	76019.6	54400	86010.97			
Median rent	375	0	1001	427.978	406	151.94177			

Objective Model

Water

		N	Min	Max	Mean	Median	Std. Dev.		Freq	Cum Freq
DIAM1	>= 2.5	375	0	1	0.4986	0	0.5006	0	188	188
								1	187	375
DIAM2	2.5 <> 6	375	0	1	0.4986	0	0.5006	0	188	188
								1	187	375
DIAM3	8 <> 12	375	0	1	0.4986	0	0.5006	0	188	188
								1	187	375
DIAM4	12 <> 24	375	0	1	0.488	0	0.5005	0	192	182
								1	183	375
DIAM5	> 24	375	0	1	0.4026	0	0.49109	0	224	224
								1	151	375
T_MAIN	main line	375	0	1	0.496	0	0.5006	0	189	189
								1	186	375
T_WCL	well collection line	375	0	1	0.1386	0	0.34606	0	323	323
								1	52	375
T_COLL	collector	375	0	1	0.3733	0	0.18983	0	361	361
								1	14	375
T_HYDL	hydrant lead	375	0	1	0.4986	0	0.50066	0	188	188
								1	187	375
T_FIRE	fire line	375	0	1	0.4533	0	0.498482	0	205	205
								1	170	375
T_CASE	casing	375	0	1	0.3733	0	0.4843357	0	235	235
								1	140	375
T_TRANS	transmission line	375	0	1	0.04	0	0.196221	0	360	360
								1	15	375

M_AC	asbestos	375	0	1	0.4986	0	0.5006	0	188	188
								1	187	375
M_CI	cast iron	375	0	1	0.4986	0	0.5006	0	188	188
								1	187	375
M_CONC	concrete	375	0	1	0.08266	0	0.2757	0	344	344
								1	31	375
M_COP	copper	375	0	1	0.2266	0	0.4192	0	290	290
								1	85	375
M_DI	ductile iron	375	0	1	0.296	0	0.4571	0	264	264
								1	111	375
M_GALV	galvanized iron	375	0	1	0.3786	0	0.4857	0	233	233
								1	142	375
M_PCPE	pcpe	375	0	1	0.032	0	0.1762	0	363	363
								1	12	375
M_PCPL	pcpl	375	0	1	0.0133	0	0.1148	0	370	370
								1	5	375
MAT78	pcpe/pcpl	375	0	1	0.0426	0	0.2023	0	359	359
								1	16	375
M_PVC	polyvinyl	375	0	1	0.5006	0	0.5006	0	190	190
								1	185	185
M_SRC	steel cylinder	375	0	1	0.2674	0	0.2674	0	346	346
								1	29	375
M_STL	steel	375	0	1	0.3542	0	0.3542	0	55	55
								1	320	375
AGE	median age of housing	375	0	90	68.402	70	14.1362			
SERV	repair date	375	0	90	24.7733	0	36.2977			
Loop610		375	0	1	0.304	0	0.4605	0	261	261
								1	114	375
Sewer										
T CASE	casing	375	0	1	0.1626	0	0.3695	0	314	314
								1	61	375
T COLL	collector	375	0	1	0.4986	0	0.5006	0	188	188
								1	187	375
T FM	force main	375	0	1	0.4133	0	0.493	0	220	220
								1	155	375
T LATL	lateral	375	0	1	0.4266	0	0.4952	0	215	215
								1	160	375
T OF	overflow	375	0	1	0.2986	0	0.4582	0	262	262
								1	112	375
T SIPH	siphon	375	0	1	0.1653	0	0.3719	0	313	313
								1	62	375

T SLDG	sludge	375	0	1	0.0746	0	0.2632	0	347	347
								1	28	375
T STUB	sub	375	0	1	0.4986	0	0.5006	0	188	188
								1	187	375
M ABS	acrylonitrile buadiniene styrene	375	0	1	0.4586	0	0.4989	0	203	203
								1	172	375
M CGMP	corrugated metal pipe	375	0	1	0.0933	0	0.2912	0	340	340
								1	35	375
M CI	cast iron	375	0	1	0.48	0	0.5002	0	196	196
								1	179	375
M CLAY	clay	375	0	1	0.24	0	0.4276	0	285	385
								1	90	375
M CONC	concrete	375	0	1	0.496	0	0.5006	0	189	189
								1	186	375
M DI	ductile iron	375	0	1	0.4746	0	0.5002	0	197	197
								1	178	375
M ESP	extra strength concrete pipe	375	0	1	0.496	0	0.5006	0	189	189
								1	186	375
M MRC	monlithic reinforced concrete	375	0	1	0.416	0	0.4935	0	219	219
								1	156	375
M PVC	polyvinyl chloride	375	0	1	0.4933	0	0.5006	0	190	190
								1	185	375
M RCP	reinforced concrete pipe	375	0	1	0.4933	0	0.5006	0	190	190
								1	185	375
M STL	steel	375	0	1	0.1786	0	0.3835	0	308	308
								1	67	375
DIAM1	0 < > 4	375	0	1	0.336	0	0.4729	0	249	249
								1	126	375
DIAM2	6 < > 8	375	0	1	0.496	0	0.5006	0	189	189
								1	186	375
DIAM3	10 < > 20	375	0	1	0.4933	0	0.5006	0	190	190
								1	185	375
DIAM4	> 20	375	0	1	0.4853	0	0.5004	0	193	193

Political Model

		N	Min	Max	Mean	Median	Std. Dev.		Freq	Cum Freq
VOTE92		64	1	4	2.5937	2.5	1.178	1	15	23.44
								2	17	50
								3	11	67.19
								4	21	100
VOTE93		64	1	4	2.5937	2.5	1.1229	1	13	20.31
								2	19	50
								3	13	70
								4	19	100
VOTE94		64	1	4	2.5312	205	1.0978	1	14	21.88
								2	18	50
								3	16	75
								4	16	100
VOTE95		64	1	4	2.5312	2.5	1.0978	1	14	21.88
								2	18	50
								3	16	75
								4	16	100
VOTE97		64	1	4	2.6406	2.5	1.0445	1	12	18.75
								2	20	50
								3	16	75
								4	16	100
VOTE98		64	1	4	2.6262	2.5	1.0573	1	9	14.06
								2	32	50
								3	45	71
								4	64	100
VOTE99		64	1	4	2.625	2.5	1.091	1	11	17.19
								2	32	50
								3	45	70.31
								4	64	100
TEN92		375	2	6	4.986	6	1.742			
TEN93		375	1	6	2.04	1	1.614			
TEN94		375	2	6	3.04	2	1.617			
TEN95		375	1	5	2.578	3	1.284			
TNE96		375	2	6	3.578	4	1.284			
TEN97		375	1	5	3.858	5	1.379			
TNE98		375	2	6	4.858	6	1.379			
TEN99		375	1	5	2.594	1	1.84			
ELYR	Value yes or no	375								

STABLE	Value yes or no	375	0	2	0.0666	0	0.3406	0	360	360
								1	5	365
								2	10	375
ACTIVE93		64	0	1	0.4843	0	0.5037	0	33	51.56
								1	64	100
ACTIVE94		64	0	1	0.4843	0	0.5037	0	33	51.56
								1	64	100
ACTIVE95		64	0	1	0.4843	0	0.5037	0	33	51.56
								1	64	100
ACTIVE96		64	0	1	0.4843	0	0.5037	0	33	51.56
								1	64	100
ACTIVE97		64	0	1	0.4843	0	0.5037	0	33	51.56
								1	64	100
ACTIVE98		64	0	1	0.4843	0	0.5037	0	33	51.56
								1	64	100
ACTIVE99		64	0	1	0.4843	0	0.5037	0	33	51.56
DISTA		43	0	1	0.1146	0	0.319	0	332	332
								1	43	375
DISTB		47	0	1	0.1253	0	0.3315	0	328	328
								1	47	375
DISTC		40	0	1	0.1066	0	0.3091	0	335	335
								1	40	375
DISTD		52	0	1	0.1386	0	0.346	0	323	323
								1	52	375
DISTE		36	0	1	0.096	0	0.2949	0	339	339
								1	36	375
DISTF		23	0	1	0.0613	0	0.2402	0	352	352
								1	23	375
DISTG		39	0	1	0.104	0	0.3056	0	336	336
								1	39	375
DISTH		55	0	1	0.1466	0	0.3542	0	320	320
								1	55	375
DISTI		40	0	1	0.1066	0	0.3091	0	335	335
								1	40	375

Dependent Variable

	N	Min	Max	Mean	Median	Std. Dev.		Freq	Cum Freq
WCIP92	375	0	1	0.18933	0	0.3922966	0	304	304
							1	375	375
WCIP93	375	0	1	0.09333	0	0.2912876	0	340	340
							1	375	375
WCIP94	375	0	1	0.13067	0	0.3374857	0	326	326
							1	49	375
WCIP95	375	0	1	0.144	0	0.3515588	0	321	321
							1	54	375
WCIP96	375	0	1	0.08533	0	0.2797503	0	343	343
							1	32	375
WCIP97	375	0	1	0.14933	0	0.3568929	0	319	319
							1	56	375
WCIP98	375	0	1	0.08	0	0.2716556	0	345	345
							1	30	375
WCIP99	375	0	1	0.072	0	0.2588333	0	348	348
							1	27	375
SCIP92	375	0	1	0.12	0	0.3253957	1	330	330
							2	45	375
SCIP93	375	0	1	0.0933	0	0.2912876	1	340	340
							2	35	375
SCIP94	375	0	1	0.06133	0	0.2402613	1	352	352
							2	23	375
SCIP95	375	0	1	0.07466	0	0.2632039	1	347	347
							2	28	375
SCIP96	375	0	1	0.07467	0	0.2632039	1	347	347
							2	28	375
SCIP97	375	0	1	0.13333	0	0.3403888	1	325	325
							2	50	375
SCIP98	375	0	1	0.06667	0	0.2497771	1	350	352
							2	25	375
SCIP99	375	0	1	0.06667	0	0.24977771	1	350	350
							2	25	375

APPENDIX B: COMPLETE CLASS BIAS MULTIVARIATE ANALYSIS

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Water 1992					
WWO	.7063	.0001	2.026	(1550	2.650)
COST	.2086	.8167	1.029	(.808	1.311)
MIN	.1715	.2976	1.187	(.860	1.639)
INC	.5027	.2082	1.653	(.756	3.616)
OWN	-.0041	.5254	.996	(.983	1.009)
-2 Log Likelihood		Likelihood Ratio		Score	
intercept only	363.941	Chi-square	31.7123	Chi-square	30.1832
with covariates	332.224	p-value	<.0001	p-value	<.0001

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Water 1993					
WWO	.4271	.0152	1.533	(1.086	2.164)
MIN	.3565	.0958	1.428	(.939	2.173)
COST	-.2192	.1896	.803	(.579	1.114)
INC	.3648	.4518	1.440	(.557	3.725)
OWN	.0036	.6812	1.004	(.987	1.021)
-2 Log Likelihood		Likelihood Ratio		Score	
intercept only	232.637	Chi-square	12.5110	Chi-square	12.2843
with covariates	220.126	p-value	.0019	p-value	.0030

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Water 1994					
MIN	.4961	.0093	1.642	(1.130	2.387)
WWO	.1922	.1959	1.212	(.906	1.622)
COST	-.0609	.6755	.941	(.707	1.252)
OWN	.0057	.4453	1.006	(.991	1.021)
INC	.1033	.8034	1.109	(.492	2.500)
-2 Log Likelihood		Likelihood Ratio		Score	
intercept only	290.739	Chi-square	12.0683	Chi-square	11.7749
with covariates	278.671	p-value	.0005	p-value	.0006

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Water 1995					
WWO	.2430	.0035	1.275	(.976	1.667)
COST	-.0091	.9450	.991	(.764	1.285)
MIN	.2227	.2055	1.249	(.885	1.764)
INC	.1695	.6755	1.185	(.536	2.620)
OWN	.0030	.6662	1.003	(.989	1.017)
-2 Log Likelihood		Likelihood Ratio		Score	
intercept only	309.119	Chi-square	NA	Chi-square	NA
with covariates	NA	p-value	NA	p-value	NA

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Water 1996					
WWO	.2596	.1411	1.296	(.918	1.832)
COST	.3693	.0312	1.447	(1.034	2.024)
MIN	.5693	.0185	1.757	(1.099	2.809)
INC	.0179	.9725	1.018	(.369	2.811)
OWN	-.0059	.4866	.994	(.978	1.011)
-2 Log Likelihood		Likelihood Ratio		Score	
intercept only	218.704	Chi-square	7.3505	Chi-square	6.9248
With covariates	211.354	p-value	.2534	p-value	.0314

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Water 1997					
WWO	.3285	.0162	1.389	(1.063	1.815)
COST	.0288	.8223	1.029	(.800	1.324)
MIN	.0701	.6881	1.073	(.762	1.510)
INC	.1229	.7631	1.131	(.509	2.514)
OWN	-.0060	.3750	.994	(.981	1.007
-2 Log Likelihood		Likelihood Ratio		Score	
intercept only	316.163	Chi-square	6.0386	Chi-square	5.9567
with covariates	310.125	p-value	.0140	p-value	.0147

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Water 1998					
WWO	.4548	.0126	1.576	(1.103	2.252)
COST	1.6669	.0089	5.296	(1.520	18.448)
MIN	.1252	.4851	1.133	(.797	1.611)
INC	.2592	.2949	1.296	(.798	2.105)
OWN	-.0151	.1136	.985	(.967	1.004)
-2 Log Likelihood		Likelihood Ratio		Score	
intercept only	209.077	Chi-square	20.94	Chi-square	19.80
with covariates	188.131	p-value	.0001	p-value	.0001

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Water 1999					
WWO	.6249	. 0025	1.868	(1.245	2.803)
COST	-.1610	.3821	.851	(.593	1.221)
INC	1.553	.0116	4.726	(1.414	15.794)
OWN	-.0018	.8513	.998	(.979	1.107)
MIN	.3636	.1319	1.438	(.896	2.308)
-2 Log Likelihood		Likelihood Ratio		Score	
intercept only	194.086	Chi-square	15.34	Chi-square	14.48
with covariates	178.745	p-value	.0015	p-value	.0023

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Sewer 1992					
COST	.2170	.1344	1.242	(.395	1.651)
SWO	.2095	.1300	1.233	(.940	1.617)
INC	.6720	.1509	1.958	(.783	4.899)
MIN	.3268	.1015	1.387	(.938	2.050)
OWN	-.0092	.2262	.991	(.976	1.006)
-2 Log Likelihood		Likelihood Ratio		Score	
intercept only	275.194	Chi-square	5.5456	Chi-square	5.7051
with covariates	269.48	p-value	.0185	p-value	.0169

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Sewer 1993					
MIN	.3365	.1113	1.400	(.925	2.118)
SWO	.1271	.4103	1.387	(.839	1.537)
COST	-.2165	.1917	.805	(.582	1.115)
INC	.3274	.4938	1.387	(.543	3.543)
OWN	.0028	.7441	1.003	(.986	1.020)
-2 Log Likelihood		Likelihood Ratio		Score	
intercept only	232.637	Chi-square	6.4442	Chi-square	6.3269
with covariates	226.193	p-value	.0111	p-value	.0119

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Sewer 1994					
SWO	.5069	.0166	1.660	(1.097	2.513)
COST	.1118	.5820	1.118	(.751	1.665)
INC	.5125	.3906	.599	(.186	1.930)
MIN	.3019	.2626	1.352	(.797	2.294)
OWN	.0051	.6203	1.005	(.985	1.026)
-2 Log Likelihood		Likelihood Ratio		Score	
intercept only	172.965	Chi-square	5.3656	Chi-square	5.1883
with covariates	167.600	p-value	.0205	p-value	.0227

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Sewer 1995					
SWO	.2059	.2512	1.229	(.864	1.747)
COST	-.0145	.9366	.986	(.828	2.095)
INC	-.0858	.8711	.918	(.326	2.587)
MIN	.2755	.2445	1.317	(.987	1.025)
OWN	.0059	.5286	1.006	(.689	1.410)
-2 Log Likelihood		Likelihood Ratio		Score	
intercept only	199.160	Chi-square	NA	Chi-square	NA
with covariates	NA	p-value	NA	p-value	NA

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Sewer 1996					
SWO	.0919	.6057	1.096	(.773	1.554)
COST	.3886	.0307	1.475	(.037	2.098)
INC	.0000	.9993	1.000	(.337	2.972)
MIN	.4476	.0738	1.564	(.958	2.556)
OWN	-.0113	.2188	.989	(.971	1.007)

-2 Log Likelihood		Likelihood Ratio		Score	
Intercept only	199.160	Chi-square	5.9996	Chi-square	5.7145
with covariates	193.160	p-value	.0498	p-value	.0574

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Sewer 1997					
SWO	.4193	.0008	1.521	(1.153	2.006)
COST	.1292	.3450	1.138	(.870	1.488)
INC	.2503	.5684	1.248	(.543	3.036)
MIN	.0718	.7014	1.074	(.744	1.551)
OWN	-.0051	.4754	.995	(.981	1.009)

-2 Log Likelihood		Likelihood Ratio		Score	
Intercept only	294.506	Chi-square	9.7463	Chi-square	9.5296
with covariates	284.760	p-value	.0018	p-value	.0020

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Sewer 1998					
INC	1.317	.0491	3.732	(1.005	13.858)
WWO	3.011	.1052	1.351	(.939	1.945)
COST	.1674	.3801	1.182	(.814	1.718)
MIN	.1580	.5502	1.171	(.697	1.967)
OWN	-.0166	.1034	.984	(.964	1.003)

-2 Log Likelihood		Likelihood Ratio		Score	
Intercept only	183.698	Chi-square	9.0618	Chi-square	8.9727
with covariates	174.636	p-value	.0026	p-value	.0027

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Sewer 1999					
SWO	.5775	.0047	1.782	(1.193	.660)
COST	-.1604	.4138	.852	(.580	1.252)
INC	1.474	.0206	4.369	(1.254	15.22)
MIN	.2887	.2390	1.335	(.825	2.158)
OWN	-.0002	.9801	1.000	(.980	1.020)

