Dealing with Wastewater and Water Purification from the Age of Early Modernity to the Present: An Inquiry Into the Management of the Ottawa River

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Abstract:

This thesis examines the impact of urban water infrastructure on the Ottawa River through an exploration of the City of Ottawa's historical development from the early modern period to the present. The primary aim is to explain how the Ottawa River came to be removed or ignored from the City of Ottawa's urban development strategy. The thesis focuses on the periods of 1910-1920 (early modernity) and 1999-2012 (present). The theories applied are risk, risk management, normal accident theory and the politics of infrastructure. The data and information for this thesis were primarily retrieved from the City of Ottawa website as well as from the archives of the City of Ottawa. The thesis identifies several factors explaining why the Ottawa River has been mistreated over time, as well as the challenges involved in reforming present-day practices and infrastructure. Several recommendations to fix the situation are advanced.

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With special honour, I would like to acknowledge all those who helped make this thesis possible.

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Chapter One: *Introduction*

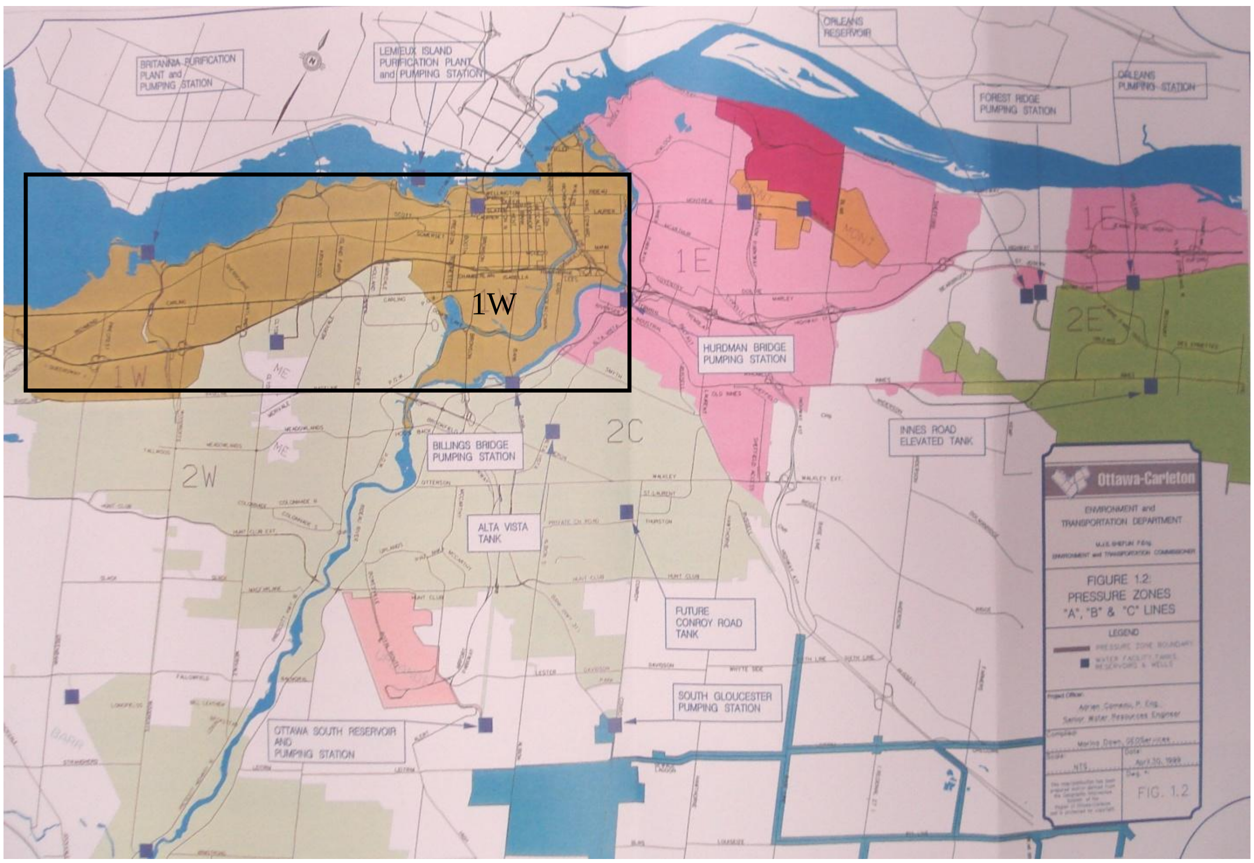
Recently the Ottawa River has become an epicentre for interest regarding the environmental processes of the City of Ottawa. These processes such as the release of raw untreated wastewater into the Ottawa River from the City of Ottawa, have attracted undesirable attention from various sources (media, the public, etc). In turn, they have resulted in public campaigns to show that processes are in place or going to be in place to resolve conditions of environmental degradation. Although these concerns are more recent, they have been in existence for a much longer period of time.

As Canada's Capital, the City of Ottawa has been subject to several periods of growth, expansion and change ranging from the early modern period of 1909-1920 where primary infrastructure was established in a standard format to the present (1999-2012) where environmental concerns have renewed interest into providing solutions to several older problems that continue toexist withthe present infrastructure. These problems only continue to persist as the City of Ottawa develops and grows. Part of that growth has been due to a significant population increase as people from all over flock to the capital for a variety of reasons. The other part of that growth has been due to municipal annexation which has resulted in the expansion of the existing systems and a change in the economy as the City expands both in size and population. As such, the city has gone from a smaller population in the early modernity to being one of the largest cities in Canada in the present. With these changes occurring, the city's layout, design, and challenges for infrastructure have changed as well.

Population and economic growth have caused significant problems, such as pollution. Waterborne pollution has caused persistent problems for the City, particularly heavy metal infiltration into the Ottawa River. However, none of the studies conducted in the past (in the period of the 1970's to 1980's) focused on the questions of how or why theseproblems were occurring. Rather they have only sought to describe the existing problems as they appear. However, the real reasons for these problems and various other problems for the Ottawa River have remained mostly unexplored by sociology. These problems for the most part have been allowed to continue with minimal exploration of the rootcauses. As such, the lack of exploration has allowed for the continuance towards excluding the environment from the social and economic spheres without any clear explanation of why the City of Ottawa's infrastructure continues to contaminate the Ottawa River.

Overall, this is a sociological problem because the current state of the river is the direct outcome of decisions made by municipal authorities over time. I will argue that these decisions are the product of particular priorities and views of nature that were held in an earlier phase of modernity. One of the major problems today is that these older priorities and views have been concretized in physical infrastructure, which makes them difficult and expensive to reverse. Sociology can also inform us about how subsequent generations of city politicians and administrators have tried to deal with these problems within the institutional and decisional constraints they face.

In the case of this thesis, the key question motivating the research into the Ottawa River and the existing problem is: "*How has the Ottawa River become removed/ignored from the City of Ottawa's strategy for development from the early modern period (1909-1920) to the present period (1999-2012)?*". The research into this problem is timely, as the City of Ottawa has recentlyimplemented anaction planfor fixing some of the urban infrastructure as well as increasing some of the development that will fix some of the existing problems both with selective parts of the water purification and wastewater management systems. This includes updates to selective key water mainlines primarily within the urban core region of 1Was seen in *Figure1.1* below showing a map of the current water infrastructure:



(*Figure1.1*, "Pressure Zones, A,B & C Lines", City of Ottawa 1999).

The thesis has been organized into seven chapters. Chapter two provides a review of existing research about the Ottawa River. The following chapters (three and four) are organized to provide a discussion of the existing sociological theories to be used in analysis along with a review of the methodology taken to explain the research problem. Chapter five and sixpresents some of the analysis of the findings with regard towards the theories being applied. Chapter seven reviews the findings with an eye to possible future avenues of research.

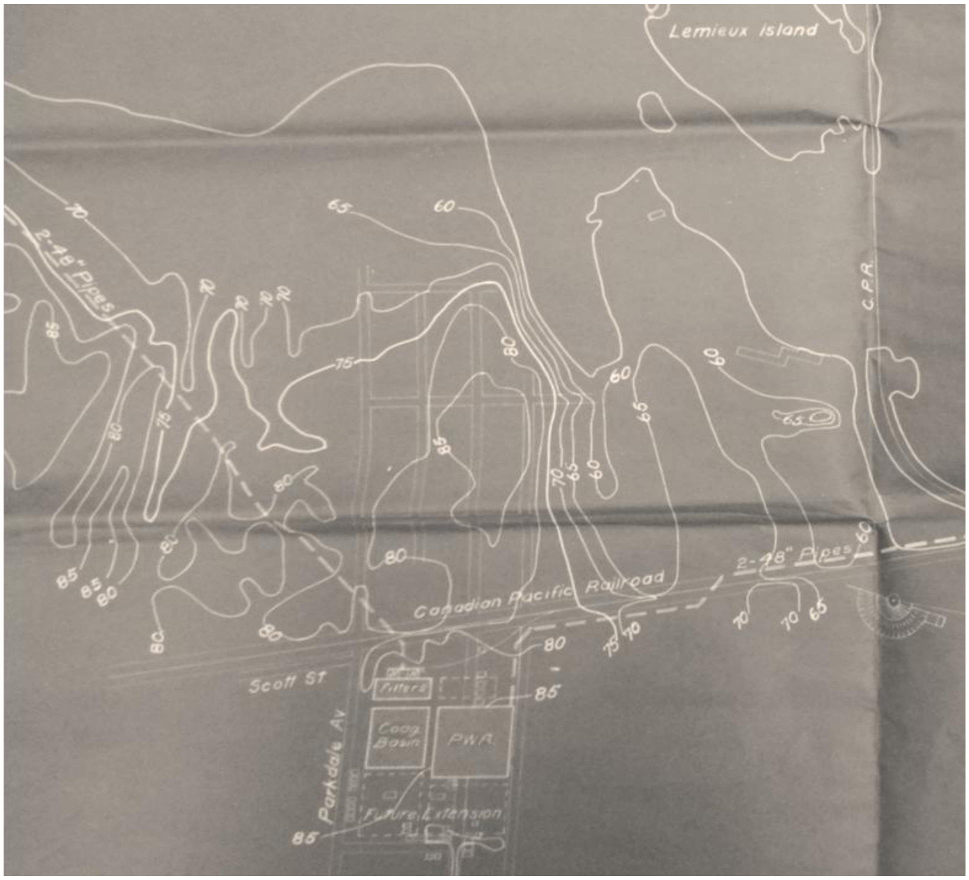
<u>Chapter Two</u>*<u>: Ottawa's Urban Water Infrastructure, Then and Now</u>*: *Policies and Processes of the City of Ottawa*

2.1 Introduction:

This chapter provides a description of the processes that were in place for the wastewater and water management system within the early modernperiod as well as the present. Throughout this chapter, I will discuss background information into the topic that has been found with regard towards the primary processes as well as the City of Ottawa's new strategy, the social as well as environmental impact and how these researched elements are important for figuring out the reason why the Ottawa River has become excludedand ignored.

2.2 The City of Ottawa's Early System:

The early modern system for the City of Ottawa was designed initially to handle only a smaller population of approximately 250,000 residents back in the period of 1909-1920 and was administered by a few sources (primarily water coming from the main intake out of the Ottawa River). The old water purification plant (as shown in *Figure2.1* below) was located on Parkdale Avenue and ran along the CP Rail line.

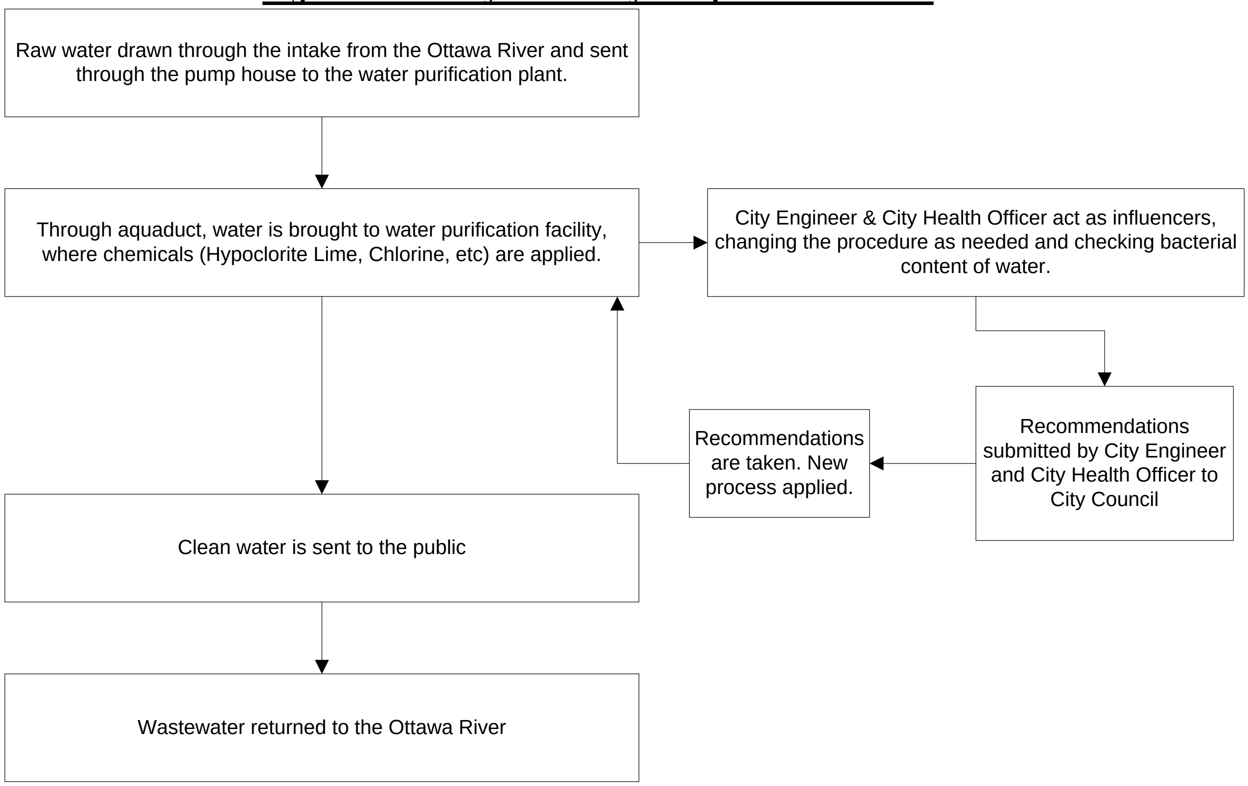


(*Figure2.1* - City of Ottawa 1914 "Pipeline to Purification Plant")

The old plant was designed on a simple scale with a power source, tank and purification pump to take water from the River intake and processes it with chemicals and then pass the water back into the system for public consumption (City of Ottawa 1914, pg 177).

As a process during this period, the purification system was primarily influenced by the role of the City Health Officer, who was tasked to procure materials for the City Engineer such as Hypochlorite Lime, Chlorine, and other chemical compounds to allow for rudimentary purification of water drawn into the system through the primary intake from the river. This process as illustrated in *Figure 2.2*, was relatively simple and dependent upon both agreement from City Council as well as the opinion of both experts.

Figure 2.2 - Early Modernity Purification Process:



As shown above, the process was relatively simple in design. First, water would be drawn from the river through the pump house and brought to the purification plant where a variety of chemicals would be applied (City of Ottawa 1914, pg 174).Second, the purified water would be distributed to the citizens through the mainline infrastructure and eventually returned to the river via the sewer lines (City of Ottawa 1914, pg 174). Although this process was relatively simple, it was highly adaptable and influenced by first the City Engineers and Health officers report, then second by City Council who would make a decision based upon the findings within the report that would result in changes to the existing system at the purification process level.

As the purification process becamesystematic during this period, urban centers would need to be flexible as they would continue to grow due to an increase in populationand expansion in size. This growth was anticipated by the City Engineer then relayed to City Council who understood they would need another source in the future for water purification. This is when the option for the Ottawa River development of Lemieux Island was proposed (in favour by the City Engineer) and the Thirty-One Mile Lake option.

Due to the health risks associated with human habitation near the Thirty-One Mile Lake option, the City Engineer, in conjunction with the City Health Officer proposed that Lemieux Island would be the best option. However,health of the citizens was only the secondary reason for not selecting the Thirty-One Mile Lake option as the primary reason for Lemieux Island being chosen was cost. Lemieux Island's plant would cost $623,000 (City of Ottawa 1914, pg 8) versus Thirty-One Mile Lake which would cost approximate $8,000,000 (City of Ottawa 1914, pg 177). As Lemieux Island was both cheaper and closer to the City it would provide easier development and future expansion for the City of Ottawa without any consideration for the Ottawa River which was seen according to the City Engineer at the time of 1914 Allen Hazen as "the most economical " (City of Ottawa 1914, pg 7). Throughout this period and after the suggestions of the experts (City Engineer and City Health Officer) Lemieux Island would become the primary water purification hub for the City of Ottawa. This in turn would start the process for the modern water purification plants and the continual use of the Ottawa River as both a source for water and a place to deposit wastewater along with the foundations of the primary infrastructure like the water main lines listed as A, B, & C (City of Ottawa 2001, pg 1).