-2 Log Likelihood		Likelihood Ratio		Score	
Intercept only	183.698	Chi-square	14.92	Chi-square	14.92
with covariates	168.774	p-value	.0107	p-value	.0150

APPENDIX C: BIVARIATE ANALYSIS OF DECISION RULE VARIABLES

Water

	T_MAIN	T_COLL	T_HYDL	T_FIRE	T_TRANS	M_CI	M_CONC	M_COP
M_CI	C=14.20 (.0002)	C=.0630 (.8017)	C=1.410 (.2350)	C=.2134 (.6441)	C=4.793 (.0286)			
M-CONC	C=.9686 (.3250)	C=3.418 (.0645)	C=.0412 (.8391)	C=.1574 (.6915)	C=1.310 (.2523)			
M_COP	C=4.755 (.0292)	C=.0262 (.8715)	C=3.320 (.0684)	C=.1320 (.7163)	C=.2893 (.5907)			
M_DI	C=16.48 (.0001)	C=.8444 (.3581)	C=17.80 (.0001)	C=5.889 (.0152)	C=.2609 (.6095)			
M_GALV	C=10.98 (.0009)	C=2.194 (.1385)	C=5.298 (.0213)	C=1.447 (.2289)	C=3.437 (.0637)			
M_PC	C=4.313 (.0378)	C=4.930 (.0264)	C=1.067 (.3016)	C=1.987 (.1586)	C=21.03 (.0001)			
M_PVC	C=34.03 (.0001)	C=1.477 (.2242)	C=22.08 (.0001)	C=2.190 (.1389)	C=4.530 (.0333)			
M_SRC	C=1.954 (.1621)	C=68.02 (.0001)	C=3.079 (.0793)	C=2.239 (.1346)	C=3.822 (.0506)			
M_STL	C=24.45 (.0001)	C=.2895 (.5906)	C=13.16 (.0003)	C=12.24 (.0005)	C=.0017 (.9672)			
DIAM1	C=29.39 (.0001)	C=.6402 (.4236)	C=.2161 (.6420)	C=.3311 (.5650)	C=1.165 (.2804)	C=67.41 (.0001)	C=4.319 (.0377)	C=36.86 (.0001)
DIAM2	C=176.1 (.0001)	C=2.790 (.0948)	C=219.6 (.0001)	C=11.33 (.0008)	C=.2858 (.5929)	C=4.930 (.0264)	C=.8503 (.3565)	C=.3466 (.5560)
DIAM3	C=222.7 (.0001)	C=6.220 (.0126)	C=142.2 (.0001)	C=25.26 (.0001)	C=2.630 (.1043)	C=1.943 (.1633)	C=.0412 (.8391)	C=4.516 (.0336)
DIAM4	C=29.37 (.0001)	C=14.29 (.0002)	C=35.27 (.0001)	C=12.50 (.0004)	C=.4051 (.5245)	C=4.053 (.0441)	C=.0023 (.9617)	C=3.443 (.0635)
DIAM5	C=6.497 (.0108)	C=2.142 (.1433)	C=1.441 (.2299)	C=9.466 (.0021)	C= 8.871 (.0029)	C=7.154 (.0075)	C=10.60 (.0011)	C=.9005 (.3426)
LOOP 610	C=5.511 (.0189)	C=4.9502 (.0261)	C=11.90 (.0001)	C=.9491 (.3299)	C=6.352 (.0117)	C=31.89 (.0001)	C= .0551 (.8143)	C=57.01 (.0001)
AGE	T=.59 (.5542)	T=-.70 (.4866)	T=1.27 (.2048)	T=.39 (.6949)	T=1.05 (.3116)	T=-4.34 (.0001)	T=.23 (.8166)	T=-.38 (.7066)

(shaded) = Indicates significance at p=<.05

	M_DI	M_GALV	M_PC	M_PVC	M_SRC	M_STL	DIAM1	DIAM2
DIAM1	C=.1390 (.7093)	C=118.7 (.0001)	C=1.022 (.3119)	C=8.064 (.0045)	C=.3192 (.5721)	C=.5019 (.4787)		
DIAM2	C=19.76 (.0001)	C=1.530 (.2161)	C=.2724 (.6017)	C=18.36 (.0001)	C=4.586 (.0322)	C=6.051 (.0139)	C=1.943 (.1633)	
DIAM3	C=14.18 (.0002)	C=6.736 (.0094)	C=2.383 (.1226)	C=51.52 (.0001)	C=.9635 (.3263)	C=20.28 (.0001)	C=9.282 (.0023)	C=123.2 (.0001)
DIAM4	C=39.67 (.0001)	C=.4928 (.4827)	C=.3713 (.5423)	C=5.865 (.0154)	C=11.71 (.0006)	C=10.02 (.0015)	C=.0236 (.8778)	C=26.13 (.0001)
DIAM5	C=.9856 (.3208)	C=.6881 (.4068)	C=19.87 (.0001)	C=.8955 (.3440)	C=13.50 (.0002)	C=2.346 (.1256)	C=5.078 (.0242)	C=.6076 (.4357)
LOOP 610	C=.4554 (.4998)	C=122.5 (.0001)	C=2.530 (.1116)	C=8.209 (.0042)	C=2.572 (.1088)	C=.7450 (.3881)	C=52.11 (.0001)	C=4.889 (.0270)
AGE	T=.57 (.5687)	T=-.74 (.4578)	T=3.77 (.0002)	T=1.31 (.1983)	T=.42 (.6815)	T=-2.52 (.0123)	T=.04 (.9668)	T=2.97 (.0031)

= Indicates significance at p=<.05

	DIAM3	DIAM4	DIAM5	LOOP 610
LOOP 610	C=5.1958 (.0226)	C=.0201 (.8871)	C=.8791 (.3484)	
AGE	T=-25 (.8003)	T=.60 (.5510)	T-2.31 (.0251)	T=-.38 (.7066)

Sewer

	T_CASE	T_COLL	T_FM	T_LATL	T_OF	T_SIPH	T_SLDG	T_STUB
M_ABS	C=1.988 (.1585)	C=36.70 (.0001)	C=23.24 (.0001)	C=16.50 (.0001)	C=.0963 (.7563)	C=.5111 (.4747)	C=.1104 (.7397)	C=4.465 (.0340)
M_CGMP	C=6.515 (.0107)	C=3.878 (.0489)	C=7.375 (.0066)	C=.1466 (.7018)	C=16.73 (.0001)	C=.0104 (.9188)	C=2.598 (.1070)	C=.7587 (.3837)
M_CI	C=5.964 (.0146)	C=47.21 (.0001)	C=26.66 (.0001)	C=1.556 (.0075)	C=6.443 (.0111)	C=1.398 (.2381)	C=3.215 (.0730)	C=6.402 (.0114)
M_CLAY	C=141.9 (.0001)	C=4.864 (.0274)	C=40.13 (.0001)	C=.3442 (.5574)	C=1.829 (.1762)	C=.1329 (.7154)	C=11.21 (.0008)	C=.5693 (.4506)
M_CONC	C=.2383 (.6255)	C=5.398 (.0202)	C=1.647 (.1993)	C=.3039 (.5814)	C=2.825 (.0928)	C=3.017 (.0824)	C=4.034 (.0446)	C=4.481 (.0343)
M_DI	C=15.48 (.0001)	C=56.17 (.0001)	C=43.55 (.0001)	C=.6809 (.4093)	C=4.940 (.0262)	C=5.692 (.0170)	C=2.129 (.1445)	C=5.401 (.0201)
M_MRC	C=.9185 (.3379)	C=5.515 (.0188)	C=.0122 (.9119)	C=.0141 (.9056)	C=.3039 (.5815)	C=5.358 (.0206)	C=.8788 (.3485)	C=5.113 (.0237)
M_PVC	C=.0644 (.7997)	C=18.36 (.0001)	C=13.52 (.0002)	C=.0002 (.9889)	C=.3842 (.5353)	C=.0132 (.9085)	C=.1021 (.7493)	C=8.064 (.0045)
M_RCP	C=6.213 (.0127)	C=20.18 (.0001)	C=13.52 (.0002)	C=7.295 (.0069)	C=1.147 (.2841)	C=.1544 (.6943)	C=.7383 (.3902)	C=5.888 (.0152)
M_STL	C=193.6 (.0001)	C=4.186 (.0407)	C=51.86 (.0001)	C=1.526 (.2113)	C=8.657 (.0033)	C=1.124 (.2889)	C=12.87 (.0003)	C=.9365 (.3332)
DIAM1	C=16.00 (.0001)	C=4.018 (.0450)	C=44.12 (.0001)	C=.8784 (.4386)	C=19.25 (.0001)	C=.8693 (.3512)	C=12.77 (.0004)	C=.2247 (.6355)
DIAM2	C=1.762 (.1843)	C=154.8 (.0001)	C=17.80 (.0001)	C=1.252 (.2630)	C=5.559 (.0184)	C=.8155 (.3665)	C=5.767 (.0163)	C=112.0 (.0001)
DIAM3	C=13.04 (.0003)	C=114.2 (.0001)	C=46.56 (.0001)	C=2.744 (.0976)	C=12.62 (.0004)	C=5.472 (.0193)	C=.2174 (.6410)	C=4.928 (.0264)
DIAM4	C=6.917 (.0085)	C=47.19 (.0001)	C=13.90 (.0002)	C=.1193 (.7298)	C=3.801 (.0510)	C=9.207 (.0024)	C=.8979 (.3433)	C=8.662 (.0032)
LOOP 610	C=.1962 (.6578)	C=.4089 (.5225)	C=2.634 (.1045)	C=125.5 (.0001)	C=2.908 (.0881)	C=.7408 (.3894)	C=.4039 (.5251)	C=.8691 (.3512)
AGE	T=-1.11 (.2718)	T=.53 (.5989)	T=-.22 (.8251)	T=.85 (.3931)	T=.81 (.4192)	T=-1.09 (.2756)	T=.61 (.5481)	T=.20 (.8399)

[shaded box] = Indicates significance at p=<.05

Sewer

	M_ABS	M_CGMP	M_CI	M_CLAY	M_CONC	M_DI	M_MRC
DIAM1	C=8.398 (.0038)	C=9.590 (.0020)	C=16.42 (.0001)	C=16.27 (.0001)	C=.9699 (.3247)	C=30.42 (.0001)	C=.3285 (.5665)
DIAM2	C=20.20 (.0001)	C=2.714 (.0995)	C=30.51 (.0001)	C=4.087 (.0432)	C=6.930 (.0085)	C=24.05 (.0001)	C=1.926 (.1650)
DIAM3	C=72.74 (.0001)	C=1.757 (.1850)	C=91.23 (.0001)	C=16.11 (.0001)	C=11.25 (.0008)	C=83.53 (.0001)	C=.7167 (.3972)
DIAM4	C=14.75 (.0001)	C=.1295 (.7189)	C=14.86 (.0001)	C=3.136 (.0766)	C=5.874 (.0154)	C=32.63 (.0001)	C=45.84 (.0001)
LOOP 610	C=10.36 (.0013)	C=.4006 (.5268)	C=8.169 (.0043)	C=.1278 (.7207)	C=.1202 (.7288)	C=2.556 (.1098)	C=2.140 (.1434)
AGE	T=1.85 (.0649)	T=-.17 (.8686)	T=1.61 (.1072)	T=.38 (.7045)	T=1.16 (.2461)	T=1.02 (.3085)	T=-.05 (.9634)

= Indicates significance at p=<.05

Sewer

	M_PVC	M_RCP	M_STL	DIAM1	DIAM2	DIAM3	DIAM4	LOOP 610
DIAM3	C=18.34 (.0001)	C=35.23 (.0001)	C=23.41 (.0001)	C=16.91 (.0001)	C=34.03 (.0001)			
DIAM4	C=3.625 (.0569)	C=25.04 (.0001)	C=2.186 (.1392)	C=1.636 (.2008)	C=18.34 (.0001)	C=25.04 (.001)		
LOOP 610	C=1.142 (.2851)	C=3.423 (.0643)	C=.9742 (.3236)	C=.0274 (.8686)	C=2.869 (.0903)	C=5.287 (.0215)	C=.6803 (.4095)	
AGE	T=2.90 (.0039)	T=.75 (.4537)	T=-.16 (.8704)	T=1.13 (.2589)	T=.46 (.6429)	T=.54 (.5921)	T=.05 (.9612)	T=2.58 (.0103)

B=Kendall's Tau B T=T-test C=Chi-square K=Kruskal-Wallis

= Indicates significance at p=<.05

APPENDIX D: COMPLETE DECISION RULES MULTIVARIATE ANALYSIS

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Water 1992					
WWO92	.6064	.0008	1.834	(1.284	2.618)
T_MAIN	.7581	.1880	2.134	(.690	6.599)
T_COLL	-.7749	.1831	.461	(.147	1.442)
T_HYDL	-.4395	.4475	.644	(.207	2.003)
T_FIRE	.2129	.5302	1.237	(.636	2.405)
M_CI	-.1021	.7888	.903	(.428	1.906)
M_CONC	-3.1172	.0047	.044	(.005	.385)
M_COP	.1102	.7819	1.116	(.512	2.436)
M_DI	.0769	.8345	1.080	(.525	2.221)
M_GALV	.4995	.2857	1.648	(.659	.4123)
M_AC	-.3529	.3226	0.703	(.349	1.414)
M_PVC	.2709	.4441	1.311	(.655	2.624)
M_SRC	.5371	.4358	1.711	(.443	6.607)
M_STL	1.2660	.0369	3.547	(1.080	11.645)
DIAM1	-.1552	.7266	0.856	(.359	2.044)
DIAM2	.1872	.7515	1.206	(.378	3.842)
DIAM3	-.2749	.6008	0.760	(.271	2.127)
DIAM4	-.3486	.3185	.706	(.356	1.400)
DIAM5	.6952	.0352	2.004	(1.049	3.827)
LOOP 610	1.3310	.0021	3.785	(1.620	8.844)
AGE	.0036	.7759	1.004	(.979	1.029)
-2 Log Likelihood		Likelihood Ratio		*Score*	
intercept only	363.941	Chi-square	85.9509	Chi-square	76.8191
with covariates	277.990	p-value	.0001	p-value	.0001

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Water 1993					
WWO93	.3433	.1454	1.410	(.888	2.237)
T_MAIN	-.4837	.4845	.617	(.159	2.392)
T_COLL	.2254	.7127	1.253	(.377	4.158)
T_HYDL	-.1277	.8572	.880	(.219	3.538)
T_FIRE	.4563	.2755	1.578	(.695	3.583)
M_CI	-.3073	.5175	.735	(.290	1.865)
M_CONC	.1572	.8241	1.170	(.293	4.680)
M_COP	-.2469	.6109	.781	(.302	2.022)
M_DI	-.8487	.0926	.428	(.159	1.151)
M_GALV	.7538	.1584	2.125	(.746	6.057)
M_AC	.7704	.0853	2.161	(.898	5.196)
M_PVC	-.1730	.6781	.841	(.372	1.904)
M_SRC	-.1955	.8159	.822	(.159	4.264)
M_STL	-.0448	.9389	.956	(.304	3.009)
DIAM1	.3529	.5115	1.423	(.496	4.081)
DIAM2	.5699	.4254	1.768	(.436	7.178)
DIAM3	-.4707	.4627	.625	(.178	2.193)
DIAM4	.7566	.0762	2.131	(.923	4.918)
DIAM5	.3699	.3664	1.448	(.649	3.230)
LOOP 610	1.0330	.0525	2.809	(.989	7.983
Age	.0285	.0380	1.029	(1.003	1.056)
-2 Log Likelihood		*Likelihood Ratio*		*Score*	
intercept only	232.637	Chi-square	19.6973	Chi-square	20.4805
with covariates	212.940	p-value	.0002	p-value	.0001

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Water 1994					
WWO94	-.2012	.3289.	.818	(.546	1.225)
T_MAIN	-1.1525	.0667	.316	(.092	1.082)
T_COLL	.1856	.7179	1.204	(.440	3.295)
T_HYDL	.1636	.7689	1.178	(.396	3.506)
T_FIRE	.4652	.1985	1.592	(.784	3.236)
M_CI	.1550	.6989	1.168	(.533	2.560)
M_CONC	-.3028	.6608	.739	(.191	2.857)
M_COP	.1207	.7678	1.128	(.506	2.514)
M_DI	.1322	.7238	1.141	(.548	2.376)
M_GALV	1.5473	.0012	4.699	(1.838	12.014)
M_AC	-.4067	.2859	.666	(.315	1.405)
M_PVC	1.0099	.0096	2.745	(1.279	5.893)
M_SRC	-.2590	.7402	.772	(.167	3.566)
M_STL	.3595	.5126	1.433	(.488	4.203)
DIAM1	.0383	.9344	1.039	(.417	2.587)
DIAM2	1.5189	.0084	4.567	(1.477	14.126)
DIAM3	-.2881	.6037	.750	(.253	2.225)
DIAM4	.2155	.5676	1.241	(.592	2.598)
DIAM5	-.3090	.3997	.734	(.358	1.507)
LOOP 610	.1519	.7335	1.164	(.485	2.791)
AGE	-.00663	.6438	.993	(.966	1.022)
-2 Log Likelihood		*Likelihood Ratio*		*Score*	
intercept only	290.739	Chi-square	34.85	Chi-square	35.10
with covariates	255.880	p-value	.0001	p-value	.0001