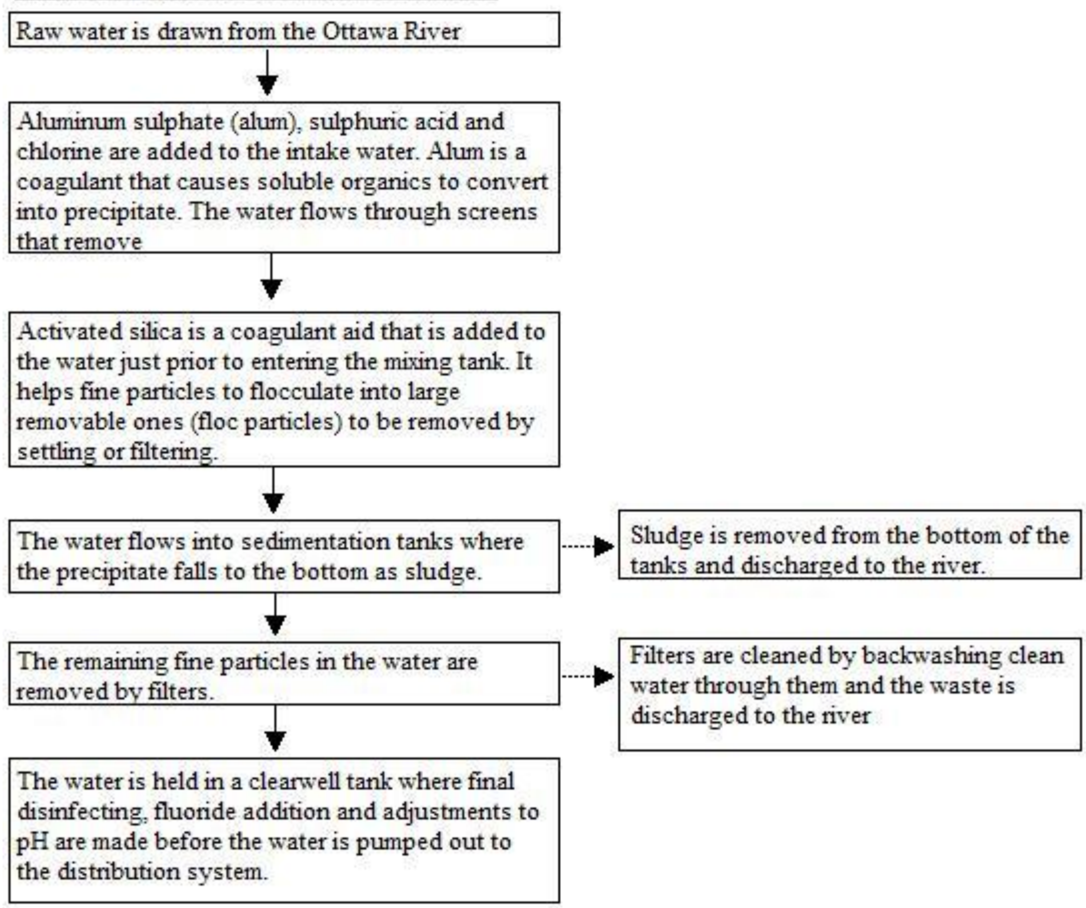
2.3 The City of Ottawa Water Purification Process and Wastewater Process in the present.

Today, the City of Ottawa runs a very largeand complicated networked system that provides a population around or above a million people with fresh water production and wastewater disposal. These processes often require largeamounts of knowledge to process and apply basic daily outputto ensure that the needs of the City'scitizens are met with full expected potential and necessary resources coming to and from the Ottawa River. First of all, in order to meet these expectations the City of Ottawa has over the years expanded its operations of production and treatment to handle the daily grind to ensure that fresh, clean, drinkable water is provided. Water as everyone knows is importantfor maintaining life and crucial for our existence. Thus the treatment of water is important for society and has come to be in the present a subject of concern with issues like Walkerton being raised over the quality of our drinkable water. As such, the systems in place for water for larger urban cities has become more complex to prevent negative outcomes and for a growing city like Ottawa has resulted in the foundations forthe two water purification plants (Britannia and Lemieux Island) and the one wastewater treatment facility (The Robert O. Pickard Environmental Center) as will be discussed in the later chapters. The operation of these facilities and the processes that are involved with treatment on both ends are the primary subject of research here within this chapter and will be explained in full detail in this section starting with the environmental outcomes and impacts of the water purification process in Ottawa.

The water purification process in Ottawa is a complicated systemthat takes into account several factors that ranges from the City of Ottawa's mandate to provide high-quality drinking water for residents, ensure plentiful flow and supplies, to the actual complicated processes that involve getting the water from the river (City of Ottawa *Water* website http://www.ottawa.ca/residents/water/index_en.html retrieved on January 15th, 2012). All of these factors can have an influence on river ecology. For example, the City of Ottawa has to draw on more water during a day than the average populaceof Ottawa (a million or so people) can use from the Ottawa River. The purpose of this, is to ensure that the population has sufficient supply and pressure due to the sprawl or size of the City.

The size or urban sprawl of Ottawa, which takes into account the various suburbs like Orleans and Kanata plays a role in the way the water and wastewater systems are managed to provide sufficient resources. Urban sprawl plays a role in how the city treatsthe Ottawa River, as the size and population of the city continue to grow, so does the need for more water and system infrastructure. This increases costs, as well as reliance on scientific practices to ensure safety and quality of the drinking water. However, to get this water from the river at the two aforementioned plants of Britannia and Lemieux Island requires a procedure that is articulated clearly in “*Figure 2.3: Water Purification Process*” from the City of Ottawa’s *Surface Water Quality Program* guide and shown just below (City of Ottawa 2000, pg 7).

<u>Figure 2.3 Water Purification Process</u>



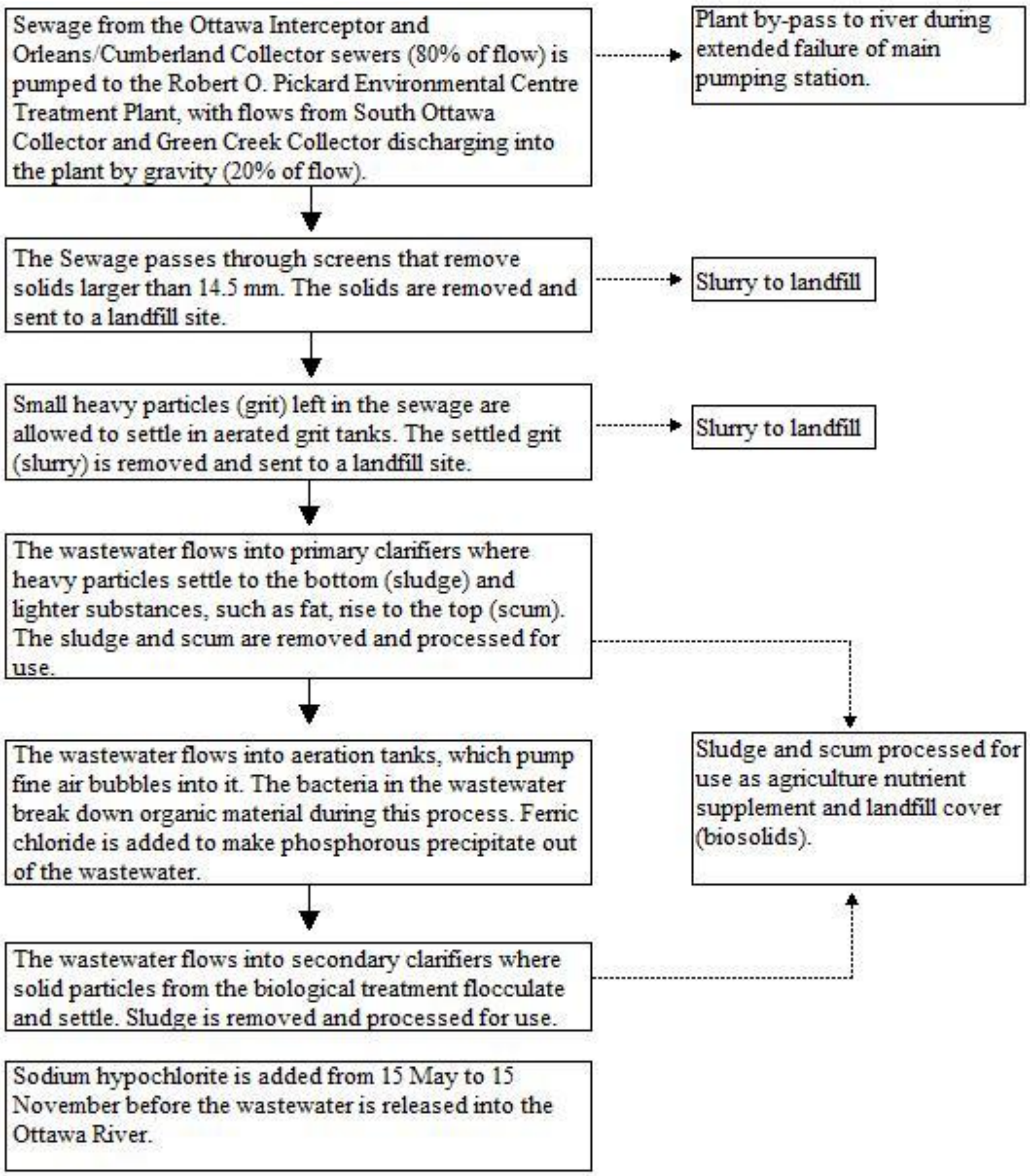
First, this diagram explains in detail how the water is retrieved from the Ottawa River and what is done to it before it goes into the City's water lines. This process initially starts with drawing water through massive filters that are designed remove suspended solids (City of Ottawa2000, pg 5). These initial filters are cleaned six times a day with backwashing, which the City describes as pushing water from the treatment tanks back out into the river to remove suspended solids from the filters and thus also releases portions of Aluminum Sulphate and Chlorine into the tributary of the river that flows into the treatment facility (City of Ottawa 2000, pg 5). In the case of Britannia, it is well known and documented within the reported details that the environmental impacts of this process includes an impact upon the local Large Mouth Bass population(City of Ottawa 2000, pg 6). This includes releasing the sludge into the effluent from the facility and occasionally accidentally releasing diesel fuel (used for power generators) from drains or through cooling processes of engines located in the facilities(City of Ottawa 2000, pg 5). Diesel fuel as mentioned in the guide contains "polycyclic aromatic hydrocarbons (PAHs) such as naphthalene, phenanthrene and anthracene" (City of Ottawa 2000, pg 5). Naphthalene is highly toxic to local fish populations and as the report also found can cause upwards of 50% mortality of Large Mouth Bass populations within 96 hours (City of Ottawa 2000, pg 6).

The second process outside of filtration and its issues is the addition of Aluminum Sulphate, Sulphuric Acid and Chlorine which are also noted for toxic values to local flora and fauna if leached into the river. Of course this is what happens when Silica is added to the water to remove and settle sediments along with chemicals at the bottom of the deposit tanks as sludge, where it is then released into the river as a waste by-product (wastewater) of the purification process.

From this point the water goes into the mixing tank where it goes through its final sterilization and receives additives like fluoridation (City of Ottawa2000, pg 7). In this final stage the water is tested. According to the City of Ottawa website testing of the water happens over 125,000 times a year in accordance with Health and Government standards (City of Ottawa *Water* website http://www.ottawa.ca/residents/water/index_en.html retrieved on January 12th, 2010). Essentially this can be calculated out to approximately 342 tests a day or 14 tests an hour. Thus it implies that the water supplies are tested fairly often to ensure the City meets its mandate of quality. This procedure is relatively the same for both purification plants with a few exceptions. Lemieux Island is located a point where the water flows at a higher rate thus there is less plant or animal life located near this facilities position (down river from Britannia) along the river. After this point the water ends up in the City's water lines where it is distributed to around a million people daily and returned eventually through the wastewater lines to be treated again before being pumped back into the river system on a normal day.

The wastewater procedure is much more complicated than the initial process of gathering the water from the river with the purification process. First, unlike the case for the purification process of there being two plants there is only one wastewater treatment plant for the whole city of Ottawa that is located further east and down river from the purification plants. This process has several other factors involved with it that include facts such as 80% of the wastewater has to be pumped to the facility, while only 20% comes through natural gravity (City of Ottawa2000, pg 13). However, once this wastewater arrives it goes through the City's complex process of purification and treatment that is designed this time not to make the water drinkable for the human population, but to ensure that it has less of an impact upon river ecology. This can be explained further within the diagram included below titled "*Figure 2.4:Wastewater Treatment Process"*(City of Ottawa2000, pg 15).

Figure 2.4: Wastewater Treatment Process



This diagram, much like the previous figure, (*Figure 2.4*) displays an outline of how the process works for treating wastewater (including elements of what happens if the system cannot handle its load). This process starts with the wastewater treatment facility (The Robert O. Pickard Environmental Center) receiving the waste through either gravity or being pumped through the system. Then that process is followed by filtration to remove solids and other material from the waste to be sent away to the City's landfills as slurry (City of

Ottawa2000, pg 16). The City of Ottawadefines "slurry" as heavier particles of waste material, biosolids, grit, scum and chemical compounds that form sludge (City of Ottawa2000, pg 16). Slurry is removed throughout the process to be sent either to landfills or to be used for agricultural nutrient supplements. Eventually as this process happens, bacterium is added to the wastewater in the aeration tanks to break down the organic material and Ferric Chloride is added to breakdown phosphorus since it is harmful if released into the river (City of Ottawa2000, pg 16). After these processes, the wastewater is treated a final time then released in an effluent plume “between Lower Duck Island and the Ontario shoreline where the river moves quickly” (City of Ottawa2000, pg 13).

As a final process the wastewater treatment facility between the months of May and November will add Chlorine to the effluent as a final sanitizer before it enters the river. The purpose of this Chlorination is to remove potentially harmful bacteria from the effluent such as Escherichia coli and fecal streptococcus which can cause sickness in humans (City of Ottawa2000, pg 13). However, this is only if the system does not incur a power failure or other circumstances that the aging infrastructure cannot handle outside of normal daily values.

2.4 The City of Ottawa's present strategy

The City of Ottawa is under pressure from many sources that include the public, higher tiers of government and environmental action groups who are pushing the City to adapt its Water and Waste strategy with respect to the Ottawa River. As a result of some of these influences, the City of Ottawa releasedthe*Ottawa River Action Plan*in 2010 which is meant to address the problems mostly assumed to be associated with the combined sewer overflows (City of Ottawa website, 2012 http://ottawa.ca/en/env_water/tlg/alw/brs/orap/index.html). The City's strategy in this case through the*Ottawa River Action Plan* is designed to have a 17 point project implementation process towards solving problems related to combined sewer overflows for over the next 25 years. These points are shown below in*Table 2.5* where they present each project that the City is either implementing or intending to implement through the action plan:

Table 2.5 - Ottawa River Action Plan

1. Implementation of Real Time Control
2. Critical Combined Sewer Overflow and Storm Outfall Monitoring
3. Combined Sewer Overflows Storage for Ultimate Combine Sewer Area
4. Review and implement Sewer Interconnection Program
5. Sewer Separation Outside the Ultimate Combined Sewer Area
6. Development of a Wet Weather Infrastructure Management Plan
7. Implementation of a Wet Weather Infrastructure Management Plan
8. Installation of Floatable Traps in Combined Sewer Area Catchbasins
9. Pinecrest Creek/Westboro Stormwater Management Retrofit Pilot
10. Eastern Subwatersheds Stormwater Retrofit Plan
11. Implementation of Stormwater Management Stormwater Retrofit Plans
12. R.O. Pickard Environmental Centre Effluent Dechlorinization
13. Water Environment Strategy
14. Monitoring and Source Control Programs
15. Wastewater and Drainage Environmental Quality Management System
16. Updates to the Ottawa River Bacterial Water Quality Computer Model
17. Public Outreach and Education.

Each point above represents a distinct program that the City of Ottawa is either in the process of implementing or will implement as a part of its strategy to both renew urban infrastructure and deal with the problems that are affecting the Ottawa River (City of Ottawa 2012, pg 1). For example the R.O. Pickard Environmental Centre Effluent Dechlorinization project (#12) is designed to bring down the amount of Chlorine found within the effluent during swimming season"to a safe level of 0.02 mg/l" through a new system being applied at the facility (City of Ottawa 2010, pg 28). Other steps such as the one mentioned are meant to be implemented in the near future to coincide with the plans short term policy for the next five years, while some are for the full length of the 25 year plan with a total value of $251.64 million (City of Ottawa 2010, pg7). Although, each step is a positive step in the right direction, the strategy is still centered (as will be explained further within the analysis) around human needs and continues todownplay the River's environmental needs. As well, many of the programs are designed in some instances to make the systems more complex which can result in further problems through the span of the 25 year period.

Chapter Three: Literature Review - *Risky developments for the Ottawa River*

3.1 Introduction:

In this chapter I will discuss previous research on the subject of the Ottawa River as well as the major theories used in this thesis, namely Risk, Risk Management, Normal Accident Theory, and the Politics of Infrastructure. This chapter will also provide a framework for understanding the chronological differences between the two time periods considered in the study the early modern period (1909-1920) and the late modern or present (1999-2011) along with a justification as to why these periods were chosen. The literature review will also be used to articulate how sociology can explain the primary subject of the Ottawa River's ecology in relation to water usage, wastewater management as well as why this research is important for sociology. First this chapter will begin by providing a brief overview of the theoretical basis of the study, starting with risk and risk management followed by a brief discussion of other social researchers views towards similar subjects.

3.2 Risk & Risk Management:

Risk, according to Ulrich Beck, is "a systematic way of dealing with hazards and insecurities induced and introduced by modernization itself" (Beck 1992, pg 21). Essentially, as societies develop and advance through systematic processes like industrialization that are based in part on technological innovation, they overcome and incur new problems relative to these forces of modernity. The forces of modernity according to Beck are connected to society's need to overcome the limitations and dangers of the natural world ranging from floods, disease, climate and various other factors that society's have been dealing with for hundreds to thousands of years (Beck 1992, pg 23). According to Beck this can be further defined by specific periods of change within history that influence how risks and how societies develop (Beck 1992, pg 23). For Beck, this meant focusing upon history within the last 150 years and primarily focusing on the periods of modernity: Early, second and present modernity.

Beck defined the early modern period as being a transition from the institutions and structures of traditional society to the individual freedom and autonomy found within industrialization and the rationality of science(Beck 1992, pg 23). He also defined this period as being "marked by socio-economic conflicts between labour and capital" and "by the antagonism between political systems" which would eventually result in the second modern period (Beck 2007, pg 73). The second modern period was defined by Beckas being formalized by the age of nuclear power, political reform and socio-differentiation from the traditional (Beck 1992, pg 23). In this case, the second modern period became a period where risks from the early modern period were compounded by times of change"introduced through cultural collision" (an increase in the merging of cultures and globalization)and high risk technologies (Beck 2007, pg 74).As Beck describes, society was going through an overhaul from the traditional, especially within the Western part of the world where science and decisions made in the early modernity were expanded upon and made more globalized. As such, the second modern period is also defined by the introduction of these high risk technologies (such as nuclear power) from the standard of industrial practises that were present in the early modern period.According to Beck, this introduction paved the way for reflexive modernization which isexplained by Beck as more of transition from the early modern industrial society to the second modernity and present (Beck 2007, pg 109). Essentially, reflexive modernization is atransitional period that takes place after"industrial societies create and legitimize risks that they cannot control" and when "industrial society then sees risks and criticizes itself as risk society" (Beck 2007, pg 109). In this case, the concept does not signify reflection but self-confrontation for risk based societies (pg Beck 2007, pg 10).Overall, this means that the second modernity was a period of looking back at the early modern technologies for risks they are now associated with, but offered no way to explain these risks. Instead, the second modernity became a period where risks would increase in both complexity and were compounded by the risks that were developed and equally misunderstood from the early modern period. Due to this situation, the present is considered by Beck as a point of reflexive modernization as well, where "institutions are being judged completely differently - no longer as trustees but as suspects" because of the influence and loss of control over high risk based technologies during the second modernity which has perpetuated into the present, even though the risks might originate within the early modernity (Beck 2007, pg 54). As such,these periods in many ways have become iconic as points of separation for modern history that show societies evolution.

Even though the ideals and principles during the periods differed,the influences of risk mixed with technology and society's acceptance of the risksassociated with progress has contributed to the present world at risk. The reason for this acceptance has come from the eventual loss of control over the management ofrisks. Therefore, the loss of control for society has further created perfect situations for future problems to develop. However, all of these risks and technologies originate within the early modernity. In this case it establishes this period as a point of interest for this thesis and the first focus for reflection from the present situation. As such, prior to the period of reflexive modernity many solutions in the early modern period were developed around technological advancement as ways to overcome the natural world. As Beck mentions, risk played a role in technological achievement as a way to advance and modernize a nation-state through observing factors that create risk then finding solutions through technology to overcome these factors (Beck 1992, pg 22).

In order to find solutions to risk, according to Niklas Luhman, one must observe factors relative to risk like danger, harm and potential threats (Luhman 2005, pg 26). However, according to Luhman, the act of observation of risk also defines risk from the other concepts such as harm as well as danger which should be considered as separate concepts from risk (Luhman 2005, pg 26). For example, danger and harm must be observed in order to define what can later be considered a risk. If fire burns and water floods it is considered a danger that can harm members of society therefore it becomes a risk and a solution must be found for the potential threat. If a risk is observed, a solution can later be found through analysis of what causes the danger, what creates the harm and in turn what the potential threat will be (Luhmann 2005, pg 21). In this way, risk, as Luhman points out, is a timeless concept that has a development within the past and has been used for centuries (Luhman 2005, pg 19). However, Luhman's view of risk differs in some ways from Beck's as Beck focuses upon periodization whereas Luhman presents risk as timeless, ageless and most importantly not selective of a period. However, this does not mean that Luhman's views of risk cannot help support Beck's interpretation as both involve acts of observation, defining harm and danger as it appears. The only other difference comes from Beck's focus upon the early modern period, where many risks were created and perpetuated (Beck 1992, pg 20).

The early modern period for risk was a time when many risks that had existed for centuries, like water based diseases relative to sanitation (typhoid, diphtheria, dysentery, etc) and other environmental limitations, were overcome through scientific achievement, industrialization as well as trial and error processes. As Beck points out many of these solutions that allowed society to adapt came at a price with new risks being developed that would either remain unnoticed, misunderstood or would be pushed off to other locations (Beck 1992, pg 20). Through this uneven distribution of risks, many powerful centers were able advance during this period while non-powerful centers remained marginalized. For example, within the first modern period for many growing urban centres of power in Canada, they accepted many risks associated with the development of the urban municipal water ways towards infrastructure that would provide clean water to the members of its residency for they did not understand or know what the potential risks could be for the future. Some of these acceptable risks included the construction of wastewater returns that accepted storm water, regular runoff (snow melting, rain, etc) as well as standard household sewage (OSWCA 2001, pg12).These wastes would be pumped directly through the process of gravity or manned pumphouses straight into the rivers or other bodies of water without any concern or regard towards the issues of pollution (OSWCA 2001, pg12). In this sense, the processes associated with these type of system practises were considered common and accepted as the risks of maintaining the primary locations right toadvancement of its infrastructure needs. In this case, Beck had stated that during the early modern period, much of the West had developed processes to accept risk and pass off the negative side effects towards other sources through the chains of inequality on the scales that can in turn create societies at risk (Beck 1992, pg 21). What Beck means by this is that when societies push off risks, they only reduce the initial repercussions within the time period of development of the risks (Beck 1992, pg 37). In this sense, they do not limit the return of these risks in other formats in the future which can figuratively boomerang upon any given society that creates them (Beck 1992, pg 37).

The boomerang effect as Beck explains is when the "formerly latent side effects strike back even at the centers of their production" (Beck 1992, pg 37) and the centers of power.Those societies that produce risks can in turn become victims of their own advancement.According to Beck, this can happen in three ways. First, the divisions between perpetrator and victim start to become blurred over time and the unthinkable becomes imaginable (Beck 1992, pg 37). An example of this is air pollution associated to the release of toxic chemicals like sulphur through a variety of industrial and urban sources (such as automobiles)which can cause visible changes to the surrounding environment that are not fully recognized, nor understood for the effects they can have upon the natural sphere. These toxins become the unthinkable and difficult to imagine as the scale of their release due to the processes of developmentwereboth difficult to know in advance as well as understand. Secondly, as unseen ecological secondary effects (acid rain or smog) become clearer they eventually become primary effects that emerge and affect the causal production center (Beck 1992, pg 37). An example is deforestation near urban developments that results in land and mudslides during seasonal rains. Lastly, through the boomerang effect, the barriers that divide the perpetrator from thevictim disappear completely asunforeseenconsequences continue to occur(Beck 1992, pg 38). An example of this would be the belief that climate change may be caused by the release of toxic chemicals through industrial production (Sulphur, Nitrogen, polychlorinated biphenyl PCB's, etc)that affects everyone, including the various centers of production which makes everyone a victim of risk. Therefore, in this sense to highlight Beck's views Murphy argues that "the very success of modernization has resulted in side effects that turn back against the human modernizers. Reflective action in terms of the development of knowledge has led to reflexive action defined as unintentional self-endangerment" (Murphy 1997, pg 145). As societies modernize they produce risks that become side effects that in turn come back at a later point in time like a boomerang. As Murphy further points out they become factors in developing the concept of 'risk based societies' which have captured a period of human history when human societies produce hazards on a global scale that later manifest into future problems (Murphy 1997, pg 120). Although risk based societies (like the ones in the present) have developed a way to understand risk, this view over time is continuing tochange as risks are produced and create new future problems. Through this understanding of modernity and risk Beck defines the later epoch (reflexive modernity) as a time when the unseen and unwanted effects of progress develop into a force for societal change (Beck 1995, pg 2). Essentially, as the mistakes of the past become visible, society seeks ways to find methods to resolve the unforeseen and manage risks.

Risk management involvescalculating the most “probable risks, but not the worst possible risks” (Beck 2007, pg 130) and according to Niklas Luhmann it is also a system of minimizations of risk (Luhmann 2005, pg 11). It is designed to take into account various aspects of risk as a theory and apply them to reduce the prevalence of danger or harm through prediction, and awareness. It is also a process that takes into account some risks and allow them to happen as they are deemed acceptable based upon aspects of a selective risk management approach (Luhmann 2005, pg 12). Risk managementapproaches are developedthrough planning and looking at past data for patterns that can be applied to the future. It is also about making value judgments about what is deemed important and what is not. "The very concept of 'risk' involves a value judgement concerning the undesirable" according to Murphy, and is a process also of observance as well as determinacy (Murphy 1997, pg 12). The undesirable effects that become risks can only be observed through past information and determined as value laden processes by using algorithms and mathematic predictions (Beck 2007, pg 130). The problem with doing this, as Beck points out, is that with the use of mathematic predictions, risk management processes create assumptions that can give false security under the belief that the unknowable can be controllablethrough risk models (Beck 2007, pg 130).

The assumptions of control in turn mask any value judgements made by a risk management strategist and offer a view that these assumptions are scientific fact rather than value laden choices. This type of thinking according to Beck also fails to take into account that risk management "systematically underestimates *unforeseen* and *improbable*, but not therefore *impossible*, occurrences, as regards both their frequency and the extent of the damage they cause" (Beck 2007, pg 130). By doing so, risk management only blurs the boundaries between improbable and impossible, which are very different terms. Improbable means that something is unlikely to happen. Whereas impossible implies that something will not happen at all. These terms in any risk management strategy can become blurred together and can equally become difficult to manage. The reason for this is that the impossible can become the improbable and the improbable could become the impossible when select variables are used to calculate outcomes for predictive purposes.When this happens and these outcomes are determined by a risk manager, the risk manager may choose to ignore events that are improbable and assume them as impossible. If this occurs, these events may be excluded from the strategy although. As a result this blurs the boundaries between these two terms, which creates insecurity in any findings in a risk management strategy and leaves gaps for possible risks to occur because they were assumed to be improbable or impossible. Furthermore, other insecurities can exist in a risk management strategy because often risk management strategies are dependent upon past information that can be either qualitative or quantitatively found through historical research based upon the frequency of risk (in this case how often a particular risk happens) (Beck 2007, pg 130).

The frequency of risk acts as a way to find historical precedence for damage based onpast incidents. Risk management due to this past orientated outlook can create a false sense of confidence for a risk management strategist and society as calculations for the future using past data can mask value orientated judgements. According to Beck,this means that risk management strategists are in positions of power when they weigh the possibility of risks versus probability using past data (Beck 2007, pg 111). As such, risk management strategists have the power to make believable assumptions based upon value laden opinions to create strategies that will allow people to cope with possible risks (Beck 2007, pg 111). By doing so, they create strategies which can allow institutions using high risk technologies for public use (like nuclear power) appear as if they are safely managed with little to no possibility of errors occurring which could harm the interests of the public. This type of strategy allows for both institutions and society to cope with the use of high risk technologies. Essentially, risk management is all about attempting to remove the threat of insecurity for the public by preventing the two components of risk, chance and danger. By establishing knowledge about the possible to prevent the improbable, risk management strategists are attempting to provide society with mechanisms to cope with the use of technologies that could generate possible harm for society.

3.3 Normal Accident Theory:

Normal Accident Theory is important for this thesisfor many reasons as it provides a sociological basis for understanding decisions surrounding infrastructure and environmental management. As well, Normal Accident Theory shows how systems constructed by humanity are never perfect and are prone to error. According to Charles Perrow's book *Normal Accidents: Living with High-Risk Technologies*, a 'normal' or system accident is based upon the basis that:

> "nothing is perfect - neither designs, equipment, operating procedures, operators, materials, and supplies, nor the environmental - there will be failures. If the complex interactions defeat designed-in safety devices or go around them, there will be failures that are unexpected and incomprehensible. If the system is also tightly coupled, leaving little time for recovery from failure, little slack in resources or fortuitous safety devices, then the failure cannot be limited to parts of units, but will bring down subsystems or systems. These accidents then are caused initially by component failures, but become accidents rather than incidents because of the nature of the system itself; they are system accidents, and are inevitable, or "normal" for these systems." (Perrow 1999, pg 330).

Essentially, this means that in tightly coupled systems a normal accident can occur simply due to the nature and design of that system mixed with factors that are incomprehensible within its management by operators (humans).

A tightly coupled system, is a system that has been designed with redundancy as a way to protect primary functions like having several safety measures within a given system to prevent major accidents from occurring. Therefore, as systems become more complex Perrow points out that these systems become designed inherently with weaknesses and problems within them as it becomes easier to patch a problem than to fix it altogether (Perrow 1999, pg 363). In turn, this means that these weaknesses and errors increase the chances for normal accidents to happen due to the incomprehensible.

The "incomprehensible" according to Perrow, is when a piece of information in any given situation is not clearly presented (Perrow 1999, pg 26). In other words the incomprehensible could be a variety of variables for any given situation that may not be visible to the individual who is analyzing the situation. It is up to the individual providing analysis to determine the best course of action to prevent a catastrophe and only result in a normal accident.

A catastrophe as Perrow points out is when the preventative systems fail to such a degree that the system starts to collapse and is caused when preventive systems are overrun by a series of events to cause severe harm. If this happens as Perrow points out, these system errors can go from a catastrophe and result in a disaster (an incident where severe harm is inflicted upon either the environment or society or both) which may result in extreme harm or semi-permanent to permanent problems as well as risks for the future (Perrow 1999, pg 363). An example that Perrow points out is the Chernobyl Disaster and its long lasting effect that went from a normal accident to a catastrophe then a disaster as the severity of the problems increased due to the primary problem (radiation) (Perrow, pg 363). However, disasters for high risk systems are often prevented by highly expensive safety systems designed to prevent the social costs for replacement or general costs of rebuilding and clean up (Perrow 1999, pg 341). These costs are often borne by society, as a vast majority of "systems with the most catastrophic potential are government activities" according to Perrow such as dams, power plants, water treatment facilities, etc (Perrow 1999, pg 341). These are also the systems with the highest social cost for activity such as pollution, injuries, anxieties that are not always reflected in the cost of activity and are often the burden of those who do not benefit from them (Perrow 1999, pg 341). Those that often do benefit from the high-risk systems that can cause normal accidents are usually found within the private sector who receive beneficial use of these otherwise public facilities without bearing the aforementioned costs (Perrow 1999, pg 341). An example is the relatively cheap price of clean water that is highly subsidized by the government who maintains the natural resource, with industry (such as oil companies) paying less for it than it is worth.

The reason these high-risk systems are subsidized is to allow for the acceptance of normal accidents as a cost of production and to allow society to become adjusted to them. However, if for any reason any of these high-risk systems were to collapse due to a series of events, the overwhelming situation becomes the burden of society and those directly impacted. To prevent this from escalating beyond the controls of coping many systems are designed to accept normal accidents as normal process of activity.

Coping with errors is also a function of a normal accident or system accidents. Complex systems like the wastewater or water purification system of the City of Ottawa have been re-designed over a long period of time to cope with normal accidents. As Perrow points out in order to cope with these errors it requires a degree of awareness within an operation that would allow for the system operators to handle these errors, thus preventing a system collapse (Perrow 1999, pg 330). However, by preventing a system collapse,operators also increase the chance of developing future errors that can become hidden within the design of the system due to its complexity. For example, a complex system like any modern wastewater treatment system is designed with several redundant features to prevent major incidents from occurring such as the build up of explosive gases, high volume liquids mixed with biosolids building up pressure in the receiving system, other systems designed to prevent damage to the facilities or from biosolids mixed with fluids being returned to the public via a back up (City of Ottawa2000, pg 20). In return a majority of those systems are complex and designed by experts in such a way that they could remain incomprehensible in a time of crisis for an operator to resolve. The reason for this is that in order for an operator to prevent a normal accident from occurring, they would need to overcome a series of overlays that have been created through years of developments (Perrow 1999, pg 25). In the case of Ottawa, the often result to prevent major incidents is for the normalized accident of leaking wastewater untreated directly into the river to prevent harm to the citizens or the primary treatment system. In this case, the wastewater being directed to the river is a normal or accepted accident for the system and its operators as it presents a way for the City of Ottawa to cope with the present systems limitations.

Limitations of a system that is tightly coupled is also a key factor for Normal Accident Theory. Limitations establish what can cause operational errors and present the possible flaws in a system design or management plan for high risk systems. These limitations can be explored by Normal Accident Theory and can explain why these problems occur. Overall, this understanding of both the limitations and Normal accident theory helps to explain the City of Ottawa's management plan for the Ottawa River's development of fresh water and wastewater returns.

3.3.1 Critics of Perrow's Normal Accident Theory:

Perrow's explanation of Normal Accident Theory has been contested versus High Reliability Theory and critiqued by Andrew Hopkins along with many others social theorists as to whether Perrow's application of the theory is valid. The primary focus for Hopkins, for example has been Perrow's interpretation of what is a 'normal accident' and how this interpretation has been applied. For example,his interpretation of Three Mile Island which Hopkins has argued was more to do with human rational errors rather than with systems actually failing in a sequence (Hopkins 2001, pg 65). In this case, Hopkins has sought to disprove and reduce Perrow's influence, while others like La Porte have suggested High Reliability Theory in contrast to his views (Shrivastava et al 2009, pg 1358). High Reliability Theory has been articulated as studying how high risk, complex systems that are tightly coupled still manage to "execute error-free operations" (Shrivastava et al 2009, pg 1363). Although High Reliability Theory has often been considered in contrast to Normal Accident Theory, some have suggested that it merely looks at accidents through another lens that can compliment Perrow's works. High Reliability Theory can also be used though to disprove many of the primary focuses of Normal Accident Theory where many high risk systems have proven that they can operate without acceptable normal accidents occurring. In this sense, High Reliability Theory does offer some contrast for this thesis, but not enough to justify removing Normal Accident Theory as a theory which can shed light upon the situation with the Ottawa River. Although, many critics of Perrow do have some compelling arguments, for this thesis Perrow's work upon Normal Accident Theory offers a valid interpretation that presents as well as explains complex subject aspects of the thesis later on and providesa way to help explain the thesis material through sociology. Furthermore, although not all the critics of Perrow's works have been looked at here, it should be understood that like all social theories they are not complete without criticisms or alternate views.

3.4 The Politics of Infrastructure:

The Politics of Infrastructure is a perspective that helps to explain how social positions can influence societal developments and infrastructure in general. It also acts as the mortar that connects Normal Accidents and Risk to the realm of infrastructure. It does this by providing an explanation of how political careers within the past and present have impacted infrastructures design through politicalterms of office. Furthermore, as a framework of analysis for this thesis, it helps explain how social limits due to political positions can limit physical and long-term systems like infrastructure. However, in order to explain this more clearly through sociology, the politics of infrastructure must be defined first.

According to Westphal, the politics of infrastructure is less of a theory and more of a "form of analysis, or a framework" to explain government action (in some cases inaction) through strategic fiscal policy as well as the expectations of office for any given political career (Westphal 2008, pg 793). Essentially, this means that the politics of infrastructure examines decisions that are made by elected representatives who are working with short timelines relative to election cycles which in turn create incentives to displace costs towards the future. In this case, it means that political commitments and government action can be subject to election cycles and terms of office which may not provide resolution for the needs of infrastructure and society. However, the politics of infrastructure as a form of analysis is not just limited to selective periods of time, political careers or individual politicians. The politics of infrastructure can be utilized to explore the divisions of government ranging from the tiers (Federal, Provincial, Municipal) of government to the political structure of government (Leaders, Party lines, Positions) and in turn be used to explain how each group influences the other (Westphal 2008, pg 792). Westphal further explains that this is done through analyzing the intercommunication between the various tiers of government and the influence of social funding (taxation) upon lower tiers of government (Westphal 2008, pg 792). Essentially, this means that taxation and government budgets not only impact infrastructure, but the dialog that occurs between government levels through power relations will shape whether or not infrastructure projects receive funding in the first place. Funding, in turn can be influenced by a variety of factors that include societal needs and wants as well as political ambitions. For example, Québec City and Regina did not receive federal funding for new stadium projects because the projects did not meet the federal government's strategy for Canada both for economic reasons and political career reasons. Even though, it could be stated that a new stadium might support economic factors.