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Water 1995					
WWO955	.0731	.6744	1.076	.765	1.513
T_MAIN	.2634	.6624	1.301	.399	4.247
T_COLL	-.5324	.3230	.587	.204	1.688
T_HYDL	-.0662	.9090	.936	.301	2.911
T_FIRE	.1225	.7304	1.130	.563	2.269
M_CI	-.5776	.1365	.561	.262	1.201
M_CONC	.9809	.0545	2.667	.981	7.247
M_COP	.1928	.6569	1.213	.518	2.840
M_DI	-.3860	.3173	.680	.319	1.448
M_GALV	.3985	.3880	1.490	.603	3.681
M_AC	-.5912	.1160	.554	.265	1.157
M_PVC	.9997	.0081	2.717	1.297	5.693
M_SRC	-.5773	.4974	.561	.106	2.974
M_STL	.9348	.1296	2.547	.760	8.532
DIAM1	.9370	.0373	2.552	1.057	6.165
DIAM2	.6417	.2415	1.900	.649	5.559
DIAM3	-.4635	.3926	.629	.217	1.821
DIAM4	-.2728	.4654	.761	.366	1.584
DIAM5	.4038	.2450	1.497	.758	2.958
LOOP 610	-1.0826	.0296	.339	.128	.898
AGE	.0398	.0108	.961	.932	.991
-2 Log Likelihood		*Likelihood Ratio*		*Score*	
intercept only	309.119	Chi-square	36.8278	Chi-square	35.4732
with covariates	272.292	p-value	.0001	p-value	.0001

	Estimate	(p-value)	Odds Ratio	Confidence Intervals
Water 1996				
WWO96	.0213	.9224	1.021	(.666 1.567)
T_MAIN	-.3185	.6707	.727	(.167 3.157)
T_COLL	-.0569	.9291	.942	(.253 3.502)
T_HYDL	1.3272	.0962	3.770	(.790 18.005)
T_FIRE	.6131	.1682	1.846	(.772 4.415)
M_CI	.7899	.1446	2.203	(.762 6.368)
M_CONC	.2740	.6720	1.315	(.370 4.675)
M_COP	-.1888	.7252	.828	(.289 2.373)
M_DI	-1.0943	.0640	.335	(.105 1.066)
M_GALV	-1.5123	.0248	.220	(.059 0.825)
M_AC	.0192	.9695	1.019	(.381 2.728)
M_PVC	-1.7458	.0007	.175	(.063 0.480)
M_SRC	-1.0032	.4047	.367	(.035 3.883)
M_STL	.0206	.9766	1.021	(.258 4.043)
DIAM1	1.0092	.0758	2.744	(.901 8.358)
DIAM2	-1.3999	.0734	.247	(.053 1.142)
DIAM3	1.4100	.0496	4.096	(1.003 16.735)
DIAM4	.1239	.7852	1.132	(.464 2.759)
DIAM5	.4084	.3299	1.504	(.661 3.422)
LOOP 610	1.8123	.0096	6.124	(1.644 22.817)
AGE	.0106	.4937	1.011	(.980 1.042)

-2 Log Likelihood		*Likelihood Ratio*		*Score*	
intercept only	218.704	Chi-square	43.8190	Chi-square	38.4342
with covariates	174.885	p-value	.0025	p-value	.0015

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Water 1997					
WWO97	.2866	.0861	1.332	(.960	1.874)
T_MAIN	.2155	.7206	1.241	(.381	4.041)
T_COLL	.1744	.7111	1.190	(.473	2.995)
T_HYDL	.3699	.5145	1.448	(.476	4.402)
T_FIRE	.4191	.2106	1.521	(.789	2.930)
M_CI	.2377	.5376	1.268	(.596	2.701)
M_CONC	-.6895	.2809	.502	(.143	1.757)
M_COP	-.1976	.6327	.821	(.365	1.846)
M_DI	.3145	.3800	1.370	(.679	2.764)
M_GALV	.5563	.1766	1.744	(.778	3.908)
M_AC	.2957	.4135	1.344	(.662	2.730)
M_PVC	.2116	.5478	1.236	(.620	2.463)
M_SRC	-1.6360	.1342	.195	(.023	1.657)
M_STL	.3051	.5343	1.357	.518	3.552
DIAM1	1.2769	.0029	3.586	1.549	8.300
DIAM2	-.9684	.0871	0.380	.125	1.151
DIAM3	-.7948	.1357	0.452	.159	1.283
DIAM4	.0920	.7954	1.096	.547	2.198
DIAM5	-.0242	.9426	0.976	.506	1.884
LOOP 610	-.9984	.0300	0.368	.150	0.908
AGE	-.0255	.0907	0.978	.953	1.004

-2 Log Likelihood		*Likelihood Ratio*		*Score*	
intercept only	316.163	Chi-square	22.7035	Chi-square	22.2134
with covariates	293.460	p-value	.0001	p-value	.0001

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Water 1998					
WWO98	.4132	.0460	1.512	1.007	2.269
T_MAIN	-.9627	.1713	.382	.096	1.517
T_COLL	-.1292	.8416	.879	.247	3.122
T_HYDL	.4471	.5326	1.564	.384	6.369
T_FIRE	.1483	.7320	1.160	.496	2.711
M_CI	.2585	.5889	1.295	.507	3.307
M_CONC	-.3244	.6869	.723	.149	3.502
M_COP	-.2480	.6563	.780	.262	2.326
M_DI	-.0869	.8513	.917	.370	2.274
M_GALV	-.4404	.4737	.644	.193	2.148
M_AC	.1647	.7207	1.179	.478	2.908
M_PVC	.0428	.9227	1.044	.440	2.476
M_SRC	.3842	.6416	1.469	.291	7.405
M_STL	-.2169	.7123	.805	.254	2.549
DIAM1	.5640	.2708	1.758	.644	4.796
DIAM2	.4379	.5336	1.549	.390	6.149
DIAM3	.4023	.5468	1.495	.404	5.534
DIAM4	-.1944	.6629	.823	.344	1.973
DIAM5	.2261	.5885	1.254	.553	2.844
LOOP 610	.2703	.6622	1.310	.390	4.407
AGE	-.0262	.1497	.974	.940	1.009
-2 Log Likelihood		*Likelihood Ratio*		*Score*	
intercept only	209.077	Chi-square	6.8556	Chi-square	6.573
with covariates	202.221	p-value	.0088	p-value	.0099

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Water 1999					
WWO99	1.0274	.0005	2.794	1.572	4.964
T_MAIN	-.1359	.8742	.873	.162	4.695
T_COLL	.2045	.7653	1.227	.320	4.698
T_HYDL	-2.3048	.0064	.100	.019	.523
T_FIRE	1.3069	.0136	3.695	1.309	10.430
M_CI	.5731	.3041	1.774	.595	5.291
M_CONC	.5093	.5050	1.664	.372	7.439
M_COP	-2.1125	.0032	.121	.030	.493
M_DI	.8561	.1017	2.354	.844	6.563
M_GALV	.3167	.6211	1.373	.391	4.819
M_AC	-.3805	.4955	.684	.229	2.041
M_PVC	-.1840	.7197	.832	.305	2.273
M_SRC	1.2971	.1337	3.659	.672	19.933
M_STL	-1.1369	.1042	.321	.081	1.264
DIAM1	.2358	.6992	1.266	.383	4.186
DIAM2	.5343	.4929	1.706	.371	7.857
DIAM3	1.1570	.1659	3.180	.619	16.342
DIAM4	.1612	.7541	1.175	.429	3.220
DIAM5	.1125	.8156	1.119	.435	2.879
LOOP 610	.3281	.6131	1.388	.389	4.953
AGE	-.0300	.0903	.968	.931	1.005

-2 Log Likelihood		*Likelihood Ratio*		*Score*	
intercept only	194.086	Chi-square	30.3965	Chi-square	28.5495
with covariates	163.690	p-value	.0001	p-value	.0001

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Sewer 1992					
SW092	.1369	.3945	1.150	.834	1.585
T_CASE	.1668	.8137	1.181	.295	4.731
T_COLL	.1975	.7180	1.218	.417	3.559
T_FM	-.4093	.3893	.664	.262	1.686
T_LATL	.4905	.3138	1.633	.629	4.241
T_OF	-.1630	.6937	.850	.377	1.912
T_SIPH	.0859	.8598	1.090	.420	2.828
T_SLDG	.6319	.3166	1.881	.546	6.479
T_STUB	.1125	.7919	1.119	.485	2.580
M_ABS	-1.2061	.0073	.299	.124	0.722
M_CGMP	.9091.	.0895	2.482	.869	7.088
M_CI	.0835	.8407	1.087	.482	2.454
M_CLAY	-.3869	.6533	.679	.125	3.675
M_CONC	-.1833	.6196	.833	.404	1.717
M_DI	-.2237	.6142	.800	.335	1.908
M_MRC	-.5229	.2097	.593	.262	1.342
M_PVC	.1212	.7457	1.129	.543	2.347
M_RCP	.7188	.0610	2.052	.967	4.353
M_STL	.4238	.6764	1.528	.209	11.179
DIAM1	-.2862	.5079	.751	.322	1.753
DIAM2	-.1272	.8008	.881	.328	2.364
DIAM3	.9595	.0503	2.610	.999	6.822
DIAMR	.1801	.6608	1.197	.536	2.676
LOOP 610	1.2221	.0108	3.394	1.326	8.687
AGE	-.00700	.6199	.993	.966	1.021

-2 Log Likelihood		*Likelihood Ratio*		*Score*	
intercept only	275.194	Chi-square	33.3533	Chi-square	34.9764
with covariates	241.840	p-value	.0001	p-value	.0001

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Sewer 1993					
SW093	.00665	.9724	1.007	.691	1.467
T_CASE	-.4521	.6162	.636	.109	3.728
T_COLL	.1306	.8385	1.139	.325	4.001
T_FM	.6381	.1770	1.893	.750	4.780
T_LATL	1.4161	.0052	4.121	1.527	11.122
T_OF	.3069	.4988	1.359	0.559	3.308
T_SIPH	.7418	.1386	2.100	.787	5.604
T_SLDG	.5681	.4311	1.765	0.429	7.259
T_STUB	-1.0846	.0336	0.338	0.124	0.919
M_ABS	.6600	.1612	1.935	0.769	4.871
M_CGMP	-1.8105	.0995	0.164	0.019	1.411
M_CI	-.1387	.7728	0.871	0.340	2.231
M_CLAY	.6427	.3814	1.902	.451	8.017
M_CONC	.8474	.0501	2.334	1.000	5.448
M_DI	-.4481	.3714	.639	0.239	1.707
M_MRC	-.6688	.1436	.512	0.209	1.256
M_PVC	-.2441	.5652	.783	0.341	1.800
M_RCP	.1783	.6860	1.195	0.504	2.837
M_STL	-.6742	.5425	.510	.058	4.461
DIAM1	-.2686	.5902	.764	0.288	2.032
DIAM2	.5452	.3783	1.725	0.513	5.801
DIAM3	-.2108	.7019	.810	0.275	2.384
DIAMR	-.2812	.5488	.755	0.301	1.893
LOOP 610	.5384	.2672	1.713	0.662	4.434
AGE	.0287	.0429	1.029	1.001	1.058

-2 Log Likelihood		*Likelihood Ratio*		*Score*	
intercept only	232.637	Chi-square	20.6564	Chi-square	20.6564
with covariates	211.981	p-value	.0001	p-value	.0001

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Sewer 1994					
SW094	.4612	.0657	1.586	.971	2.592
T_CASE	-.1558	.8709	.856	.131	5.598
T_COLL	.1823	.8185	1.200	.253	5.697
T_FM	-.2713	.6752	.762	.214	2.712
T_LATL	-.0370	.9501	.964	.302	3.073
T_OF	-.4689	.4093	.626	.205	1.906
T_SIPH	-.6076	.3967	.545	.134	2.220
T_SLDG	-11.5552	.9320	<.001	<.001	>999.999
T_STUB	-.2909	.6249	.748	.233	2.399
M_ABS	-1.6787	.0117	.187	.051	0.688
M_CGMP	.3739	.6141	1.453	.340	6.216
M_CI	-.7044	.2371	.494	.154	1.589
M_CLAY	-10.2626	.9525	<.001	<.001	>999.999
M_CONC	.9325	.0728	2.541	.917	7.036
M_DI	.3468	.5528	1.415	.450	4.447
M_MRC	-.2151	.7017	.806	.268	2.424
M_PVC	-.2318	.6709	.793	.272	2.311
M_RCP	-.0756	.8856	.927	.331	2.597
M_STL	11.3652	.9475	>999.999	<.001	>999.999
DIAM1	.7413	.1973	2.099	.680	6.477
DIAM2	-.3944	.5857	.674	.163	2.783
DIAM3	.5413	.4070	1.718	.478	6.175
DIAMR	-.5022	.3810	.605	.197	1.862
LOOP 610	.5298	.4044	1.699	.489	5.902
AGE	.0105	.5982	1.011	.972	1.051

-2 Log Likelihood		*Likelihood Ratio*		*Score*	
intercept only	172.965	Chi-square	13.5877	Chi-square	12.4164
with covariates	159.378	p-value	.0011	p-value	.0020

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Sewer 1995					
SW095	.1908	.3662	1.210	.800	1.830
T_CASE	1.2972	.1125	3.695	.737	18.156
T_COLL	-1.1617	.0915	.313	.081	1.206
T_FM	-.2021	.7114	.817	.280	2.383
T_LATL	.2513	.6157	1.286	.482	3.429
T_OF	-.0498	.9212	.951	.354	2.554
T_SIPH	-.3505	.5704	.704	.210	2.363
T_SLDG	.0378	.9655	1.038	.188	5.748
T_STUB	-.0439	.9335	.957	.341	2.686
M_ABS	-.0324	.9474	.968	.369	2.537
M_CGMP	.5825	.3742	1.790	.495	6.470
M_CI	.2049	.6860	1.227	.454	3.315
M_CLAY	.2872	.7438	1.333	.238	7.461
M_CONC	-.2886	.5101	.749	.317	1.769
M_DI	-.5107	.3315	.600	.214	1.682
M_MRC	.6457	.1616	1.907	.772	4.710
M_PVC	.1759	.6942	1.192	.496	2.865
M_RCP	-.4493	.3376	.638	.255	1.599
M_STL	-.8109	.4448	.444	.056	3.557
DIAM1	-.7043	.1885	.494	.173	1.413
DIAM2	.5431	.4046	1.721	.480	6.173
DIAM3	1.4796	.0112	4.391	1.399	13.783
DIAMR	-.6664	.1887	.514	.190	1.387
LOOP 610	-.3210	.5618	.725	.245	2.146
AGE	-.00215	.8942	.998	.967	1.030
-2 Log Likelihood		*Likelihood Ratio*		*Score*	
intercept only	199.160	Chi-square	NA	Chi-square	NA
with covariates	NA	p-value	NA	p-value	NA

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Sewer 1996					
SW096	.1342	.5153	1.144	(.763	1.714)
T_CASE	.2421	.7660	1.274	(.259	6.275)
T_COLL	-1.3521	.0575	.259	(.064	1.044)
T_FM	.6208	.2351	1.860	(.668	5.184)
T_LATL	.0271	.9623	1.028	(.334	3.165)
T_OF	-.0920	.8604	.912	(.327	2.542)
T_SIPH	1.1598	.0180	3.189	(1.220	8.340)
T_SLDG	1.4154	.0456	4.118	(1.028	16.500)
T_STUB	.9410	.0871	2.562	(.872	7.529)
M_ABS	.5732	.2676	1.774	(.644	4.887)
M_CGMP	-.1017	.9084	.903	(.160	5.109)
M_CI	-.3028	.5578	.739	(.268	2.034)
M_CLAY	-.6392	.5713	.528	(.058	4.824)
M_CONC	-.8884	.0483	.411	(.170	.993)
M_DI	.3172	.5195	1.373	(.523	3.605)
M_MRC	.4475	.3521	1.564	(.610	4.015)
M_PVC	-.0529	.9072	.948	(.390	2.308)
M_RCP	.1967	.6728	1.217	(.489	3.034)
M_STL	.4296	.7422	.651	(.050	8.418)
DIAM1	-.5869	.2495	.556	(.205	1.510)
DIAM2	-.2877	.6470	.750	(.219	2.569)
DIAM3	1.2004	.0439	3.321	(1.034	10.673)
DIAMR	-.5179	.3139	.596	(.217	1.632)
LOOP 610	1.0872	.0579	2.966	(.964	9.124)
AGE	-.00109	.9502	.999	(.965	1.034)
-2 Log Likelihood		*Likelihood Ratio*		*Score*	
intercept only	199.160	Chi-square	8.4252	Chi-square	9.4295
with covariates	190.734	p-value	.0148	p-value	.0090

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Sewer 1997					
SW097	.4273	.0083	1.533	(1.116	2.106)
T_CASE	.8237	.2032	2.279	(.641	8.104)
T_COLL	.1202	.8127	1.128	(.417	3.048)
T_FM	-.0219	.9581	.978	(.433	2.213)
T_LATL	-.0103	.9800	.990	(.441	2.220)
T_OF	.1163	.7625	1.123	(.528	2.389)
T_SIPH	-.4027	.3962	.668	(.264	1.695)
T_SLDG	-.7222	.3026	.486	(.123	1.917)
T_STUB	.2895	.4750	1.336	(.604	2.956)
M_ABS	-.4479	.2656	.639	(.290	1.406)
M_CGMP	-.1274	.8215	.880	(.291	2.663)
M_CI	-.0888	.8215	.915	(.423	1.979)
M_CLAY	.3463	.5883	1.414	(.404	4.953)
M_CONC	.0679	.8420	1.070	(.549	2.087)
M_DI	.0777	.8444	1.081	(.497	2.349)
M_MRC	.6572	.0738	1.929	(.939	3.966)
M_PVC	-.3823	.2773	.682	(.342	1.360)
M_RCP	-.1134	.7467	.893	(.449	1.777)
M_STL	-.5607	.5152	.571	(.105	3.089)
DIAM1	.0395	.9202	1.040	(.480	2.255)
DIAM2	-.1969	.6826	.821	(.320	2.110)
DIAM3	-.5306	.2445	.588	(.241	1.438)
DIAMR	.1077	.7813	1.114	(.521	2.382)
LOOP 610	-.1177	.7899	.889	(.374	2.113)
AGE	-.0203	.1490	.980	(.953	1.007)
-2 Log Likelihood		*Likelihood Ratio*		*Score*	
intercept only	294.506	Chi-square	18.1679	Chi-square	17.5063
with covariates	267.338	p-value	.0004	p-value	.0006

	Estimate	(p-value)	Odds Ratio	Confidence Intervals
Sewer 1998				
SW098	.2041	.3373	1.226	(.808 1.861)
T_CASE	.4081	.6916	1.504	(.200 11.295)
T_COLL	2.8248	.0006	16.857	(3.355 84.686)
T_FM	.6846	.2331	.504	(.164 1.554)
T_LATL	.3885	.5737	1.475	(.431 5.042)
T_OF	.7297	.2150	.482	(.152 1.528)
T_SIPH	.9426	.0860	2.567	(.875 7.529)
T_SLDG	.2880	.7492	1.334	(.228 7.797)
T_STUB	-.6921	.2578	.501	(.151 1.660
M_ABS	.8213	.1462	2.274	(.751 6.885)
M_CGMP	1.1837	.0812	3.267	(.863 12.358)
M_CI	.4178	.4754	1.519	(.482 4.783)
M_CLAY	.0881	.9201	1.092	(.195 6.111)
M_CONC	.0551	.9108	1.057	(.403 2.768)
M_DI	-.5678	.3220	.567	(.184 1.743)
M_MRC	.2024	.7131	1.224	(.416 3.601)
M_PVC	-.2335	.6452	.792	(.293 2.139)
M_RCP	.0874	.8642	1.091	(.401 2.971)
M_STL	-.4085	.7472	.665	(.055 7.967)
DIAM1	-.0754	.8902	.927	(.318 2.707)
DIAM2	-.3716	.6001	.690	(.172 2.767)
DIAM3	-.9792	.1353	.376	(.104 1.358)
DIAMR	-.5314	.3851	.588	(.177 1.950)
LOOP 610	-.6603	.3614	.517	(.1252 .133)
AGE				

-2 Log Likelihood		*Likelihood Ratio*		*Score*	
intercept only	183.698	Chi-square	17.2211	Chi-square	17.5990
with covariates	166.476	p-value	.0002	p-value	.0002

	Estimate	(p-value)	Odds Ratio	Confidence Intervals	
Sewer 1999					
SW099	.5908	.0167	1.805	1.114	2.925
T_CASE	-.2925	.1871	..275	.040	1.873
T_COLL	-.5755	.4567	.562	.124	2.560
T_FM	-.4544	.4629	.635	.189	2.136
T_LATL	-.2215	.7459	.801	.210	3.060
T_OF	-.1302	.8130	.878	.298	2.583
T_SIPH	.8977	.1304	2.454	.767	7.852
T_SLDG	.7075	.3616	2.029	.444	9.276
T_STUB	.4346	.4744	1.544	469	5.080
M_ABS	-1.0503	.1350	.350	.088	1.387
M_CGMP	.7000	.3374	2.014	.482	8.417
M_CI	-.2723	.6467	.762	.238	2.441
M_CLAY	.8167	.3314	2.263	.4361	1.760
M_CONC	-.5833	.2548	.558	.205	1.523
M_DI	-1.1312	.0751	.323	.093	1.121
M_MRC	.5509	.3228	1.735	.582	5.171
M_PVC	.7322	.1642	2.080	.741	5.835
M_RCP	.6389	.2147	1.894	.690	5.197
M_STL	-.1908	.8629	.826	.095	7.199
DIAM1	1.4067	.0162	4.083	1.297	12.847
DIAM2	.4479	.5382	1.565	.376	6.515
DIAM3	-.1658	.8003	.847	.234	3.061
DIAMR	.1372	.8197	1.147	.353	3.730
LOOP 610	.3432	.6197	1.409	.364	5.464
AGE	-.0292	.2009	.971	.929	1.016

-2 Log Likelihood		*Likelihood Ratio*		*Score*	
intercept only	183.698	Chi-square	20.7120	Chi-square	19.5195
with covariates	162.985	p-value	.0001	p-value	.0002

APPENDIX E: BIVARIATE ASSOCIATION OF POLITICAL VARIABLES

Water

1992

	ACTIVE	TEN	STABLE	VOTE
ACTIVE		C=-.0170 (.7419)	K=2.463 (.2918)	K=9.388 (.0246)
TEN			B=.0224 (.6284)	B=.0787 (.4946)
STABLE				B=.0393 (.7262)
DISTA	C=.085 (.7701)	K=142.7 (.0001)	K=2.018 (.3645)	K=1.268 (.7367)
DISTB	C=2.493 (.1143)	K=18.18 (.0001)	K=.7925 (.6728)	K=1.153 (.7642)
DISTC	C=.6307 (.4271)	K=15.15 (.0001)	K=1.657 (.4367)	K=6.043 (.1095)
DISTD	C=.0210 (.8847)	K=177.4 (.0001)	K=.4908 (.7824)	K=3.011 (.3899)
DISTE	C=2.674 (.1020)	K=13.47 (.0002)	K=5.613 (.0604)	K=2.691 (.4416)
DISTF	C=.0151 (.9022)	K=8.291 (.0040)	K= 1.018 (.6010)	K=3.266 (.3523)
DISTG	C=.0021 (.9633)	K=14.72 (.0001)	K= 1.660 (.4360)	K=2.604 (.4667)
DISTH	C=1.373 (.2413)	K=21.80 (.0001)	K= 1.084 (.5814)	K=2.205 (.5309)
DISTI	C=.6307 (.4271)	K=15.15 (.0001)	K= .6105 (.7369)	K=3.676 (.2986)

1993

	ACTIVE	TEN	STABLE	VOTE
ACTIVE		C=.0515(.6079)	K=2.347 (.3092)	K=10.84 (.0126)
TENURE			B=-.0387 (.4360)	B=-.165 (.1381)
STABLE				B=.0448 (.6901)
DISTA	C=.0475 (.8276)	K=142.7 (.0001)	K=2.018 (.3645)	K=1.709 (.6347)
DISTB	C=.0095 (.9225)	K=30.14 (.0001)	K=.7925 (.6728)	K=.7790 (.8445)
DISTC	C=.1506 (.6979)	K=25.11 (.0001)	K=1.657 (.4367)	K=4.601 (.2035)
DISTD	C=2.050 (.1521)	K=177.4 (.0001)	K=.4908 (.7824)	K=1.744 (.6271)
DISTE	C=2.898 (.0887)	K=22.34 (.0001)	K=5.613 (.0604)	K=4.417 (.2198)
DISTF	C=.0308 (.8606)	K=13.74 (.0010)	K=1.018 (.6010)	K=3.923 (.2699)
DISTG	C=.0135 (.9073)	K=24.41 (.0001)	K= 1.660 (.4360)	K=2.957 (.3982)
DISTH	C=5.079 (.0242)	K=36.15 (.0001)	K= 1.084 (.5814)	K=2.503 (.4747)
DISTI	C=.1506 (.6979)	K=374.0 (.0001)	K= .6105 (.7369)	K=3.046 (.3845)

1994

	ACTIVE	TEN	STABLE	VOTE
ACTIVE		C=.1086(.8170)	K=2.214 (.3304)	K=8.828 (.0317)
TENURE			B=-.0387 .4360)	B=-.157 (.1573)
STABLE				B=-.018 (.8709)
DISTA	C=.2938 (.5878)	K=142.7 (.0001)	K=2.018 (.3645)	K=2.413 (.4912)
DISTB	C=.1675 (.6823)	K=30.14 (.0001)	K=.7925 (.6728)	K=.8694 (.8328)
DISTC	C=.5223 (.4699)	K=25.11 (.0001)	K=1.657 (.4367)	K=3.753 (.2893)
DISTD	C=.6962 (.4041)	K=177.4 (.0001)	K=.4908 (.7824)	K=1.592 (.6610)
DISTE	C=1.827 (.1764)	K=22.34 (.0001)	K=5.613 (.0604)	K=2.879 (.4106)
DISTF	C=.3673 (.5445)	K=13.74 (.0010)	K=1.018 (.6010)	K=3.571 (.3116)
DISTG	C=.3139 (.5753)	K=24.41 (.0001)	K= 1.660 (.4360)	K=1.001 (.2613)
DISTH	C=.6306 (.4271)	K=36.15 (.0001)	K= 1.084 (.5814)	K=2.407 (.4923)
DISTI	C=.1506 (.6979)	K=374.0 (.0001)	K= .6105 (.7369)	K=2.580 (.4609)

= Indicates significance at p=<.05

1995

	ACTIVE	TEN	STABLE	VOTE
ACTIVE		C=.0345(.7999)	K=2.347 (.3092)	K=8.10 (.0457)
TENURE			B=-.0599 (.2255)	B=.1502 (.1788)
STABLE				B=-.018 (.8709)
DISTA	C=.0475 (.8276)	K=346.4 (.0001)	K=2.018 (.3645)	K=2.413 (.4912)
DISTB	C=.1675 (.6823)	K=44.92 (.0001)	K=.7925 (.6728)	K=.8694 (.8328)
DISTC	C=.0029 (.9573)	K=37.43 (.0001)	K=1.657 (.4367)	K=3.753 (.2893)
DISTD	C=.0560 (.8129)	K=120.4 (.0001)	K=.4908 (.7824)	K=1.592 (.6610)
DISTE	C=1.827 (.1764)	K=73.15 (.0001)	K=5.613 (.0604)	K=2.879 (.1406)
DISTF	C=1.074 (.3000)	K=20.48 (.0001)	K=1.018 (.6010)	K=3.571 (.3116)
DISTG	C=.0135 (.9073)	K=36.38 (.0001)	K= 1.660 (.4360)	K=4.001 (.2613)
DISTH	C=3.849 (.0498)	K=53.88 (.0001)	K= 1.084 (.5814)	K=2.407 (.4923)
DISTI	C=.1506 (.6979)	K=77.16 (.0001)	K= .6105 (.7369)	K=2.580 (.4609)

1996

	ACTIVE	TEN	STABLE	VOTE
ACTIVE		C=.0982 (.1641)	K=1.906 (.3855)	K=6.828 (.0776)
TENURE			B=-.0599(.2255)	B=.1246 (.2644)
STABLE				B=.0000 (1.000)
DISTA	C=.3355 (.5625)	K=346.4 (.0001)	K=2.018 (.3645)	K=2.500 (.4717)
DISTB	C=.988 (.3202)	K=44.92 (.0001)	K=.7925 (.6728)	K=.8146 (.8460)
DISTC	C=.0080 (.9289)	K=37.43 (.0001)	K=1.657 (.4367)	K=3.686 (.2973)
DISTD	C=1.934 (.1643)	K=120.4 (.0001)	K=.4908 (.7824)	K=.9268 (.8189)
DISTE	C=2.785 (.0951)	K=73.15 (.0001)	K=5.613 (.0604)	K=2.252 (.5217)
DISTF	C=.0223 (.8814)	K=20.48 (.0001)	K=1.018 (.6010)	K=4.333 (.2276)
DISTG	C=.8721 (.3501)	K=36.38 (.0001)	K= 1.660 (.4360)	K=3.878 (.2749)
DISTH	C=5.275 (.0216)	K=53.88 (.0001)	K= 1.084 (.5814)	K=6.399 (.0937)
DISTI	C=.0080 (.9289)	K=77.16 (.0001)	K= .6105 (.7369)	K=3.567 (.3122)

1997

	ACTIVE	TEN	STABLE	VOTE
ACTIVE		C=.1004(.1510)	K=.2328 (.8901)	K=6.915 (.0745)
TENURE			B=-.0068 (.8907)	B=.0442 (.6950)
STABLE				B=.2222 (.8440)
DISTA	C=1.506 (.2196)	K=374.0 (.0001)	K=2.018 (.3645)	K=2.674 (.4445)
DISTB	C=.0644 (.7997)	K=44.92 (.0001)	K=.7925 (.6728)	K=1.576 (.6648)
DISTC	C=.5752 (.4482)	K=37.43 (.0001)	K=1.657 (.4367)	K=4.863 (.1821)
DISTD	C=5.232 (.0222)	K=116.1 (.0001)	K=.4908 (.7824)	K=1.628 (.6529)
DISTE	C=2.785 (.0951)	K=76.64 (.0001)	K=5.613 (.0604)	K=3.400 (.3340)
DISTF	C=.3361 (.5621)	K=20.48 (.0001)	K=1.018 (.6010)	K=6.111 (.1063)
DISTG	C=.0661 (.7971)	K=36.38 (.0001)	K= 1.660 (.4360)	K=3.043 (.3849)
DISTH	C=.2970 (.5858)	K=53.88 (.0001)	K= 1.084 (.5814)	K=9.834 (.0200)
DISTI	C=2.038 (.1534)	K=86.17 (.0001)	K= .6105 (.7369)	K=3.110 (.3749)

= Indicates significance at p=<.05

1998

	ACTIVE	TEN	STABLE	VOTE
ACTIVE		C=.1692(.0047)	K=.7093 (.7014)	K=7.347 (.0616)
TENURE			B=-.0068 (.8907)	B=.0536 (.6348)
STABLE				B=.0139 (.9021)
DISTA	C=3.519 (.0607)	K=374.0 (.0001)	K=2.018 (.3645)	K=2.455 (.4835)
DISTB	C=.4653 (.4951)	K=44.92 (.0001)	K=.7925 (.6728)	K=2.092 (.5534)
DISTC	C=.0602 (.8062)	K=37.43 (.0001)	K=1.657 (.4367)	K=6.739 (.0807)
DISTD	C=6.688 (.0097)	K=116.1 (.0001)	K=.4908 (.7824)	K=1.951 (.5826)
DISTE	C=5.617 (.0178)	K=76.64 (.0001)	K=5.613 (.0604)	K=3.199 (.3619)
DISTF	C=.0791 (.7785)	K=20.48 (.0001)	K=1.018 (.6010)	K=6.111 (.1063)
DISTG	C=1.618 (.2033)	K=36.38 (.0001)	K=1.660 (.4360)	K=2.755 (.4308)
DISTH	C=4.019 (.0450)	K=53.88 (.0001)	K=1.084 (.5814)	K=9.899 (.0164)
DISTI	C=.1796 (.6717)	K=86.17 (.0001)	K= .6105 (.7369)	K=3.302 (.3472)

1999

	ACTIVE	TEN	STABLE	VOTE
ACTIVE		C=.1173(.0758)	K=1.871 (.3924)	K=10.60 (.0140)
TENURE			B=.0532 (.2830)	B=.0385 (.7319)
STABLE				B=-.001 (.9674)
DISTA	C=2.982 (.0841)	K=374.0 (.0001)	K=2.018 (.3645)	K=2.733 (.4346)
DISTB	C=.0461 (.8301)	K=44.92 (.0001)	K=.7925 (.6728)	K=2.669 (.4454)
DISTC	C=2.980 (.0843)	K=37.43 (.0001)	K=1.657 (.4367)	K=6.715 (.0815)
DISTD	C=.6962 (.4041)	K=116.1 (.0001)	K=.4908 (.7824)	K=2.326 (.5075)
DISTE	C=1.827 (.1764)	K=76.64 (.0001)	K=5.613 (.0604)	K=2.297 (.5131)
DISTF	C=.3673 (.5445)	K=20.48 (.0001)	K=1.018 (.6010)	K=4.818 (.1856)
DISTG	C=2.481 (.1152)	K=36.38 (.0001)	K=1.660 (.4360)	K=2.847 (.4158)
DISTH	C=.0442 (.8335)	K=53.88 (.0001)	K=1.084 (.5814)	K=7.470 (.0583)
DISTI	C=.5223 (.4699)	K=86.17 (.0001)	K= .6105 (.7369)	K=3.768 (.2876)

= Indicates significance at p=<.05

Sewer

1992

	ACTIVE	TEN	STABLE	VOTE
ACTIVE		C=-.121 (.0188)	K=2.184 (.3355)	K=5.949 (.1141)
TEN			B=.0249 (.6284)	B=.0787 (.4946)
STABLE				B=.0393 (.7262)
DISTA	C=1.030 (.3100)	K=142.7 (.0001)	K=.2018 (.3645)	K=.0999 (.7519)
DISTB	C=.3193 (.5720)	K=18.18 (.0001)	K=.7925 (.6728)	K=.5733 (.4489)
DISTC	C=.0191 (.8900)	K=15.15 (.0001)	K=1.657 (.4367)	K=1.858 (.1728)
DISTD	C= 4.087(.0432)	K=177.4 (.0001)	K=.4908 (.7824)	K=1.021 (.3123)
DISTE	C=.0174 (.8685)	K=13.47 (.0002)	K=5.613 (.0406)	K=.0730 (.7871)
DISTF	C=.8673 (.3517)	K=8.291 (.0040)	K=1.018 (.6010)	K=1.888 (.1694)
DISTG	C=2.782 (.0953)	K=14.72 (.0001)	K=1.660 (.4360)	K=1.364 (.2427)
DISTH	C=1.163 (.2807)	K=21.80 (.0001)	K=1.084 (.5814)	K=1.300 (.2541)
DISTI	C=1.441 (.2299)	K=15.15 (.0001)	K=.6015 (.7369)	K=1.940 (.1636)

1993

	ACTIVE	TEN	STABLE	VOTE
ACTIVE		C=.1396(.0258)	K=2.214 (.3458)	K=5.706 (.1268)
TENURE			B=-.0387(.4360)	B=-.181 (.1043)
STABLE				B=.0448 (.6901)
DISTA	C=.1018 (.7497)	K=57.37 (.0001)	K=.2018 (.3645)	K=.0998 (.7521)
DISTB	C=.0853 (.7702)	K=28.95 (.0001)	K=.7925 (.6728)	K=.0636 (.8009)
DISTC	C=.2453 (.6204)	K=24.10 (.0001)	K=1.657 (.4367)	K=2.158 (.1418)
DISTD	C=5.194 (.0227)	K=71.32 (.0001)	K=.4908 (.7824)	K=.5038 (.4778)
DISTE	C=.3024 (.5824)	K=21.43 (.0001)	K=5.613 (.0406)	K=.3247 (.5688)
DISTF	C=1.926 (.1651)	K=13.18 (.0003)	K=1.018 (.6010)	K=2.042 (.1530)
DISTG	C=7.389 (.0066)	K=23.42 (.0001)	K=1.660 (.4360)	K=1.440 (.2300)
DISTH	C=.0022 (.9627)	K=34.69 (.0001)	K=1.084 (.5814)	K=1.481 (.2235)
DISTI	C=3.363 (.0997)	K=148.4 (.0001)	K=.6015 (.7369)	K=2.127 (.1447)