The relations of power are very important and crucial towards the politics of infrastructure as they not only explain how limits are set, but how political positions can shape projects or prevent them from occurring, especially if they fall into the normal reasons for exclusion. The normal reasons for exclusion for infrastructure tends to come down to the standard motto of "If it's not broken, why fix it" as a justification for various forms of government to go on a stance of inaction towards infrastructures designs (Westphal 2008, pg 793). However, much of these types of infrastructure designs have either been taxed to their limits by over population or are in a state of decaydue to age and are only maintained as needed. In turn this can result in a series of other problems that show how political careers can shape the outcome for infrastructure just the same as they can for the commons. The commons and infrastructure are relatively similar in a sense as infrastructure may not be natural to our world but has come to be taken for granted just the same. In turn infrastructure can suffer through relations of power the same way as the commons (like natural resources) can and still result in a tragic incident. An example of this would be the Walkerton tragedy in Ontario, where limited funding for infrastructure resulted in both a crisis and a tragedy that could have been averted if the infrastructure had been properly funded and managed. However, just like with a tragedy of the commons, the end result was a tragedy and a lesson learned when it was already too late to fix the situation as loss of life had already occurred. Essentially the freedom to choose and continually add to infrastructure without putting in funding to fix or expand a particular resource (the commons) "in a world that is limited" results in tragedy (Harding 1968, pg 1244). In this case it shows how infrastructure is heavily based upon inter-government cooperation mixed with funding to prevent and resolve a situation, or to provide a resolution when fixing the situation is the only choice left. It also shows how political short sightedness and economic factors limit infrastructure decisions (Crain andOakley 1995, pgs 1-5).

Social action (public rallies, petitions, strikes, etc) in many cases can overcome political stubbornness towards infrastructure if the opinion of society is strong enough to influence politics and make politicians change their mind towards fiscal policy. However, this can only happen if the requirements for infrastructure renewal or development become noticeable to government, especially the higher tiers like the federal level which oversees a much larger area. As such, this can prove difficult as the problems for infrastructure can vary due to time, place society, government, nation, state, province, city, environment, etc.Furthermore, the problem of providing task resolution for infrastructure can vary due to cost, other political obligations to society, and the limits of available capital for projects which can push resolution off to another politicians term of office.According to Murphy this is the "not in my term of office" (NIMTOO) syndrome, which acts as a brake on decision making action that would provide resolution unless political pains are involved with little visible gains (Murphy 2009, pg 269). As Murphy points out, the lack of political decisions being made effectively only delays, then threatens to cause problems that can become irreversible (Murphy 2009, pg 269). This in turn can create vulnerability in the present as systems and infrastructure are treated as either tools for political advancement or are only maintained as necessary. Whereas, during the early modernity, it was much easier to create infrastructure as society was more willing to put in place systems that did not yet exist and viewed them as ways to modernize and empower a given society.

According to Graham and Marvin, putting in new infrastructure during the early modern period was"a way to clean up as well as domesticate the modern city"(Graham & Marvin 2001 pg 55). Today, infrastructure that is already in place is more costly to repair or replace because it is more difficult to access as other levels of infrastructure have been placed overtop or underneath (Graham & Marvin 2001, pg 56). In some cases it is easier to just update infrastructure by building overtop of it, although, this often means increased taxation and other associated problems with development (Westphal 2008, pgs 793-795). For example, when cities, municipalities or other regions go through urban renewal projects (such as the Bank Street project in the City of Ottawa from 2004-2012), the associated costs of the projects are levied upon the citizens as older developed areas require increased time and cost to replace aged infrastructure. Often in these cases the process is not only long but can create unwanted public disturbances such as traffic congestion, increased noise due to construction, and many other constraints for public access. In turn all of these negatives can translate for a politician in office as public unrest, which will create political tension over taxation and a variety of other infrastructure related reasons. On this note, since a majority of the present infrastructure was put in place during the early modern period it means that due to age as well as consistent expansion over the years upon existing systems has resulted in the perfect situation for normal accidents to occur. Furthermore, the present situation for infrastructure has caused an increase in risks and even increased the chances for catastrophes to occur due to political constraints created by unwillingness to increase taxation (Westphal 2008, pgs 793-794).

Politically speaking, these political constraints create limits and limits create problems for infrastructure. Sociologically this means that patterns of errors and political judgement in the present are linked inherently to the foundations laid in the past by previous political regimes (Graham & Marvin 2001, pg 64). These past regimes had been primarily interested during the early modern period in applying standardisation to infrastructure or sticking with particular styles, sizes and designs for infrastructure builds that would continue to work for as long as possible (Graham & Marvin 2001, pg 64). The purpose of standardizing infrastructure in the past was to attempt to maintain a particular design that was known to work and would continue to function even with factors like population growth and newer technology being applied. However, as time progressed the advantages created by standardization were lost as technology evolved and growth outstripped original plans for infrastructure development (Graham & Marvin 2001, pg 41). An example of this is the massive urban expansion in Ottawa that has happened in the last one hundred years which has seen the city grow from a mere one hundred and fifty thousand at the turn of the last century (City of Ottawa 1915, pg 1) to almost one million in 2010. This massive leap in the population has resulted in numerous problems for the urban infrastructure in the present. Especially, sincethe originalinfrastructure was standardized in 1915 and as explained through the City of Ottawa's 'Main drainage report', was built for a population of only half the present number (City of Ottawa 1915, pg 10 - 'Main drainage report'). Specifically,this increase in population has impacted the storm lines and wastewater system that wereoriginally constructed in the early modern period and at present need to be updated to accommodate the increased population and demands. However, to solve these demands, the solutions prove to be both politically costly as well as financially costly since they come with a high price tag. For politicians dealing with situations as suggested above, this can once again translate into political pains with little visible gains unless the economic situation and social consciousness is in the right frame of mind to support the actions to replace aged infrastructure (Westphal 2008, pgs 793-794).

In situations such as the one suggested for Ottawa, if the public does not see a resolution towards the problem coming from the government, the situation will be perceived as inaction between the tiers of government.In turn this will result in an internal political process of laying blame upon one another for problems incurred by one tier or another. A theoretical example of this would be the City of Ottawa blaming the province of Ontario for lack of funding for social renewal projects and infrastructure due to economic reasons which will eventually translate into the Province blaming the Federal Government. This cycle can also be reversed as is pointed out by Graham and Marvin, where the upper tiers can in turn blame the lower tiers for not bringing forth action (Graham and Marvin 2001, pg 40. This whole process of laying blame creates a question of responsibility as tiers of government argue over who is to blame and as previously explained create ways to push off resolution upon other politicians terms of office or to blame past risk management strategies for the present situations. However, within this process of governance, experts also play a key role. Experts provide for politicians, reports, data and gathered information that can support political claims or create reasons to adjust policy as well as force blame upon another organization, government etc. Expert's opinions can influence political careers and create both reasons to fix infrastructure or delay a response. In this case, the views of experts such as engineers are very important.However they are only one view to be explored further through the methods and analysis within this thesis.Therefore, in relative terms the politics of infrastructure combines a series of political views, communication, opinions from experts and in several instances lack of action that can translate into political turmoil, or public unrest eventually due to the past situations not being reconciled with modern updates in an efficient manner.

3.5 Previous research into the Ottawa River and its influence upon this study:

Many other researchers such asRamamoorthy and Kushner in 1975, Dutka et al in 1973, Otson et al in 1981, have conducted research into the Ottawa River and the negative effects of urban infrastructure developments (such as water pollutants, urban expansion, recreation, etc) upon the rivers cycles through the natural sciences. Although, it should be first noted that other researchers views provide informative views about the river there is very little actually written directly about the subject of this thesis outside of information direct from the City of Ottawa. As such, the primary works of other researchers have looked at other trends and developments regarding the Ottawa Region and the City of Ottawa's influence through the natural sciences.

First, and foremost, research into the Ottawa River has mostly been done from the perspective of biology to explain the influence of development upon river ecology (such as fish populations, and other living organisms that inhabit the river itself). Other studies have focused upon heavy metal infiltration (Ramamoorthy & Kushner 1975, pg 1755). Heavy metals, were introduced to the river's ecology by effluents coming from the various pulp mills that are either located near or in the Ottawa area or along the Ottawa River tributaries (Rideau River and Gatineau River) (Ramamoorthy & Rust 1976 pg 531). These studies investigated the possible human impacts of ingesting heavy metals through food and drinking water (Ramamoorthy & Rust 1976, pg 531).Some studiesalso focused on wastewater (effluents) specifically bacterial contamination studies like the one done by Dutka et al dealing with bacterial indicators of water pollution within the Ottawa River, concluded that cholesterol levels being measured showed forms of fecal pollution (Dutka et al 1973, pg 1053). Although the study by Dutka et al focused upon pollution, it did not present fully aspects of the effects this pollution and processes developed by treatment facilities have upon water sources like the Ottawa River. Instead Dutka et al study was designed more for the scientific community to present what is going on as a practise, rather than ways to resolve or explain the 'how's' related to pollution into the various water sources or its impact upon the natural sphere.

Similarly, the study by Otson et al dealing with three water treatment plants along the Ottawa River presents informative explanations of the effects of chlorination for human populations (Otson et al 1981, pg 1075). It does this by discussing the parameters for water treatment and the use of chlorine to treat the raw river water. In turn the study explains through extrapolation of data through a period of 10-13 months that chlorine amounts used by the plants (which was understood as toxic to human populations) were increased in times when organics were considered still present through the process of treatment (Otson et al 1981, pgs 1075 - 1079). In turn the conclusion of this study and its findings were to explain how chlorine was being used and its impact if over used upon human populations could be considered detrimental.

Overall, studies like Otson et al and Dutka et al's,were consulted to show how the natural sciences have explored problems related to urban wastewater contamination. Although, these studies do not offer a focus on the natural sphere, they do offer insight into how these problems have been viewed in the past. As such, they provide some information as to how previous studies were conducted into processes that affect the Ottawa River.

3.6 Conclusion:

Many of the studies conducted in the past by other researchers tend to take an anthropocentric view of the problems affecting the Ottawa River. In turn, they mostly focus upon the natural sciences view of the world and pushed emphasis upon many human developed elements (infrastructure, consumption, etc). This thesis on the other hand is designed to look at both elements represented by science through an analysis of the problems affecting the natural world and the social worldthrough the impacts of wastewater, water purification processes, along with a variety of other factors (expertise, limits of infrastructure, exclusion of the river, etc). Although, the previous studies have helped establish the problems, these problems still have remained relatively unexplored and in need of social analysis through an understanding of risk, risk management, normal accident theory and the politics of infrastructure.

Chapter Four: Methodology - *The Ottawa River and Expertise*

4.1 Introduction:

This Chapter focuses on providing details about the research problem, the purpose of the research, the primary objectives and the approach taken. This chapter will also focus upon the strengths and weaknesses of the approaches used. First, it will discuss the primary research problem and then explain how the research was conducted, the process for data sorting then ending with an explanation of the primary method, Historical document analysis.

4.2 The Research Problem:

The City of Ottawa from the early modernity developed the primary systems for wastewater and water supply for the citizens of Ottawa that uses the Ottawa River as both the primary artery for fresh water and repository for wastewater. The early development of this infrastructure has caused many problems in the present with the City of Ottawa directly pumping both storm water and effluents into the river during times of high volume flow that the system cannot handle due to existing limitations in design. Even with increased funding and taxation this problem still persists as aged infrastructures costs are difficult to overcome.

The review of the literature about this re-occurring problem has suggested several questions. The primary research question motivating this thesis is: How has the Ottawa River become removed (in the sense of being ignored) from the City of Ottawa's strategy for development from the early to first modern period (1909-1920) to the present period (1999-2012)?

The key secondary questions for the thesis are: How has expert opinion impacted the City of Ottawa's strategy?As well, how have the limitations of infrastructure impacted the City of Ottawa's design plan for urban infrastructure with regard towards the Ottawa River's use?

The research into this subject is timely because the City of Ottawa is in the process of updating infrastructure and planning to apply a resolution to the design flaws.

4.3 Purpose Statement of Research:

The research for this thesis is concerned with explaining some of the causes of the present situation for the City of Ottawa dealing with the urban infrastructure of water and wastewater production as well as its influence upon the Ottawa River's ecology. This influence and its media coverage over the more recent years have created some momentum into resolution for this situation. However, it has also presented opportunity to provide analysis for the causes of this present concern with the Ottawa River's ecology and the strategy for the River presented by the City of Ottawa. Overall, the purpose of the research is to understand how the Ottawa River has come to be a repository for wastes from the City of Ottawa and provide some recommendations that may help bring the Ottawa River into the equation.

4.4 Research Objectives:

The objectives for this research are as follows:

1). First, to identify the City of Ottawa's strategy towards the Ottawa River and policies that were issued in the early modern period (1909-1920).

2). Second, to indentify themes within the strategy towards the Ottawa River through an evaluation of the primary periods of interest the early modern period (1909-1920) and the present period (1999-2012).

3.) Lastly, to provide some details as to why the Ottawa River became excluded or ignored by the City of Ottawa.

4.5 The Qualitative Method:

Typically, an analysis of documents relies on qualitative research methods, which are methods that can permit unique responses when conducting interviews and offer a way to understand social action (Silverman 2000, pg 1). One such method is Historical document analysis (that will be discussed later in this chapter), which offers ways to provide social accounts and meanings instead of numerical information like a quantitative method. Although qualitative research methods can offer richness and depth to social research, quantitative methods can offer a measure of accounts through numerical data to provide frequency, amounts or quantities (Denzin and Lincoln 2003, pg 13). A weakness though to a quantitative method versus a qualitative method is the elimination of social meanings during the process of conversion of non-numerical values and turning them into numbers (Jupp, 2006). In contrast to this, qualitative methods recognize the complexity of social meanings and permit flexible judgments to gather values from (Silverman 2000, pg 1). This allows a social researcher to build upon social meanings that can be extracted from documents and gather values to relay a sense of 'truth' from literary works like government documents which are a key focus of research for this thesis (Riggens 1997, pg 2).

Qualitative methods as discussed thus far, for this thesis are key, as they allow for data and documentation to be explored for primary social meanings rather than frequent occurrences. In turn the values found through this method can provide social relevance and understanding towards a situation that is relatively complex and difficult to explain without the social contexts behind it. Due to so many variables at play, some had to be selected out of many to maintain a focus for this thesis. Although some of these sources could have provided another form of understanding the key elements chosen had to deal with the primary categories of water, wastewater and the Ottawa River along with anything dealing with politics or the City of Ottawa's strategy towards the use of water.

4.6 Methodological Step Process:

The process for the research was accomplished in the following steps: Identification of the primary problem; establishment of the location for research and development of a plan of action; data sorting and analysis; and interpretation of documents through Historical document analysis as will be explained in the following sections of this chapter.

4.7 Location of Research and Plan of action:

The primary location for researching the Ottawa River and the City of Ottawa's strategy towards water and wastewater occurred at the City of Ottawa's Archives that was located in the Old City Hall at 111 Sussex Drive before being moved to its new location near Baseline and Algonquin College at 100 Tallwood Drive and the Corner of Woodroffe.

The format for researching the primary objectives was broken down into a system to first search for key words such as "water", "wasterwater" and the "Ottawa River" through the archive's online database. The purpose of the search was to first find boxes of information that may support the primary objectives and secondarily to help identify other aspects of the City of Ottawa's strategy. The following table (*Table 4.1*) helps illustrate the process that was developed and undertaken as a plan of action.

Table 4.1: Research Strategy for the Ottawa River:

1. Identify Primary Problem: - Wastewater leaching into the Ottawa River
2. Identify Research key words: - Wastewater - Water - Ottawa River - Risk - Water Pollution - Sewers
3. Search Database for boxes
4. Identify primary research boxes and define time frame for analysis. (Early Modern to first modernity 1909-1920 versus present 1999-2012)
5. Request selected boxes that meet criteria for further review of the materials.
6. Visit Archives to review materials and ensure they deal with the primary problem, time frame and indentify with the key research words.
7. Capture data either through digital photos or by summarizing information from reports into Microsoft Word files to be sorted later.

As displayed in *Table 4.1*, the process towards researching the primary problem took into account first the problem itself followed by looking for key words that were selected from the problem. As information was identified and noted, it was later categorized by period and then researched further by a direct examination of the materials at the City of Ottawa Archives location. The primary method for examining the materials was a quick search for the key words within the document. This search would establish if a document could be considered valuable enough to be recorded and researched further or if it should be returned as there were insufficient details about any of the key processes identified by the key words. This process took over a full year and several hours (200+) to complete as it eventually included the City of Ottawa Council Minutes from 1909-1920 to help identify other documentation.

4.8 Data Sorting and Analysis:

All documents that were found through the online database and requested to be reviewed at the City of Ottawa Archives were first inspected and searched for primary research words and secondly categorized by period (either early modern '1909-1920' or present '1999-2012'). Each document containing relevant material was then classified by time period. Any documents that contained information relating to the primary key words and periods established were either recorded into either Microsoft Word files or captured through photography to provide a digital copy for continual analysis. As each document was reviewed, the strategy towards the Ottawa River began to unfold and several themes emerged that are discussed in this thesis as well as are shown in *Table 4.2*.

Table 4.2: Emergent Themes for the Ottawa River:

Limitations to existing Infrastructure: - Two Water Treatment Plants (Lemieux Island & Britannia) - One Wastewater Treatment Plant (Robert O. Picard) - Development in the early to first modern period (Sewers, Water Treatment Plant, A-C Water main lines).

Public Health:
- Water Quality
  - Water borne illness
  - Purification methods

Cost and Policy: - Influence of the market - Influence of politics - Influence of professionals - Influence of technology
Recreation: - Use of waterways - Use of public water
Urban expansion and annexation
Stormwater Conditions

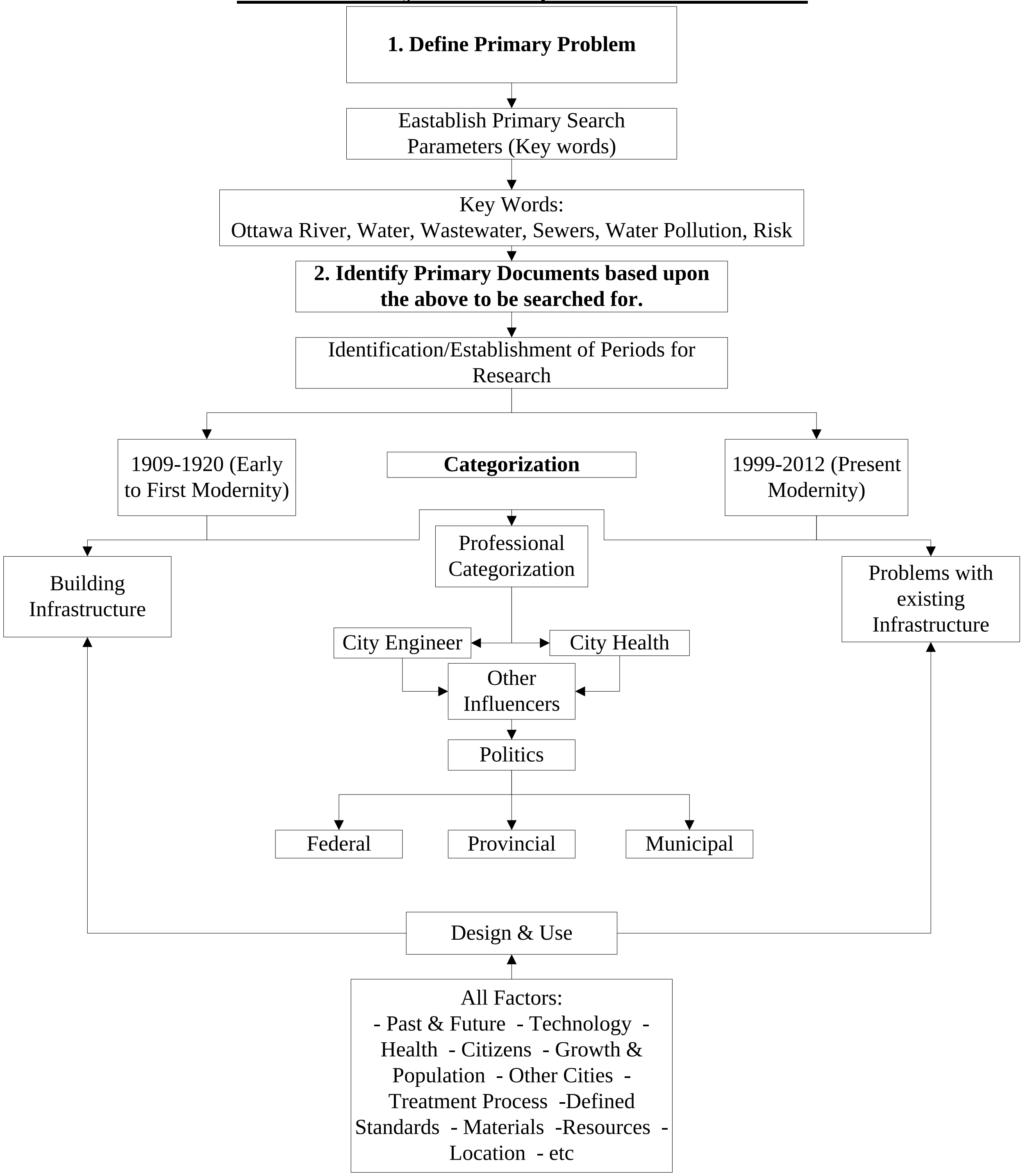
As some of these themes emerged,I realized that many of them are interconnected and would be suited to be observed within this thesis. Although, there were many other themes found that are not noted on *Table 4.2*, these themes such as 'water taxation rates' or 'water consumption and uses' could be considered in the future for analysis.

Many of the first documents procured were from the present period and helped establish the primary periods for infrastructure expansion within the City of Ottawa along with the base period for development of the present systems within the early modern period. This allowed for secondary searches to establish time frames for the study and research based goals to help set limits upon the data searched. It was also established through these secondary searches the type of documents to be looked at to provide further research goals and define the research question even further from just being about an exploration of the Ottawa River's history of how the river is being excluded to ignored as well as how it became that way.

One of the first documents examined was a report from 2000titled *Surface Water Quality Program, Regional Facilities Environmental Effects Monitoring Project, Preliminary Study of Ottawa-Carleton's Water Purification and Wastewater Treatment Plants*. This document was selected first for meeting several key research words (Water, Wastewater, etc) and secondly for being about the present process and systems regarding the urban infrastructure that is impacting the Ottawa River's ecology. The third reason for selection, was that this document was connected through history to many other documents and reports. For this document, this connection presented a vast amount of sourced information that established periods of interest and development to help explain the primary research problem.

As documents like the one mentioned above were researched, a process for analysis was developed. *Table 4.3* (below) illustrates the process that was used for the analysis of the documents and how each document researched was categorized based on period and influence then recorded according to this table. *Table 4.3* also shows how each document provides support and further defines the research as well as framed the periods to be looked at for comparison.

Table 4.3: Analysis Process for Document Research:



As each document,was found the process above was applied to maintain focus and help categorize for future analysis. For example, with the above process chart, as each category was defined (eventually by period), the influence of experts on the influence politics was discovered. Furthermore, this influence was found to be similar to how 'design' and 'use' influences the building of infrastructure with the present problems. So as individual documents were researched and would fall into this categorization, they would be stored (documented) to be used for this thesis to provide support for providing some answers to the primary problem (including the research question). The method used to conduct this was historical document analysis.

4.9 Historical Analysis:

Historical analysis is based upon looking at social phenomena within their historical contexts to derive sociological meaning through comparing and contrasting selective information found during these periods (Denzin& Lincoln 2000, pg 375). Historical analysis is also a method that searches for patterns across cases to help find meaningful information to support reasoning to explain the "why and how" in a given situation that show characteristics of path dependency (Mahoney & Rueschemeyer 2003, pg 8). Path dependency "characterizes specifically those historical sequences in which contingent events set into motion institutional patterns or event chains that have deterministic properties" (Mahoney 2000,pg 507). Event chains and contingent events can set the stage for conducting research into a specific time period. They do this by allowing a search for socially defined research that may explain how a particular event was set into motion and continues to influence. This can be done with an analysis of key sequential factors and variables that would be examined using a path dependent analysis. Path dependent analysis takes into account a variety of sequential variables from two or more time periods (such as 1909-1920 and the present period of 1999-2012) that are not considered as dependent processes of change (events that are set by a dependent value) for examination (Mahoney 2000, pg 507). Rather they are considered processes of a "deterministic property" such as key historical events that may shape the present outcome (Mahoney 2000, pg 507). These key events can also be used to explain the limits of a given situation ranging from the use of technology to other variables to help answer the '*why*' questions that may arise through analysis (Mahoney 2000, pg 507). An example of this is how this thesis is taking the two time periods of 1909-1920 (early modern period) and the present (1999-2012), to help answer the '*whys*' and '*how's*' for the limits of infrastructure through a combination of the views of experts from these time periods mixed with determining which key event(s) created the strategy that caused the Ottawa River to be excluded or ignored by the City of Ottawa. Therefore, as a method historical analysis searches for these "chains of temporally ordered or causally connected events" (Mahoney 2000, pg 509). The purpose of this search for temporal order and connection of events is to determine how features of the past may be impacting the present or even the future by constraining decisions being made within the present through the consequences of the past. To do so a researcher must select a point in time and an event believed to have historical importance that is limited to the time frame of study and is not contingent upon the perpetual nature of other connections to that event from prior periods (Mahoney 2000, pg 516). In other words, the event must be allowed to only push from one point in time to create a focus for study. By limiting to key events as well, presents the opportunity to establish a starting point for analysis and a way to provide an explanation to a social problem. By providing a starting point for researching a problem, this can create a focus and limit that would prevent a researcher from going down a path of unlimited sourcing. Although, this is not entirely a bad thing, having a limit to the information for explanation helps this thesis maintain a focus that would otherwise be obscured by the vastness of information that could be potentially found.

The limits of using a historical analysis method with and path dependency can be numerous depending upon how documents are selected and interpreted. For example, since historical analysis remains primarily a qualitative method it derives selective information from texts to draw out meanings rather than being quantitative with numerous sources for support (Mahoney & Rueschemeyer 2003, pg 17-18). Although this limitation of information can be perceived as a negative it does provide a more concise focus to the research. At the same time this depends upon how the research is conducted and how the documents for the research are selected. If a researcher is doing a comparative historical search and just selects all key words that pertain to a particular subject line, "they may limit the results and obscure factual findings by being inclusive of all types" as well as "all forms of documents that have been produced in a give time period for comparison" (Mahoney 2000, pg 527). To prevent this from occurring, the best solution for this method is "to draw upon documents that are of a narrative base, rather than opinionated media base to find more secure factual findings that will be less limited and more concise" (Mahoney 2000, pg 530). Although having some limits can be helpful towards analysis to help present information, "they can present a bias unless they are based upon a historical account or narrative" that provides facts rather than opinions (Wolff 2004, pg 284). An example of this is using the factual accounts found within the City of Ottawa's Council Minutes rather than articles or views from newspapers. The City of Ottawa's Council Minutes are both a narrative in this sense and factual as they are based upon the discussions and data accumulated as well as approved by council at the time they were produced (in this case the early modern period of

1909-1920). The views expressed in the minutes may contain opinions, however unlike standard media reports (such as information from newspapers) the opinionated values in the minutes are 'institutionalized', thus they retain importance as primary documents. The reason for this, is that many of the opinions expressed can be and often are based upon law as well as infrastructure that has be put into place to provide a path-dependent variable for analysis.

A path-dependent variable operatesindependently in history andis crucial to historical analysis for it establishes a"beginning point that provides meaning to establish path-dependent outcomes" (Mahoney 2000, pg 510). For historical sociologists path-dependent analysis involves three processes that Mahoney explains as the following:

- "First, path-dependent analysis involves the study of causal processes that are highly sensitive to events that take place in the early stages of an overall historical sequence." (Mahoney 2000, pg 510).
- "Second, in a path-dependent sequence, early historical events are contingent occurrences that cannot be explained on the basis of prior events or initial conditions. Since these early historical events are of a decisive importance for the final outcome of the sequence, this criterion rules out the possibility of predicting the final outcome on the bases of initial conditions." (Mahoney 2000, pg 511).
- "Third, once contingent historical events take place, path-dependent sequences are marked by relatively deterministic causal patterns or what can be thought of as inertia i.e., once processes are set into motion and begin tracking a particular outcome, these processes tend to stay in motion and continue to track this outcome."(Mahoney 2000, pg511).

An example of this process, would be the establishment of institutional values (principals, methods, laws, ways to do the job) for water and waste water infrastructure in Ottawa within the early modern period (Such as the A, B & C, water main lines that were built in 1915-1950, (City of Ottawa 2001, pg 1). The establishment of these processes act as a point in time where a path-dependent variable can be observed for analysis through its independent influences such as future growth, aging infrastructure problems, expert opinions or a variety of other independent factors. In turn, a path-dependent variable, such as the implementation of primary infrastructure can result in a process that sets in motion path-dependent outcomes such as river water contamination and would then be contingent upon its original development.

Chapter Five: *Findings – Knowledge about the System*

5.1 Introduction:

This chapter focuseson the City of Ottawa's original strategy towards the Ottawa River as well as the research findings found from the comparison of the early modern period and the present. It will do so by first going through the early modern views than comparing them to the present period.

5.2 The City of Ottawa's Strategy towards the Ottawa River:

The City of Ottawa's strategy towards the Ottawa River is both complex and old in design. Like many other cities that have been around longer than 100 years, the infrastructure design plan comes from the early modern period and reflects years upon years of build up as well as standardized models for building infrastructure. A standardized model for infrastructure means a model for future growth that is based upon selected technologies, materials and principal designs that were either created or expressed through actions by experts (Graham and Marvin 2001, pg 40). For example designing all primary routes within an urban environment such as roads to act as both arteries for traffic and utilities reflects a standardized model for urban design. By creating a standardized model cities such as Ottawa can continue to expand with the knowledge that all infrastructures from a set point in time will reflect the original design, even if it was created over a hundred years ago. So how did Ottawa come to a standardized design and strategy towards the Ottawa River?

Ottawa's original strategy took into account various factors ranging from the influence of expert opinions, to the limits of infrastructure within the early modern period (technology, materials, etc) and as shown in *Table 5.1*includes being influenced by key events that occurred in the past to result in the present system.

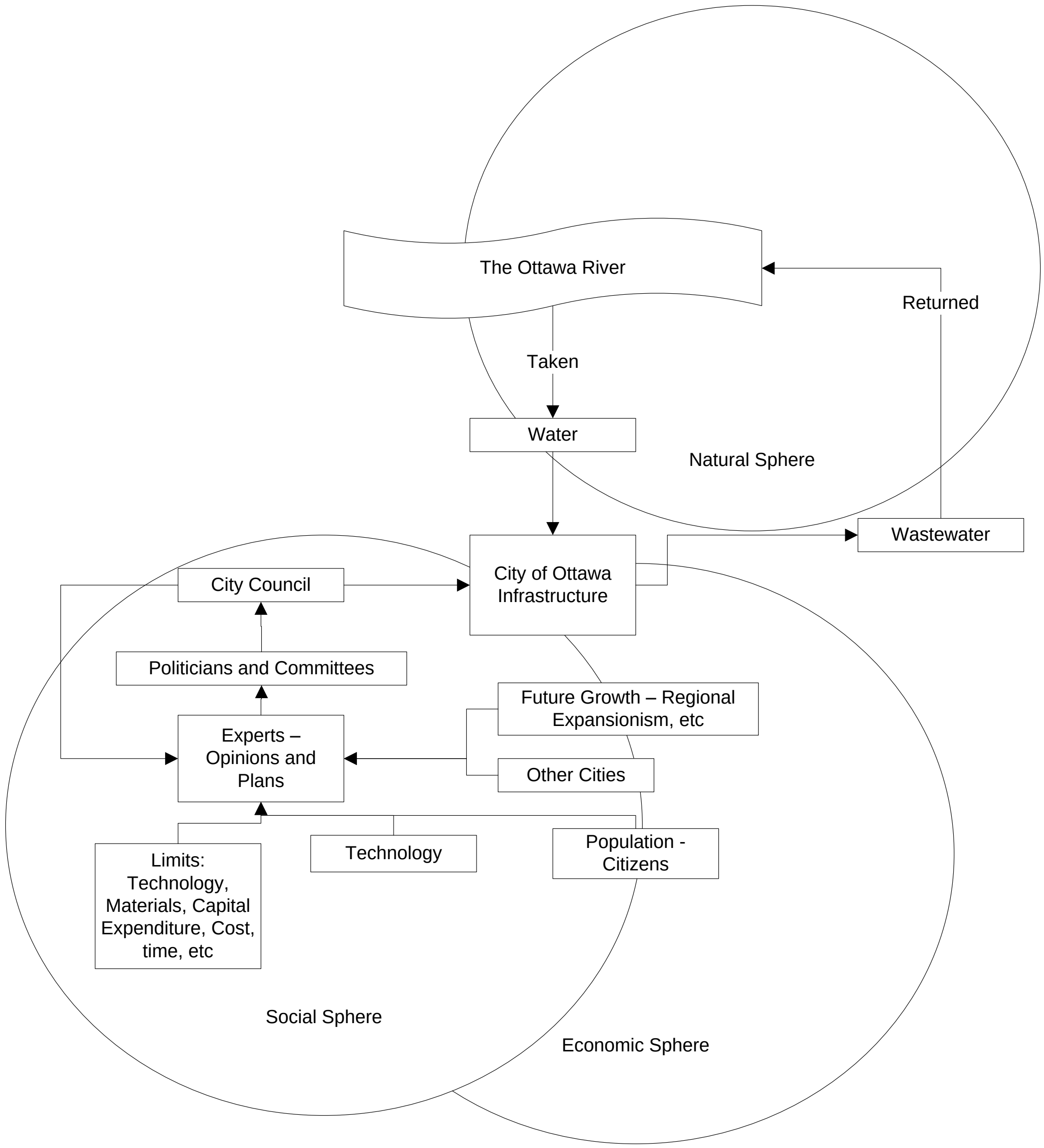
Table 5.1: Key Events:

Early modern period: (1909-1920)
- 1909-1910 - City Council decides to find another source for water over concerns from Aylmer'sraw sewage seeping into the Ottawa River. (City of Ottawa 1910 pg 36)
- 1914 - Choice to use the Ottawa River over another source (31 Mile Lake). (City of Ottawa 1914, pg)
- 1914 - Lemieux Island Water treatment Plant built (City of Ottawa 1914, pg)
- 1915 - Rideau River designated as Recreational due to wastewater seeping in. (City of Ottawa 1915, pg)
- 1915 - A & B Water main lines put in (City of Ottawa 1915, pg)

Present: (1999-2012)
- City of Ottawa fined repeatedly for wastewater being directly pumped into the River - Forced to find a solution.

Each event shown above corresponds with moments in history that establish the basis of the strategy and are pulled from the City of Ottawa Council Minutes. For example the first event (as will be explained later on) is both a crucial event as well as a path-dependent event. Furthermore, as each of these events unfold, they present preliminary elements towards the foundations of the strategy which is shown below in *Figure 5.2*.

Figure 5.2 - The City of Ottawa Strategy



As shown in *Figure 5.2*experts played a major role and continue to play a major role within the strategy. For experts were called upon to provide information and opinions about various projects. For example, experts such as the City Engineer and Medical Health Officer, were used to conduct and gather information from other cities for Ottawa's future systems by City Council. In this case, they were "to investigate the systems in use in other cities and report upon the most suitable for Ottawa, together with an estimate of cost of same: and further that they be authorized to procure, if considered necessary, other expert evidence in arriving at a decision" (City of Ottawa 1910, pg 35-36). This information would then be documented and presented along with information from the public, the knowledge about the technology gathered and the other details that would be generated into a report for the politicians within Council as is shown in *Figure 5.2* above. The politicians and committee members would then deliberate about the findings of reports from the specified experts, were they would in turn report to council the findings. An example of this is the annexation of Lemieux Island in 1912 that was subject to a report from the City Engineer and pushed in Council by Mr. Fuller who "addressed the Council upon the subject of the proposed filtration system and the best methods of securing a pure water supply" (City of Ottawa 1912, pg 534). In turn these recommendationswere ruled upon by Council who would then enact them resulting in changes to the infrastructure and systems.