1994

	ACTIVE	TEN	STABLE	VOTE
ACTIVE		C=.1600(.0082)	K=4.123 (.1273)	K=2.764 (.4293)
TENURE			B=-.0387 .4360)	B=-.1811(.1043)
STABLE				B=-.018 (.8709)
DISTA	C=1.50 (.2196)	K=57.37 (.0001)	K=.2018 (.3645)	K=.1849 (.6672)
DISTB	C=.4653 (.4951)	K=28.95 (.0001)	K=.7925 (.6728)	K=.0552 (.8142)
DISTC	C=.1796 (.6717)	K=24.10 (.0001)	K=1.657 (.4367)	K=3.005 (.0830)
DISTD	C=3.597 (.0579)	K=71.32 (.0001)	K=.4908 (.7824)	K=.7368 (.3907)
DISTE	C=1.738 (.1874)	K=21.43 (.0001)	K=5.613 (.0406)	K=.1757 (.6751)
DISTF	C=2.075 (.1497)	K=13.18 (.0003)	K=1.018 (.6010)	K=1.956 (.1618)
DISTG	C=2.058 (.1514)	K=23.42 (.0001)	K=1.660 (.4360)	K=1.724 (.1891)
DISTH	C=.3879 (.5334)	K=34.69 (.0001)	K=1.084 (.5814)	K=2.367 (.1239)
DISTI	C=2.038 (.1534)	K=148.4 (.0001)	K=.6015 (.7369)	K=1.779 (.1822)

= Indicates significance at p=<.05

1995

	ACTIVE	TEN	STABLE	VOTE
ACTIVE		C=.1131(.0907)	K=14.95 (.0600)	K=4.911 (.1784)
TENURE			B=-.059 (.2255)	B=.2041 (.0682)
STABLE				B=.0000 (1.000)
DISTA	C=.9563 (.3281)	K=139.7 (.0001)	K=.2018 (.3645)	K=.1849 (.6672)
DISTB	C=.0004 (.9841)	K=8.917 (.0028)	K=.7925 (.6728)	K=.0552 (.8142)
DISTC	C=.2453 (.6204)	K=7.430 (.0064)	K=1.657 (.4367)	K=3.005 (.0830)
DISTD	C=3.920 (.0477)	K=100.3 (.0001)	K=.4908 (.7824)	K=.7368 (.3907)
DISTE	C=1.565 (.2018)	K=57.94 (.0001)	K=5.613 (.0406)	K=.1757 (.6751)
DISTF	C=1.926 (.1651)	K=4.066 (.0437)	K=1.018 (.6010)	K=1.956 (.1618)
DISTG	C=-5.663 (.0173	K=7.223 (.0072)	K=1.660 (.4360)	K=1.724 (.1891)
DISTH	C=.2887 (.5910)	K=10.69 (.0011)	K=1.084 (.5814)	K=2.367 (.1239)
DISTI	C=2.248 (.1338)	K=58.17 (.0001)	K=.6015 (.7369)	K=1.779 (.1822)

1996

	ACTIVE	TEN	STABLE	VOTE
ACTIVE		C=.0646(.4571)	K=4.204 (.1222)	K=8.284 (.0405)
TENURE			B=-.0599 (.2255)	B=.2041(.0682)
STABLE				B=.0000 (1.000)
DISTA	C=.0010 (.9745)	K=139.7 (.0001)	K=.2018 (.3645)	K=.1396 (.7087)
DISTB	C=.0004 (.9847)	K=8.917 (.0028)	K=.7925 (.6728)	K=.1631 (.6863)
DISTC	C=.6307 (.4271)	K=7.430 (.0064)	K=1.657 (.4367)	K=2.836 (.0922)
DISTD	C=2.688 (.1011)	K=100.3 (.0001)	K=.4908 (.7824)	K=.4100 (.5220)
DISTE	C=.8726 (.3502)	K=57.94 (.0001)	K=5.613 (.0406)	K=.1025 (.7489)
DISTF	C=.3062 (.5800)	K=4.066 (.0437)	K=1.018 (.6010)	K=2.126 (.1448)
DISTG	C=4.311 (.3079)	K=7.223 (.0072)	K=1.660 (.4360)	K=1.647 (.1993)
DISTH	C=.0000 (.9969)	K=10.69 (.0011)	K=1.084 (.5814)	K=4.246 (.0393)
DISTI	C=.6307 (.4271)	K=58.17 (.0001)	K=.6015 (.7369)	K=1.192 (.2748)

1997

	ACTIVE	TEN	STABLE	VOTE
ACTIVE		C=.0977(.1672)	K=14.50 (.0696)	K=8.437 (.0378)
TENURE			B=-.0068 (.8907)	B=.1214 (.2802)
STABLE				B=.02122(.8440)
DISTA	C=.3800 (.5376)	K=142.7 (.0001)	K=.2018 (.3645)	K= .4819 (.4876)
DISTB	C=.0004 (.9847)	K=41.90 (.0001)	K=.7925 (.6728)	K=.0141 (.9056)
DISTC	C=.0156 (.9006)	K=34.92 (.0001)	K=1.657 (.4367)	K=4.108 (.0427)
DISTD	C=1.797 (.1800)	K=41.73 (.0001)	K=.4908 (.7824)	K=.3068 (.5797)
DISTE	C=.8726 (.3502)	K=27.53 (.0001)	K=5.613 (.0406)	K=.1705 (.6797)
DISTF	C=2.005 (.1573)	K=19.10 (.0001)	K=1.018 (.6010)	K=2.410 (.1205)
DISTG	C=7.579 (.0059)	K=33.94 (.0001)	K=1.660 (.4360)	K=1.382 (.2396)
DISTH	C=.3456 (.5566)	K=50.26 (.0001)	K=1.084 (.5814)	K=5.092 (.0240)
DISTI	C=3.233 (.0722)	K=30.95 (.0001)	K=.6015 (.7369)	K=1.722 (.1894)

[grey box] = Indicates significance at p=<.05

1998

	ACTIVE	TEN	STABLE	VOTE
ACTIVE		C=.1151 (.0834)	K=18.40 (.0184)	K=10.85 (.0126)
TENURE			B=-.0068 (.9807)	B= .0836 (.6348)
STABLE				B=.0139 (.9021)
DISTA	C=.3355 (.5625)	K=142.7 (.0001)	K=.2018 (.3645)	K=.4431 (.5056)
DISTB	C=.1370 (.7112)	K=41.90 (.0001)	K=.7925 (.6728)	K=.0026 (.9595)
DISTC	C=1.194 (.2744)	K=34.92 (.0001)	K=1.657 (.4367)	K=4.993 (.0254)
DISTD	C=3.597 (.0579)	K=41.73 (.0001)	K=.4908 (.7824)	K=.3534 (.5522)
DISTE	C=.9364 (.3332)	K=27.53 (.0001)	K=5.613 (.0406)	K=.1390 (.7093)
DISTF	C=3.501 (.0613)	K=19.10 (.0001)	K=1.018 (.6010)	K=2.413 (.1203)
DISTG	C=7.773 (.0053)	K=33.94 (.0001)	K=1.660 (.4360)	K=1.307 (.2528)
DISTH	C=.0015 (.9689)	K=50.26 (.0001)	K=1.084 (.5814)	K=5.158 (.0231)
DISTI	C=3.105 (.0780)	K=30.95 (.0001)	K=.6015 (.7369)	K=1.783 (.1817)

1999

	ACTIVE	TEN	STABLE	VOTE
ACTIVE		C=.1151(.0834)	K=18.40 (.0184)	K=11.02 (.0116)
TENURE			B=.0531 (.2830)	B=-.150 (.1804)
STABLE				B=-.004 (.9674)
DISTA	C=.3355 (.5625)	K=7.482 (.0062)	K=.2018 (.3645)	K=.5186 (.4715)
DISTB	C=.1370 (.7112)	K=41.90 (.0001)	K=.7925 (.6728)	K=.4666 (.4946)
DISTC	C=1.194 (.2744)	K=34.92 (.0001)	K=1.657 (.4367)	K=5.187 (.0227)
DISTD	C=3.597 (.0579)	K=98.23 (.0001)	K=.4908 (.7824)	K=.2415 (.6231)
DISTE	C=.9364 (.3332)	K=64.79 (.0001)	K=5.613 (.0406)	K=.6762 (.4109)
DISTF	C=3.501 (.0613)	K=19.10 (.0001)	K=1.018 (.6010)	K=2.219 (.1363)
DISTG	C=7.773 (.0053)	K=33.94 (.0001)	K=1.660 (.4360)	K=1.371 (.2416)
DISTH	C=.0015 (.9689)	K=50.26 (.0001)	K=1.084 (.5814)	K=4.650 (.0310)
DISTI	C=3.105 (.0780)	K=72.85 (.0001)	K=.6015 (.7369)	K=1.482 (.2234)

[shaded] = Indicates significance at p=<.05

APPENDIX F: BIVARIATE ANALYSIS OF WATER VARIABLES

	NONWHITE	OWN	COST	INCOME	STABLE	VOTE92	VOTE93	VOTE94	VOTE95	VOTE96	VOTE97	VOTE98
T_MAIN	K=1.322 (.7238)	T=-.84 (.4010)	T=-.82 (.4125)	K=3.282 (.1937)	K=9.096 (.0106)	K=.5666 (.4516)	K=1.120 (.2898)	K=.7196 (.3963)	K=.7196 (.3963)	K=1.274 (.2589)	K=1.702 (.1919)	K=1.971 (.1603)
T_COLL	K=3.082 (.3791)	T=.46 (.6486)	T=.40 (.6918)	K=1.411 (.4937)	K=2.130 (.3447)	K=.0411 (.8393)	K=.0122 (.9120)	K=.0069 (.9340)	K=.0069 (.9340)	K=.1041 (.7470)	K=.3418 (.5588)	K=.3986 (.5278)
T_HYDL	K=.8126 (.8464)	T=-.83 (.4088)	T=-.70 (.4865)	K=1.857 (.3951)	K=5.560 (.0620)	K=5.257 (.0128)	K=5.772 (.0163)	K=5.888 (.0152)	K=5.888 (.0152)	K=6.260 (.0123)	K=6.097 (.0135)	K=6.564 (.0104)
T_FIRE	K=2.309 (.5107)	T=1.55 (.1226)	T=-1.30 (.1940)	K=5.696 (.0579)	K=3.051 (.2174)	K=2.218 (.1364)	K=1.782 (.1818)	K=1.909 (.1671)	K=1.909 (.1671)	K=1.416 (.2340)	K=.7424 (.3889)	K=.9087 (.3405)
M_CI	K=1.438 (.6966)	T=.48 (.6344)	T=-.08 (.9390)	K=.6013 (.7404)	K=.5957 (.7424)	K=2.319 (.1277)	K=2.714 (.0994)	K=2.081 (.1491)	K=2.081 (.1491)	K=2.341 (.1260)	K=3.017 (.0824)	K=2.574 (.1086)
M-CONC	K=3.645 (.3024)	T=2.30 (.0218)	T=1.77 (.0779)	K=3.598 (.1654)	K=6.774 (.0338)	K=1.940 (.1636)	K=2.127 (.1447)	K=1.779 (.1822)	K=1.779 (.1822)	K=2.098 (.1474)	K=1.722 (.1894)	K=1.783 (.1897)
M_COP	K=2.463 (.4820)	T=.73 (.4675)	T=-.24 (.8079)	K=.7877 (.6745)	K=.9009 (.6374)	K=.2381 (.6256)	K=.0636 (.8009)	K=.2536 (.6145)	K=.2536 (.6145)	K=.0181 (.8929)	K=.1517 (.6969)	K=.1037 (.7475)
M_DI	K=2.040 (.5640)	T=-.85 (.3975)	T=-.10 (.9232)	K=2.176 (.3369)	K=6.166 (.0458)	K=4.046 (.0443)	K=4.515 (.0336)	K=4.260 (.0390)	K=4.260 (.0390)	K=3.818 (.0507)	K=6.187 (.0129)	K=6.785 (.0092)
M_GALV	K=1.279 (.7340)	T=.99 (.3229)	T=-1.38 (.1698)	K=2.252 (.3243)	K=2.149 (.3414)	K=5.236 (.0221)	K=5.830 (.0157)	K=6.628 (.0100)	K=6.628 (.0100)	K=6.733 (.0095)	K=5.778 (.0162)	K=6.064 (.0138)
M_PC	K=2.259 (.5204)	T=.25 (.7997)	T=1.10 (.2726)	K=2.332 (.3115)	K=.6945 (.7066)	K=.1133 (.7365)	K=.1539 (.6948)	K=.2262 (.6343)	K=.2262 (.6343)	K=.2273 (.6335)	K=.1793 (.6720)	K=1.688 (.1939)
M_PVC	K=2.608 (.4560)	T=.03 (.9754)	T=-.91 (.3609)	K=4.650 (.0977)	K=5.863 (.0533)	K=.0260 (.8719)	K=.0012 (.9721)	K=.0216 (.8832)	K=.0216 (.8832)	K=.0673 (.7953)	K=.0050 (.9437)	K=.0312 (.8599)
M_SRC	K=4.097 (.2511)	T=.52 (.6052)	T=.41 (.6793)	K=.9539 (.6207)	K=1.888 (.3890)	K=.1272 (.7214)	K=.5401 (.4624)	K=.3472 (.5557)	K=.3472 (.5557)	K=1.074 (.3000)	K=1.550 (.2131)	K=1.637 (.2007)
M_STL	K=1.575 (.6651)	T=-.38 (.7039)	T=-.68 (.4939)	K=.9955 (.6079)	K=1.859 (.3947)	K=1.219 (.2695)	K=1.31 (.2520)	K=1.775 (.1827)	K=1.775 (.1827)	K=1.619 (.2032)	K=2.012 (.1561)	K=1.866 (.1718)
DIAM1	K=1.495 (.6833)	T=.32 (.7501)	T=45 (.6497)	K=1.484 (.4761)	K=2.291 (.3180)	K=.0040 (.9499)	K=.0741 (.7854)	K=.1990 (.6555)	K=.1990 (.6555)	K=.2126 (.6447)	K=.1607 (.6885)	K=.2785 (.5977)
DIAM2	K=2.187 (.5344)	T=-.40 (.6862)	T=-1.38 (.1690)	K=1.292 (.5241)	K=6.856 (.0324)	K=5.882 (.0153)	K=6.568 (.0104)	K=7.055 (.0079)	K=7.055 (.0079)	K=7.388 (.0066)	K=8.112 (.0044)	K=8.527 (.003)

= Indicates significance at p=<.05

	VOTE99	ACTIVE92	ACTIVE93	ACTIVE94	ACTIVE95	ACTIVE96	ACTIVE97	ACTIVE98	ACTIVE99	TEN92	TEN93	TEN94
T_MAIN	K=2.515 (.1128)	C=.2639 (.0001)	C=.2533 (.0001)	C=.3280 (.0001)	C=.3280 (.0001)	C=.2693 (.0001)	C=.3119 (.0001)	C=.2799 (.0001)	C=.3173 (.0001)	K=.2528 (.6151)	K=.9267 (.3357)	K=.9267 (.3357)
T_COLL	K=.2678 (.6048)	C=-.048 (.3502)	C=-.067 (.1928)	C=-.038 (.4513)	C=-.010 (.8382)	C=-.022 (.6658)	C=-.050 (.3266)	C=-.022 (.6658)	C=-.024 (.6321)	K=1.424 (.2327)	K=.0020 (.9643)	K=.0020 (.9643)
T_HYDL	K=7.423 (.0064)	C=.2267 (.0001)	C=.2160 (.0001)	C=.2587 (.0001)	C=.2907 (.0001)	C=.2320 (.0001)	C=.2533 (.0001)	C=.2640 (.0001)	C=-.301 (.0001)	K=.1061 (.7447)	K=.0004 (.9843)	K=.0004 (.9843)
T_FIRE	K=1.927 (.1651)	C=-.004 (.9317)	C=-.089 (.0843)	C=-.003 (.9471)	C=-.024 (.6303)	C=.0121 (.8141)	C=.0229 (.6580)	C=.0657 (.2032)	C=-.003 (.9471)	K=1.456 (.2275)	K=.2137 (.6439)	K=.2137 (.6439)
M_CI	K=3.016 (.0824)	C=.1733 (.0008)	C=.1413 (.0062)	C=.1093 (.0343)	C=.1627 (.0016)	C=.1466 (.0045)	C=.1573 (.0023)	C=.1573 (.0023)	C=.1200 (.0202)	K=6.351 (.0117)	K=11.09 (.0009)	K=11.097 (.0009)
M-CONC	K=1.482 (.2234)	C=.0153 (.7672)	C=-.007 (.8879)	C=-.007 (.8879)	C=-.026 (.6058)	C=.0137 (.7910)	C=.0137 (.7910)	C=.0524 (.3100)	C=.0121 (.8150)	K=.2438 (.6215)	K=2.827 (.0927)	K=2.827 (.0927)
M_COP	K=.1778 (.6733)	C=.0929 (.0719)	C=.1508 (.0035)	C=.1636 (.0015)	C=.1890 (.0003)	C=.0391 (.4493)	C=.1028 (.0466)	C=.1537 (.0029)	C=.0234 (.6499)	K=.1886 (.6641)	K=.8808 (.3709)	K=.8008 (.3709)
M_DI	K=6.136 (.0132)	C=-.040 (.4331)	C=-.024 (.6418)	C=-.070 (.1706)	C=-.024 (.6418)	C=-.020 (.6905)	C=-.008 (.8635)	C=-.032 (.5323)	C=.0227 (.6601)	K=.0523 (.8192)	K=1.913 (.1666)	K=1.913 (.1666)
M_GALV	K=5.937 (.0148)	C=.2125 (.0001)	C=.2042 (.0001)	C=.2152 (.0001)	C=.2262 (.0001)	C=.1864 (.0003)	C=.1864 (.0003)	C=.1644 (.0015)	C=.0612 (.2358)	K=1.478 (.2241)	K=7.858 (.0051)	K=7.858 (.0051)
M_PC	K=1.672 (.1960)	C=.0567 (.2720)	C=.0281 (.5866)	C=.0809 (.1174)	C=.1072 (.0378)	C=.0820 (.1124)	C=.0820 (.1124)	C=.1612 (.0018)	C=.0545 (.2915)	K=.3085 (.5786)	K=.0004 (.9834)	K=.0004 (.9834)
M_PVC	K=.2151 (.6428)	C=.1945 (.0002)	C=.1519 (.0033)	C=.2053 (.0001)	C=.2266 (.0001)	C=.1679 (.0012)	C=.1892 (.0002)	C=.1465 (.0046)	C=.1412 (.0062)	K=.0010 (.9748)	K=3.772 (.0521)	K=3.772 (.0521)
M_SRC	K=2.376 (.1232)	C=-.064 (.2117)	C=-.047 (.3566)	C=-.027 (.5926)	C=-.007 (.8820)	C=-.066 (.2010)	C=-.066 (.2010)	C=-.046 (.3724)	C=-.007 (.8820)	K=.0841 (.7718)	K=1.683 (.1945)	K=1.683 (.1945)
M_STL	K=2.025 (.1547)	C=-.090 (.0791)	C=-.101 (.0498)	C=-.086 (.0949)	C=-.025 (.6156)	C=-.028 (.5858)	C=-.088 (.0867)	C=-.133 (.0096)	C=-.010 (.8335)	K=.1278 (.7207)	K=.1110 (.7390)	K=.1110 (.7390)
DIAM1	K=.2614 (.6092)	C=.2800 (.0001)	C=.2800 (.0001)	C=.2480 (.0001)	C=.3013 (.0001)	C=.2533 (.0001)	C=.2533 (.0001)	C=.2427 (.0001)	C=.1947 (.0002)	K=.0221 (.8819)	K=9.203 (.0024)	K=9.203 (.0024)
DIAM2	K=9.578 (.0020)	C=.2907 (.0001)	C=.2693 (.0001)	C=.3120 (.0001)	C=.2907 (.0001)	C=.2853 (.0001)	C=.3173 (.0001)	C=.2640 (.0001)	C=.3120 (.0001)	K=.1061 (.7447)	K=.0803 (.7768)	K=.0803 (.7768)

= Indicates significance at p=<.05

	TEN95	TEN96	TEN97	TEN98	TEN99	DISTA	DISTB	DISTC	DISTD	DISTE	DISTF
T_MAIN	K=2.410 (.1205)	K=2.410 (.1205)	K=2.548 (.1104)	K=2.548 (.1104)	K=4.316 (.0377)	C=-.005 (.9153)	C=-.107 (.0490)	C=-.1009 (.0507)	C=-.0277 (.5923)	C=.1112 (.0312)	C=.0354 (.4932)
T_COLL	K=2.281 (.1309)	K=2.281 (.1309)	K=.5732 (.4490)	K=.5732 (.4490)	K=.1045 (.7465)	C=.1037 (.0446)	C=-.064 (.2104)	C=.0499 (.3339)	C=-.017 (.7283)	C=-.0035 (.9465)	C=.0317 (.5387)
T_HYDL	K=.0054 (.9414)	K=.0054 (.9414)	K=2.029 (.1543)	K=2.029 (.1543)	K=1.604 (.2052)	C=.0428 (.4071)	C=-.071 (.1663)	C=-.050 (.3242)	C=-.060 (.2401)	C=.1276 (.0135)	C=.0563 (.2760)
T_FIRE	K=4.325 (.0375)	K=4.325 (.0375)	K=.3298 (.5658)	.3298 (.5658)	K=1.542 (.2143)	C=.0421 (.4144)	C=-.053 (.3002)	C=.0150 (.7709)	C=-.117 (.0230)	C=-.024 (.6421)	C=.1021 (.0480)
M_CI	K=3.206 (.0734)	K=3.206 (.0734)	K=3.221 (.0727)	K=3.221 (.0727)	K=.2466 (.6195)	C=.1432 (.0055)	C=-.039 (.4471)	C=-.120 (.0201)	C=.0319 (.5363)	C=-.180 (.0005)	C=-.077 (.1353)
M-CONC	K=.1018 (.7496)	K=.1018 (.7496)	K=1.346 (.2460)	K=1.346 (.2460)	K=.8464 (.3576)	C=.0439 (.3950)	C=.0034 (.9482)	C=.0218 (.6736)	C=-.008 (.8713)	C=-.032 (.5344)	C=-.076 (.1373)
M_COP	K=1.866 (.1719)	K=1.866 (.1719)	K=.4338 (.5101)	K=.4338 (.5101)	K=1.294 (.2553)	C=.0251 (.6275)	C=-.031 (.5380)	C=-.042 (.4089)	C=-.051 (.3200)	C=-.133 (.0099)	C=-.138 (.0074)
M_DI	K=.0653 (.7983)	K=.0653 (.7983)	K=2.146 (.1429)	K=2.146 (.1429)	K=1.774 (.1829)	C=.0417 (.4199)	C=-.033 (.5136)	C=.0220 (.6708)	C=-.023 (.6487)	C=.0267 (.6058)	C=-.044 (.3940)
M_GALV	K=6.674 (.0098)	K=6.674 (.0098)	K=.2088 (.6477)	K=.2088 (.6477)	K=.9438 (.3313)	C=-.125 (.0150)	C=-.013 (.7977)	C=-.145 (.0050)	C=.0367 (.4768)	C=-.142 (.0058)	C=-.199 (.0001)
M_PC	K=4.477 (.0343)	K=4.477 (.0343)	K=.0063 (.9369)	K=.0063 (.9369)	K=1.448 (.2288)	C=.0897 (.0825)	C=-.040 (.4379)	C=.0125 (.8082)	C=-.046 (.3676)	C=-.068 (.1828)	C=-.0560 (.2780)
M_PVC	K=7.038 (.0080)	K=7.038 (.0080)	K=1.312 (.2519)	K=1.312 (.2519)	K=5.339 (.0208)	C=-.070 (.1720)	C=-.115 (.0250)	C=.0046 (.9289)	C=.0671 (.1939)	C=.0225 (.6637)	C=.0966 (.0613)
M_SRC	K=.9701 (.3247)	K=.9701 (.3247)	K=.3869 (.5339)	K=.3869 (.5339)	K=1.088 (.2968)	C=.0211 (.6823)	C=-.019 (.7110)	C=-.003 (.9534)	C=-.0006 (.9905)	C=.0073 (.8873)	C=.1340 (.0094)
M_STL	K=1.003 (.3164)	K=1.003 (.3164)	K=.1070 (.7435)	K=.1070 (.7435)	K=.1387 (.7096)	C=-.063 (.2172)	C=-.093 (.0702)	C=.0212 (.6819)	C=.0355 (.4921)	C=.0328 (.5259)	C=.0431 (.4035)
DIAM1	K=2.034 (.1538)	K=2.034 (.1538)	K=.4980 (.4804)	K=.4980 (.4804)	K=1.405 (.2357)	C=-.024 (.6400)	C=.0574 (.2664)	C=-.189 (.0002)	C=.0319 (.5363)	C=-.125 (.0148)	C=-.143 (.0054)
DIAM2	K=.5162 (.4725)	.5162 (.4725)	K=2.281 (.1309)	K=2.281 (.1309)	K=2.499 (.1139)	C=.0261 (.6137)	C=-.119 (.0203)	C=-.033 (.5148)	C=-.045 (.3811)	C=.1276 (.0135)	C=.0563 (.2760)

= Indicates significance at p=<.05

	DISTG	DISTH	DISTI
T_MAIN	C=-.006 (.9073)	C=.0259 (.6156)	C=.0892 (.0843)
T_COLL	C=-.015 (.7680)	C=-.007 (.8807)	C=-.064 (.2088)
T_HYDL	C=.0970 (.0603)	C=-.112 (.0301)	C= .0182 (.7245)
T_FIRE	C=.0758 (.1421)	C=-.029 (.5708)	C=.0324 (.5305)
M_CI	C=-.042 (.4075)	C=.1443 (.0052)	C=.0873 (.0909)
M-CONC	C=-.102 (.0476)	C=.0398 (.4411)	C=.0845 (.1018)
M_COP	C=-.038 (.4572)	C=.2617 (.0001)	C=.0812 (.1160)
M_DI	C=-.029 (.5672)	C=-.037 (.4660)	C=.078 (.1274)
M_GALV	C=-.121 (.0183)	C=.3601 (.0001)	C=.2467 (.0001)
M_PC	C=.0145 (.7785)	C=.0244 (.6370)	C=-.030 (.5586)
M_PVC	C=.0308 (.5515)	C=.0131 (.8002)	C=.1256 (.0150)
M_SRC	C=-.033 (.5199)	C=.0211 (.6833)	C=-.100 (.0527)
M_STL	C=-.031 (.5405)	C=.0653 (.2058)	C=-.0033 (.9497)
DIAM1	C=-.1476 (.0043)	C=.2649 (.0001)	C=.1910 (.0002)
DIAM2	C=.0795 (.1235)	C=-.081 (.1131)	C=.0355 (.4921)

[shaded box] = Indicates significance at p=<.05

	NONWHITE	OWN	COST	INCOME	STABLE	VOTE92	VOTE93	VOTE94	VOTE95	VOTE96	VOTE97
DIAM3	K=5.9544 (.1136)	T=-.49 (.1381)	T=-2.55 (.0113)	K=8.906 (.0116)	K=6.856 (.0324)	K=.0980 (.7543)	K=.6169 (.4322)	K=.3318 (.5646)	K=.3318 (.5646)	K=.6624 (.4157)	K=.5100 (.4751)
DIAM4	K=2.604 (.4067)	T=-.56 (.5740)	T=-1.04 (.2968)	K=1.641 (.4402)	K=3.354 (.1869)	K=4.572 (.0325)	K=3.986 (.0459)	K=4.854 (.0276)	K=4.854 (.0276)	K=4.219 (.0400)	K=4.188 (.0407)
DIAM5	K=8.632 (.0346)	T=.81 (.4178)	T=-.43 (.6649)	K=2.070 (.3551)	K=.8182 (.6642)	K=.0777 (.7804)	K=.0939 (.7593)	K=.3251 (.5686)	K=.3251 (.5686)	K=.6313 (.4269)	K=1.228 (.2677)
LOOP 610	K=6.420 (.0929)	T=.51 (.6117)	T=-4.60 (.0001)	K=17.57 (.0002)	K=.6788 (.7122)	K=5.982 (.0145)	K=6.409 (.0114)	K=6.169 (.0130)	K=6.169 (.0130)	K=6.053 (.0139)	K=4.824 (.0281)
AGE	B=.1183 (.0028)	B=.0105 (.7674)	B=-.203 (.0001)	B=-.232 (.0001)	B=-.067 (.1183)	B=-.208 (.0317)	B=-.163 (.0913)	B=-.170 (.0787)	B=-.170 (0787)	B=-.134 (.1651)	B=-.143 (.1415)
NON WHITE					B=-.041 (.3740)	B=.0310 (.7690)	B=-.003 (.9751)	B=-.038 (.7130)	B=-.038 (.7130)	B=-.046 (.6573)	B=-.050 (.6371)
OWN					B=-.046 (.2698)	B=.1362 (.1538)	B=.1348 (.1576)	B=.1465 (.1243)	B=.1465 (.1243)	B=.1333 (.1626)	B=.1284 (.1806)
COST					B=.0329 (.4522)	B=-.053 (.5902)	B=-.026 (.7902)	B=-.000 (.9952)	B=-.000 (.9952)	B=.0065 (.9569)	B=.029 (.7653)
INCOME					B=-.007 (.8810)	B=-.053 (.6374)	B=-.010 (.9272)	B=-.019 (.8662)	B=-.019 (.8662)	B=.0063 (.9551)	B=-.003 (.9774)

[shaded box] = Indicates significance at p=<.05

	VOTE98	VOTE99	ACTIVE 92	ACTIVE 93	ACTIVE 94	ACTIVE 95	ACTIVE 96	ACTIVE 97	ACTIVE 98	ACTIVE 99	TEN92	TEN93
DIAM3	K=.6719 (.4124)	K=1.093 (.2956)	C=.2693 (.0001)	C=.2480 (.0001)	C=.3013 (.0001)	C=.2907 (.0001)	C=.2427 (.0001)	C=.2960 (.0001)	C=.2533 (.0001)	C=.2587 (.0001)	K=.1061 (.7447)	K=1.792 (.1807)
DIAM4	K=4.638 (.0313)	K=3.416 (.0646)	C=.0129 (.8029)	C=-.018 (.7149)	C=.0665 (.1979)	C=.0772 (.1351)	C=.0717 (.1650)	C=.0717 (.1650)	C=.0930 (.0716)	C=.1198 (.0203)	K=.7456 (.3879)	K=3.485 (.0619)
DIAM5	K=1.457 (.2273)	K=.9161 (.3383)	C=-.001 (.9848)	C=-.042 (.4119)	C=-.031 (.5419)	C=-.031 (.5419)	C=-.027 (.5995)	C=.0490 (.3426)	C=.0925 (.0732)	C=.0446 (.3874)	K=15.44 (.0001)	K=.2070 (.6492)
LOOP610	K=5.093 (.0240)	K=4.163 (.0413)	C=.1051 (.0418)	C=.0865 (.0941)	C=.0980 (.0576)	C=.1096 (.0337)	C=.0320 (.5354)	C=.0668 (.1959)	C=.0668 (.1959)	C=.0053 (.9184)	K=.0834 (.7728)	K=11.13 (.0008)
AGE	B=-.147 (.1316)	B=-.125 (.1975)	T=-1.10 (.2701)	T=-.98 (.3286)	T=-.50 (.6199)	T=-.90 (.3661)	T=-1.94 (.0535)	T=-1.20 (.2299)	T=-.67 (.5034)	T=-1.20 (.236)	B=.0461 (.2862)	B=.0413 (.3232)
NON-WHITE	B=-.036 (.7292)	B=-.061 (.5602)	C=.1033 (.2609)	C=.0959 (.3278)	C=.1054 (.2439)	C=.1477 (.0424)	C=.0813 (.4791)	C=.0893 (.0392)	C=.0879 (.4081)	C=.1114 (.1993)	B=.0433 (.3600)	-.1413 (.0020)
OWN	B=.1209 (.2074)	B=.1269 (.1844)	T=-.81 (.4185)	T=-.67 (.5034)	T=-.04 (.9711)	T=-.26 (.7978)	T=-.72 (.4723)	T=-.27 (.7907)	T=76 (.4484)	T=-1.22 (.2235)	B=-.021 (.6074)	B=-.032 (.4248)
COST	B=.0145 (.8837)	B=.0414 (.6756)	T=-1.19 (.2359)	T=.12 (.9011)	T=-.67 (.5016)	T=-1.15 (.2524)	T=-.77 (.4436)	T=.56 (.5758)	T=-.50 (.6167)	T=-1.47 (.1416)	B=-.014 (.7460)	B=.1334 (.0017)
INCOME	B=-.018 (.8705)	B=.018 (.8712)	C=.0533 (.5866)	C=.0274 (.8685)	C=.0598 (.5118)	C=.0061 (.9930)	C=.0319 (.8261)	C=.0519 (.6033)	C=.0391 (.7510)	C=.0609 (.4991)	B=.0463 (.3538)	B=.0907 (.0605)

[shaded] = Indicates significance at p=<.05

	TEN94	TEN95	TEN96	TEN97	TEN98	TEN99	DISTA	DISTB	DISTC	DISTD	DISTE	DISTF
DIAM3	K=1.792 (.1807)	K=2.841 (.0919)	K=2.841 (.0919)	K=2.830 (.0925)	K=2.830 (.0925)	K=4.880 (.0272)	C=-.007 (.8859)	C=-.168 (.0011)	C=.0336 (.5148)	C=-.014 (.7809)	C=.0914 (.0768)	C=.0340 (.5100)
DIAM4	K=3.485 (.0619)	K=3.542 (.0598)	K=3.542 (.0598)	K=1.001 (.3169)	K=1.001 (.3169)	K=.0004 (.9838)	C=.1007 (.0511)	C=-.031 (.5458)	C=-.043 (.3990)	C=-.036 (.4775)	C=-.100 (.0509)	C=-.005 (.9232)
DIAM5	K=.2070 (.6492)	K=3.962 (.0465)	K=3.962 (.0465)	K=2.739 (.0979)	K=2.739 (.0979)	K=.0068 (.9341)	C=-.176 (.0007)	C=.1162 (.0245)	C=-.072 (.1613)	C=-.093 (.0704)	C=.0462 (.3708)	C=.1754 (.0007)
LOOP610	K=11.13 (.0008)	K=17.72 (.0001)	K=17.72 (.0001)	K=.8139 (.3670)	K=.0139 (.3670)	K=1.806 (.1790)	C=-.201 (.0001)	C=-.057 (.2649)	C=-.003 (.9536)	C=.2045 (.0001)	C=-.215 (.0001)	C=-.168 (.0011)
AGE	B=.0413 (.3232)	B=-.251 (.0001)	B=-.251 (.0001)	B=-.055 (.1838)	B=-.055 (.1838)	B=.172 (.0001)	K=17.00 (.0001)	K=2.684 (.1013)	K=1.343 (.2465)	K=6.049 (.0139)	K=15.32 (.0001)	K=.0325 (.8569)
NON WHITE	B=-.143 (.0020)	B=.1739 (.0001)	B=.1739 (.0001)	B=.1118 (.0140)	B=.1118 (.0140)	B=-.165 (.0003)	K=4.336 (.2273)	K=21.43 (.0001)	K=2.075 (.5568)	K=6.448 (.0917)	K=3.815 (.2821)	K=19.95 (.0002)
OWN	B=-.032 (.4248)	B=.0345 (.3981)	B=.0345 (.3981)	B=-.032 (.4328)	B=-.032 (.4328)	B=.0085 (.8353)	T=-1.19 (.2344)	T=-1.23 (.2183)	T=1.01 (.3116)	T=.57 (.5687)	T=-1.53 (.1270)	T=2.78 (.0096)
COST	B=.1334 (.0017)	B=-.224 (.0001)	B=-.224 (.0001)	B=-.073 (.0809)	B=-.073 (.0809)	B=.1728 (.0001)	T=3.15 (.0018)	T=4.72 (.0001)	T=-.31 (.7589)	T=-2.77 (.0060)	T=-.37 (.7144)	T=.27 (.7891)
INCOME	B=.0907 (.0605)	B=-.204 (.0001)	B=-.204 (.0001)	B=-.033 (.4920)	B=-.033 (.4920)	B=.1331 (.0057)	K=11.45 (.0033)	K=15.72 (.0004)	K=.4153 (.8125)	K=3.004 (.2226)	K=7.060 (.0293)	K=1.329 (.5145)