Overall, the process as shown in *Figure 5.2* may appear simple, however it is actually much more complicated than it appears. For each report that an expert generates requires them to accumulate large amounts of information from the various listed sources (technology available, the public, other cities, cost, capital available to be spent to produce the infrastructure, etc). As such, these sources rely heavily upon the social and economic spheres and exclude or ignore the natural sphere outside of its primary uses (to draw upon water or deposit wastewater). As this occurs, the strategy becomes reliantupon the social and economic spheres as is illustrated in *Figure 5.2.* For the key elements (technology, cost, population, health, etc) influence how experts make decisions to influence the outcomes decided upon by City Council. The overall strategy then comes to the central connector of all spheres which is infrastructure for the City. In this case, infrastructure acts as the primary focus for all processes. As decisions made within the social/economic are connected to the processes that occur within the natural (water taken and returned)through infrastructure.

As such, the City's strategy is heavily based upon both the need for infrastructure and the continual need to keep it growing to compensate for changes within society during this period. However, this strategy only came to be developed as the infrastructure design was first developed by experts after they were influenced by City Council to do so. In this sense, there is a chain of connections which shows that both the decision process influences the experts and the experts influence the decision process to develop the strategy. Therefore, this creates an extremely complicated situation, where it can be difficult to determine who came up with the idea in the first place. This complicated matter of who came up with the idea though, will be further explained within the next section.

5.3 The Early Modern model for the Ottawa River's use through Expertise:

The early modern model for the Ottawa River started with a desire to develop a similar schema of design to that of other metropolitan centers that were considered at the time from 1910-1920 as centers of modernity like Toronto, Montréal, and New York (City of Ottawa 1910, pg 90:a; City of Ottawa 1911, pg 61:b). However, it is important to note with regards tothe previously mentioned centers of modernity, that in the past they had relied upon other foreign centers like Paris in France, or London in the United Kingdom as examples for how to modernize during the age of early modernity.

According to Graham and Marvin's *Splintering Urbanism* we should look back and reflect upon the urban design principals of Baron Georges-Eugène Haussmann's Paris and the renewal of infrastructure that started the early modern period back in 1853 with the development of roads, water lines and sewers as commonly connected pieces of urban infrastructure (Graham and Marvin 2001, pg 53). During this period for the first time, roads, sewage lines and water lines were constructed along the same routes (see *Example 5.3* below)(Graham and Marvin 2001, pg 53-55). As such, they acted as ways to bring systematic rationality that would bind a city through a comprehensive and integrated design to" 'domesticate'...the unruly 'body' of the modern city" (Graham and Marvin 2001, pg 53-55). "It was essentially a time of uninhibited engineering" that was brought about by expert opinion "to create a sterile utopia" (Graham and Marvin 2001, pg 53-55).

West End Main Drainage System, showing Hinton Avenue Section, August 15.

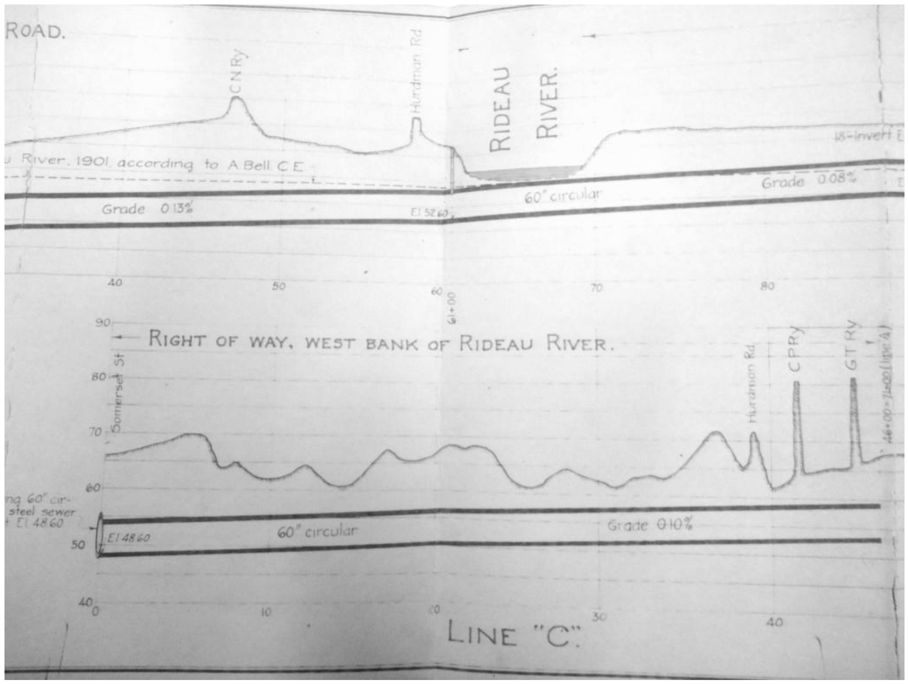
*Example 5.3*Urban Construction in the Early to first Modern Period in Ottawa *"West End Main Drainage"*. (City of Ottawa 1911, pg 17)

In turn, expert opinions during the early modern period resulted in an increase in the value of expert roles such as the City Engineer and the City Medical Health Officer. Due to the elevated status of these positions within a modernizing society (where expertise was less questioned as compared to today), their opinions carried increased weight as well as influence with civil leadership. As well, it was much easier for experts to position themselves, as problems were often conceptualized as narrowly focused. Many such examples of this can be seen throughout the history of the City of Ottawa including the selected periods of 1909-1920 through the City Council minutes and 1999-2012 through various other documents and reports. An example from the research can be found on page 90 of the 1910 City Council Minutes which describes a reliance upon data coming from Toronto as well as the Ontario Government for development that is based upon the "expert" opinion of then City Engineer Allen Hazen (City of Ottawa 1910, pg 90). The purpose of this opinion was to provide preliminary information for the ‘then proposed’ City water purification project for the water supply that did not entirely take into account any other details than the need for allowing urban growth at the expense of the environment and the Ottawa River.

Expert opinion aboutthe Ottawa River was considered as evidence, even fact for municipal leadership to use to reinforce public policy due to the elevated status of the 'expert'. Examples of expert opinion can be found throughout the time period's reports with regards towards urban development plans to build upon the City of Ottawa and use the Ottawa River as the primary source for growth within the region. An example of a report from this time would be the 1915 *City of Ottawa Main Drainage Report on the Rideau River Interceptor* by R.S & W.S. Lea, two consulting engineers from Montréal who submitted the report to then acting City Engineer for Ottawa Mr. F.C. Askwith. This report and its contents were first commissioned by the City of Ottawa to find a solution to protect the Rideau River as is stated on page one of the report (R.S. & W.S. Lea 1915, pg1). This very same report was later used to provide expertviews towards the development of an interceptor to prevent "the discharge of domestic sewage" and "eliminate contamination of this vital tributary" (R.S. & W.S. Lea 1915, pg 4). The other purpose of this report was to provide a limit upon the existing infrastructure to remove discharges of effluents into the Rideau River, which would eventually end up in the greater Ottawa River. To do so R.S. & W.S. Lea took into account various factors such as the influence of the past and possibilities of future harm within the report by stating the following:

> "It is not to be expected, however, that overflows of combined sewage from these districts will be entirely eliminated in the future. There will be certainly no danger of this for several years, but, as everyone knows, the effect of the building up and paving of any section is that a greater proportion of the rain that falls on it runs off into the sewers and, besides that, it runs over the surface to the catch basins and into the sewers in a much shorter time. In fact, we do not think it would be safe to build the interceptor without providing overflows for the main sewers from Ottawa South and from Ottawa East. These overflows will come into action as the result of the operation of regulators which will not allow more of the combined sewage to enter the interceptor than it will carry. It is this protection of the interceptor against gorging by surface water which will prevent floods from interfering with the sanitary sewers." (R.S. & W.S. Lea 1915, pgs 15-16)

The overflows in this case were designed through the ideals of expert views like R.S. & W.S. Lea (Engineers) to skip the Rideau River as an immediate release and divert through complex systems tightly coupled through regulators, combined lines and processes that use gravity to propel effluents downhill into the final repository, the Ottawa River. *Example 5.4*illustrates how R.S. & W.S. Lea had illustrated the plan.



Example 5.4'Rideau River Interceptor' - R.S. & W.S. Lea, 1915

It was understood through this type of expert thought that this solution would have to be "permanent" so as to protect the safety of the citizens and reduce the risk towards the Rideau River as is outlined through the report on page 10 (R.S. & W.S. Lea, 1915, pg 10). However, by providing permanence for this type of infrastructure this creates limits to the design, which at the time were considered more than adequate for the population in 1915 of around 100,000 people by City Council.

Through thedevelopment of policy influenced by expert opinion to remove potential threats, the City utilized reports like that of R.S. & W.S. Lea to apply standards to infrastructure to maintain a defined system. However, by creating these standards, the city imposed limitations that resulted in unforeseeable problems for the future. The limits of this type of infrastructure were not always understood by allexperts.However, experts who authored many of the reports in this time period, such as R.S. & W.S. Lea understood that limiting infrastructure with permanence wouldnot (in any way) defeat the purpose for which they were designed (R.S. & W.S. Lea 1915, pg 16). Furthermore, as Murphy points out about risk and technology (especially during the early modern period) that they "bring new opportunities," but also brings hazards with them as a twofold danger of threats to both socially constructed institutions and the ecosystem (Murphy 1997, pg 145). Essentially, by limiting infrastructure as reports like R.S. & W.S. Lea's did, they did bring about a new opportunity to protect the Rideau River for recreational purposes and to prevent urban flooding. However, through these actions they brought about increased danger towards the Ottawa River by redirecting the wastewater. By increasing the danger towards the Ottawa River, it increased the influence of another expert during this time period that of the City Medical Officer.

According to the City Council minutes, the City Medical Officer was in chargedwith"the task of regulating the water sources for the health of the citizens of Ottawa" (City of Ottawa 1910, pg 35). During the early modern period this meant regulating sources like the Ottawa River and providing reports in conjunction with the City Engineer to help improve and increase infrastructure services that would supplement municipal health (City of Ottawa 1911, pg 33). The opinion of the City Health Officer was taken always above that of the public for Council in favour of what Graham and Marvin have described as the age of rationality of engineering the metropolis based upon expert opinion (Graham and Marvin 2001, pg 55). For example, some reports during this period by the City Health Officer influenced engineering projects like the proposed Thirty-One Mile Lake scheme of 1913 versus the Lemieux Island scheme.

The Thirty-One Mile Lake (Lac a Trente-un mille, Québec) scheme was described in the minutes by Dr. A.C. Houston and Sir Alexander R. Binnie's Reportas being a "prime location for an urban water reservoir for the City of Ottawa" and was considered as an option versus using the Ottawa River directly (City of Ottawa 1913, pg 413). The plan was to take lakes like Thirty-One Mile in Québec and construct a water filtration plant there for the City. The water would then be pumped through aqueducts to the City of Ottawa at an approximate cost of eight to ten million dollars for the whole scheme (City of Ottawa 1913, pg 412). Thealternative to Thirty-One Mile Lake was just developing a water purification plant along the Ottawa River (Lemieux Island) at a cost of one to two million dollars (City of Ottawa 1913, pg 422).All these schemes were considered in great detail by City Council from the various views of the experts. The City Health Officer with the report from Civil Engineer Archibald Currie (for Lemieux Island), over-ruled the scheme on the basis that due to "its relation to a possible or probable source of human pollution" the reservoir scheme for Thirty-One Mile Lake would not be suitable as a source (City of Ottawa 1913, pg 415). As well, to further this, it was pushed by Archibald Currie and the Bell Filtration Company that if their plan was chosen at its cheaper cost they could "guarantee delivery and operation within two years...instead of estimating that it can be done within three to five years" (City of Ottawa 1913, pg 421). However, after this report and the initial approval through the expressed concerns of the City Health Officer and the City Engineer, the City was pushed to go with Lemieux Island over the Thirty-One Mile Lake plan due to cost and primarily the concern overhuman pollution causing diseases like typhoid fever, diphtheria and other bacterial concerns that could be found within the lake (City of Ottawa 1913, pg 422 & City of Ottawa 1913, pg 503). Due to those concerns, the City Health Officer was then imbued with elevated position and power which forced City Council to act and choose the Lemieux Island plan. In doing so, the City showed that during this time period the health of the citizens was valued higher than the environment as they went with a plan that was both cheaper and perceived through expert opinion from an internal source to be less of a problem for human health.

The City of Ottawa and Council during this period also used provincial and other laws to their advantage. They did so to also take control of significant resources like the Ottawa River and to limit other centers like towns upstream of the City. For example,the 'Public Health Act' was used by the Mayor of Ottawa in 1910 (Charles Hopewell) to limit the amount of effluents found within the river upstream due to discharge from Aylmer and Hull in a way to state 'not in my backyard' (City of Ottawa 1910, pg 36). The result of this action of political policy and limiting another's infrastructure was to create an area of public health protection for Ottawa within "70 miles of Ottawa, on the water course from which Ottawa derives its water supply" (City of Ottawa 1910, pg 93). However, this policy would not prevent the City of Ottawa from pumping raw effluents into the Ottawa River as was the norm of this period and a common accident of production (or normal accident) that was designed as a process of the everyday production mixed with prevention (just like the construction of the Rideau River interceptor). Prevention and production were also key factors during this period for the City of Ottawa as they were growing influences developed out of the rationality of engineering the metropolis based upon expert opinion versus the protection of the Ottawa River and the environment (Graham and Marvin 2001, pg 55). The Ottawa River as a factor on its own was never truly valued during this period besides it economic factors as mentioned earlier with the situation over Thirty-One Mile

Lakeregarding health. The City of Ottawa used the Ottawa River to propel its progress during this period in what could be described as the 'Age of Engineering Infrastructure' where cities like Ottawa focused on building newer types of combined infrastructure(Graham and Marvin 2001, pg 43). This also meant building new facilities as was the major influence of this period with the construction of Lemieux Island versus Thirty-One Mile Lake in 1913 and the eventual building of the primary water lines (A & B) (City of Ottawa 1916, pg 23). These focuses took precedence over the Ottawa River which was valued more as a resource rather than an environment that was in danger. So as time progressed during this period the City of Ottawa often shifted views based upon what it had seen in other cities like Toronto, Montreal, New York, etc to determine the right path for water treatment and use for the River as a source. An example from the minutes of this would be when the Board of Health recommended "that J. Race, City Bacteriologist be granted permission to visit Montreal and Little Falls, N.J., in order to inspect the chlorinating plants in these cities where electrolytic instead of bleach hypochlorite is used" (City of Ottawa 1917, pg 160). As a result of visits like the one for Mr. J. Race, a variety of chemical compounds such as lime, chlorine and ammonia were used to treat the water to prevent diseases like typhoid and other fevers that were documented by the City Health Officer (first example is from 1910 City Council meeting, pg 658). In many cases these diseases were spread by human habitation and pollution found in the water (as previously described) and it was pointed out that according the Water Works Act that the City was only concerned with its upstream influences, not its downstream effect (City of Ottawa 1910, pg 93). As well, this act was later used by the City to enforce the protection of its water supply for health reasons from human pollution. An example of this can be found on page 74 of the 1916 minutes where it is stated:

> "The City Bacteriologist having directed the attention of your Committee to a report made to the Local Board of Health by the City Solicitor on the question of the protection of the City's water supply from pollution, and having pointed out that such report states that the Corporation has power under the Water Works Act to protect the raw water for a distance of three miles above the intake pipe on the Ontario side of the river, your Committee recommends that the City Solicitor be instructed to notify the Municipalities within the three-mile limit on the Ontario side of the river that the Corporation will prosecute in accordance with the Act in any cases of pollution of the City's water supply; also that notices be inserted in the press that the City will take action against any offenders in this matter." (City of Ottawa 1916, pg 74).

In this case, the City Bacteriologist, Mr. J. Race provided direction to the City towards the law which would in turn grant power to the city and another expert (the City Solicitor) to pursue the use of the law on the behalf of the citizens for the protection of their health over concerns with the environment. However, in this case it was a concern over a known problem, there were many unknown problems with the technology during this period, that experts did not know about until much later. An example of this would be installing lead pipes because they were affordable, rather than the more expensive alternative(copper piping) during this period. The limited scope of the problems such as the piping or upstream influences and others during this time period, along with the trust in experts to make the right decision did contribute to many future problems. In this case, as new technologies were implemented that were not yet properly tested by experts, the problems that would come were often considered a part of the unknown and a risk for the future. This kind of trust (as has been shown) was put into experts and was a common practise for a modernizing City during the early modern period. Often case, the reason this kind of trust was invested in experts such as the City Bacteriologist, City Health Officer, and City Engineer, was because the problems they presented were defined too narrowly with solutions that seemed both logical and easy to implement such as the use of the Water Act. In return for these quick solutions to narrowly defined problems, the Ottawa River quickly became a release valve for future problems even though this behaviour was illegal and could have been prosecuted. However, this would prove difficult for many other centers downriver who lacked the power and influence that the City of Ottawa had. For during the early modern period larger and growing centers had priority over others and smaller centers were seen as lesser factors in the grand scheme of events.

5.4 The present model for the Ottawa River's use versus the past model through Expert Opinion:

The early modern period established many of the problems that the City of Ottawa is having right now withurban infrastructure, sprawl and the City's use/situation with the Ottawa River. For example, views from experts had been used in the past to first define and justify expansion with a narrow focus towards future problems.Whereas now, expertviews or 'opinions'are used to provide solutions to the limited thought and decisions made by past experts.These opinions are also used to provide views that help exclude or ignore through political structures the Ottawa River as a natural sphere of influence. The present situation also provides an exampleof the limits of past infrastructure from design to its implementation as well as how these limited infrastructures such as the wastewater and regular water systems arbitrarily disregard the environmental sphere of the Ottawa River in favour of the social sphere of the City of Ottawa. To explain this further this section will now draw upon reports from the present period 2000-2012 (the 'Age of Environmental Consensus & Economic Crisis') that take into analysis opinions drawn from the early modern period of 1910-1920 (the 'Age of Engineering Infrastructure') versus the present concerns of maintenance, design and limitations.