= Indicates significance at p=<.05

	DISTG	DISTH	DISTI
DIAM3	C=.0446 (.3879)	C=-.021 (.6770)	C=.1046 (.0428)
DIAM4	C=.0693 (.1793)	C=-.027 (.5910)	C=.0774 (.1338)
DIAM5	C=-.119 (.0208)	C=-.002 (.9653)	C=.1743 (.0007)
LOOP610	C=-.111 (.0313)	C=.2504 (.0001)	C=.2036 (.0001)
AGE	K=4.692 (.0303)	K=2.148 (.1427)	K=5.419 (.0199)
NON WHITE	K=13.97 (.0029)	K=21.24 (.0001)	K=9.175 (.0270)
OWN	T=.64 (.5245)	T=1.34 (.1823)	T=1.30 (.2011)
COST	T=-5.24 (.0001)	T=4.14 (.0001)	T=-3.67 (.0003)
INCOME	K=6.701 (.0351)	K=3.676 (.1591)	K=14.58 (.0007)

= Indicates significance at p=<.05

B=Kendall's Tau B
C=Chi-square/chi coefficient
T= T-test
K=Kruskal-Wallis

APPENDIX G: BIVARIATE ANALYSIS OF SEWER VARIBLES

	NONWHITE	OWN	COST	INCOME	STABLE	VOTE92	VOTE93	VOTE94	VOTE95	VOTE96	VOTE97
T_CASE	K=.0032 (.9552)	T=.29 (.7693)	T=1.18 (.2375)	K=.0330 (.8558)	K=6.298 (.0121)	K=.1370 (.7112)	K=.1520 (.6966)	K=.2905 (.5899)	K=.2905 (.5899)	K=.1025 (.7489)	K=.0536 (.8168)
T_COLL	K=4.150 (.0416)	T=-.79 (.4321)	T=-2.36 (.0186)	K=3.117 (.0775)	K=.6066 (.4361)	K=2.384 (.1226)	K=2.691 (.1009)	K=3.489 (.0618)	K=3.489 (.0618)	K=3.772 (.0521)	K=2.872 (.0901)
T_FM	K=.0621 (.8033)	T=-2.02 (.0436)	T=-.35 (.7272)	K=.1290 (.7194)	K=.8711 (.3507)	K=.1744 (.6763)	K=.0435 (.8347)	K=.0000 (.9945)	K=.0000 (.9945)	K=.0527 (.8184)	K=.0110 (.9163)
T_LATL	K=2.913 (.0879)	T=1.04 (.2996)	T=-2.79 (.0055)	K=9.464 (.0021)	K=3.695 (.0546)	K=.5561 (.4558)	K=.9371 (.3330)	K=1.480 (.2237)	K=1.480 (.2237)	K=1.453 (.2279)	K=.7087 (.3999)
T_OF	K=3.671 (.0553)	T=-.62 (.5366)	T=-1.32 (.1884)	K=1.105 (.2931)	K=4.064 (.0438)	K=.1846 (.6775)	K=.1972 (.6570)	K=.2753 (.5998)	K=.2753 (.5998)	K=.1427 (.7056)	K=.2206 (.6386)
T_SIPH	K=.5538 (.4568)	T=-.85 (.3986)	T=.23 (.8199)	K=.7048 (.4012)	K=2.954 (.0856)	K=1.156 (.2821)	K=1.338 (.2474)	K=.8416 (.3589)	K=.8416 (.3589)	K=.7014 (.4023)	K=1.172 (.2790)
T-SLDG	K=1.223 (.2687)	T=.41 (.6789)	T=-1.39 (.1665)	K=1.942 (.1634)	K=1.257 (.2622)	K=.0967 (.7558)	K=.1509 (.6977)	K=.0884 (.7662)	K=.0884 (.7662)	K=.1614 (.0398)	K=4.082 (.0433)
T_STUB	K=.0016 (.9685)	T=-2.61 (.0093)	T=-.28 (.7773)	K=.7957 (.3724)	K=.0711 (.7898)	K=4.284 (.0385)	K=3.007 (.0829)	K=3.927 (.0475)	K=3.927 (.0475)	K=4.227 (.0980)	K=2.965 (.0851)
M_ABS	K=4.070 (.0436)	T=.31 (.7555)	T=-1.56 (.1203)	K=3.888 (.0486)	K=.2360 (.6271)	K=.3510 (.5536)	K=.6639 (.4152)	K=1.514 (.2184)	K=1.514 (.2184)	K=1.556 (.2122)	K=1.389 (.2386)
M_CGMP	K=.7593 (.3835)	T=1.10 (.2735)	T=.64 (.5222)	K=.3322 (.5644)	K=.1489 (.6996)	K=5.936 (.0148)	K=6.574 (.0103)	K=5.476 (.0193)	K=5.476 (.0193)	K=5.502 (.0190)	K=4.975 (.0257)
M_CI	K=10.28 (.0013)	T=-1.42 (.1561)	T=-2.62 (.0092)	K=6.808 (.0091)	K=.0143 (.9050)	K=.6828 (.4086)	K=.7554 (.3848)	K=1.493 (.2217)	K=1.493 (.2217)	K=1.721 (.1895)	K=.8318 (.3618)
M_CLAY	K=.0087 (.9259)	T=-1.11 (.2691)	T=-.21 (.8370)	K=1.119 (.2900)	K=.6884 (.4067)	K=.1056 (.7453)	K=.0194 (.8893)	K=.0086 (.9262)	K=.0086 (.9262)	K=.0613 (.8045)	K=.1283 (.7202)
M_CONC	K=4.128 (.0422)	T=.03 (.9788)	T=-1.47 (.1416)	K=4.288 (.0384)	K=.0504 (.8223)	K=.0040 (.9497)	K=.2337 (.6288)	K=.0059 (.9387)	K=.0059 (.9387)	K=.0012 (.9720)	K=.0241 (.8766)
M_DI	K=6.490 (.0108)	T=-.46 (.6483)	T=-3.09 (.0022)	K=3.293 (.0696)	K=6.504 (.0108)	K=.1746 (.6761)	K=.2248 (.6354)	K=.3439 (.5576)	K=.3439 (.5576)	K=.3290 (.5662)	K=.6837 (.4083)
M_MRC	K=.0205 (.8861)	T=1.54 (.1241)	T=-.70 (.4827)	K=.6693 (.4133)	K=.3923 (.5311)	K=1.378 (.2403)	K=1.552 (.2128)	K=1.988 (.1585)	K=1.988 (.1585)	K=1.916 (.1662)	K=2.553 (.1101)
M_PVC	K=3.962 (.0465)	T=-.18 (.8606)	T=-2.50 (.0129)	K=10.76 (.0010)	K=.0711 (.7897)	K=.2439 (.6214)	K=.6389 (.4241)	K=.7051 (.4011)	K=.7051 (.4011)	K=.7804 (.3770)	K=1.045 (.3067)

= Indicates significance at p=<.05

	VOTE98	VOTE99	ACTIVE92	ACTIVE93	ACTIVE94	ACTIVE95	ACTIVE96	ACTIVE97	ACTIVE98	ACTIVE99	TEN92	TEN93
T_CASE	K=.0740 (.7856)	K=.2415 (.6231)	C=-.052 (.3128)	C=-.025 (.6207)	C=-.030 (.5580)	C=-.054 (.2915)	C=-.056 (.2713)	C=-.042 (.4121)	C=-.030 (.5580)	C=-.030 (.5580)	K=.6213 (.4306)	K=.9622 (.3266)
T_COLL	K=3.219 (.0728)	K=1.594 (.2066)	C=.2480 (.0001)	C=.2640 (.0001)	C=.2960 (.0001)	C=.2960 (.0001)	C=.3120 (.0001)	C=.3440 (.0001)	C=.3173 (.0001)	C=.3173 (.0001)	K=.0078 (.9295)	K=1.594 (.2066)
T_FM	K=.0442 (.8335)	K=.0438 (.8342)	C=-.0241 (.6404)	C=.0472 (.3603)	C=.0274 (.5952)	C=.0256 (.6205)	C=.0211 (.6830)	C=.0428 (.4077)	C=.0058 (.9109)	C=.0058 (.9109)	K=.6187 (.4315)	K=.7066 (.4006)
T_LATL	K=.5227 (.4697)	K=.5381 (.4632)	C=.0253 (.6240)	C=.0854 (.0981)	C=.0223 (.6660)	C=.0315 (.5419)	C=.0377 (.4656)	C=.0592 (.2513)	C=.0762 (.1400)	C=.0762 (.1400)	K=2.453 (.1173)	K=10.71 (.0011)
T_OF	K=.1505 (.6981)	K=.2858 (.5929)	C=.1357 (.0086)	C=.1206 (.0195)	C=.1019 (.0484)	C=.0506 (.3268)	C=.0938 (.0694)	C=.0821 (.1118)	C=.0670 (.1947)	C=.0670 (.1947)	K=.1266 (.7220)	K=3.064 (.0800)
T_SIPH	K=1.001 (.3170)	K=1.162 (.2810)	C=.1423 (.0058)	C=.0969 (.0607)	C=.0777 (.1323)	C=.0969 (.0607)	C=.1088 (.0351)	C=12320 (.0171)	C=.0777 (.1323)	C=.0777 (.1323)	K=2.854 (.0911)	K=.5880 (.4432)
T-SLDG	K=.3605 (.5482)	K=.2437 (.6216)	C=.0083 (.8718)	C=-.033 (.5131)	C=-.106 (.7493)	C=-.013 (.7941)	C=-.015 (.7716)	C=-.015 (.7716)	C=-.016 (.7493)	C=-.016 (.7493)	K=3.409 (.0648)	K=4.224 (.0399)
T_STUB	K=4.464 (.0346)	K=4.133 (.0421)	C=.1733 (.0008)	C=.1573 (.0023)	C=.1573 (.0023)	C=.1893 (.0002)	C=.1413 (.0062)	C=.2053 (.0001)	C=.1893 (.0002)	C=.1893 (.0002)	K=.3880 (.5333)	K=2.443 (.1180)
M_ABS	K=1.686 (.1941)	K=2.319 (.1278)	C=-.0479 (.3532)	C=-.031 (.5427)	C=-.009 (.8596)	C=-.042 (.4145)	C=-.014 (.7725)	C=-.036 (.4816)	C=-.030 (.5542)	C=-.030 (.5542)	K=2.338 (.1262)	K=.5361 (.4641)
M_CGMP	K=4.694 (.0303)	K=4.650 (.0310)	C=.0920 (.0750)	C=.0536 (.2997)	C=.0318 (.5383)	C=.0536 (.2997)	C=.0518 (.3155)	C=.0335 (.5166)	C=.0501 (.3318)	C=.0501 (.3318)	K=.0030 (.9567)	K=.0838 (.7723)
M_CI	K=1.105 (.2931)	K=.9198 (.3375)	C=-.0250 (.6255)	C=-.030 (.5570)	C=-.019 (.7098)	C=-.019 (.7036)	C=-.024 (.6315)	C=-.014 (.7849)	C=-.029 (.5627)	C=-.029 (.5627)	K=.6512 (.4197)	K=.7242 (.3948)
M_CLAY	K=.0294 (.8639)	K=.0002 (.9876)	C=-.0710 (.1694)	C=.0010 (.9846)	C=-.055 (.2873)	C=-.036 (.4800)	C=-.076 (.1362)	C=-.027 (.6014)	C=-.042 (.4109)	C=-.042 (.4109)	K=1.113 (.2914)	K=.2729 (.6014)
M_CONC	K=.0758 (.7830)	K=.0000 (.9944)	C=.0078 (.8804)	C=.0238 (.6447)	C=.0452 (.3811)	C=.0025 (.9618)	C=.0399 (.4402)	C=.0185 (.7198)	C=.0452 (.3811)	C=.0452 (.3811)	K=.4665 (.4946)	K=1.235 (.2664)
M_DI	K=.8205 (.3650)	K=.8385 (.3598)	C=.0706 (.1714)	C=.0869 (.0923)	C=.0661 (.2007)	C=.1083 (.0360)	C=.0925 (.0732)	C=.1246 (.0159)	C=.1088 (.0351)	C=.1088 (.0351)	K=.4764 (.4901)	K=.3033 (.5818)
M_MRC	K=2.770 (.0960)	K=2.841 (.0919)	C=.0572 (.2676)	C=.0419 (.4170)	C=.0545 (.2909)	C=.0636 (.2184)	C=.1023 (.0475)	C=.0374 (.4689)	C=.0545 (.2909)	C=.0545 (.2909)	K=7.627 (.0057)	K=1.477 (.2241)
M_PVC	K=1.240 (.2653)	K=.6769 (.4106)	C=.0023 (.9648)	C=.0077 (.8817)	C=-.013 (.7936)	C=.0290 (.5741)	C=.0024 (.9629)	C=.0344 (.5050)	C=.0078 (.8796)	C=.0078 (.8796)	K=.0010 (.9748)	K=.1291 (.7194)

[shaded box] = Indicates significance at p=<.05

	TEN94	TEN95	TEN96	TEN97	TEN98	TEN99	DISTA	DISTB	DISTC	DISTD	DISTE
T_CASE	K=.9622 (.3266)	K=2.787 (.0950)	K=2.787 (.0950)	K=1.851 (.1736)	K=1.851 (.1736)	**K=3.963 (.0465)**	C=.0226 (.6622)	**C=.1169 (.0236)**	C=-.011 (.8184)	C=-.030 (.5548)	**C=.1016 (.0490)**
T_COLL	K=1.594 (.2066)	K=1.142 (.2851)	K=1.142 (.2851)	K=3.145 (.0761)	K=3.145 (.0761)	**K=4.486 (.0342)**	C=.0093 (.8566)	C=-.087 (.0899)	C=-.050 (.3242)	C=-.014 (.7809)	C=.0914 (.0768)
T_FM	K=.7066 (.4006)	K=.5227 (.4697)	K=.5227 (.4697)	K=3.201 (.0736)	K=3.201 (.0736)	**K=3.985 (.0459)**	C=.0208 (.6864)	C=.0257 (.6183)	C=-.079 (.1235)	C=.0704 (.1727)	C=.1309 (.0113)
T_LATL	**K=10.71 (.0011)**	**K=19.20 (.0001)**	**K=19.20 (.0001)**	K=.0162 (.8987)	K=.0162 (.8987)	**K=5.360 (.0206)**	**C=-.175 (.0007)**	**C=-.131 (.0111)**	C=-.088 (.0866)	C=.059 (.2493)	C=-.079 (.1223)
T_OF	K=3.064 (.0800)	**K=4.424 (.0354)**	**K=4.424 (.0354)**	K=1.563 (.2111)	K=1.563 (.2111)	**K=4.903 (.0268)**	C=-.052 (.3141)	**C=-.123 (.0165)**	C=.0199 (.7002)	C=.0248 (.6314)	C=.0445 (.3892)
T_SIPH	K=.5880 (.4432)	**K=4.273 (.0387)**	**K=4.273 (.0387)**	K=.4240 (.5150)	K=.4240 (.5150)	K=.0672 (.7955)	C=.0877 (.0896)	C=-.081 (.1134)	C=.0788 (.1272)	C=.0291 (.5726)	C=-.071 (.1636)
T-SLDG	**K=4.224 (.0399)**	K=3.681 (.0550)	K=3.681 (.0550)	K=.7720 (.3796)	K=.7720 (.3796)	K=2.498 (.1139)	C=-.038 (.4554)	C=.0457 (.3764)	C=.0333 (.5190)	C=-.084 (.1013)	C=.0107 (.8352)
T_STUB	K=2.443 (.1180)	K=.0846 (.7712)	K=.0846 (.7712)	K=.9695 (.3248)	K=.9695 (.3248)	K=.2568 (.6124)	C=.0595 (.2489)	C=.0896 (.0827)	**C=-.154 (.0028)**	C=-.014 (.7809)	C=-.073 (.3007)
M_ABS	K=.5361 (.4641)	K=.0731 (.7868)	K=.0731 (.7868)	K=.7097 (.3996)	K=.7097 (.3996)	K=.3479 (.5553)	C=.0383 (.4589)	**C=-.122 (.0180)**	C=.0113 (.8264)	C=.0643 (.2134)	C=.0815 (.1144)
M_CGMP	K=.0838 (.7723)	K=.0281 (.8670)	K=.0281 (.8670)	K=.0215 (.8834)	K=.0215 (.8834)	K=.0303 (.8617)	C=-.029 (.5724)	C=.0170 (.7423)	C=-.021 (.6732)	C=.0304 (.5559)	C=.0199 (.6998)
M_CI	K=.7242 (.3948)	K=.1204 (.7286)	K=.1204 (.7286)	K=1.612 (.2041)	K=1.612 (.2041)	K=.4897 (.4840)	C=.0730 (.1572)	C=-.037 (.2664)	**C=-.107 (.0379)**	C=-.014 (.7740)	C=.0130 (.8006)
M_CLAY	K=.2729 (.6014)	**K=5.849 (.0156)**	**K=5.849 (.0156)**	K=3.701 (.0544)	K=3.701 (.0544)	**K=7.511 (.0061)**	C=-.025 (.6164)	C=.0136 (.7926)	C=-.032 (.5308)	C=-.044 (.3856)	**C=.1984 (.0001)**
M_CONC	K=1.235 (.2664)	K=.4112 (.5214)	K=.4112 (.5214)	K=.0763 (.7823)	K=.0763 (.7823)	K=.0411 (.8394)	C=.0447 (.3864)	C=-.037 (.4708)	C=.0373 (.4699)	C=.0039 (.9504)	C=-.087 (.0887)
M_DI	K=.3033 (.5818)	K=.3274 (.5672)	K=.3274 (.5672)	K=2.928 (.0871)	K=2.928 (.0871)	K=3.336 (.0678)	C=.0266 (.6060)	C=-.069 (.1783)	C=.0175 (.7343)	C=.0204 (.6934)	**C=4.307 (.0380)**
M_MRC	K=1.477 (.2241)	K=.0214 (.8836)	K=.0214 (.8836)	K=1.799 (.1798)	K=1.799 (.1798)	K=1.078 (.2991)	C=.0528 (.3062)	**C=-.123 (.0169)**	C=.0149 (.9028)	**C=.1310 (.0112)**	C=-.036 (.4822)
M-PVC	K=.1291 (.7194)	K=1.897 (.1684)	K=1.897 (.1684)	K=.9487 (.3300)	K=.9487 (.3300)	K=2.830 (.0925)	C=-.037 (.4731)	C=-.035 (.4951)	C=-.047 (.3604)	C=.0362 (.4831)	C=.094 (.0662)

[shaded] = Indicates significance at p=<.05 (shaded cells shown in bold above)

	DISTF	DISTG	DISTH	DISTI
T_CASE	C=-.052 (.3099)	C=-.102 (.0465)	C=-.101 (.0504)	C=.1052 (.0417)
T_COLL	C=.0563 (.2760)	C=.0970 (.0603)	C=-.142 (.0059)	C=.0873 (.0909)
T_FM	C=-.056 (.2733)	C=.0511 (.3225)	C=-.103 (.0459)	C=.0959 (.0633)
T_LATL	C=-.175 (.0007)	C=-.064 (.2131)	C=.2825 (.0001)	C=.2958 (.0001)
T_OF	C=-.094 (.0688)	C=.0640 (.2154)	C=-.023 (.6491)	C=.1331 (.0099)
T_SIPH	C=.1256 (.0150)	C=-.081 (.1164)	C=-.022 (.6675)	C=-.037 (.4675)
T-SLDG	C=-.072 (.1597)	C=.0029 (.9548)	C=-.117 (.0226)	C=.2305 (.0001)
T_STUB	C=-.166 (.0013)	C=.0096 (.8518)	C=.0991 (.0550)	C=.0700 (.1751)
M_ABS	C=.1216 (.0186)	C=.2299 (.0001)	C=-.230 (.0001)	C=-.127 (.0136)
M_CGMP	C=-.005 (.9136)	C=.1009 (.0507)	C=-.081 (.1159)	C=-.021 (.6732)
M_CI	C=.1993 (.0001)	C=.1972 (.0001)	C=-.232 (.0001)	C=.0138 (.7888)
M_CLAY	C=-.091 (.0761)	C=-.089 (.0842)	C=-.021 (.6817)	C=.0890 (.0848)
M_CONC	C=.0308 (.8606)	C=.1163 (.0243)	C=-.094 (.0667)	C=.0373 (.4699)
M_DI	C=.0464 (.3694)	C=.1135 (.0280)	C=-.2129 (.0001)	C=.002 (.9964)
M_MRC	C=.0774 (.1340)	C=.0138 (.7900)	C=-.044 (.3937)	C=-.063 (.2167)
M-PVC	C=.0145 (.7785)	C=.1181 (.0222)	C=-.137 (.0077)	C=.0219 (.6717)

[shaded] = Indicates significance at p=<.05

	NONWHITE	OWN	COST	INCOME	STABLE	VOTE92	VOTE93	VOTE94	VOTE95	VOTE96	VOTE97
M_RCP	K=2.103 (.1469)	T=.58 (.5630)	T=-1.24 (.2154)	K=1.250 (.2634)	K=.6741 (.4116)	K=2.978 (.0844)	K=3.319 (.0865)	K=3.436 (.0638)	K=3.436 (.0638)	K=3.662 (.0556)	K=1.982 (.1591)
M_STL	K=.0056 (.9404)	T=-.29 (.7722)	T=.45 (.6529)	K=.1304 (.7180)	K=.7411 (.3893)	K=.1293 (.7192)	K=.0143 (.9047)	K=.0030 (.9560)	K=.0030 (.9560)	K=.1360 (.7123)	K=.1179 (.7313)
DIAM1	K=1.326 (.2494)	T=-.32 (.7457)	T=-1.98 (.0482)	K=4.528 (.0333)	K=2.621 (.1054)	K=.5391 (.4628)	K=.3329 (.5640)	K=.5058 (.4770)	K=.5058 (.4770)	K=.2214 (.6380)	K=.5046 (.4775)
DIAM2	K=.0337 (.8543)	T=-1.03 (.3058)	T=.71 (.4751)	K=.2633 (.6079)	K=1.777 (.1825)	K=9.749 (.0018)	K=10.98 (.0009)	K=11.41 (.0007)	K=11.41 (.0007)	K=12.24 (.0005)	K=10.68 (.0011)
DIAM3	K=4.027 (.0448)	T=-.87 (.3834)	T=-1.72 (.0868)	K=.8630 (.3529)	K=.6741 (.4116)	K=.3836 (.5357)	K=.1919 (.6613)	K=.0625 (.8026)	K=.0625 (.8026)	K=.0699 (.7914)	K=.3545 (.5516)
DIAM4	K=7.550 (.0060)	T=-.47 (.6396)	T=-3.08 (.0022)	K=10.56 (.0012)	K=3.890 (.0486)	K=1.209 (.2715)	K=1.300 (.2541)	K=1.312 (.2520)	K=1.312 (.2520)	K=1.956 (.1619)	K=1.752 (.1855)
LOOP610	K=5.331 (.0209)	T=.51 (.6117)	T=-4.60 (.0001)	K=17.10 (.0001)	K=.6785 (.4101)	K=5.982 (.0145)	K=6.409 (.0114)	K=6.169 (.0130)	K=6.169 (.0130)	K=6.053 (.0139)	K=4.824 (.0281)
AGE	B=.1773 (.0000)	B=.0190 (.5878)	B=-.324 (.0001)	B=-.340 (.0001)	B=-.021 (.6164)	B=.0860 (.0664)	B=.0283 (.7681)	B=.0449 (.6394)	B=.0449 (.6394)	B=.0370 (.6999)	B=.0310 (.7480)
MIN					B=-.041 (.3740)	B=.0310 (.7690)	B=-.003 (.9751)	B=-.038 (.7130)	B=-.038 (.7130)	B=-.046 (.6573)	B=-.050 (.6371)
OWN					B=-.046 (.2698)	B=.1362 (.1538)	B=.1348 (.1576)	B=.1465 (.1243)	B=.1465 (.1243)	B=.1333 (.1626)	B=.1284 (.1806)
COST					B=.0329 (.4522)	B=-.053 (.5902)	B=-.026 (.7902)	B=-.000 (.9952)	B=-.000 (.9952)	B=.0065 (.9569)	B=-.029 (.7653)
INCOME					B=-.007 (.8810)	B=-.053 (.6374)	B=-.010 (.9272)	B=-.019 (.8662)	B=-.019 (.8662)	B=.0063 (.9551)	B=-.003 (.9774)

[shaded] = Indicates significance at p=<.05

	VOTE98	VOTE99	ACTIVE92	ACTIVE93	ACTIVE94	ACTIVE95	ACTIVE96	ACTIVE97	ACTIVE98	ACTIVE99	TEN92	TEN93
M_RCP	K=2.249 (.1336)	K=2.826 (.0927)	C=.0129 (.8020)	C=.0077 (.8817)	C=-.002 (.9561)	C=.0077 (.8817)	C=.0238 (.6455)	C=.0344 (.5050)	C=.0185 (.7203)	C=.0185 (.7203)	K=.0423 (.8371)	K=.3847 (.5351)
M_STL	K=.1449 (.7034)	K=.0622 (.8030)	C=-.0072 (.8890)	C=.0182 (.7251)	C=-.014 (.7764)	C=-.009 (.8511)	C=-.040 (.4382)	C=.0017 (.9730)	C=-.014 (.7764)	C=-.014 (.7764)	K=.0908 (.7632)	K=1.183 (.2766)
DIAM1	K=.6124 (.4339)	K=.6291 (.4277)	C=-.0130 (.8010)	C=.0510 (.3237)	C=.0095 (.8543)	C=.0058 (.9108)	C=.0020 (.9693)	C=-.009 (.8570)	C=.0095 (.8543)	C=.0095 (.8543)	K=.9684 (.3251)	K=.3892 (.5327)
DIAM2	K=10.08 (.0015)	K=10.32 (.0013)	C=.2319 (.0001)	C=.2265 (.0001)	C=.2586 (.0001)	C=.2586 (.0001)	C=.2426 (.0001)	C=.3066 (.0001)	C=.2693 (.0001)	C=.2693 (.0001)	K=.0436 (.8347)	K=1.595 (.2066)
DIAM3	K=.2205 (.6386)	K=.0438 (.8342)	C=.0877 (.0896)	C=.0610 (.2372)	C=.0505 (.3281)	C=.0504 (.3294)	C=.0558 (.2802)	C=.0771 (.1354)	C=.0612 (.2362)	C=.0612 (.2362)	K=2.116 (.1458)	K=.9214 (.3371)
DIAM4	K=1.453 (.2280)	K=1.423 (.2329)	C=.1566 (.0024)	C=.1301 (.0118)	C=.1624 (.0017)	C=.1407 (.0064)	C=.1782 (.0006)	C=.1676 (.0012)	C=.1624 (.0017)	C=.1624 (.0017)	K=.0006 (.9798)	K=.1589 (.6901)
LOOP610	K=5.093 (.0240)	K=4.163 (.0413)	C=.0310 (.5484)	C=-.030 (.0602)	C=.0784 (.1290)	C=-.056 (.2713)	C=.0093 (.0702)	C=.0935 (.0702)	C=.1132 (.0281)	C=.1132 (.0284)	K=.0834 (.7728)	K=11.13 (.0008)
AGE	B=.0316 (.7433)	B=-.005 (.9519)	T=-1.39 (.1664)	T=-2.02 (.0441)	T=-3.13 (.0019)	T=-3.01 (.0028)	T=-3.05 (.0024)	T=-2.75 (.0062)	T=-3.22 (.0014)	T=-3.22 (.0014)	B=-.046 (.2862)	B=-.041 (.3232)
NON WHITE	B=-.036 (.7292)	B=-.061 (.5602)	K=6.218 (.1014)	K=3.142 (.3702)	K=5.636 (.1307)	K=3.416 (.3317)	K=2.529 (.4700)	K=1.724 (.6314)	K=3.289 (.3490)	K=3.289 (.3490)	B=.0433 (.3600)	-.1413 (.0020)
OWN	B=.1209 (.2074)	B=.1269 (.1844)	T=-.58 (.5616)	T=-.39 (.6987)	T=-.69 (.4890)	T=-.67 (.5028)	T=-.32 (.7494)	T=-.02 (.9814)	T=-.85 (.3933)	T=-.85 (.3933)	B=-.021 (.6074)	B=-.032 (.4248)
COST	B=.0145 (.8837)	B=.0414 (.6756)	T=-1.59 (.1137)	T=-1.22 (.2222)	T=-1.03 (.3201)	T=-.54 (.5883)	T=-.83 (.4061)	T=.08 (.9333)	T=-.83 (.4093)	T=-.83 (.4093)	B=-.014 (.7460)	B=.1334 (.0017)
INCOME	B=-.018 (.8705)	B=.018 (.8712)	K=1.235 (.5390)	K=.8920 (.6402)	K=.4343 (.8048)	K=.0898 (.9561)	K=.1412 (.9318)	K=.4574 (.7956)	K=.2898 (.8651)	K=.2898 (.8651)	B=.0463 (.3538)	B=.0907 (.0605)

= Indicates significance at p=<.05

	TEN94	TEN95	TEN96	TEN97	TEN98	TEN99	DISTA	DISTB	DISTC	DISTD	DISTE
M_RCP	K=.3847 (.5351)	K=.0134 (.9080)	K=.0134 (.9080)	K=.9487 (.3300)	K=.9487 (.3300)	K=2.830 (.0925)	C=.0036 (.9449)	C=.0292 (.5716)	C=-.099 (.0551)	C=-.010 (.8452)	C=.0768 (.1371)
M_STL	K=1.183 (.2766)	K=2.797 (.0944)	K=2.797 (.0944)	K=.0734 (.7864)	K=.0734 (.7864)	K=.1483 (.7001)	C=.0288 (.5773)	C=.0127 (.8062)	**C=-.048 (.0484)**	C=-.046 (.3716)	**C=.1788 (.0005)**
DIAM1	K=.3892 (.5327)	K=1.183 (.2766)	K=1.183 (.2766)	K=.0019 (.9653)	K=.0019 (.9653)	K=.4862 (.4856)	C=-.061 (.2368)	C=.0035 (.9452)	C=-.026 (.6100)	C=-.077 (.8813)	C=.094 (.0688)
DIAM2	K=1.595 (.2066)	K=.5784 (.4469)	K=.5784 (.4469)	K=2.565 (.1092)	K=2.565 (.1092)	K=2.796 (.0945)	C=.028 (.5875)	C=.0272 (.5985)	**C=-.118 (.0221)**	C=-.012 (.8129)	C=.0569 (.2703)
DIAM3	K=.9214 (.3371)	K=.1304 (.7180)	K=.1304 (.7180)	**K=3.847 (.0498)**	**K=3.874 (.0498)**	K=3.592 (.0581)	C=.0466 (.3663)	**C=-.131 (.0107)**	C=-.081 (.1132)	C=.0517 (.3172)	C=.0768 (.1371)
DIAM4	K=.1589 (.6901)	K=1.446 (.2292)	K=1.446 (.2292)	K=.0304 (.8615)	K=.0304 (.8615)	K=.3340 (.5633)	C=-.064 (.2096)	C=-.061 (.2344)	C=-.024 (.6362)	C=.058 (.2606)	C=-.008 (.8685)
LOOP610	**K=11.13 (.0008)**	**K=17.72 (.0001)**	**K=17.72 (.0001)**	K=.8139 (.3670)	K=.8139 (.3670)	K=1.306 (.1790)	**C=-.201 (.0001)**	C=-.057 (.2649)	C=-.003 (.9536)	**C=.2045 (.0001)**	**C=-.215 (.0001)**
AGE	B=-.041 (.3232)	**B=.2518 (.0001)**	**B=.2518 (.0001)**	B=.0553 (.1838)	B=.0553 (.1838)	**B=-.172 (.0001)**	**K=17.00 (.0001)**	K=2.684 (.1013)	K=1.343 (.2465)	**K=6.049 (.0139)**	**K=15.32 (.0001)**
NON WHITE	**B=-.143 (.0020)**	**B=.1739 (.0001)**	**B=.1739 (.0001)**	**B=.1118 (.0140)**	**B=.1118 (.0140)**	**B=-.165 (.0003)**	K=4.336 (.2273)	**K=21.43 (.0001)**	K=2.075 (.5568)	K=6.448 (.0917)	K=3.815 (.2821)
OWN	B=-.032 (.4248)	B=.0345 (.3981)	B=.0345 (.3981)	B=-.032 (.4328)	B=-.032 (.4328)	B=.0085 (.8353)	T=-1.19 (.2344)	T=-1.23 (.2183)	T=1.01 (.3116)	T=.57 (.5687)	T=-1.53 (.1270)
COST	**B=.1334 (.0017)**	**B=-.224 (.0001)**	**B=-.224 (.0001)**	B=-.073 (.0809)	B=-.073 (.0809)	**B=.1728 (.0001)**	**T=3.15 (.0018)**	**T=4.72 (.0001)**	T=-.31 (.7589)	**T=-2.77 (.0060)**	T=-.37 (.7144)
INCOME	B=.0907 (.0605)	**B=-.204 (.0001)**	**B=-.204 (.0001)**	B=-.033 (.4920)	B=-.033 (.4920)	**B=.1331 (.0057)**	**K=11.45 (.0033)**	**K=15.72 (.0004)**	K=.4153 (.8125)	K=3.004 (.2226)	**K=7.060 (.0293)**

[shaded box] = Indicates significance at p=<.05

	DISTF	DISTG	DISTH	DISTI
M_RCP	C=.1034 (.0452)	C=.1181 (.0222)	C=-.137 (.0077)	C=-.030 (.5619)
M_STL	C=-.061 (.2360)	C=-.067 (.1900)	C=-.075 (.1448)	C=.0869 (.0924)
DIAM1	C=.0064 (.9014)	C=.0905 (.0795)	C=-.087 (.0904)	C=.0102 (.8428)
DIAM2	C=-.053 (.3000)	C=-.049 (.3383)	C=-.049 (.3383)	C=.0719 (.1640)
DIAM3	C=.1257 (.0149)	C=.1880 (.0003)	C=-.198 (.0001)	C=-.012 (.8062)
DIAM4	C=.1076 (.0372)	C=.0537 (.2984)	C=-.055 (.2807)	C=.0274 (.5954)
LOOP610	C=-.168 (.0011)	C=-.111 (.0313)	C=.2504 (.0001)	C=.2036 (.0001)
AGE	K=.0325 (.8569)	K=4.692 (.0303)	K=2.148 (.1427)	K=5.419 (.0199)
NON WHITE	K=19.95 (.0002)	K=13.97 (.0029)	K=21.24 (.0001)	K=9.175 (.0270)
OWN	T=2.78 (.0096)	T=.64 (.5245)	T=1.34 (.1823)	T=1.30 (.2011)
COST	T=.27 (.7891)	T=-5.24 (.0001)	T=4.14 (.0001)	T=-3.67 (.0003)
INCOME	K=1.329 (.5145)	K=6.701 (.0351)	K=3.676 (.1591)	K=14.58 (.0007)

[shaded] = Indicates significance at p=<.05

B=Kendall's Tau B T= T-test C=Chi-square/Phi coefficient K=Kruskal-Wallis

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