Reports from the present, tend toexpressmore scientific policies thatheighten the position of experts andhelp explain the limits of the existinginfrastructure due to its past influence. Several examples of this can be found in a wide range of reports published by first party and third party contributors for the Ottawa River and the City of Ottawa. An example is the *Surface Water Quality Program, Regional Facilities Environmental Effects Monitoring Project, Preliminary Study of Ottawa-Carleton's Water Purification and Wastewater Treatment Plants* report from 2000. Within this report the City of Ottawa's urban experts (Engineers, Scientists, Urban Water Specialists, etc) have highlighted numerous past designs found within the existing structure to attain fresh clean water that present potential risk in the present (such as the need for more chemical compounds during the purification process). As well, by addressing these past designs, they offer reasoning as to why more chemicals in the present need to be applied to the system to remove potential risks, such as suspended solids from the River (City of Ottawa 2000, pg 4). In doing so, they attempt to provide justification for the present system and its attempts to negate or manage risks versus the past system. An example of this would be when they explain that Aluminum

Sulphate must be used "to remove impurities from the water by making particles in the water clump together so that they will precipitate from the water in the settling basins" (City of Ottawa 2000, pg 4) versus the past use of chemicals like Chlorine or hypochlorite lime where no impurities are removed (City of Ottawa 1910, pg 681). In this case, the impurities range in values from suspended solids like "silt, leaves and other organic matter" that can affect the nature of pure water for the citizens (City of Ottawa 2000, pg 5). On top of this, it is understood that using aluminum sulphate is both harmful for aquatic life and human life. However, the use of aluminum sulphate is required, for it acts as a chemical compound that removes further unwanted elements from the river water during the purification process. According to the City, this occurs when the chemical compound is combined with the suspended solids in the river water during the purification process, which is then deposited directly back into the river through backwashing (City of Ottawa 2000, pg 5). By doing so, they remove the risk to the human population by using the River again as a valve for release with the present system to negate any risk to public health. In this case, this is done at both water treatment facilities located on the map below and shown in *Figure5.5*.

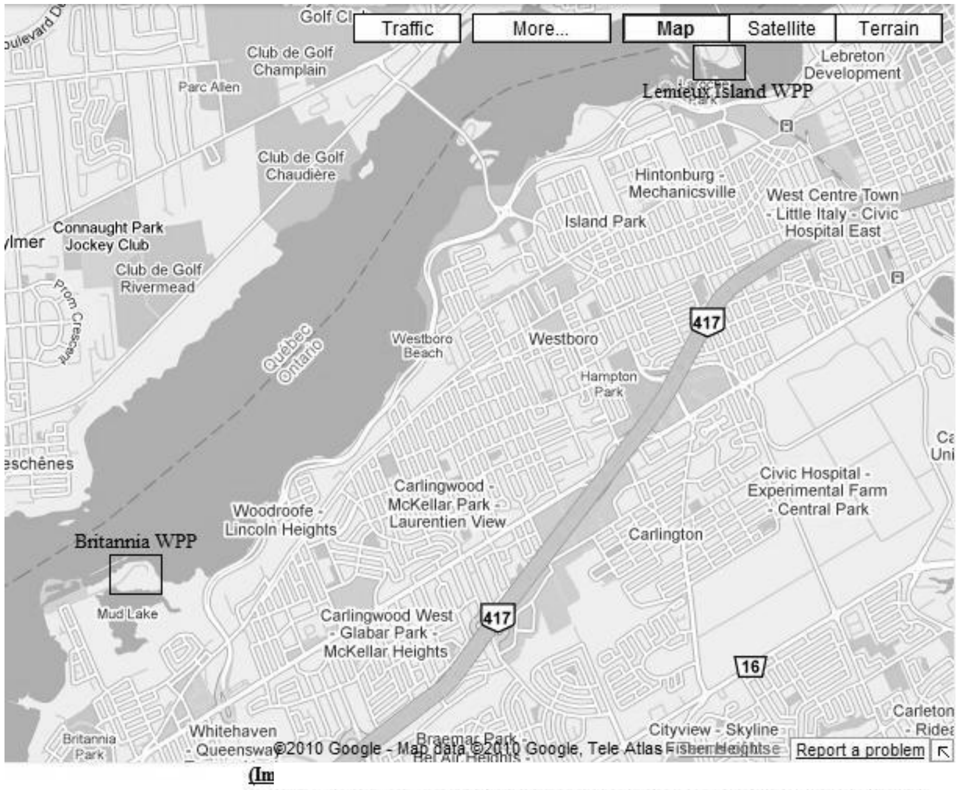


Figure5.5- 'Location of Water Treatment Plants in Ottawa' Retrieved from Google Maps - March 19th, 2010

Both facilities shown on the map above in *Figure5.5*are developments of the early modern system (especially Lemieux Island) and over the years have been expanded upon to reduce the risk of elements getting in the water. The process of backwashing is considered better for Lemieux Island by experts versus Britannia because "the water flows more rapid around this area so there are very little risks to wildlife and vegetation" (City of Ottawa 2000, pg 21). As such, the City's experts consider the risk acceptable for Lemieux Island and in this case are less concerned with the problems related to the production of treated water. However, these are not the only options positioned by experts within the reports.

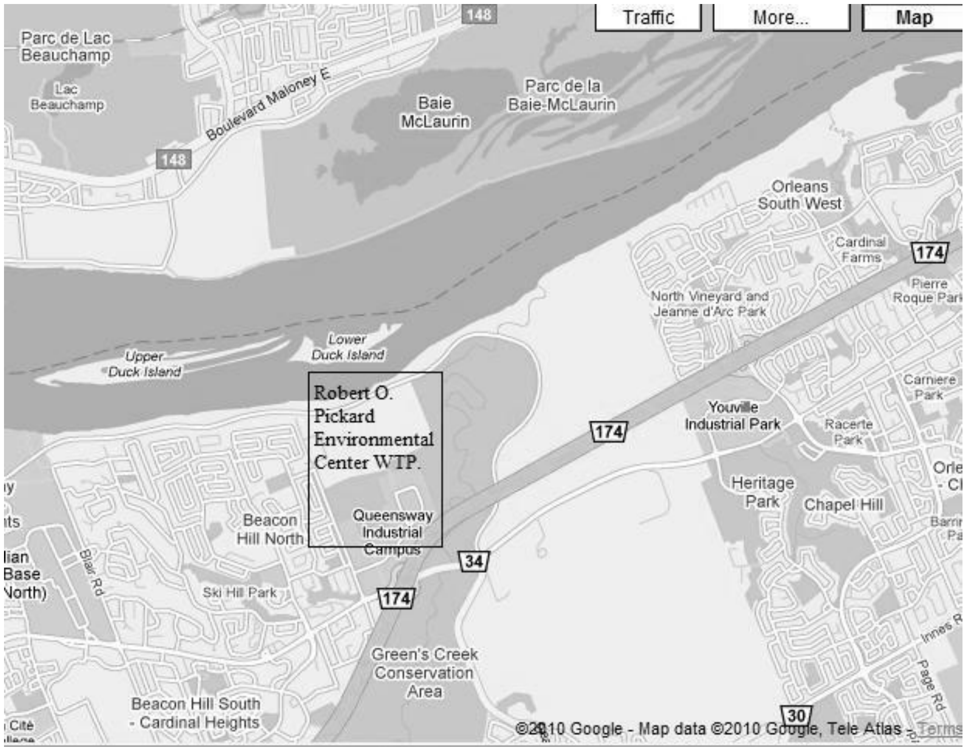
Other factors that are considered within the reports are "the use of chemicals within laboratories and diesel powered generators that may leak/contain petroleum by-products or polycyclic aromatic hydrocarbons (PAH's) into the river" (City of Ottawa 2000, pg 5). All of these chemicals and methods are considered as necessary measures to ensure the protection and quality of the water produced by the City of Ottawa's facilities that in turn return unwanted wastes to the river mixed with slight toxic elements like chlorine and aluminum sulphides (City of Ottawa 2000, pg 4). Through this same form of analysis by experts, the systems in place are viewed ascomplex and tightly coupled where leakage, spillage and the release of chemicals like PAH's and aluminum sulphide are considered acceptable risks and common normal accidents. Even though these chemicals are also highly toxic in small forms, PAH's such as Naphthalene are considered in the reports by experts as "moderately toxic to aquatic life, whereas Phenanthrene is more acutely toxic and a concentration of 19mg in a litre of water will kill of 50% of largemouth bass in 96 hours" (City of Ottawa 2000, pg 5). As such, the experts present this information with clear views of what it can do, but is accepted as what Beck would state as "calculated risks" or as Perrow would state normal accidents of production (Beck 2007 pg 123; Perrow 1999, pg 26) . In the case of risk, these type of problems are positioned through risk management to be calculable and then treatable if considered severe enough (Beck 2007, pg 123). For example, the use of chemicals that are knowingly toxic have been calculated and explained by the report to only impact the area designated as a fallout zone (City of Ottawa 2000, pg 5). On the same token, these processes that can cause harm to local species within the River, have been calculated through risk management by experts based upon the probability of death being caused due to exposure within the designated fallout zone. For example from the research, the impacts upon Large Mouth Bass near Britannia Purification Plant are reduced through environmental impact studies based upon proximity to the plant of the Bass populations spawning grounds and location of the filters, where the City of Ottawa points out "that only a small percentage of aluminum sulphate ends up in the river from the backwashing process" near this location(City of Ottawa2000, pg 5). Furthermore, the studies that are conducted upon the effluent like the one below titled "*Table 5.6: Benthic Invertebrate Sampling for Britannia Water Purification Plant*" (City of Ottawa 2000, pg 29), are meant to show that over a distance the effluent's effects are reduced to show a decreasing trend/impact upon the river's ecology or in this close improving some conditions for creatures like Amphipoda's (freshwater shrimp).

Table 5.6: Benthic Invertebrate Sampling for Britannia Water Purification Plant

Organisms	**Near Field**		**Far Field**		**Reference**	
	Number of Species	**Number of Organisms**	**Number of Species**	**Number of organisms**	**Number of species**	**Number of organisms**
Annelida (Leeches and worms)			1	2	3	5
Nemertea (ribbon worms)			1	1	1	15
Platyelminthes (flatworms)					1	5
Gastropoda (snails, slugs)			4	6	7	162
Pelecypoda (mussels and other bivalve molluscs)			2	55	2	15
Amphipoda (freshwater shrimp)	1	3			1	42
Coleoptera (beetles)					1	1
Diptera (flies, mosquitoes)			1	1		
Trichoptera (caddis flies)			6	17+	6	7+
Totals	**1**	**3**	**15**	**82+**	**22**	**252+**

With this chart, the City of Ottawa's experts attempt to show a reduction in the risks associated with the production of water, articulating the view of this situation as being less detrimental to the environment. Through this position, experts (scientists, etc) show that the purification process is adequate towards its production requirements and commitments towards the environment. Furthermore, these accepted risks would be explained by Perrow as socially accepted errors to bring what society needs (Perrow 1999, pg 26). However, it is not in the sense that the City of Ottawa's experts are stating that normal accidents like releasing chemicals into the river through backwashing is acceptable. What they are stating is that these accidents occur because of the nature of the system itself.By using probabilities and calculations of risks the experts are attempting in some instances to present that due to the limits with both infrastructure and design the plants must proceed with these processes in order to operate for the water purification process Due to both the complicated nature of protection of the citizens health and the need for this type of infrastructure it presents a complicate situation for this side of the equation. However, this can also been seen with regard towards the wastewater system as well within the reports.

The wastewater system as explained in the report has been designed through the years with the use of combination sewers and stormwater ways (developed in the early modern period) to pump effluents (biosolids, other wastewater) towards the Robert O. Pickard Wastewater Treatment plant located near Orléans, Ontario (City of Ottawa 2000, pg 15) as is shown in *Figure5.7*below.



(Image retrieved from Google Maps on March 19th, 2010. http://maps.google.ca)

Figure5.7'Location of Wastewater Treatment Plant in Ottawa' Retrieved from Google Maps - March 19th, 2010

The alternative as proposed by the report, in times of power outage or other extenuating circumstances, is to pump the effluents directly into the Ottawa River as a normal outcome or acceptable risk to protect the infrastructure's limited carrying capacity as well as the treatment plant's capabilities to handle the more than the maximum normal return (City of Ottawa 2000, pg 13). This limit in turn comes into play more often today than in the past. In the past when the infrastructure was first created it was designed for a carrying capacity or population of a few hundred thousand people (City of Ottawa 1915, pg 10 - 'Main drainage report'). Today this carrying capacity has remained relatively the same as the past and the population has bloomed long past its original design. As the infrastructure was designed with limits and built up over the years it has become expensive to maintain or propose solutions to remedy situations.

Another report by the City of Ottawa, the *Water Purification Plant Waste Management, Final Process Selection* from 2002 highlights some of these costs for alternative methods to prevent seepage into the river (City of Ottawa 2002, pg 1). It also highlights the costs and planned options as well as the direction the City took to implement the suggestions from the City Engineer's report thatwas designed to attend to the concerns from the Ministry of the Environment and Energy (City of Ottawa 2002, pg 1). For example, the best plan that was titled 'Plan C' was to dewater both water purification facilities (Lemieux and Britannia) with regard toeffluents produced and estimated at around $41 million to implement by 2004. The purpose of dewatering or removing water from biosolids, and suspended solids, was to "prevent the need for backwashing six times a day at the facilities and instead have the suspended solids dried then removed and taken to the landfill" (City of Ottawa 2002, pg 11-12). The reason for this was that the filters at the facilities were only catching "on average 17% of the solids generated by the water treatment process"(City of Ottawa 2002, pg 11-12). In this case, it meant that a majority of the bio-solids and suspended solids, such as Aluminum Sulphide were still being released back into the River (City of Ottawa 2002, pg 4). The report also explained that "the release of aluminum sulphide into the River was linked to causing Alzheimer's" by medical experts from the Ministry of Health through consumption during recreation (City of Ottawa 2002, pg 4). However, the City went with Plan B that was proposed within the report by the City Engineer. Plan B in this case, was to discharge effluents through the already complex and tightly coupled sewer systems to be later "treated by the Robert O. Pickard Wastewater

Treatment Facility at a cost of roughly $36.4 million" (City of Ottawa 2002, pg 10). Plan B was also designed to discharge a mixture of clean water mixed with effluent at roughly a ratio of 75/25 to the Ottawa River (City of Ottawa 2002, pg 10). Although Plan C (that was also proposed within the report by the City Engineer) was the best plan environmentally speaking, the cost and politics involved limited the political willingness of the City of Ottawa's politicians to implementit. Forin this case, the result would have been an increase in taxation to pay for the costs of the plan which would have translated into a 'negative' for the political careers of those involved. As Westphal points out,it's difficult for politicians to move forward towards urban renewal or the fixing of past errors if it involves increased taxation (Westphal 2008, pgs 793-795). The politics of this situation may have produced some action as well as reduced social concern with the Ottawa River being contaminated by effluents from the treatment plants, it still did not resolve the original problem, which was "to protect the Ottawa River from contaminates like Aluminum Sulphide".Instead the River was sacrificed in favour of monetary savingsdue to the limits of the present infrastructure and cost to implement a realsolution (City of Ottawa 2002, pg 1). This is not entirely the fault of the City orexperts as social concern and limits to present infrastructure created a need to find a partial solution. In many ways this is the present and same situation for other aspects of the Wastewater system as previously explained. For example, the Storm water ways were constructed in the early modern period of 1915 and have been in use ever since, the same could be said for the sewers and the water main lines, which according to another report the *A, B & C Lines Environmental Assessment Report* from 2001 were constructed also in 1915 to 1950 (City of Ottawa 2001, pg 1). As a result, these systems are significantly aged and costly to replace as the infrastructure is hard to access. However, this does not mean that the City is not aware of these problems with the infrastructure, as they eventually came up with another three plans to deal with the situation.

5.5 The Present Situation - Experts and Politics

As was explained in Chapter two, the City of Ottawa has recently been forced by the Ontario Environment Commissioner to go through with another plan of action towards the Ottawa River that has been titled "*The Ottawa River Action Plan*" (City of Ottawa 2010, pg 1).Originally, this plan was to address the growing concern regarding the "bacterial contamination that follows rainfall events" within the River (Miller 2009, pg 1). That same report explained that these events were happening due to the age of the infrastructure which was described as being developed "in the early times" where it was "deemed necessary in the interests of public health to build sewers to transport human sewage from outlets and drains (sanitary sewage) combined with manure charged rainwater runoff from the streets (stormwater) out to the nearest river or large body of water (hence the term combined sewers)" (Miller 2009, pg 1). As well, the report described how the system changed when knowledge and technology provided ways to offer interceptors to allow for sewage to run to a sewage treatment plant (as is presented earlier in this chapter) (Miller 2009, pg 1). However, to tackle the increased volumes generated by major events, overflows were designed into the system to allow for discharge directly into the river (Miller 2009, pg 1). These events were increasing in frequency and defined as "requiring change" to meet the guidelines set by the Provincial Government (Miller 2009, pg 6). Therefore, through the Environmental Services Department, the City positioned three plans they could take towards the future.

The first plan titled "Option A" by the Environmental Services Department (experts) was a quick fix plan that would primarily address concerns of the provinces at a cost of approximately $40-$60 million dollars over the next five years (City of Ottawa 2010, pg 3). The second plan title "Option B" was to engage in a 17 step project plan, that was set to occur over the next five to six years and up to the next 25 years at a cost of $95-$140 million dollars (City of Ottawa 2010, pg 3-4). Whereas, the third option from the City of Ottawa was titled "Option C that would virtually eliminate overflows at a cost of $1.3-$2.2 billion over 30-50 years" (City of Ottawa 2010, pg 4). These options were position by the Environmental Services Department and the City Engineer to the City Council and Mayor at the time (Larry O'Brien). After careful deliberation the City chose the plan it felt would best resolve the situation even if it was a temporary resolution.

The option chosen by the City of Ottawa was "Option B" which was approved for the next five to six years at $251.64 million dollars (City of Ottawa 2010, pg 1). This option would start being implemented by 2009 (as is shown in *Table 5.8*) and continue to be implemented throughout the years to attempt to resolve the errors with the combined sewers.

Table 5.8- ORAP Financial Requirements

	5-year ORAP ($ million)				**2014 and beyond[3]**
	2009	**2010**	**2011-13**	**TOTAL**	
Total ORAP pe	$54.13	$23.86	$173.65	**$251.64**	$11M/yr
Less					
Ottawa River Fund Approved in 2009	$19.75	$31.25	$88.0	$139.0	
Other Works in Progress (WIPs)	$34.38			$34.38	
Costs not previously budgeted		($7.39)	$85.65	**$78.26**	$11M/yr

Table 5.8 "ORAP Financial Requirements" (City of Ottawa 2010, pg 7)

As per Chapter two, each fiscal budget (shown above per year) is to be completed through the 17stages of the project plan. In this case experts within the department for the City of Ottawa drew up the plan that was presented to the City Council to both favour financial concerns and favour the response required to the Province where it was stated that the plan was to "achieve and sustain compliance with regulatory requirements" (City of Ottawa 2010, pg 14). However, by taking the middle ground in this case, the plan does not completely resolve the problem, it simply provides short term solutions to a problem that will continue so long as the City continues to expand. In this case the City's politicians took the middle ground to offer a solution that would satisfy the requirements, but not take thorough action that would involve raising taxes. In this case Larry O'Brien used this plan to appease the higher tiers of government and show action which allowed for the relations of power and politics of the situation to be temporarily resolved.

As a result it is easier and common practice for experts to suggest as in many of the reports to push the excess off to the Ottawa River in times of extenuating circumstances. In this sense, the original design to ignore the river from the early modern period stays in effect due to cost and need to maintain public services. The river, although it has become slightly more presentwithin the reports, is still excluded due to the original reasons as to protect the health of the Citizens of Ottawa (City of Ottawa 2010, pg 1).

5.6 Conclusion:

By using science,expertsin the past were able to enhance their power and position. In doing so, they were able toidentify solutions that would help improve as well as protect the health of the citizens through the construction of infrastructure that wouldutilize the Ottawa

River as the primary source for clean water extraction and wastewater returns. Whereas today, experts are hampered by the decisions made in past and are unable to resolve present situations without resorting to:

- either laying blame on past expertise for the problems occurring now due to design of existing infrastructure; or
- by increasing taxes to cover the costs of fixing these problems caused by the limits of the present infrastructure.

In both cases, (past and today) the Ottawa River has been sacrificed by experts as well as the municipal government, who have presented information as well as knowledge to show that they are in favour of protecting the health of the citizens, as well as having access to an affordable source for clean water. By doing so, they have positioned the Ottawa River in a supplementary position towards the City's citizens and infrastructures needs. However, in the present, the infrastructures negative influences are beginning to be questioned increasingly by both the citizens as well as the various higher tiers of government who are seeing the environmental impacts from wastewater seepage due to the infrastructure design as no longer being acceptable.As such, solutions to these problems are being required to be found and dealt with. However, even in these cases experts who may not have the same unquestionable power they once had, have managed through a combination of strategies to maintain with the politics of infrastructure the basis to keep plans that are cost effective and temporary. In this case, the present findings shown can imply that the City is still going to be limited to its approach to these problems as time goes on.

Chapter Six: Discussion of the findings: how expertise has impacted the outcome for the Ottawa River.

6.1 Introduction:

This chapter presents a discussion of findings to help explain further the City of Ottawa's strategy towards the Ottawa River. It also seeks to explain how the findings are important for sociology and how sociology can explain them further to articulate why the Ottawa River has been treated this way.

6.2 Expertise, historical analysis and a discussion of the present versus the past:

Today's experts are constrained by the earlier decisions and mindsets staged in the past. As the systems continue to become strained due to population growth, experts have adopted a number of coping strategies to resolve the eventual issues that impact infrastructure. These notions include the mentality of "Fix or repair daily" versus fix for the long-term and provide a proper solution (Urban Dictionary online, 2012). For example, to develop the present *Ottawa River Action Plan* for 2010, much of the information regarding the background of the plan was based upon the earlier reports and designs put into place by Engineers from the early modern period like Mr. Allen Hazen (City of Ottawa 2010, pg 1).

Mr. Hazen's past reports for infrastructure established events that would result in the present infrastructure and secondly the limitations that cause future experts to become stuck due to the past. For example, it was during that particular point of time (the early modern period of 1909-1920) that Mr. Hazen was selected by Council to procure details for the City of Ottawa, where he was "recommended as an expert, for the purpose of securing data and preliminary information relating to the proposed purification of the City's water supply"

(City of Ottawa 1910, pg 90). In turn, Mr Hazen would write a report in 1914 where he would state that:

> "the Ottawa River supply is in many respects a magnificent supply. The catchment area is large, the flow of the river is well balanced by natural storage, in innumerable lakes, thereis surprisingly little sewage pollution in the water for so large a river, the water is soft, it is close to the center of the city, and it is cheaply delivered under pressure by water power" (City of Ottawa 1914, pg 1).

Furthermore, Mr Hazen, would also state in the same report that:

> "the sewage pollution is small in comparison with that of other rivers, but it is already sufficient so that the water cannot be used in its raw state with confidence, and is steadily increasing. The best way to purify the present supply is to build filters on Lemieux Island" (City of Ottawa 1914, pg 1-2).

As such, Mr. Hazen's report would establish for experts an event that could be considered 'path-dependent' as it acts as a key event that is of a "deterministic property, which shapes the events to come" (Mahoney 2000, pg 507). In this case, Mr. Hazen established the dominant view of the river that would guide the City's approach to this resource: that location and proximity of the Ottawa River would act as both excellent source for pure water and while pollution was considered a factor, the primary concern was over how to remove it for the health of the citizens. In this sense, future reports would have to consider these factors and build within them similar focuses. For example, within the present report titled the *Ottawa River Action Plan*, one of the key focuses is related to health where the plan is stated as being necessary for the purposes of optimizing "recreational use and economic development of the river, with a focus on reducing beach closures" (City of Ottawa 2010, pg

3). In this case the River is treated as being of both an economic value and social value. However, the primary reason is still related to health because the beach closures were presented as being due to the influence of E-coli caused by the combined sewers (City of Ottawa 2010, pg 13). In this sense, the combined sewers also act as a relation to past experts designs.

The combined sewers and interceptors were also developed in the early modern period by experts to prevent flooding, backups and other issues within the City. The events that resulted in their development have become events that have constrained the experts in the present as they are still required to find solutions to prevent flooding and protect the citizens. Experts in the present due to those original developments are now tasked with providing resolution to what was considered originally a solution in the first place. In this sense, these events are also 'path dependent' of the early modern period of 1909-1920 to the present period of 1999-2012. For infrastructure like combined sewers and interceptors, such as the Rideau River Interceptor that was propositioned by Engineers R.S. and W.S. Lea in 1914 (City of Ottawa 1914, pg 411) and implemented in 1915, were developed during the period of 1909-1920 to prevent risk to society. However, in this case, these developments have resulted in a chain of "temporally ordered or causally connected events (Mahoney 2000, pg 509) that have resulted in the present situation and the "need to prevent overflows from occurring" (City of Ottawa 2010, pg 13). Events like the development of interceptors and combined sewers present the primary concern for present reports as the offshoot to protect the system from potential catastrophe is "to engage in an overflow" which acts as a normal accident (Miller 2009, pg 1). In this sense, experts in the present are constrained by the limited design and now have to find a solution around the overflow which can prove more costly and politically toxic.

In turn, the views by experts have also been stymied by political decisions related to cost. However, cost and politics unlike the development of the infrastructure are not path dependent events, as such they influence both the past and the present periods equally, just as much as health and protection of the citizens do. The decisions though within the past related to cost can be considered path dependent as they do create situations for the present and future. For example, cost in the past resulted in Lemieux Island and the Ottawa River being chosen through expert opinions coming from Mr. Hazen, Archibald Currie and the Bell Filtration Company versus the proposed Thirty-One Mile Lake plan from Dr. A.C. Houston and Sir Alexander R. Binnie. Where in this case the cost was articulated as being only "less than one and a half million dollars" versus the "Thirty-One Mile Lake plan at a cost of eight to ten millions of dollars to the City of Ottawa" (City of Ottawa 1913, pg 412). As such, these past decisions have placed serious constraints on both the experts and politicians of today.

As well, cost has also produced situations that have resulted from the past into the present positions for politicians to consider moves of a NIMTOO strategy, where political pains result in little visible gains for the future (Murphy 2009, pg 269). An example of this could easily be the present *Ottawa River Action Plan* and choice to go with "Plan B" at a cost of $251.64 million for the next five years, versus "Plan C" at a cost of $1-2 billion (City of Ottawa 2010 ,pg 3). In this sense, like many plans in the past such as the plan to develop a new source for water purification in 1910 by Mayor Charles Hopwell (which was only implemented in 1913-1914 by Mayor Taylor McVeity), the present plan attempts to only resolve a few problems within five years, but not the complete problem which is left for many generations in the future to deal with (City of Ottawa 1910, pg 1). In this sense, the present plans are stymied by the decisions of the past and reliant upon the original infrastructure's cost as well as designed limitations.

The original infrastructure’s limits act as a path-dependent event as well, as they are categorical of events that are both temporal and characterize historical sequences with deterministic properties for the future (Mahoney 2000, pg 507). For in the case of the City of Ottawa, the limits of infrastructure are once again a development of the early modern period where technology, knowledge and a limited view of society resulted in the development of the original infrastructure that has resulted in the present circumstances for experts today. Events like the management of risks that are more common today were not considered as often in the past and the size of the city as well was not considered. For example, the original infrastructure of Ottawa during the early modern period was positioned by experts to be developed for a population of around 200,000 to 250,000 people, whereas the present system is handling a population of a million or more people. Furthermore, the development of the location of the facilities and the systems like the combined sewers or "trunk" sewers which have been described as "running along the river" (Miller 2009, pg 2) have limited the approach as well of the present experts. In this case, this is due to the fact that the majority of the sewers were designed and implemented without a waste treatment facility to go to in the past (Miller 2009, pg 2). Many of the combined or trunk sewers were implemented to act as a valve for the City to allow for the excess to be combined and dumped directly into the river. The reason past experts had proposed this was due to "the urgent necessity for drainage facilities" to prevent "property damage" and provide "surface water drainage by direct drainage into the Ottawa River for the health of the City" (City of Ottawa 1914, pg 471). However, in doing so, the past experts constrained the design by preventing ways to properly incorporate the one waste treatment facility. As well, the fact that there is one waste treatment facility for the City of Ottawa is another issue that limits the approach of present experts who must rely upon the facility to incorporate their present designs.

6.3Probable reasons for why the Ottawa River has been ignored:

The present designs of experts have been limited overall by the past decisions made within the early modern period. Those decisions created the original strategy for the City of Ottawa in an age where expert's views were often accepted without question v. As such, the present strategy has carried with it the legacy of concerns over health and concerns over cost. These concerns have transitioned from the past to the present, to make experts constrained to carry on the cycle by pushing them forward over concerns with the actual river itself. Such examples that have been listed thus far include the economic and social concerns with present beaches within the summer as well as the potential for outbreak of E-coli.

In this sense, the environmental degradation of the Ottawa River has not been a priority for the City, whose infrastructure in fact depends on polluting the river to maintain its viability. For example, costs associated with bringing the environmental sphere into the economic are presented by experts as being socially taxing for several reasons. Firstly, to include the Ottawa River, the City of Ottawa within the present would have to make up for the errors within the past to select a strategy that would over-ride the creation of standardized infrastructure. This process would have to allow for an overhaul of the existing infrastructure to create a system that could be easily adjustable. However to achieve this, the cost would be quite high and is thus articulated by experts as unattainable. In this sense, this is why for the present, the City of Ottawa choose Option B over Option C which was viewed as the best plan that "would virtually eliminate overflows at a cost of $1.3-$2.2 billion over 30-50 years" (City of Ottawa 2010, pg 4). Secondly, to include the river, this would mean taking accountability for processes that cause harm to the river (water purification, wastewater, storm water, etc). Although this might appear rather easy to do, it would also be highly difficult considering the current situation with the mix of infrastructure and population as well as size of the City of Ottawa, along with the age of the infrastructure (use of combined sewers from the early modern). The third probable reason for being ignored is the actual size of the Ottawa River which allows the City of Ottawa to offload a majority of its environmental impact to other regions and municipalities.Although, the Ottawa River appears in many of the diagrams in this thesis with the environment as a smaller element, it is actually much more vast and contains many more regions than just the City of Ottawa. Not only has this been articulated by experts, it had been set forth by experts in the early modern period like Mr. Hazen who stated that the Ottawa River is vast and that "with the flow of the river is well balanced by natural storage, in innumerable lakes"(City of Ottawa 1914, pg 1). This has been continued to the present where experts still position the Ottawa River as vast and described in full detail as being "1,271 km in length; the watershed 146,222 km^2 in size, with a flow rate that is the sixth largest in Canada" (City of Ottawa 2010, pg 12). Therefore, the difficulty to include would mean attempting to include the other different regions within this process and for the City of Ottawa to absorb the costs of fixing the environment for even the other regions.. As this would also be highly costly, and socially awkward it creates a situation to allow for the river to continue to be ignored by the City of Ottawa.

6.4 Conclusion:

This chapter has sought to further explain the findings by providingsome facts,and details to help explain the position of the Ottawa River as being ignored as well as howexperts have positioned this as the primary strategy for the Ottawa River's use. It has done this in part, by discussing the findings and presenting probable reasons for exclusion. In truth, this chapters presents these details in a manner to show the primary influence of experts who remain key to the research overall.

Chapter Seven: *Conclusion*

7.1 Introduction:

This chapter summarizes the research problem, the findings, and the recommendations that have been presented by this thesis and begins by a review of the statement of the purpose of the research to assist in providing a summary of the findings. This chapter also will identify other areas that can be looked into for future research upon this subject.

7.2 Purpose of the Research:

The City of Ottawa is in the process of updating urban infrastructureand has recently planned to update the primary water mains and wastewater lines to compensate for the presently over taxed system that is resulting in normal accidents during peak periods. The City of Ottawa, however, has not to this date proceeded or achieved a significant amount of urban infrastructure renewal for the water infrastructure for the most part. The key question motivating the research was *"How has the Ottawa River become removed/ignored from the City of Ottawa's strategy for development from the early modern period (1909-1920) to the present period (1999-2012)?".*

7.3 Research Findings:

The City of Ottawa's strategy towards the Ottawa River was quite clear from the early modernity onward to the present period. It has primarily classified the Ottawa River as a resource to be used for water and wastewater, with secondary functions for recreation and considered after the health of the citizens as well as cost. As such, the City of Ottawa has classified other resources of water such as the Rideau River to be protected due to the primary factor of recreation to have the main waterway of the Ottawa River used as the all sourced depository. The City has also pushed through expert opinion the idea of protection, but has not acted much upon this opinion within the recent years. Instead it has pointed out the problems with the existing infrastructure relative to age, design, and other facets, but has yet to act to fix these problems mostly due to the heavy economic burden and costs associated with fixing the situation. The City's strategy in turn has become a guide towards expansion, but not a guide to fixing the current problems with water and wastewater infrastructure.

7.4 Why Water is important

With the growing trend for society to be concerned over the quality of our water and with events like Walkerton on the mind of many Canadians, urban water supplies had started to become questioned by society for quality reasons. However, in the case of the City of Ottawa, urban water supplies as shown in this thesis have remained top notch for the most part due to the role of experts who have strived at great cost to the Ottawa River to protect the quality of water for the Citizens of Ottawa and the surrounding regions. In this sense water is not only an element of health, but it has become an element of an environmentally conscious society where we all understand how crucial clean water is not only for sustaining our lives, but as a resource we can use on a daily basis.

In many ways the opinions of experts, such as health officers and engineers have illustrated the importance of societies need for water which has only over the years since the early modernity become more crucial a subject for society. In this sense we recognize water, waterways and other sources of water for a variety of purposes like consumption, recreation, transportation and a source for food. However, we have also come to see that water is important for our continual advancement of society at the cost of many sources of water like the Ottawa River. Although this thesis looked at many aspects about water, its primary focus was how the City of Ottawa had ignored/excluded the Ottawa River from its strategy, even though in reality the reason for this is because its exclusion is due to the needs of society to have fresh water versus the needs of the river.

7.5 Why Experts are important

Experts like many members of society are important as they establish and develop opinions for our government based upon public views. In the case of this thesis, experts play a crucial role as influencers who present information they gather from various sources to provide the City of Ottawa Council with options and possible outcomes that could occur. In this sense, experts offer dialog and opinions that can shape how our society is developed, how structures are built, how infrastructure is designed and put into action. For the Ottawa River, experts have acted as the primary definer of the river's role by presenting the river as both a source for water, and a source to handle our wastes due to its size and carrying capacity which was defined by leading experts like Allan Hazen. Experts in all walks of life have provided information, knowledge, services, opinions, values, and a variety of other positions for society which have changed the face of our world. Their roles have become the positions of power which influence how society see's the world and understands.

7.6 Recommendations:

The best possible recommendation to be offered is to increase the financial burden (costs, taxation, etc), to bring the Ottawa River or the natural sphere in this case closer to the social and economic. To do so, the City of Ottawa would need to build improved systems, remove the combined sewers/stormwater ways or build another waste treatment plant to reduce the burdens that are causing the release of wastewater into the Ottawa River. However, this would mean massive expenditure to prevent ecological problems and would prove difficult for politicians to as well as experts to recommend as it could kill a political career or term in office. As such, the probable solution is not likely to occur until it becomes the necessary solution.

7.7 Further Research:

Not only does the recommendation presented within this thesis create another area for further research. The primary problem can also be looked at from many other different angles and time periods to provide further vantage points. An example, would be looking at the influences of urban sprawl further by conducting research into the impacts of amalgamation such as when the City of Ottawa merged with its suburbs (Orleans, Kanata, Nepean, Barrhaven, etc) or by looking at the City of Ottawa's design prior to the early modern period which resulted in eventual urban sprawl. Furthermore, the Ottawa River was not only influenced by the City of Ottawa, it has been influenced by the various other townships and locations upriver along the tributaries and down river. Further, one could research the influence of the Pulp mill industry, its history with the loggers which developed Ottawa and the fact that some Pulp mills were responsible for municipal water supplies. As well, other ecological factors that are present such as the influence of the Chalk River Power Plant's tailing ponds (Government of Canada, 1999) leaching into the tributary of the Ottawa River and the radioactivity of its tailings upon river ecology could even be considered as a subject for further research.

Overall, there are endless possibilities for research that could be explored further when considering the issues that are presented within this thesis. They could be looked at a variety of angels, explored through various topics and defined in several different ways.

7.8 Concluding Statements:

Wastewater treatment and water purification are crucial processes that allow for societies like the City of Ottawa to continue to thrive and grow. Water is life and a commons that we all take advantage of on a daily basis. As a subject, it can be difficult to approach and will continue to be a difficult subject for the future to deal with for both City Council and experts as the Ottawa River will always in turn be at the heart of this debate. Although many solutions in the present have been proposed, the difficult part will be to put these infrastructure solutions into action in time to compensate for the various new problems that will come in time. Therefore, as the City of Ottawa continues to grow, so will the demands upon the Ottawa River. Which in turn means that at some point, someone of authority and who is empowered by the public to make the necessary investments will absolutely need to drive an initiative to bring the environment back into the social and economic sphere sooner than later. The longer they wait to make the necessary significant investments, the costs to do so will only increase over time as materials and labour costs increase which is a normal trend. This trend will create risk in that the project will always appear to be too expensive and out of reach. These changes to the infrastructure will be critical to protect the public health and welfare of the current generation and provide a more prosperous future for generations to come.

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